



How emerging technologies impact companies' business models – the case of AI in the telecom industry

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Abstract

Title: How emerging technologies impact companies' business models – the case of AI in the telecom industry

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The transformational potential of emerging technologies can be very attractive for a company, but the uncertainty associated with them can easily discourage investments. In this dissertation, the business model stress test method is presented and adjusted to be able to analyze the future impact of emerging technologies on companies' business models, taking the case of Artificial Intelligence (AI) in the telecommunications (telecom) industry.

In order to find the most relevant industry AI applications, the telecom industry business model, and apply the method, a literature review and interviews to industry experts were performed. After the method was adjusted and applied, the type of future impact of each AI application on each business model component was identified, and the conclusion was that telecom companies should continue to invest in AI that perform network operation management, customer support operation and customer relationship management functions, while having precautions on customer's perception of AI used in customer relationship management. It was also found a mostly negative potential impact of business-to-business (B2B) clients deploying AI. This effect on the business model of telecoms is expected to make it unsustainable and requires measures to be taken from the companies.

The results from this dissertation are the founding work for further development of the business model stress test, with its replicability with other emerging technologies and industries as a fundamental question to be answered.

Key words: emerging technologies; artificial intelligence; telecommunications industry; business models; business model stress testing.

Resumo

Título: Como as tecnologias emergentes afetam o modelo de negócios das empresas – o caso da IA na indústria das telecomunicações

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O potencial de transformação das tecnologias emergentes pode ser muito atraente para uma empresa, mas a incerteza a elas associada também pode ser um desincentivo ao investimento. Nesta dissertação, o teste de stress de modelos de negócios é o método apresentado e ajustado para analisar o impacto futuro de tecnologias emergentes no modelo de negócios das empresas, tomando o caso da Inteligência Artificial na indústria de telecomunicações.

De modo a encontrar as aplicações de IA mais relevantes na indústria e o seu modelo de negócios, para depois aplicar o método, uma revisão da literatura e entrevistas com especialistas da indústria foram realizadas. Depois do método ser ajustado e aplicado, foi identificado o tipo de impacto futuro de cada aplicação de IA em cada componente do modelo de negócios, e concluiu-se que as empresas de telecomunicações deveriam continuar a investir em IA que realize funções de gestão de operação de rede, operação de suporte ao cliente e gestão de relacionamento com o cliente (CRM), tendo cuidado com a perceção do cliente à IA usada na CRM. Também foi constatado o impacto negativo da implantação de IA por clientes B2B no modelo de negócios das telecomunicações. É esperado que este efeito torne o seu modelo de negócios insustentável e pede que medidas sejam tomadas pelas empresas.

Os resultados desta dissertação são o trabalho de base para um maior desenvolvimento do teste de stress de modelos de negócios, sendo sua replicabilidade com outras tecnologias emergentes e indústrias uma questão fundamental a ser respondida.

Palavras-chave: tecnologias emergentes; inteligência artificial; indústria de telecomunicações; modelos de negócios; teste de stress de modelos de negócios.

Table of Contents

List of Tables	v
List of Figures	vi
List of Abbreviations	vii
1. Introduction	1
2. Literature Review	3
2.1 Emerging technologies	3
2.1.1 Artificial intelligence	4
2.1.2 AI in business	5
2.2 Telecommunications industry	6
2.2.1 (Telecom) business model	8
2.3 Business model stress test	9
3. Methodology and Data Collection	12
3.1 Methodology	12
3.2 Data collection	13
3.3 Emerging technologies and the telecom industry	16
4. Data Analysis	17
4.1 Stress factors selection	17
4.2 Business model alterations	20
4.3 Mapping the stress factors to the business model components	21
4.4 Creation of the heat map	24
5. Discussion of Results	26
5.1 The case of AI in the telecom industry	26
5.2 Improved business model stress test	27
5.3 The final telecom business model	28
5.4 Other findings	29
6. Conclusion	30
7. Bibliography	32
Appendix	I
Appendix I: Business model canvas from literature review	I
Appendix II: LinkedIn message to contact experts	III
Appendix III: Interview script	III
Appendix IV: Filtered telecom business model canvas	V
Appendix V: Interview summaries	VI

List of Tables

Table 1: Criteria for expert selection.....	14
Table 2: Interviewees overview.	14
Table 3: AI applications mentioned during the interviews.....	17
Table 4: AI applications selected as stress factors.	19
Table 5: Telecom business model alterations.	20
Table 6: Mapping of the stress factors to the business model's components.	22

List of Figures

Figure 1: Future challenges for the telecom industry	8
Figure 2: Six-step approach to business model stress testing.	10
Figure 3: Color scheme of the heat map.....	11
Figure 4: Overall methodology design.	13
Figure 5: Final telecom business model.	21
Figure 6: Stress test heat map.	25

List of Abbreviations

AI	Artificial intelligence
telecom	Telecommunications
B2B	Business-to-business
et al.	Et alii (and others)
IoT	Internet of Things
IBM	International Business Machines Corporation
IT	Information technology
5G	5 th generation standard for broadband cellular networks
GDPR	General Data Protection Regulation
e.g.	Exempli gratia (for example)
HR	Human resources
ICT	Information and communications technology
EAI	Enterprise application integration
CRM	Customer relationship management
OTT	Over-the-top
IVR	Interactive voice response

1. Introduction

In this growing digital world, emerging technologies bring novelty and transformational potential to the industries they are introduced in (Rotolo et al., 2015), altering the way people and companies live, work and interact (World Economic Forum & Accenture, 2017). AI is an emerging technology capable of interpreting data, learn from it, and improve on the task it is set to do (Kaplan & Haenlein, 2019), which gives the technology endless business applications. Despite these possibilities and studies suggesting AI causes cost reductions in the 40% levels (Racounter, 2020, p. 6), the technology still has not become ubiquitous, with 30% of companies not having or still planning to implement it in their operations (Brock & von Wangenheim, 2019). One possible explanation for that gap could be that emerging technologies are defined by their uncertainty and ambiguity towards the future, which makes their future impact on companies hard to predict (Rotolo et al., 2015) and thus discouraging to invest.

Surprisingly, tools that help managers and academics understand the effects of emerging technologies on companies are scarce despite their utility and importance to better decision making (Haaker et al., 2017). Therefore, this dissertation addresses this problem by answering the research question “How do emerging technologies impact companies’ business model?”. The business model stress test will be altered and used as the core methodology to investigate the future impact of AI as an emerging technology on the telecom industry. This method is used for analyzing how companies are prepared for future environments through the representation of their business model – a illustration of how firms intend to create and capture value from their products and services (Bouwman et al., 2008, as cited in Haaker et al. 2017).

The choice of AI as the technology to be analyzed was due to the still existing knowledge gap on what AI can do in the business world, with studies reporting that 37% of managers do not understand how AI works (Davenport & Ronanki, 2018), let alone its impact in their businesses. The telecom industry is the chosen industry to analyze this impact because of its interesting role as a support industry to the digital revolution of other industries (World Economic Forum & Accenture, 2017) and for being expected to take the second biggest advantage from deploying AI comparing to other industries (Racounter, 2020, p. 6).

To answer this broad research question, the methodology requires to have the industry’s generic business model and stress factors that englobe the most relevant applications of the technology. During the dissertation, the AI knowledge gap problem will also be tackled by providing an

academic background on the topic and a validated generic telecom business model will be proposed for the academic field.

The general structure of this dissertation will start by a literature review on the phenomenon of emerging technologies and AI, where it will be provided an understanding of what they are, followed by a contextualization of where the telecom industry is currently and the elaboration of a first draft of the generic telecom business model. At the end of this section, the business model stress test is presented. The following section is the methodology and data collection, where the steps taken to answer the research question are described and justified, and the data collected is presented in a structured manner. During the data analysis section, the business model stress test is applied, resulting in the validated generic telecom business model and a heat map. This map is used to answer the research question and supports the discussion of results and the conclusion, which are the final sections.

2. Literature Review

The purpose of this section is to explore the current academic and field knowledge about the key concepts needed to answer the research question. First, it is provided a basic understanding of emerging technologies and their characteristics. Then, the research deepens on one specific emerging technology, AI, and its connections to the business world are pointed out. After this, the industry chosen to explore is presented, the telecommunications, with an external analysis and a first draft of the generic industry business model. Finally, the method to interpret the impact emerging technologies have on business models' robustness is described.

2.1 Emerging technologies

The business world has long been familiarized with the concept of emerging technologies, but a consensus on its definition is still unreached (Rotolo et al., 2015). By the year 2000, Day and Schoemaker (2000) came up with the first “management-based” academic definition of emerging technologies (Rotolo et al., 2015), while discussing the most common pitfalls of companies dealing with these technologies (Day & Schoemaker, 2000). For these researchers, emerging technologies are “science-based innovations that have the potential to create a new industry or transform an existing one” (p.30). Similarly, Porter and colleagues (2002) believe that emerging technologies are solely defined by their potential to influence economically an industry in its following 15 years, and other studies simply describe them as technologies in an early phase of development, with high uncertainty and specificity of their functionality (Boon & Moors, 2008).

Therefore, and in order to reach consensus, a systematic review of the core studies on the matter was conducted by Rotolo and colleagues (2015). The result of this work was a more concrete definition of emerging technologies, where they see them as:

“a relatively fast-growing and radically novel technology characterised by a certain degree of coherence persisting over time and with the potential to exert a considerable impact on the socio-economic domain(s) which is observed in terms of the composition of actors, institutions and the patterns of interactions among those, along with the associated knowledge production processes. Its most prominent impact, however, lies in the future and so in the emergence phase is still somewhat uncertain and ambiguous” (Rotolo et al., 2015, p. 14)

From this definition, the main characteristics of emerging technologies are evident and are consistent with previous studies. The researchers' most agreed characteristic of emerging technologies is their prominent impact. It is believed that they have the capability of creating and transforming industries (Day & Schoemaker, 2000), bringing benefits to a wide range of

sectors in the socio-economic system (Rotolo et al., 2015). Moreover, emerging technologies are uncertain and ambiguous in the future. Since the technology is still not in its final stage of development, predictions can be complicated. There is uncertainty on what prediction for the future will occur, and what predictions are not being considered as possibilities.

The study by Rotolo et al. (2015) also brings to light emerging technologies as new to the domain they are being introduced, either radically new to all domains or just to the domain they are being introduced. They are also fast-growing or in other words, expanding. This expansion can be viewed in public and private investments, new products and services, the number of players getting involved in them, etc. and finally they are coherent over time, meaning they bring together research streams and communities, who work professionally together on detaching the technology from its original technologies and transforming it into a sustainable technology

Even with this concrete definition of emerging technologies, these technologies may be defined as such without fully correspond to every characteristic presented by Rotolo and colleagues. This is due to the subjectivity of their characteristics in the context they are being presented.

In order to answer the research question proposed, the analysis of all the emerging technologies on companies' business model robustness was unfeasible. For that reason, one specific emerging technology, AI, was chosen and will be deeper analyzed in the following section.

2.1.1 Artificial intelligence

Although it has been around since the 1950s (Haenlein & Kaplan, 2019), AI is still considered an emerging technology. This lasting status occurs because AI's full potential has been dormant, until the rise of recent technologies like Big Data, better computing power, and the Internet of Things (IoT), which are being the driver of AI's development (Kaplan & Haenlein, 2019). Moreover, time has made AI a broad umbrella technology, which covers many variations of itself that evolved over the years, making it hard to define what AI exactly is (Kaplan & Haenlein, 2019).

Researchers define Artificial Intelligence as programs and systems that demonstrate intelligence (Shankar, 2018), or at least show some sign of human intelligence (Huang & Rust, 2018) and behavior (Syam & Sharma, 2018). A clearer and more restrictive definition for AI was suggested by Kaplan and Haenlein (2019), where AI is seen "as a system's ability to interpret external data correctly, to learn from such data, and to use those learnings to achieve

specific goals and tasks through flexible adaptation” (p.17). Kaplan and Haenlein (2019) also categorized AI into three stages of development: below human intelligence (Narrow AI), equal to human intelligence (General AI), and above human intelligence (Super AI).

For now, super AI is a highly debated idea of artificial intelligence surpassing humans, making us redundant and general AI is expected by some to enter our lives to plan, reason, and solve problems beyond just one specific area, something narrow AI cannot do (Kaplan & Haenlein, 2019). On the other hand, narrow AI has been widely diffused (Kaplan & Haenlein, 2019; Racounter, 2020, p. 1) and it is considered the most interesting stage from a business perspective (Racounter, 2020, p. 1).

2.1.2 AI in business

Even though general AI seems to be more promising than narrow AI, Oliver Pickup of Racounter (2020) describes its pursuing as if dreaming with a Tesla, right after discovering the wheel. Narrow AI is still not fully diffused, with 30% of firms surveyed by Brock and von Wangenheim (2019) not having, or still planning to implement AI in their operations. AI implementation is frequently linked to the implementation of other technologies, working as an enhancer for them and pushing the digital transformation of the company, but it can also be the main technology, for instance, Deep Learning – a machine learning (AI) technique which learns by itself and needs big amounts of data – using Big Data (Brock & von Wangenheim, 2019).

