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Centro Interdisciplinario de Posgrados
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Departamento Ingeniería
Maestría en Planeación Estratégica y Dirección de Tecnología

Tesis:

Strategic model of technological convergence for the Colombian television industry based on the study of current standards, trends in technological development and expert consulting for improving competitiveness in the modern TV industry over Internet.

Tesis para obtener el grado de Maestro en Planeación Estratégica y Dirección de Tecnología

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Se aprueba el Trabajo Práctico o Tesis:

**Strategic model of technological convergence for the
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standards, trends in technological development and expert
consulting for improving competitiveness in the modern tv
industry over internet**

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DEDICATION

This work, as well as all the achievements of my life, have God as the main author, who accompanies me and guides me at every step and who deserves all the honor and dedication for it.

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RESUMEN

La industria de la televisión a nivel mundial se encuentra atravesando un gran cambio provocado por la convergencia tecnológica, lo que obliga a los canales de televisión a modificar su modelo de negocio y las tecnologías que usa para incluir un portafolio de transmisión sobre internet, sin embargo, el panorama no es claro, cada empresa televisiva usa estrategias tecnológicas diferentes y algunas solo esperan para luego tomar sus decisiones. En la presente investigación se plantea un modelo de convergencia tecnológica de la industria de la televisión en Colombia que les permite a los participantes de esta industria realizar su planeación estratégica y prospectiva, vinculado al modelo de negocios y la cadena de valor. El modelo descriptivo propuesto se realizó de acuerdo al estado del arte, a la experiencia de los expertos internacionales, de los expertos de diferentes canales colombianos y al diseño de modelos de teoría fundamentada. El modelo recopila la experiencia de los especialistas desde sus diferentes puntos de vista profesionales y de acuerdo a su experiencia conjunta en el desarrollo las estrategias empresariales en diferentes canales y proveedores de tecnología, buscando un consenso cualitativo y predictivo del actual y futuro panorama de la industria. Como resultado, el modelo presentado relaciona los medios de transmisión actual y el nuevo paradigma de televisión sobre internet, así como los flujos de contenido, de publicidad, y suscripción, de interacción y las principales tendencias tecnológicas. Dentro de los principales hallazgos se evidencio una ausencia de interés de los canales de televisión por invertir en tecnologías UHD, puesto a que su transmisión demanda un mayor ancho de banda que puede ser aprovechado por