Interestingly, the delay of companies to implement AI suggested by Brock and von Wangenheim (2019) is not explained by the lack of evidenced-based incentives and positive predictions. Microsoft reports that businesses in the UK who use AI at scale were performing 11,5% better than those who are not (Racounter, 2020, p. 1), and the International Business Machines Corporation (IBM) points out that AI has reduced costs to 44% of firms who have implemented it (Racounter, 2020, p. 6). Additionally, IBM predicts market revenues originated from AI will grow more than 11 times by 2025, specifically those influenced by Machine and Deep Learning (Racounter, 2020, p. 6). Executives also make predictions for the impact of AI, reporting that AI will help firms create new (or improve existing) smart products and services; improve their internal business or manufacturing operations with its automation potential; and change the way companies interact with costumers (Brock & von Wangenheim, 2019; Davenport & Ronanki, 2018).

Despite the incentives and optimistic predictions, to be able to reap the full benefits of AI (or any other emerging technology) towards the digital transformation of a company, some

researchers note there is the need for specific digital resources, organizational structure, growth strategy, and metrics (Verhoef et al., 2019). More specifically, for the implementation of AI, academics believe it requires new information technology (IT) skills, data management, and analytical skills, security skills, and a suitable strategic framework (Brock & von Wangenheim, 2019). The deeper analysis of the necessary requirements to digitally transform a company through the implementation of emerging technologies are beyond the scope of this dissertation, but still worth mentioning.

Ultimately, the practical applications for AI, like many other emerging technologies, are endless, which in turn make managers confused on how these can impact their businesses. Proving that, a Deloitte study shows that 37% of the managers and executives inquired did not understand how AI works (Davenport & Ronanki, 2018), let alone the impact it could make in their businesses.

Moreover, there are industries where the potential for AI implementation is higher than others. Omdia forecasts that until 2025, behind the consumer industry, the telecommunications industry will have the biggest market revenue of all the industries that deploy AI software (Racounter, 2020, p. 6). Among many AI applications that can support this industry growth, scholars point out particular skills, such as predictive maintenance, failure detection, prediction of network and traffic demand [particularly useful for the implementation of the 5th generation standard for broadband cellular networks (5G)], optimization of network operations but also general ones, for instance, customer care and cybersecurity (Balmer et al., 2020).

2.2 Telecommunications industry

Emerging technologies are altering the way people and companies live, work, and interact, and the telecom industry is one of the main players in this digital revolution (World Economic Forum & Accenture, 2017). Industries working towards this revolution rely on telecom firms' infrastructures, applications, and productivity improvements to provide them access, interconnectivity and application services (World Economic Forum & Accenture, 2017). This industry's firms are characterized for their great employment of IT throughout their operations – they use these software systems in their distribution; to continuously expand their network; and for fault-tolerance requirements, meaning systems that keep the network working even when failures occur (Qui et al., 2007).

Today, the industry faces many potentially disruptive opportunities and threats (Deloitte, 2019; Mazars, 2020; World Economic Forum & Accenture, 2017). Even though it is still in the

infrastructure building phase, 5G is certainly coming to revolutionize the industry (Deloitte, 2019; Rosmino, 2019) with its high-speed connections and low latency technology, which in turn can make technologies such as cloud computing and IoT ubiquitous (Mazars, 2020). Moreover, specialists believe 5G and low Earth orbit satellite internet could bring change to both the low rural broadband penetration, and the lack of competition in the broadband market (Deloitte, 2019). The challenges for the industry regarding 5G will be understanding how to shape the customers' expectations towards the technology; determining all its capabilities and limitations; and the big investment needed in infrastructures for its deployment (Deloitte, 2019).

In Portugal, the telecom industry is facing a threat of new entrants with the implementation of the 5G (Observador, 2020). Recently, the regulatory entity is auctioning the bandwidth of 5G, while also incentivizing new players to enter the market with lighter conditions upon the purchase of bandwidth (Caçador, 2020). On a more global scale, this threat is also present but on potentially new telecom business opportunities such as mobile financial services, where other industries (tech, retailing, mobility) are also trying to take part (Mazars, 2020).

Policies on spectrum management – the management of the ownership of the electromagnetic waves used for telecommunications –, consistency across jurisdictions, and taxation are being written and have to become more flexible to allow a transformational change in networks and business models, driven by the digitization of the industry (World Economic Forum & Accenture, 2017).

Finally, there is a momentum for more data privacy and security, with consumers fearing identity theft, financial loss, and unauthorized use of sensitive data (Deloitte, 2019). Telecom firms are advised to create safe digital environments and bring more scrutiny to the industry (Deloitte, 2019). Blockchain and the General Data Protection Regulation (GDPR) are two tools that could help meet this new demand of consumers, in an industry where fraud counts for 18 billion (nine zeros) euros each year, globally (Rosmino, 2019).

To summarize, the factors that will likely challenge the telecom industry soon are presented in Fig. 1.

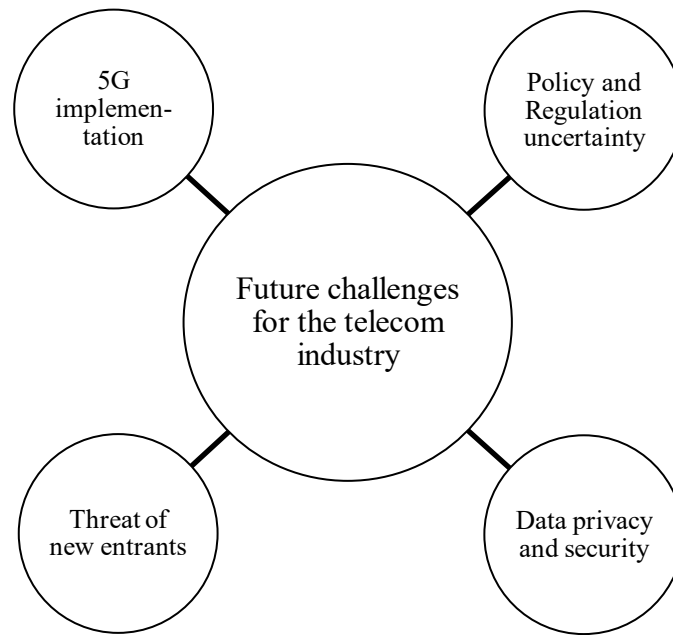


Figure 1: Future challenges for the telecom industry.

2.2.1 (Telecom) business model

In order to study how AI will influence telecom companies to face the previously mentioned and other trends, first it is necessary to understand how companies are structured. A business model does precisely that in a simple way. It describes a firm’s process of creating, distributing, and capturing value for its stakeholders (Bouwman, De Vos, et al., 2008; Chesbrough & Rosenbloom, 2002; Gordijn & Akkermans, 2003; Linder & Cantrell, 2000; Magetta, 2002; Ovans, 2015, as cited in Haaker et al., 2017). In other words, it is a representation of how a firm intends to create and capture value from its products and services (Bouwman et al., 2008, as cited in Haaker et al. 2017). This is a helpful tool for defining what a firm is and what it is not, and to communicate it without misinterpretations (Mäkelä & Lehtonen, 2010, as cited in Haaker et al., 2017).

Although more generic and broader, a business model can also represent an industry, to illustrate and refer to the general framework all companies in that industry use to direct their business. In this research, the framework used to describe the telecom business model is the Business Model Canvas, developed by Osterwalder and Pigneur in 2011 (Bouwman et al., 2018).

With the academic field lacking in possible generic telecom business models, unconventional measures had to be taken. Suggestions from websites of three telecom companies' business models and one generic telecom business model were identified and a selection of the common characteristics was made to suggest a generic reference business model for the telecom industry (Oakley, 2019; StudiosGuy, 2020; Vizologi, 2020b, 2020a), which can be consulted in Appendix I.

2.3 Business model stress test

According to Bouwman et al. (2018), stress testing applied to business models was first introduced in 2012 by Bouwman and colleagues. It was presented as a tool to improve business model implementation, making use of business models, which according to the authors were not something viewed as useful, at the time. However, there are records of stress testing being used in the early 1990s by banking institutions (Sorge & Virolainen, 2006). The general use of stress tests is for measuring the risk exposure of institutions and identify structural vulnerabilities to plausible scenarios (Sorge & Virolainen, 2006).

To Haaker et al. (2017, p.17), business model stress testing can be defined as “a systematic analysis of the robustness¹ of business model components in different future environments”, with Bouwman et al. (2018) adding that these future environments range from market, regulatory or technological scenarios. Other scholars emphasize that besides an analysis, the method is meant to cause changes in the business model tested (Bouwman et al., 2018). The result is a heatmap that shows the potential problems with specific business model components when confronted with each scenario, and that incites discussion on how to deal with those problems (Bouwman et al., 2018; Haaker et al., 2017).

From a managerial perspective, business model stress testing is useful for its universality to any business model language, and its way of providing managers a method to cope with changes in their environment, inciting business model innovation (Haaker et al., 2017). Other advantages are presented by Steiner (1969, as cited in Haaker et al., 2017) and Rohrbeck and Schwarz (2013, as cited in Haaker et al., 2017), who acknowledge that scenario planning – also called scenario analysis, or strategic forecasting – when used properly, provides quality information,

¹ Robustness: the long-term viability and feasibility of a business model when confronted with a specific scenario (Haaker et al., 2017). A business model is viable when it is creating benefits for the firm and customers, and it is feasible if it can be implemented in practice, with the resources available (Haaker et al., 2017).

increases the capacity to interpret and respond to change, and consequently improves strategic decision making.

To apply the method impartially and with little to no biases (e.g. tunnel vision), the business model stress test should be done by a group who is familiar with the business model and someone who is not, but who is still an expert in the industry (Haaker et al., 2017), for example five executives and one consultant. There is also a facilitator, who is guiding the test, knowledgeable about stress testing, and who can help the group along with the test (Haaker et al., 2017).

The uncertain scenarios should also be taken into consideration because their quality will affect the quality of the stress test (Haaker et al., 2017). They should be collected from independent sources or industry experts, to guarantee they are reliable, consistent, plausible, and challenging (Haaker et al., 2017). When dealing with multiple scenarios, they should be easy to distinguish (Van der Heijden, 2005, as cited in Haaker et al., 2017).

Finally, Haaker et al. (2017) and Bouwman et al. (2018) present a six-step approach to execute the business model stress test:

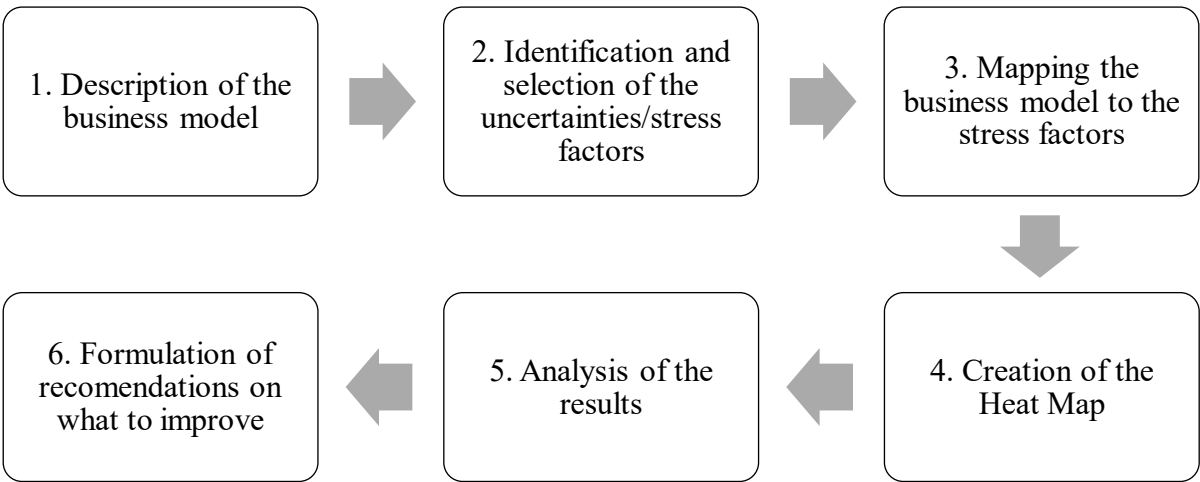


Figure 2: Six-step approach to business model stress testing.

After describing the business model, the identification and selection of the stress factors should be kept manageable by not selecting more than five factors and with those being the ones with the highest expected impact on the business model. Usually, an uncertainty is represented as two stress factors with opposite outcomes. For the third step, the mapping is meant to identify the connections between business model components and stress factors, with facts explaining

the relationships. The business model components that have no connections can be discarded from the process in this stage. The creation of the heat map assesses the relationships identified in the previous step by creating a matrix, with the business model components as the first column and the stress factors as the first row. The color scheme of the cells in the matrix expresses the type of impact the stress factor has on the business model component:

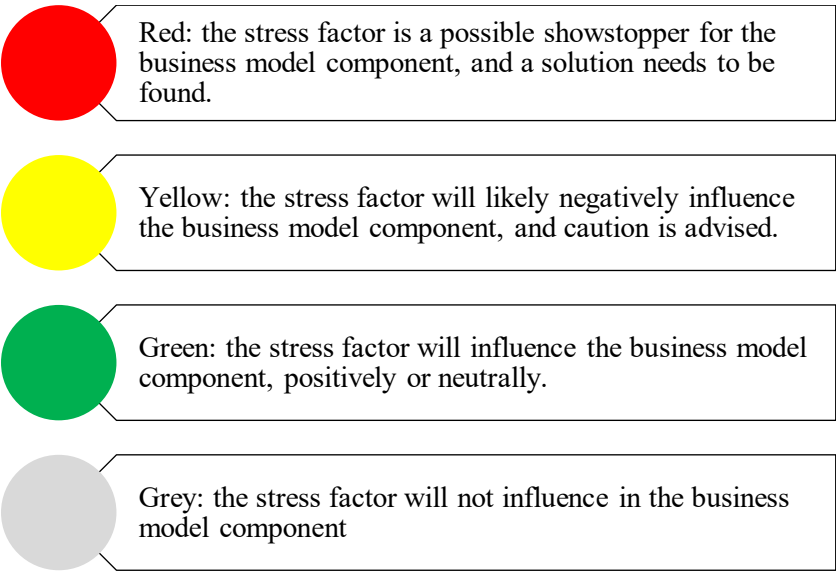


Figure 3: Color scheme of the heat map

The reason behind the choice of color must be written down, as it will be used as input for the fifth step, where an analysis of the results is made. The last step addresses the weaknesses in the business model and allows for planning actions to improve the robustness of the business model.

3. Methodology and Data Collection

In this section, the methodology used to answer the research question is carefully described, justified, and presented in a structured manner. After that, the data collected is mentioned and important insights are presented.

3.1 Methodology

This research's core methodology is the business model stress test method. However, an adaption from the academic method needs to be done, so the research question can be answered.

The new method recommends using a literature review and semi-structured expert interviews as secondary and primary methods of data collection, respectively. These will enable the first two original steps of the method – the business model description and the identification and selection of the stress factors.

The first step in this dissertation's methodology is the relevant literature identification, where essential definitions, relevant studies, and forecasts are searched for. This step closes the knowledge gap on the complexity of emerging technologies, AI and its business applications; the telecom industry's business model and challenges; and how to perform a business model stress test. In this stage, preliminary stress factors for the business model stress test and a rough generic telecom business model are found².

This phase was conducted by analyzing secondary data from the most relevant and up-to-date peer-reviewed published papers. The search platforms used to find these papers were Google Scholar and the EBSCO Business Source. Company reports, institutional reports, news articles, and websites³ were also sources for this phase.

The semi-structured expert interviews are made so the stress factors and the telecom business model can be validated. The second step in this research is the preparation of those interviews, where the experts are contacted, the interviews scheduled, the interview script written, and the business model cleaned. The third step is conducting the interviews, followed by the fourth step of processing the interviews, to finally have the validated stress factors and telecom business

² The generic telecom business model produced for the business model stress test follows the Business Model Canvas framework due to its popularity in both the academic and business world.

³ This questionable source was only used in the creation of the reference telecom business model since the academic field was lacking this representation. Later validation of the business model produced through this source will be given by the expert interviews.

model. After those steps are concluded, the remaining business model stress test's phases are performed in the final step.

Therefore, this research project's methodology design is composed of the following five-step approach:

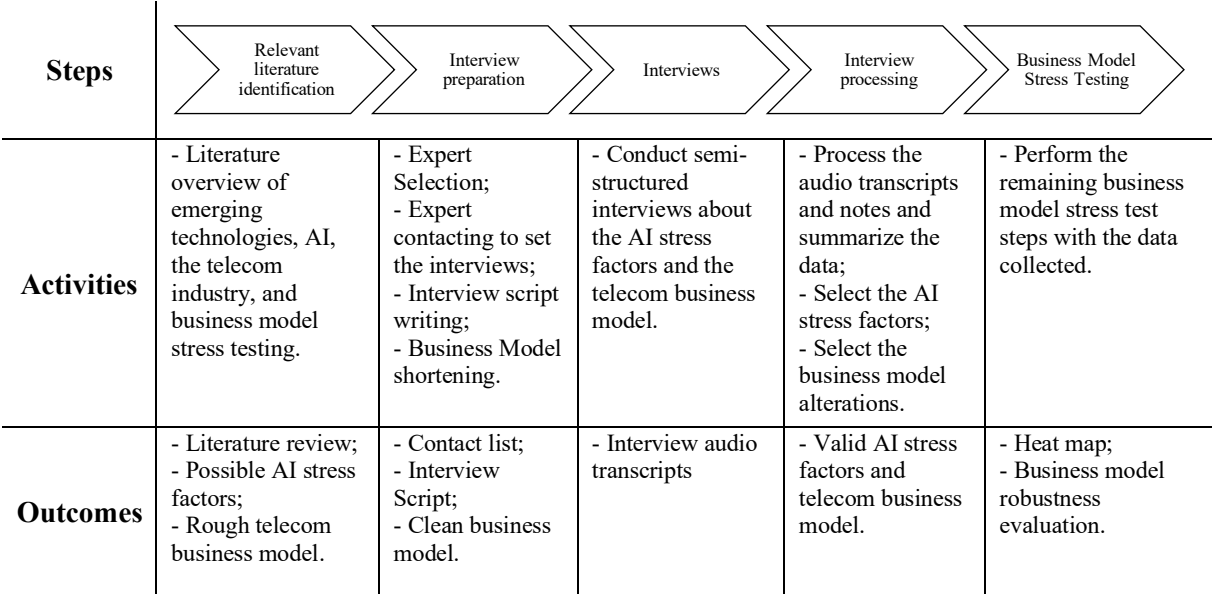


Figure 4: Overall methodology design.

This dissertation proposes business model stress test as the method to analyze the future impact of emerging technologies in business models for many reasons. The method interprets the company into a simple and easy business model format; The heat map component visually exposes what kind of impact will be in a clear color scheme; the option of choosing any business model framework makes it available for every school of thought. In addition, being a method that not only analyzes the future impact of emerging technologies but also incites business model innovation based its results, increases the capacity to interpret and respond to change, and consequently improves strategic decision making.

3.2 Data collection

The semi-structured expert interviews are the primary data collection of this dissertation and they were focused on finding what the most relevant AI applications with the potential to affect the telecom business model are, and to validate the business model constructed in the previous section. By doing this, the stress factors and the business model for the business model stress test should have the minimum bias and maximum quality possible.

The first contact with the experts was made via LinkedIn since it was the most direct channel to contact the experts in a time where personal contact is not possible. The experts were chosen considering the criteria in Table 1 and the message sent to them can be found in appendix II.

Table 1: Criteria for expert selection.

Criteria	Reason
Working in the telecom industry	So they will have an inside perspective
With an IT-related position	So they understand the technical AI implications in the industry
Or with a high administration position	So they understand the strategic AI implications in the industry
+1 year of experience in the industry	To exclude non-experts working in the industry

The qualitative approach of these interviews required the experts selected to be from different business areas, so the views could complement each other, and the results could be as closer representation of reality as possible.

Thus, the result was 11 interviews to a total of 14 experts from the three major Portuguese telecom industries, with an average of 12 years and eight months of experience in the industry, from diverse positions inside the company, varying horizontally and vertically, which are demonstrated in Table 2.

Table 2: Interviewees overview.

Interview #	Expert #	Position	Industry experience (years)
#1	#1	Network Planning and Optimization Engineer	15
#2	#2	Product and Marketing Manager for IT & IOT	1,3
#3	#3	Engineering Manager	16
#4*	#4	Network Strategy Engineer	3
	#5	Training and Development HR	18
#5	#6	Executive Board member	11
#6	#7	Director of Consumer Products	13 (continued)

Table 2: Interviewees overview (continuation).

Interview #	Expert #	Position	Industry experience (years)
#7	#8	Developers’ and Data engineers’ Manager	9
#8	#9	Sales Director, ICT executive	16
#9	#10	EAI Architect	13
#10	#11	Head of Data Science (Consumer Segment)	12
#11*	#12	Head of Radio Networks & Devices	20
	#13	Mobile Technologies & Devices Engineer	13
	#14	Senior IoT Network Engineer	18

* The first expert from this interview found it useful to bring more experts to the interview to enrich their contribution.

These semi-structured qualitative interviews were done so meaningful insights about AI applications in the telecom industry and the business model of the industry could be reached. The script of these interviews can be found in appendix III and followed questions about recent projects the experts participated in, their direct and indirect connections to AI, industry external factors and their connection to AI, and the evaluation of the predefined telecom business model.

The choice of semi-structured interviews was done so the perspective of the experts was not be restricted by close-ended questions. This method was preferred also because the insights of the experts are not predictable and are different according to the area they are working in, and the semi-structure gives the flexibility to fit with all the experts.

On average, the interviews took 39 minutes. These interviews were preferably done in Zoom calls, a videoconference free platform, capable of recording the audio and video, to have a reliable method of data recording. However, exceptions were made to match the preferences of the experts who did not accept a Zoom meeting, and in those cases, the channel chosen by the experts was a phone call⁴.

⁴ This deviation from the standard channel does not result in a data collection method deviation, since it was also a semi-structured interview. The differences were in the method of recording, which had to be made by note-taking instead of the standard Zoom call recording used on the other expert interviews, and that the phone call interviewees couldn’t validate the telecom business model.

The last task to prepare for the interviews was the business model shortening. The business model extracted during the literature review was composed of innumerable and sometimes redundant characteristics, which made the validation process harder. Consequently, these business model component's characteristics had to be filtered into a manageable business model, easy to analyze and validate. The result can be consulted in appendix IV.

The interview records and notes were transcribed into summaries and organized into relevant insights given, AI applications mentioned, and the telecom business model from each interview. These summaries can be found in appendix V.

3.3 Emerging technologies and the telecom industry

Before reaching the valid stress factors and telecom business model, the expert interviews revealed other valuable insights.

The experts pointed out the confusion still present in the industry about what is AI (interviews #1, #3 and #4) and expert #3 gives his opinion about the technology, stating *“AI is something that is absolutely fantastic, has no limits, but simultaneously is highly threatening”*.

In the interviews, the fear of AI making mistakes and not being supervised came up (interview #9) and contradicted, with some seeing the technology in its early steps, limited strictly to what is designed for (interview #2), needing a long time to be perfected (interview #7), and in the future only expected to complement human labor (interview #2).

The influence of emerging technologies on AI is mentioned, with special emphases on 5G, with expert #2 indicating *“5G will motivate – and a lot – the implementation and the large-scale adoption of AI”*, and on Big Data. This technology is expected to be the currency for the entire revolution in the industry (interviews #3 and #5) with expert #3 predicting it will be *“the most valuable thing we will have in the next century”* and clarifying that the bigger the data, the better the AI.

The experts also had insights on the industry influence over other industries' digital revolutions, explaining the telecom industry is the key support industry for that transition (interviews #2 and #6) and expert #2 going further and affirming that *“without the telecom industry, it will not be possible to leave the disappointment phase into the real functionality of emerging technologies.”* To him, *“who is going to promote the digital revolution will be the Cisco's and Microsoft's of life, but who is going to make that revolution be adopted by everyone will be the telecoms”*.

4. Data Analysis

In this section, the data collected will be subject to a cross-analysis between interviews and the previous research, which results in the selection of the AI applications to use as stress factors in the business model stress, as well as the final telecom business model components. Next, the rest of the business model stress test methodology steps are performed, beginning with the mapping of the stress factors to the business model components and followed by the creation of the heat map.

4.1 Stress factors selection

During the interviews, the experts were first asked about the recent projects they had been working on, with a special interest in those involving AI. This was done to gain knowledge on the level of understanding the experts had on the topic and make the conversation flow to the AI business applications they were aware of existing in the industry or that will be introduced and their current and future impact in the telecom industry.

The AI applications mentioned were “Network operator manager” which refers to the power AI has on detecting, preventing, and solving network operation failures on installed infrastructure; “Network implementation manager” used to understand the network coverage customer demand and plan an optimized implementation project of new infrastructure; the experts also mentioned how new AI applications implemented by “B2B clients” could have an impact on their industry; AI was also mentioned as a customer relationship manager (“CRM”), by its ability to analyze customer profiles to improve customer satisfaction and prevent churn; and as a “Customer support operator”, integrating chatbots to interact with the customer in a personalized way. Finally, the AI’s ability to prevent cyber-attacks was also mentioned. The frequency of each AI application mentioned by the interviewees can be consulted in Table 3.

Table 3: AI applications mentioned during the interviews.

Interview #	AI applications					
	Network operator manager	Network implementation manager	B2B clients	CRM	Customer support operator	Cybersecurity
#1	X	X	X			
#2	X		X	X	X	(continued)

Table 3: AI applications mentioned during the interviews (continuation).

Interview #	AI applications					
	Network operator manager	Network implementation manager	B2B clients	CRM	Customer support operator	Cybersecurity
#3	X			X	X	X
#4	X	X		X	X	
#5	X		X	X	X	
#6	X		X	X	X	
#7	X			X		
#8			X		X	X
#9			X	X	X	
#10	X		X	X	X	
#11	X	X	X	X	X	X
Total	9	3	8	9	9	3

Besides these AI applications, there were others less mentioned, for instance, AI’s digital marketing ability to profile potential and actual clients to target at campaigns and change the campaign accordingly to metric analysis; the AI’s ability of, as a financial controller, analyze and discover billing and other financial errors; or AI’s provisioning abilities to control for warehouse stock. These make a total of nine AI applications in the telecom industry.

During the interviews, many examples and detailed explanations of each AI application were provided, so the impact would be clear. These detailed insights can be consulted in the interview summaries in appendix V.

As instructed in the business model stress test guidelines mentioned in the literature section, to keep the stress test manageable, the selection criteria should be of no more than five stress factors, and those should be the applications with the biggest potential impact. Consequently,

the stress factors chosen are the most mentioned AI business applications, as these are assumed to be the most relevant applications across functions inside the industry and thus the ones with the biggest potential. To solve the tie for the fifth stress factor, both AI applications (Network implementation manager and cybersecurity) will be discarded. The reasons behind are to prevent from breaking the selection criteria by having six stress factors and to not choose from two equally mentioned applications, which in turn are not considered as relevant, with only three mentions, as the stress factors selected, which had eight or nine mentions.

Comparing with the applications that impact the industry found in literature, Balmer and colleagues (2020) mention: predictive maintenance, failure detection, and optimization of network operations. These are in line with the network operation manager application suggested in the interviews; prediction of network and traffic demand, abilities of both network implementation manager and network operation manager AI applications; customer care, which can combine CRM and customer support operator; and cybersecurity. This means the secondary and primary data collections, despite not being an exact match, validate each other as the main AI applications of the telecom industry.

Finally, the validated stress factors selected to be used in the business model stress test are presented in Table 4.

Table 4: AI applications selected as stress factors.

AI applications from the interviews	AI applications from the literature	Stress factors selected
Network operator manager	Predictive maintenance	Network operator manager
	Failure detection	
	Optimization of network operations	
	Prediction of network and traffic demand	
B2B clients	-	B2B clients
CRM	Customer care	CRM
Customer support operator		Customer support operator

4.2 Business model alterations

After all the business applications were identified, seven of the 11 interviews proceeded to the validation of the telecom business model constructed in the literature section and filtered during the interview preparations. Interviews #5, #8, and #9 were done via phone call and interview #11 had to end sooner than expected, thus all were unable to provide business model validation.

During the validation process, the experts suggested many alterations, either adding characteristics to the components, removing them, giving examples and explanations for them, or rearranging them into clearer ones. However, without one focus group, it is not possible to have a group filter in decision-making, which prevents personal biases. In order to decrease that bias, adding and removing suggestions will only be accepted if done by two or more experts. Rearrangement, clarification, and explanation suggestions will be accepted if they are considered useful for the simplification of the business model. Thus, the alterations are presented in Table 5.

Table 5: Telecom business model alterations.

Business Model Component	Alteration	Reason
Key Partners	Remove “Network Operators”	Suggested by three experts; do not exist in the industry.
	Add “Content Providers”	Suggested by two experts; important new players.
Value Proposition	Clarify the offers as “Quadruple Play”	It is a better technical term.
	Add OTT media services	Suggested by two experts; important new service.
	Substitute “Digital TV” for “IPTV”	It is a better technical term.
	Add “B2B data monetization”	Suggested by two experts; growing industry practice.
Customer Relationships	Remove “Mobile”	Suggested by three experts; term too broad.
Revenue Streams	Remove “Interconnection fees”	Suggested by three experts; it is one example of “wholesale services”.
	Add “Data monetization”	Suggested by three experts; growing industry practice.

The result is the validated generic reference telecom business model (Fig.4).

Key partners: <ul style="list-style-type: none"> - Distribution Partners - IT capability developers and integrators - Infrastructure and equipment suppliers - Content Providers 	Key Activities: <ul style="list-style-type: none"> - Deployment and maintenance of infrastructure - Network operation - Customer service and support - Marketing - R&D 	Value Proposition: <ul style="list-style-type: none"> - Connectivity and reliable telecommunications services - Quadruple Play <ul style="list-style-type: none"> - Fixed and mobile voice - Data services - IPTV - OTT media services - Cloud and Hosting services - B2B Data monetization 	Customer Relationships: <ul style="list-style-type: none"> - Sales and customer support team - Digital - Brand awareness 	Customer Segments: <ul style="list-style-type: none"> - B2C - B2B
	Key Resources: <ul style="list-style-type: none"> - Infrastructure and coverage - IT capabilities - Partnerships and alliances - Big Data - Personnel 		Channels: <ul style="list-style-type: none"> - Retail - Call centers - Website - Social media 	
Cost Structure: <ul style="list-style-type: none"> - Payroll - Infrastructure and network installation and maintenance - IT Capabilities development and maintenance - Customer service - Data centers 			Revenue Streams: <ul style="list-style-type: none"> - Subscription and service fees - Wholesales services - Data monetization 	

Figure 5: Final telecom business model.

4.3 Mapping the stress factors to the business model components

After finding the validated stress factors and telecom business model, the next steps in the business model stress testing methodology are determining the connections between the stress factors and the business model components and evaluate what kind of connection they are. Hence, Table 6 presents the connections identified and the reason for those connections, including the nature of the connection.

Table 6: Mapping of the stress factors to the business model's components.

Stress factor	Business model component	Reason
Network operator manager	Key Activities	Every expert that mentions this AI application explains the positive impact it has on network and infrastructure-related activities by being a key tool to detect, prevent, and solve network operation failures.
	Key Resources	In 44% of interviews where this AI application is mentioned, the experts point out a neutral and depending relationship between the AI application and Big Data. (Interviews #1, #2, #7 and #11).
	Value Proposition	In 44% of interviews where this AI application is mentioned, the experts indicate the positive connection between the stress factor and the quality of the service provided. (Interviews #1, #5, #10 and #11)
	Revenue Streams	In 44% of interviews where this AI application is mentioned, the experts indicate the positive effect the AI application has on solving and preventing customer network problems and thus preventing churning and maintaining the client base. (Interview #1, #5, #10 and #11)
	Cost Structure	In 33% of interviews where this AI application is mentioned, the experts stress how it positively impacts costs and expenses by substituting personnel's valuable time-solving customer problems. (Interviews #1, #4 and #10)
B2B clients	Key Resources	Every expert that mentions B2B clients suggests a big demand for 5G implementation so new AI-powered businesses can be born, pressuring the industry for new infrastructure and coverage. In one interview, the expert also stresses the B2B demand for telecom Big Data, so it can be analyzed by their AI systems (Interview #10). This pressure from the B2B clients is potentially problematic if not dealt with.
	Value Proposition	Every expert that mentions B2B clients points out the relationship between the new 5G era, which brings new AI-powered businesses, and the B2B demand for faster internet connections. This type of connection is not currently part of the value proposition, which weakens it if not addressed. (continued)

Table 6: Mapping of the stress factors to the business model's components (continuation I).

Stress factor	Business model component	Reason
B2B clients	Cost Structure	In 25% of interviews where B2B clients are mentioned, the experts believe that the implementation of 5G, driven by the digital revolution of companies, some of which deploying AI, will negatively impact the cost structure. This is due to current regulatory terms, where the demands are financially unsustainable. (Interviews #4 and interview #5)
	Revenue Streams	In 38% of interviews where B2B clients are mentioned, the experts report the positive influence of B2B clients, which deploy AI in data analytics processes and push for the monetization of the data produced by the telecom industry. (Interview #1, #10 and #11)
CRM	Key Activities	Every expert that mentions this AI application stresses how it can positively affect marketing by granting the power to analyze customer information and create more personalized service plans and content recommendations.
	Value Proposition	In 56% of interviews where this AI application is mentioned, the experts indicate the positive connection between the stress factor's ability to personalize the service and the customer satisfaction for the service provided. (Interviews #3, #6, #9, #10 and #11)
	Revenue Streams	In 44% of interviews where this AI application is mentioned, the experts explain the positive link between it and customer retention, since it can prevent and act upon churning. (Interviews #3, #6, #10 and #11)
	Customer Relationship	In one interview, the expert alerts for the potentially negative impact the application can have on the perception of the clients of their privacy and over personalization. (Interview #6)
Customer support operator	Customer Relationship	In 89% of interviews where this AI application is mentioned, the experts indicate its positive integration in the customer support team as adaptable and human behavior simulator bots, an upgrade to the traditional interactive voice responses (IVRs). (All except interview #3) (continued)

Table 6: Mapping of the stress factors to the business model's components (continuation II).

Stress factor	Business model component	Reason
Customer support operator	Key Activities	In 44% of interviews where this AI application is mentioned, the experts point out the positive impact on effectiveness in customer support and problem-solving. (Interviews #2, #6, #8 and #10)
	Cost Structure	In 22% of interviews where this AI application is mentioned, the experts report the positive effect these bots have on avoiding expensive human labor.

The choice of these connections was always based on the evidence presented during the expert interviews, either by the clear mention of it or by interpretation of what was discussed. Following the method's guidelines, the business model components that were not mentioned during this mapping will be discarded from the heat map, being these components the "Key Partners", "Channels" and "Customer Segments".

4.4 Creation of the heat map

To a better understanding of the overall impact the stress factors have on the industry business model, the business model stress test method proposes the creation of a heat map with a color scheme and in matrix form, with the stress factors as the first row and the business model components as the first column.

This dissertation suggests the following color scheme legend: red implies a certain negative impact of the stress factor on the business model component; yellow implies a potentially negative impact; green means an expected positive impact; and grey regards a neutral or unknown impact of the stress factor on the business model component.

Finally, the heat map of the business model stress test is presented in Fig. 5.

Business Model Components	AI applications			
	Network operation manager	B2B clients	CRM	Customer support operator
Customer Relationships	Neutral or unknown impact	Neutral or unknown impact	Potentially negative impact	Expected positive impact
Value Proposition	Expected positive impact	Potentially negative impact	Expected positive impact	Neutral or unknown impact
Key Activities	Expected positive impact	Neutral or unknown impact	Expected positive impact	Expected positive impact
Key Resources	Neutral or unknown impact	Potentially negative impact	Neutral or unknown impact	Neutral or unknown impact
Cost Structure	Expected positive impact	Certain negative impact	Neutral or unknown impact	Expected positive impact
Revenue Streams	Expected positive impact	Expected positive impact	Expected positive impact	Neutral or unknown impact



Figure 6: Stress test heat map.

From the visual representation of the heat map, it is possible to extract both general and detailed insights about the impact of AI applications on the telecom business model components.

The heat map brings out that the telecoms’ business model robustness only strengthens with the investment in AI as a network operation manager and as a customer support operator, with the first impacting more components (four) than the second (three). Moreover, the CRM AI application is an overall good investment with the same amount of positive impacts has the customer support operator stress factor (three), but caution is advised to telecoms about their customer relationship viability – the creation of benefits for the firm and customers – due to the potentially negative customer perception of being too supervised. However, the most concerning stress factor is the B2B clients, having one certain negative impact, two potentially negative impacts, and one positive impact on the current business model robustness. As it is, the long-term feasibility – capacity to be implemented with the resources available – and viability of the telecom business model are compromised, and adjustments need to be made to improve its robustness.

From this heat map, the most affected business model components are predicted to be the “value proposition”, the “key activities”, the “cost structure” and the “revenue streams”. The least affected should be the “key resources”, although the only impact is potentially problematic. Finally, it is possible to predict that the revenue streams and key activities of the telecom industry can only benefit from AI implementation.

5. Discussion of Results

This section purposes to interpret and consider the research findings, taking into consideration the limitations of the study, the veracity of the results found, and the contribution to answer the problem statement and research question.

5.1 The case of AI in the telecom industry

Regarding the findings from the business model stress test, the stress factor that is expected to have the most negative impact is the B2B clients, which illustrates the new AI applications implementation process by B2B clients. Surprisingly, this stress factor is the only one with an impact that comes from implementing it outside the industry. Another aspect that makes this stress factor special is the presence of a simultaneity phenomenon. Contrary to the other stress factors, which unilaterally impact the business model, here that impact is happening but there is evidence of the contrary, the business model impacting the stress factor. The new businesses that implement AI and other technologies will affect the telecom business model by pressuring for 5G implementation, but the telecom business model will also affect the new businesses that implement AI, once 5G is implemented.

Due to this phenomenon, the business model stress test may not be designed to clearly demonstrate the impact this stress factor has on the telecom business model or it could be the stress factor that needs to be altered to remove the business model influence on the stress factor. Either way, further research is necessary to treat this type of stress factor in the method.

On the other hand, this research confirms the predictions of Brock and von Wangenheim (2019) or Davenport and Ronanki (2018) that not only AI will positively impact firms by creating new smart products and services – reflected in the B2B stress factor where AI motivates the data monetization revenue stream –, but also improve their internal business operations due to its automation potential – reflected in the network operation manager and customer support operator stress factors. Moreover, it also confirms the change in the way companies interact with customers also predicted by Brock and von Wangenheim (2019) – matching the CRM stress factor. Finally, this research also specifies where does these impacts occur in the industry's generic business model.

5.2 Improved business model stress test

The main contribution of this research is the proposed business model stress testing methodology adapted to academic research and other emerging technologies. Since the method from the literature was unfeasible to perform under the conditions of this research, it was necessary to do adjustments to make it operational.

These adjustments included altering the data collection method from expert focus groups to expert interviews. This changed the data analysis too, leaving the rest of the method to be performed by the researcher. It is important to mention that the focus groups were controlling for individual biases that the interviews controlled in a different way, which could make for interesting research the analysis of the differences of results between data collection methods.

The business model stress test method was not adaptable to analyze the emerging technologies' impact on business models, since it is focused on PESTEL-related⁵ stress factors. Therefore, for a real view of the impact an emerging technology can have on the company, this dissertation suggests the disaggregation of the emerging technology into its most relevant technological applications and used them as stress factors. These applications should be ideally mutually exclusive, in order to not misinterpret the individual impact of each stress factor.

Another adaption occurred in the "Mapping the stress factors to the business model components" section, where the evaluation of those connections was included instead of being done in the following step. This adaptation was made since the reason behind the connection between a stress factor and a business model component is the same as the reason for that kind of connection. So, it made sense to present them together.

Finally, the business model stress test method required a modification in the color label attributed to each connection between stress factor and business model component. The literature suggested an imprecise color scheme legend, with the red and yellow labels being too similar, and with the green label having partially the same meaning as the grey one. Therefore, this dissertation proposed a new color scheme that is clear and mutually exclusive for defining the type of connection between stress factors and business model components exist.

⁵ PESTEL: Political, Economic, Social, Technological, Environmental, and Legal external factors that affect a company.

These alterations are an interesting subject for further investigation to test their replicability on other emerging technologies.

Besides discussing the alterations in the methodology, it is also relevant to discuss the quality of the method in analyzing the impact of emerging technologies on companies' business models. Although academics argue for its benefit of providing managers a method that incites business model innovation (Haaker et al., 2017), or helping to respond to change and improve strategic decision making (Steiner, 1969, as cited in Haaker et al., 2017; Rohrbeck and Schwarz, 2013, as cited in Haaker et al., 2017), the method lacks comparability of the stress factors' effects. For example, even though the network operation manager stress factor has the most (four) positive impacts on components, it is not clear or even necessarily true that its positive impact is bigger than the customer support operator stress factor (three positive impacts). On the other hand, the effect of AI in the business model covers customer satisfaction, cost reductions, or even client retention, which means the metrics to evaluate the true impact of these diverse applications are not feasible to be implemented in this visual and simple method.

5.3 The final telecom business model

A significant finding resulting from this research is the definition of the generic telecom business model, which was lacking in the academic field and that presents how the industry is structured to create and capture value for its stakeholders. However, this finding needs caution when interpreted because, even though it was validated in the expert interviews, there is a risk of biases since its first draft came from unreliable sources, the first filtering process before the interviews was performed without any validated criteria, and the alterations made on the characteristics could use a quantitative approach to reach more conclusive and consistent results.

The choice of the business model Canvas to represent the generic telecom business model is also target to some criticism. In prior studies, an academic has tested the impact of another emerging technology on another industry's business model with the use of business model stress testing (Klomp, 2018). This research evaluated the most technological-oriented business model frameworks, and the Canvas framework was not the best fit. However, for the purpose of this dissertation, the framework chosen was not critical and the Canvas showed to be the most practical option for its popularity in both the academic and business world.

5.4 Other findings

At the beginning of this research, the literature presented AI as a strange technology to a considerable percentage of executives, even though it is widely spread over many industries. During this research, this claim about executives was confirmed by some experts who also believe there is still a big confusion inside the telecom industry about what AI is. Yet, the strength of these claims is weak since it is a byproduct of the interviews' findings, it just regards the telecom industry, and it is not free from perception biases.

Nevertheless, this research still contributes to close the potential knowledge gap existing in the industry with a literature review on what emerging technologies are; specifically AI, its general business applications, and a suggestion of its main industry applications, which were then confirmed by the expert interviews.

Another small contribution of this research process is the identification of the telecom industry as the support industry for the digital revolution and emerging technologies' implementation in other industries, as suggested in the literature. With one expert (#2) even suggesting that *“without the telecom industry, it will not be possible to leave the disappointment phase into the real functionality of emerging technologies”*, this appeared to be the common belief for the rest of the experts and gives strength to the relevance of studying this industry. However, it is important to bear in mind the possible perception bias of this statement since it comes from experts inside the industry.

6. Conclusion

At the beginning of this research, emerging technologies were introduced as technologies filled with potential to create and transform industries, but also uncertainty and ambiguity towards their future (Rotolo et al., 2015). After analyzing the literature around AI in detail, the same characteristics arose, and the telecom industry was identified as a promising industry for the deployment of this emerging technology.

This promising opportunity for AI deployment was later confirmed by the business model stress test performed with the help of 14 experts. They specifically identified the opportunity in network operation management, customer relationship management, and customer support operation. They also clarified where and how exactly, in the future, will these applications impact the business model of the generic telecom company. The B2B clients stress factor that represents the future impact on the industry of new AI applications implemented by business clients demonstrated the most interesting results. Here, the mostly negative expected impact on the business model needs to be interpreted with caution because the findings demonstrate a simultaneity phenomenon, making further investigation on this type of stress factors and how to integrate it in the stress test the natural development of this work.

Furthermore, this dissertation adds to the scarce academic research on the impact of emerging technologies on companies a business model stress test methodology adaptable to other emerging technologies and industries, which still needs further research to confirm the method's replicability.

Besides answering the problem of lack of tools to help managers in the decision-making process of whether to implement emerging technologies or not, this dissertation adds to the academic research of the telecom business model, with an expert validated industry business model, which was missing from the academic literature and that could be used in following work as a starting point to further validation due to possible biases that may have occurred. Moreover, the dissertation also helped close the knowledge gap about AI by providing a small literature review on the topic. Although this contribution was small and beside the scope of the dissertation, the study confirmed this gap with both the literature review and during the expert interviews which makes the topic worth investigating more on the possible reasons for the gap to exist and possible ways of closing it

In conclusion, this dissertation investigated through literature and expert interviews the complex connections between a technology and a business model, to find a method that would help managers and academics to better predict those future connections and make better decisions on what technologies to implement, and with what business model. The results were that method and a business model, which both need further validation, and a small contribution to close a relevant knowledge gap across industries about AI.

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Appendix

Appendix I: Business model canvas from literature review

<p>Key Partners:</p> <ul style="list-style-type: none"> • Other telecom companies • Subsidiaries • Content providers • Entertainment industry • Distribution Partners • IT Capabilities developers and integrators • Regulatory agencies • Infrastructure vendors (suppliers) • Device or equipment manufacturers • Network operators 	<p>Key Activities:</p> <ul style="list-style-type: none"> • Marketing • Customer service and support • Content acquisition • Creation and diffusion of content • Deployment and maintenance of infrastructure • Network operation • Traffic management • Maintenance • Billing collection • Procurement • R&D • Innovation and Product development 	<p>Value Proposition:</p> <ul style="list-style-type: none"> • For individuals: <ul style="list-style-type: none"> ○ Connectivity ○ Reliable telecommunications services (fixed and mobile voice and data services, digital television) ○ Converged communications (possibility to bundle) ○ Zero-rating offers (WhatsApp, and other over-the-top (OTT) applications) • For Corporate: <ul style="list-style-type: none"> ○ Better communication ○ Enhancement of team collaboration ○ Superior customer service ○ Flexibility enhancement ○ Cloud and Hosting Services 	<p>Customer Relationships:</p> <ul style="list-style-type: none"> • Attractive services • Frequent network upgradation • Sales and customer support team • Social media customer support • Automated Billing • Digital & Mobile • Brand awareness • Users community 	<p>Customer segment:</p> <ul style="list-style-type: none"> • Mass market • Mobile 'prepaid' Segment • Mobile 'postpaid' segment • SMEs • Large Corporate • Public Sector • Other telecom companies
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	<p>Key Resources:</p> <ul style="list-style-type: none"> • Installed User Base • Government Support • Infrastructure and coverage • Digital contents • IT capabilities • Partnerships and alliances • Big Data • Technological Intellectual property • Personnel 		<p>Channels:</p> <ul style="list-style-type: none"> • Branches (own physical stores) • Retailers • Dedicated team of sales • Account management • Call centers • Website • Mobile app • Social media • TV 	
<p>=</p> <p>Cost Structure:</p> <ul style="list-style-type: none"> • Payroll • Interconnection costs • Networks • Peering agreements • Infrastructure and network installation and maintenance • IT Capabilities development and maintenance • Customer service • Energy • Procurement • Copyrights • Royalties and licenses • Content acquisition • Data centers • Taxes 	<p>Revenue Streams:</p> <ul style="list-style-type: none"> • Subscription fees • Services fees • Sales of devices (prepaid & postpaid mobiles) • Interconnection fees • Wholesales services • IT solutions • Other telecom companies 			

Appendix II: LinkedIn message to contact experts

“Hello expert first name,

As part of my thesis, I contact you because I would like to talk to you and understand your perspective on the future of Artificial Intelligence in the telecommunications industry. When would it be more appropriate for us to speak?

Greetings,

Hugo”

Appendix III: Interview script

Goal: Gain information about AI applications in the telecom industry and the business model of the industry.

- Find how will AI impact the telecom business model;
- Analyze the impact with business model stress testing;
- Already done research on AI applications in the industry and the trends happening in the telecom industry;
- To have an in-depth perspective on the industry in order to reach accurate results.

Target interviewee: Tech specialists or high positions in the telecom industry, with more than 1 year of industry experience.

Ask if the meeting can be recorded. Do prior research about the interviewee.

Start interview.

Hello, my name is Hugo and I am a master student in management, specializing in strategy and entrepreneurship. My thesis is about how will AI impact the telecom industry. In order to answer that, I started by gaining some knowledge about AI and the telecom industry from academic papers and company reports. However, I think your perspective on the topic is necessary to reach results that are more accurate and confirm the research I have done.

Q1 RECENT PROJECTS: Now that I introduced what I have been working on, can you tell me about any projects you are working on? For example, are you working with AI now?

Q1.1: If they have worked with AI before: Can you elaborate on that particular project?

Q1.1.1: If they mention some AI application: How do you think that AI application will be relevant in the future of the industry? Why?

Q2 AI AT WORK: I am pretty sure your company already uses AI for several applications. Can you tell me some of them and what do they do?

Q3 AI APPLICATIONS: So, getting right to the big question, which AI applications do you think are the most relevant for the future of the telecom industry? Or which ones do you think are the most needed?

Q3.1: if they can't name any: Maybe you have heard of any of these. There is Predictive maintenance, failure detection, prediction of network and traffic demand, optimization of network operations, AI in customer care, and in cybersecurity. **Return to ask Q3**

Q3.2: Can you explain why and how will they affect the industry? Maybe you can answer this question by telling me the benefits and limitations of those AI applications? **OR** How do you think that technology will affect the telecom business model?

Q4 EXTERNAL FACTORS AND AI: What are the biggest opportunity and threat to the industry, now?

Q4.1: if they don't remember any: Maybe 5G, the threat of new entrants, some policies or regulation, the trend of data privacy and security?

Q4.2: Does AI benefit or limit the company dealing with these trends? How?

In order to understand the impact AI will have on the telecom industry, I will use a method called business model stress test. This method uses the company, or in this case the industry's business model to analyze how AI impacts it. For that, I needed to create a business model for the telecom industry.

Show the business model created.

Q5 BUSINESS MODEL: Do you feel this business model is a fair representation of the general telecom company?

Q5.1: Would you add or remove anything from it?

That was my last question. Thank you so much for you time! Do you have any questions for me?

So, it was very nice to meet you, thank you once more for your time and knowledge, and if you would like, I can send you more dissertation once I am finished.

Goodbye.

Appendix IV: Filtered telecom business model canvas

<p>Key partners:</p> <ul style="list-style-type: none"> - Distribution Partners - IT capability developers and integrators - Infrastructure and equipment suppliers - Network operators 	<p>Key Activities:</p> <ul style="list-style-type: none"> - Deployment and maintenance of infrastructure - Network operation (e.g. traffic management) - Customer service and support - Marketing - R&D 	<p>Value Proposition:</p> <ul style="list-style-type: none"> - Connectivity and reliable telecommunications services <ul style="list-style-type: none"> - Fixed and mobile voice - Data services - Digital television - Cloud and Hosting services 	<p>Customer Relationships:</p> <ul style="list-style-type: none"> - Sales and customer support team - Digital & Mobile - Brand awareness 	<p>Customer Segments:</p> <ul style="list-style-type: none"> - B2C - B2B
<p>Key Resources:</p> <ul style="list-style-type: none"> - Infrastructure and coverage - IT capabilities - Partnerships and alliances - Big Data - Personnel 		<p>Channels:</p> <ul style="list-style-type: none"> - Retail - Call centers - Website - Social media 		
<p>Cost Structure:</p> <ul style="list-style-type: none"> - Payroll - Infrastructure and network installation and maintenance - IT Capabilities development and maintenance - Customer service - Data centers 			<p>Revenue Streams:</p> <ul style="list-style-type: none"> - Subscription and service fees - Interconnection fees - Wholesales services 	

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Appendix V: Interview summaries

Interview/Expert #1 – December 1st 2020, 5pm., Zoom call, 38min.

The expert starts by referencing the confusion still happening in the industry about what is considered AI. Then, proceeds confirming that he has worked with AI before, and distinguishes its various levels of complexity (e.g. Expert Systems and more advanced AI). After, he explains how an engineer must combine their engineering abilities with data processing skills in order to work in the telecom industry.

AI as a network operator manager

The expert identifies the AI's ability to manage the network operations through Big Data analytics, which identifies possible and actual network failures, either on the client's equipment or in the company's own infrastructure. This AI application is already at use in the industry and it is becoming more precise and ubiquitous.

The technology can manage the failures in two ways: **Predictively** or as a **Problem solver**. The expert gives examples for both cases.

Predictively, AI sets alarms for employees of potential network equipment failures and sometimes even prevents the problem from happening by predictive maintenance; it can prevent network service failures by predicting the network traffic demand and increasing the coverage where it is needed, for example in a football match. On the other hand, if some problem occurs, AI can solve remotely some alarm detected equipment failures, for example some antenna malfunctions during its installation.

Regarding this AI application, the expert points out its ability of improving the quality of the service provided, by acting faster on either potential or actual network failures, and of reducing the expensive human labor of finding and solving those problems. On the other hand, he brings out the potential problem of AI's problem-solving capabilities, which can be give a solution different from the solution engineers want and drives them to go around the AI's will. The expert explains this problem is not concerning since it is the AI developers' job to build mechanisms that go around the AI. He points out that AI does not always comprehend the full complexity of the problem and how to solve it – sometimes the most optimal way is not the right way.

AI as a network implementation manager

The expert continues, by mentioning **Self-Organizing Networks (SON)**, a self-provisioning AI technology companies are currently investing heavily in and which will have a big future impact on 5G implementation, used for network implementation management. This technology predicts and plans the best way of implementing the network to meet the coverage demand of 5G in each area. However, the technology for this application is still being developed. The expert believes 5G will bring a good internet connection to the remote parts of Portugal and that AI will help in this implementation by deploying SON.

B2B clients

The expert explains the issue with the Portuguese 5G auction and indicates 5G as currently the biggest opportunity for the telecom industry. He explains that after 5G is implemented, the B2B customers will pressure the industry with new 5G-enabled AI products and services. The example given was of Tesla's AI-powered self-driving cars that will benefit a lot from 5G

implementation, in terms of performance increase. On the other hand, currently, B2C customers do not need that much internet speed increase and will not benefit as much from 5G implementation, so there is no pressure from that segment.

Telecom Business Model

Next, the telecom’s business model canvas was presented to the expert and he was asked to verify it and do the alterations necessary.

In the key resources, the expert points out Big Data as major resource, which is being taken seriously by the operators, since it can be sold. Gives example of Disney parks taking advantage of the data location of clients from the telecom AT&T to know that there was a shortage of food vendors in one location of their parks.

When asked about data privacy and security, the expert does not think this is an issue because it is used to follow trends in people and not of one person specifically. It is also mentioned that operators are hacking targets everyday but the investment in cybersecurity makes this not a risk.

The expert explains what interconnection fees and wholesale services are. With the first being the small amount one operator pays another because the first is receiving one call from the second operator, which he clarifies it is not a relevant revenue stream, and the second being the renting of owned infrastructures to other companies. For example, the rent received from other operators for the use of undersea network cables connecting the islands to the mainland.

<p>Key partners:</p> <ul style="list-style-type: none"> - Distribution Partners (Integrator) - IT capability developers and integrators - Infrastructure and equipment suppliers - Network operators 	<p>Key Activities:</p> <ul style="list-style-type: none"> - Deployment and maintenance of infrastructure - Network operation (e.g. traffic management) - Customer service and support - Marketing - R&D 	<p>Value Proposition:</p> <ul style="list-style-type: none"> - Connectivity and reliable telecommunications services - Triple play (TV, Voice and data) - Cloud and Hosting services 	<p>Customer Relationships:</p> <ul style="list-style-type: none"> - Sales and customer support team - Digital & Everywhere - Brand awareness - 24/7 	<p>Customer Segments:</p> <ul style="list-style-type: none"> - B2C - B2B
	<p>Key Resources:</p> <ul style="list-style-type: none"> - Infrastructure and coverage - IT capabilities - Partnerships and alliances - Big Data 		<p>Channels:</p> <ul style="list-style-type: none"> - Retail - Call centers - Website - Social media 	

	- Personnel			
Cost Structure:		Revenue Streams:		
<ul style="list-style-type: none"> - Payroll - Tower Co (fee) - Infrastructure and network installation and maintenance - IT Capabilities development and maintenance - Customer service - Data centers 		<ul style="list-style-type: none"> - Subscription and service fees - <i>Interconnection fees</i> - Wholesale services (e.g. infrastructure renting) - Big Data (potential) 		

Interview/Expert #2 – December 2nd 2020, 11:39am, Zoom call, 38min.

“5G will motivate – and a lot – the implementation and the large-scale adoption of AI.”

Introduction (Emerging Technologies)

The expert points out a trend noticed in his past job in a financial services company. He mentions a trend in Europe of mobile applications that do peer-to-peer monetary transactions, and online shopping via mobile wallet.

He presents data from one study that projects the future of emerging technologies. Cloud, IoT, Big Data, and cybersecurity are the technologies that will have a bigger growth rate between 2018 and 2022, according to an IDC report. The Cloud alone will have a 21% annual growth rate, IoT will have 18%, 9% for Big Data, and 7% for cybersecurity.

According to the expert, AI has many applications, with the more obvious one being its deployment in IoT.

AI as a customer relationship manager

The expert mentions the future problem of existing too much OTT media services that require monthly subscriptions. It is impossible for the consumer to have all the OTT media services (HBO, Netflix, Disney+, etc.). He believes, this will lead to an aggregated platform of all these services by the telecom industry, which will enable AI with Big Data from all the OTT players to make more accurate recommendations of content.

AI as a network operation manager

The expert mentions the AI’s ability to manage and optimize the network operation, and he gives two examples. The first, regarding the new teleworking situation due to the pandemic, where people need to safely access the company’s intranet, something that requires many data. AI can redirect the network data service to those users, in order to prevent network failures. The expert stresses the importance of this technology and the problem it is to convince the decision makers to invest in it. The second is his company’s recent market launch of an AI-powered wi-fi extender capable of predicting and managing the wi-fi needs inside the household in order to prevent from network failures.

B2B clients

The expert predicts the telecoms can deliver AI and IoT advanced solutions for the B2B segment's need of innovation, by partnering with big tech companies who would provide the technology. For example, the expert believes the telecoms could properly deliver a Cisco's new smart watering system to agricultural companies in Alentejo. This AI-powered watering system would be able to analyze, plan, decides and solve the best time to work. Other example is the selling of a smart vending machine that able to automize the reposition of stock by analyzing the stock sales, number of people in the building, seasonality, etc. and manage to build a stock and selling plan.

AI as a customer support operator

The expert points out the AI's ability to integrate bots in customer support to a level that can be totally adaptable and simulate human behavior. This has a big potential to give a more effective response to solving the customer's problems. However, companies outside the industry are doing this and the expert thinks it should be outsourced.

Telecom Business Model

The expert corrects the model by clarifying that there are no "network operator" partners in the industry, with all of them working for their telecom companies.

He stresses the impact AI has on the key activity "network operation", while still needing someone to control what the AI is doing. He gives the example of his former job where AI controlled for fraud but human work was complementary, and of the validation process in Revolut, where everything is automated except the photo authentication, to conclude that AI is very limited to the job it is performing, and that the short and mid-term prediction is the work alliance of humans and AI, instead of AI or humans alone.

The expert speculates that R&D will go in one of two ways. Either competes with the big tech companies with just simple technical solutions, or creates partnerships with them to create innovation, with the last being the expert's best guess.

He also points out that the industry operators are partnering with OTT media services and cloud platforms, in order to improve their value proposition.

According to the expert, the future of telecom will focus on still investing in 4G, and investing in meeting the needs of more clients, with more advanced solutions, for example the ability to properly deliver Cisco's new watering system to one agricultural company in Alentejo. This would transform the big corporate telecom into the intermediary between the big tech companies and SMEs.

The expert believes that the industry has passed the first excitement about AI and the disappointment phase, where all the potential faces reality, and now the industry is able to grasp the real functionality of AI.

He finalizes with the thought that *"without the telecom industry it will not be possible to leave the disappointment phase into the real functionality of emerging technologies. To me, who is going to promote the digital revolution will be the Cisco's and Microsoft's of life, but who is going to make that revolution be adopted by everyone will be the telecoms."*

Key partners: <ul style="list-style-type: none"> - Distribution Partners - IT capability developers and integrators - Infrastructure and equipment suppliers - Big Data suppliers - OTT media services - Cloud platforms 	Key Activities: <ul style="list-style-type: none"> - Maintenance of infrastructure - Network operation (e.g. traffic management) - Customer service and support - Marketing - R&D Key Resources: <ul style="list-style-type: none"> - Infrastructure and coverage - IT capabilities - Partnerships and alliances - Big Data - Personnel 	Value Proposition: <ul style="list-style-type: none"> - Connectivity and reliable telecommunications services - Fixed and mobile voice - Data services - Digital television - Cloud and Hosting services - OTT media services 	Customer Relationships: <ul style="list-style-type: none"> - Sales and customer support team - Digital & Mobile - Brand awareness Channels: <ul style="list-style-type: none"> - Retail - Call centers - Website - Social media 	Customer Segments: <ul style="list-style-type: none"> - B2C - B2B
Cost Structure: <ul style="list-style-type: none"> - Payroll - Infrastructure and network installation and maintenance - IT Capabilities development and maintenance - Customer service - Data centers 		Revenue Streams: <ul style="list-style-type: none"> - Subscription and service fees - Interconnection fees - Wholesales services 		

Interview/Expert #3 – December 3rd 2020, 12:00pm, Zoom call, 53min.

“AI is something that is absolutely fantastic, has no limits, but simultaneously is highly threatening”

“The most valuable thing we will have in the next century is going to be data.”

The expert starts by presenting briefly the history of AI: when was it born; some of its history; its definition; its dimensions. He mentions the still existing confusion between AI and Machine Learning, clarifying that Machine learning is all the coding process done so AI can learn, meaning it is one integral part of AI. He generalizes that the bigger the data fed to the AI systems, the better the AI systems will be.

AI as a customer support operator

The expert explains that every telecom operator works with chat bots at call centers because each call answered is very expensive. The operators try to use AI to redirect the common questions (e.g. “I lost my PUK, what can I do?”) and answer them automatically without involving humans.

AI as a customer relationship manager

The expert stresses that the most important thing in the telecom industry is customer retention and explains how AI can help to retain them.

Taking into consideration the data protection regulations, AI is fed with Big Data of for example customer profiles with their billing, consumption, and customer support call records, or interactions with the brand on the internet. With this data, AI can know what the best service plan for the profile is, and when some client is unhappy with the service and about to leave. The expert suggests AI can increase revenues by helping create new service plans to meet the customers’ needs and warn them of the customers that are likely to leave the service, so they can act and reduce the churn rate.

The expert hints that all these applications could be already implemented, or very likely to be implemented, but could not tell for sure for legal reasons. He explains that it all depends on the information possessed and the information allowed to be used by the law.

AI as a digital marketing tool

The expert brings out the AI capability of digital profiling potential and actual customers and targeting them with precision in digital marketing campaigns. He adds that the companies can see the engagement rate and other metrics in real time and change the campaign if they want to change the offer or the price.

AI as a network operator manager

The expert highlights the AI’s ability to manage and optimize the network operation with preventive maintenance for network failures (e.g. predict that one antenna is going to break down in two days, so one day earlier the company sends someone to fix it), and by predicting the levels of network traffic. He adds that this AI application is being perfected with automation learning processes.

AI as a financial controller

The expert points out the potential impact on costs and revenues of AI’s ability to analyze and discover billing and other financial errors.

AI as a cybersecurity agent

The expert explains how AI can notice signals of potential security breaches, and either notice the company about the threat or fight it.

Telecom Business Model:

The expert mentions security as one key component in the value propositions of for example router security and mobile privacy; references the electricity bill as a big cost for operators, used to keep data centers and cooling systems operating.

Finally, he brings out the cost and revenue nature of interconnection fees, with both natures balancing each other, and confirms that the revenue part might be bigger because there are more

Key partners: <ul style="list-style-type: none"> - Distribution Partners - IT capability developers and integrators - Infrastructure and equipment suppliers - Network operators 	Key Activities: <ul style="list-style-type: none"> - Deployment and maintenance of infrastructure - Network operation (e.g. traffic management) - Customer service and support - Marketing - R&D 	Value Proposition: <ul style="list-style-type: none"> - Connectivity and reliable telecommunications services - Fixed and mobile voice - Data services - Digital television - Cloud and Hosting services - Security (!) 	Customer Relationships: <ul style="list-style-type: none"> - Sales and customer support team (including chatbots) - Digital & Mobile - Brand awareness 	Customer Segments: <ul style="list-style-type: none"> - B2C - B2B
	Key Resources: <ul style="list-style-type: none"> - Infrastructure and coverage - IT capabilities - Partnerships and alliances - Big Data - Personnel 		Channels: <ul style="list-style-type: none"> - Retail - Call centers - Website - Social media - partner retail 	
Cost Structure: <ul style="list-style-type: none"> - Payroll - Infrastructure and network installation and maintenance - IT Capabilities development and maintenance - Customer service - Data centers - Energy and cooling of data centers - Rental of storage space of infrastructures - Interconnection fees 			Revenue Streams: <ul style="list-style-type: none"> - Subscription and service fees - Interconnection fees - Wholesales services 	

Interview#4, Experts #4 and #5 – December 3rd 2020, 15:32pm, Zoom call, 39min.

Expert #5 starts by introducing the recent project both are working on. The project is about creating an online course useful for everyone in their company about what AI is. They want to

create a common understanding of what it is among all employees in order to incentivize synergies and innovation between departments.

Expert #4 moves on to explain how all their AI projects revolve around working with advanced analytics. He explains the company receives many data from their clients and that AI is behind its processing. The people who develop the AI software are data scientist and they are in big demand, making them well paid.

AI as a customer relationship manager

Expert #4 mentions the development of AI to make recommendations to the customer on either shows automatically recorded or shows on in the moment. These recommendations are produced by AI processing through advanced analytics the content the customer watched before. To illustrate this application, he gives the example of Netflix's recommendations.

AI as a network operator manager

Expert #4 references the already implemented AI systems that notice problems and failures in the infrastructure and network equipment, and solve about 90% of them. He mentions this happening in their global operation center (GOC), the infrastructure-supervising center. In there, they receive "tickets" – the alarms of failures – that notice them of problems and failures in their network equipment. Expert #4 stresses that 90% of the tickets are very generic and can be solved by AI, giving the example of a "My network source shut down." type of problem, which can create 100 tickets, affecting 100 clients. AI can agglomerate those 100 tickets into 1 and solve it automatically, if it can, or redirect it to the correct expert. This automation leaves the human labor with just 10% of the work to focus on. Besides solving those problems, expert #4 mentions that AI can also prevent the problems from happening by predictive maintenance. These processes involve AI understanding which network failures will happen and prevent it from happening with for example one software update. He points out this application saves on significant expenses such as human resources, electricity, and PCs.

In the future, expert #4 projects the new 5G antennas will have AI incorporated in order to adjust the antenna angle to where it is most needed to emit more data to that location.

AI formation

Expert #5 continues to explain their online course project. He justifies that since every company needs innovation, and innovation starts by sparking curiosity and adding knowledge to the employees, there is a need of building a structure for that innovation in the form of a course about AI, with the use cases of their company. This course should have a simple language and be transversal across departments. It promotes the digital transformation by abolishing the currently rigid organizational structure, by pushing the company to be more collaborative and to create synergies between people's knowledge.

AI as a network implementation manager

Expert #4 explains the AI's ability to process data about network coverage population's needs, in specific of 5G, to make predictions and plan its optimal infrastructure coverage.

However, there are some conditions influencing this planning. According to expert #4, 5G's optimal infrastructure coverage is facing the problem of regulation. He states that 90% of 5G potential revenues come from 10% of the territory (Lisbon and Porto). This happens because 5G will allow more speed in connections that will benefit mainly telecom's tech company

clients, for example, car companies selling self-driving cars, which are concentrated in the two big cities. The expert explains that the Portuguese industry is not very evolved for the use of 5G and gives example of South Korea, where 5G is needed for gaming or VR technology. Moreover, the investment needed for one area is not proportional to the number of clients using it, they spend as much covering Lisbon or Guarda. Expert #4 explains that because of the regulatory entity ANACOM, telecoms will have to invest evenly across the territory in antennas, new renting spaces to install infrastructure and new spectrum frequencies, resulting in making no profit from their investment.

Costs of AI

Expert #4 explains that the cost of AI is simply the payroll of data scientists to develop the software and do maintenance on that software for bugs and updates. In their case, their partner Microsoft develops the AI software and they only need to implement it in their network.

AI as a customer support operator

Expert #4 briefly mentions AI being used in customer support chat bots.

Telecom business model:

Expert #4 stresses the importance of the strategy department as an example of R&D to keep up innovating and planning how the infrastructure should be in five years. He also corrects the “digital television” service for “IPTV” (TV from the internet protocol), since it best represents the service provided. “digital” is generalizing, and identifies streaming channels like podcasts, twitch as a channel of reaching clients. Moreover, they are investing in podcasts as ways of spreading knowledge and advertise.

Expert 5 validates the business model as a transversal and resumed picture of what a telecom company is, and just mentions the revenue streams will be more diversified once 5G is implemented, since it will bring innovation.

Key partners:	Key Activities:	Value Proposition:	Customer Relationships:	Customer Segments:
<ul style="list-style-type: none"> - Distribution Partners - IT capability developers and integrators - Infrastructure and equipment suppliers - Network operators 	<ul style="list-style-type: none"> - Deployment and maintenance of infrastructure - Network operation (e.g. traffic management) - Customer service and support - Marketing - R&D (e.g. Network 	<ul style="list-style-type: none"> - Connectivity and reliable telecommunications services - Fixed and mobile voice - Data services - IPTV - Cloud and Hosting services 	<ul style="list-style-type: none"> - Sales and customer support team - Digital & Mobile - Brand awareness 	<ul style="list-style-type: none"> - B2C - B2B

	Infrastructure Strategy)			
	Key Resources: - Infrastructure and coverage - IT capabilities - Partnerships and alliances - Big Data - Personnel		Channels: - Retail - Call centers - Website - Social media - Streaming channels	
Cost Structure: - Payroll - Infrastructure and network installation and maintenance - IT Capabilities development and maintenance - Customer service - Data centers		Revenue Streams: - Subscription and service fees - Interconnection fees - Wholesales services		

Interview #5/Expert #6 – December 6th 2020, 6:30pm, Phone call, 20min.

The expert starts by introducing AI, explaining AI is distributed along the value chain of the company. He also stresses the importance of data as the currency for the entire industry revolution, and the enhancer for the evolution of AI, which feeds on data analysis. He breaks down the ways AI impacts the industry into **internal operations** and the **relation with clients**.

Next, the expert summarizes the applications of AI in the internal operations in **network operator management; product design**, which is included in customer relationship management; **and provisioning**.

According to the expert, those are less important, comparing to the ones involving the relation with the client, since they directly impact revenues and the most important stakeholder (the client). These applications are **customer support operator**; and as a **recommendation tool**, to adjust the content to the client, which works the same way as product design, being also customer relationship management.

AI as a customer support operator

The expert mentions AI being developed into new interfaces in the customer support area, for example in text-to-speech technology, bots, speech-to-text, sorting of clients based on their problem (e.g. someone with a billing problem is transferred to a billing expert).

The expert finalizes that all these technologies are implemented but constantly improving starting with their base model.

The 5G conjecture (B2B clients)

The expert points 5G as the biggest opportunity for the telecom industry, because it is the new era of possibilities for the industry, and gives the example of the autonomous driving dependency of AI and being boosted by 5G to demonstrate that 5G will usually involve AI. He explains the direction of 5G towards the B2B segment, because there are already use cases for this segment, while the B2C segment is still in the process of discovering applications for it.

According to the expert the biggest threat to the telecom industry is at a political and regulatory level, the Portuguese 5G auction. He thinks the industry's regulatory entity (ANACOM) considers the current telecom operators as thieves, stealing the consumers and not giving them a quality service at the best price, and is going to fight them in the future 5G coverage auction for which ANACOM is responsible. The expert lists the regulator rules of the auction and considers them an insult to the operators, taking them all incentives to invest in the new 5G network. The rules state that there is network spectrum reserved for new comers of the industry, and a demand for current operators to cover 90% of customers in 6 years, while the new comers only have to cover 50%, which corresponds to just Lisbon and Porto, the most profitable locations. Moreover, in the opinion of the expert, the worst condition is that the newcomers have the right to use the network infrastructure of all operators for 10 years.

The expert notes that the operators and ANACOM are in court because of this, and explains that there is no evidence of the ANACOM's accusations, on the contrary, the Portuguese network has been classified as one of the best in Europe, and there were no studies made of the future impact the conditions would bring to the industry, leaving the expert fearing for the worst.

Interview #6/Expert #7 – December 7th 2020, 4:06pm, Zoom call, 50min.

“Voice is going to be the main interface between human and machine in the next 3 to 5 years.”

The expert starts by specifying he is expertise is in Machine Learning, and that he's company uses AI systems from third party developers.

The expert thinks AI and digitalization will cause disruption and change to the industry, and that agility is essential to enable companies to adapt to these changes. He also believes that since telecoms sell ICT and telecommunications, they will be the support industry for this digital revolution.

AI as a customer relationship manager

The expert brings out the industry's need to adapt and adjust to address the customers' need of a personalized and empathic communication and interactions. He believes each iteration with the client is one opportunity to create an impression and make dialogue. At the moment, most iterations are moments of failure, because people reach the company mostly to complain, or have doubts about something.

The AI's job is to improve that relationship by automatically selecting and recommending service plans or adjustments to upsell or cross-sell, that specifically fit the customer better, when contact with the company is made, for example in the B2B customer webpage. Furthermore, AI can prevent customers from churning by identifying with data analytics potential churners 3 or 4 months before they churn. The expert believes this technology, although advanced when compared to other Portuguese industries, it still has much more

potential and improvements are being done to reach that potential of personalization. The expert does not consider it AI, since it still needs human labor to extract value.

“There is a very thin line between creepy and awesome.” – regarding consumer’s perspective on their data being used.

The expert advises the industry to be careful on how to disclose that they are monitoring everything the customers do, as this can be a showstopper to good customer relationships.

AI as a customer support operator

According to the expert, true AI can be seen in their Interactive Voice Response systems (IVR) used in customer support calls, which use speech recognition to interface with customers adapting to their responses in order to solve their problems or redirect it to someone that can.

AI as a network operator manager

The expert mentions AI models working to prevent network failures by analyzing potential problems and solving them before they occur.

B2B clients

The expert believes that, allied to AI, 5G promotes the connection of many devices. This will create new business opportunities in the B2B market, for example in agricultural and farming customers that will benefit the most from 5G, since they will benefit from high density connectivity and low battery consumption. The expert thinks the industry will try to understand the B2B needs of tech and sell them solutions. On the other hand, the B2C market is still undeveloped in terms of useful opportunities for new innovative 5G solutions.

Telecom business model

The expert advises to remove “network operators” from partners, since those operators are internal, and gives the example of Huawei as an infrastructure supplier.

Adds that content providers are important partners for all industry players and suggests changing “customer service and support” to “customer lifecycle management” because it involves knowing and interacting with every part of the customer journey.

Regarding the value proposition, the expert explains there are two approaches to the telecom value proposition: lean and smart. The lean is what is described in the canvas, being the supplier of one commodity, cheap, undifferentiated, reliable. The smart approach is to prioritize the ecosystem provided, not just the commodity. Companies are changing to smart operators instead of lean, with 80% of them being smart. This is due to customers also caring about the brand and experience, alongside the price.

Finally, the expert advises to include “Interconnection fees” as a part of “wholesale services” in revenue streams, because wholesale services is the commercial relationship between operators, including those fees, and classifies selling infrastructure use to other operators as wholesale services.

Key partners: <ul style="list-style-type: none"> - Distribution Partners - IT capability developers and integrators - Infrastructure and equipment suppliers (e.g. Huawei) - Content providers 	Key Activities: <ul style="list-style-type: none"> - Deployment and maintenance of infrastructure - Network operation (e.g. traffic management) - Customer lifecycle management - Marketing - R&D 	Value Proposition: <ul style="list-style-type: none"> - Connectivity and reliable telecommunications services <ul style="list-style-type: none"> - 4P (Fixed and mobile voice, Data services, Digital television) - Cloud and Hosting services - Ecosystem of services 	Customer Relationships: <ul style="list-style-type: none"> - Sales and customer support team - Digital - Brand awareness 	Customer Segments: <ul style="list-style-type: none"> - B2C - B2B
	Key Resources: <ul style="list-style-type: none"> - Infrastructure and coverage - IT capabilities - Partnerships and alliances - Big Data - Personnel 		Channels: <ul style="list-style-type: none"> - Retail - Call centers - Website - Social media 	
Cost Structure: <ul style="list-style-type: none"> - Payroll - Infrastructure and network installation and maintenance - IT Capabilities development and maintenance - Customer service - Data centers - Content 		Revenue Streams: <ul style="list-style-type: none"> - Subscription and service fees (bigger on B2C) - Wholesales services (e.g. Interconnection fees) 		

Interview #7/Expert #8 – December 8th 2020, 3:01pm, Zoom call, 44min.

The expert begins by explaining he supports the company operation and manages a Big Data cluster with data analytics and AI models, from which including Machine Learning. The main goal of his area is to improve the customer experience and network operation, by making it more efficient and effective.

The expert explains that AI models take time to learn and be implemented correctly, which is something managers do not fully understand.

“What is important is to work the data in order to extract as much value as possible from them.”

AI as a network operator manager

The expert explains the AI’s progressive ability to use data from installed infrastructure to predict network failures, and even solve them or redirect the problem identifies to the right team to solve them. He clarifies that these applications still need lots of improving in order to get to the goal of full automatization and reach to all cases. This system works with alarms that work by correlating data to warn for possible problems, which could be various, for example service breaks, network underperforming, or not performing as expected.

The expert exposes the problem holding this application from thriving as the lack of feedback loop. As these network problems affect directly the customer, it is important to evaluate them to see which ones are more important to solve and if they are in fact being solved correctly. People must do this evaluation and very often there is no way of knowing it, because there is no system to inform either the AI model or the staff if the intervention on the problem fixed the problem. Consequently, there is a gap in the learning process of the AI models to improve their skills.

According to the expert, the industry faces the challenge of their old infrastructures. The operators need quality data to work with and the data coming from the old infrastructures is most times unstructured or not operable at all. However, 5G infrastructure and new platforms are built with the concern of data collection and prepared for data analysis. For example, there are already some infrastructure suppliers that incorporate AI models in their equipment to live traffic management.

Surprisingly, the expert adds that AI is not very necessary to the implementation management of these new infrastructures.

AI as a customer relationship manager

With data analytics being an essential tool for AI development, the expert points out the GDPR has a major limitation that protect and restrict the data that can be used by companies without the customer consent. He speculates this can be solved with future new contracts that include the clients’ permission to use their data, and that will enhance new business in the industry. AI would help here by analyzing those data and extract insights from them.

The expert mentions he’s not an expert in this particular subject but he thinks this application could use in web services, interactive TV, streaming services, and box apps to understand customer’s flows, profiles and preferences, all automatically, and at the limit recommend personalized services or content.

The future for telecoms

The expert realizes 5G will generate a lot of information and potentially create new businesses, which will bring new areas of possibilities. He gives the example of IoT applications, where the telecoms will be the firsts to test the 5G network and can position themselves to help companies evolve. The expert show this comes in line with past actions, where telecoms partner with other companies and start-ups to take advantage of the network and innovate with the network.

Telecom Business Model

The expert points out that one thing is network operation, the traditional operation, but there is also service operation on top of the network e.g. apps, web platforms, TV guide, which is also relevant as a key activity.

Key partners: <ul style="list-style-type: none"> - Distribution Partners - IT capability developers, integrators and suppliers - Infrastructure and equipment suppliers 	Key Activities: <ul style="list-style-type: none"> - Deployment and maintenance of infrastructure - Network operation (e.g. traffic management) -Service operation - Customer service and support - Marketing - R&D 	Value Proposition: <ul style="list-style-type: none"> - Connectivity and reliable telecommunications services - Fixed and mobile voice - Data services - Digital television - Cloud and Hosting services - Data analytics services (B2B) 	Customer Relationships: <ul style="list-style-type: none"> - Sales and customer support team - Digital - Brand awareness 	Customer Segments: <ul style="list-style-type: none"> - B2C - B2B
	Key Resources: <ul style="list-style-type: none"> - Infrastructure and coverage - IT capabilities - Partnerships and alliances - Big Data and Cloud - Personnel 		Channels: <ul style="list-style-type: none"> - Retail - Call centers - Website - Social media 	
Cost Structure: <ul style="list-style-type: none"> - Payroll - Infrastructure and network installation and maintenance - IT Capabilities development and maintenance - Customer service - Data centers 			Revenue Streams: <ul style="list-style-type: none"> - Subscription and service fees - Interconnection fees - Wholesales services 	

Interview #8/Expert #9 – December 9th 2020, 4:25pm, Phone call, 29min.

The expert defines the goal of AI in the industry to anticipate the client’s needs and optimize the company’s resources by removing the human labor from dispensable tasks into tasks that

require human judgement. However, the expert warns for the big risk of giving too much trust to these systems and not controlling for AI mistakes.

The expert stresses the importance of partnerships with start-ups where the telecom borrows the network that makes the start-up thrive.

B2B clients

She continues by introducing one B2B contact, where the telecom supplies voice services to one medical call center company. This company needed to improve their capacity of taking calls and the telecom implemented AI bots that would take less time in each call, and that did a triage of the patients without human interaction.

Other product the expert illustrates is in the telemedicine industry, where the hospitals are evolving into having software that does initial simple diagnosis based on AI pattern recognition of lung spots, for instance.

The expert mentions a barrier in the deployment of more AI and IoT by the B2B clients, and consequently by the telecoms, because many of the current clients are behind on the digital revolution, using old tech which is not adaptable to AI or data collection at all. There are some cases where data cards can be implemented to modernize a bit, but they still lack several functions to enable data processing.

AI as a customer support operator

The expert explains how AI's natural language processing skills in IVR can typify the answers given to the client and giving up workers from those automated tasks.

AI as a cybersecurity agent

The expert explains how AI can collect and analyze data shared in a community data center that report possible hacker attacks and risks, in order to prevent those attacks from happening. However, the expert clarifies that she is not an expert on this theme and not to trust her completely on this.

Interview #9/Expert #10 – December 14th 2020, 6:00pm, Phone call, 19min.

The expert clarifies that he is not working with AI in his area and he does not have prior knowledge of working with AI before.

GDPR as a barrier

The expert stresses throughout the interview that the GDPR is the big barrier for AI deployment in the industry because the operators are really concerned about not violating the customers' rights by using their personal data without permission.

AI as a customer support operator

The only AI application the expert pointed out as being currently at use in his company is the AI chat bots, which learn automatically while answering to common questions customers have, for example "How do I reset my PIN/PUK?". He adds that this technology is bought and not internally developed.

AI as a customer relationship manager

The AI models to run in this area are still being developed and can help in the management of clients and client accounts with cross-selling abilities.

B2B clients

The expert predicts that, IoT technology will spread and produce a lot of data to power AI applications.

Interview #10/Expert #11 – December 17th 2020, 9:05am, Zoom call, 54min.

The expert starts by clarifying that the core layer of the business is to guarantee they can provide a telecom and entertainment service. He continues by dividing the most important applications into client base management (CRM), client's pain management, and management of optimization of operations.

The expert concludes that there are AI application needs for almost all the processes where decision making is necessary, or where optimization is possible. The question is if the benefit from implementing it, either customer satisfaction or productivity, is greater than the cost.

AI as a customer relationship manager

The expert explains how AI can manage the client base, analyzing what the clients want without bothering them by asking. He mentions that AI can make recommendations of service packages (next best offer), and of content, but also capable of preventing churning of clients.

AI as a network operator manager

The expert reinforces that AI can predict when the client will be unhappy and manage that pain, in the case of network failures by identifying anomalies in the network and intervene to prevent it from failing, by either repairing the anomaly, or by redirecting it to an expert. He stresses this can reduce costs in call centers or clients churning and increase revenues and client satisfaction.

AI as a customer support operator

According to the expert, in the customer support department, AI can optimize the operation by analyzing the best method to approach one client, or the best assistant to the client. He continues by projecting that IVR, as AI could know what the customers are calling for before they call, in some cases. He also thinks that AI can evolve into analyzing the conversation of the client and assistant warning for incorrect tone of voice, wording, etc.

B2B clients

Monetization of data is one business the expert believes is starting to evolve in the industry. His company already sells data, according to many ethical and legal principals, treating it anonymously and aggregated. He gives the example of geo-location data sold to municipalities, tourism organizations, or to covid-19 related studies, which lead to more efficient cities. With that data, AI can be used to draw insights from it.

Telecoms will drive the digital revolution of their B2B clients with the deployment of 5G, bringing efficiency and fast reliable connections, new use cases using AI will follow.

<p>Key partners:</p> <ul style="list-style-type: none"> - Distribution Partners - IT capability developers and integrators - Infrastructure and equipment suppliers - Network operators - HR for call center, door-to-door sales, and retail - business consultants - IT consultants 	<p>Key Activities:</p> <ul style="list-style-type: none"> - Planning, deployment and maintenance of infrastructure - Network operation (e.g. traffic management) - Customer service and support - Marketing & Sales - R&D (product development) 	<p>Value Proposition:</p> <ul style="list-style-type: none"> - Connectivity and reliable telecommunications services <ul style="list-style-type: none"> - Fixed and mobile voice - Data services - Digital television - Cloud and Hosting services - Data monetization (B2B) 	<p>Customer Relationships:</p> <ul style="list-style-type: none"> - Sales and customer support team - Digital & Mobile - Brand awareness 	<p>Customer Segments:</p> <ul style="list-style-type: none"> - B2C - B2B
	<p>Key Resources:</p> <ul style="list-style-type: none"> - Infrastructure and coverage - IT capabilities - Partnerships and alliances - Big Data - Personnel 		<p>Channels:</p> <ul style="list-style-type: none"> - Retail - Call centers (staff, IVR) - Website - Social media - SMS - Door-to-door Digital (website, social media, apps, box) 	
<p>Cost Structure:</p> <ul style="list-style-type: none"> - Payroll - Infrastructure and network installation and maintenance - IT Capabilities development and maintenance - Customer service - Data centers 		<p>Revenue Streams:</p> <ul style="list-style-type: none"> - Subscription and service fees - Interconnection fees - Wholesales services - Data monetization 		

Interview #11/Expert #12, #13 and #14 – December 17th 2020, 12:00pm, Zoom call, 45min.

The interview starts with expert #12 stressing the recent importance monetization of data collected in the industry has gained. He explains this process happens through profiling customers and geofencing (geo-localization).

AI as a network operator manager

Expert #12 explains that AI can analyze the network demand and configure it accordingly in order to prevent network failures and optimize customer satisfaction. This analysis is made via cloud and sometimes in the antennas, which can find the best internet speed or voice call quality for one specific area. Expert #14 adds that the future of networks will bring complexity, new technologies and technology generations together, and AI will be able to process more information to manage the networks to improve their efficiency and speed.

AI as a customer relationship manager

Expert #12 introduces the AI's ability to profile and analyze customers, creating a score system for them, and predict which clients can be problematic, the best service plan for each client, which he calls "the next best offer", or recommend the best content to watch next. Expert #13 confirms this use and adds that the systems of machine learning can prevent churning.

AI as a network implementation manager

Expert #14 mentions SON as centralized AI and machine learning systems installed in infrastructure by the suppliers which is not centralized. The expert explains how the SON serve to optimize and plan, according with the budget, the implementation of new network infrastructure, for instance 5G antennas. Expert #12 reinforces the idea explaining the planning also considers the customers' demand for the area and the value created by it.

B2B clients

Expert #12 explains how 5G will decrease latency and allow new businesses to expand, for example autonomous driving, and grid management for electric vehicles. In this case, the future will need AI to manage the electricity demand of electrical vehicles by optimizing where to install charging spots.

Expert #14 mentions the "sensorization" smart city's trend of integrating sensors in common objects (IoT implied), for example watering systems, garbage collectors, or traffic lights, which will enable AI to analyze all that connected data in real time.

Expert #12 thinks there are no limitations to the deployment of this new business opportunities besides having the right business cases that bring value to society.

This expert returns to the idea that data has a big value today and that selling data to companies is a growing practice in the industry. He adds that selling data has implications for the development of other industries. For example, selling data to one large retail company so it can decide where to open one supermarket, or the example of car charging stations' implementation process. Expert #14 carries on mentioning the example of public institutions needing data for security purposes of controlling agglomerates of people.

Other AI applications

Expert #13 briefly mentions three AI applications without exploring them. He notes AI as machine learning implemented in call centers, and AI's pattern detection and data analysis capabilities used to prevent financial fraud or in cybersecurity.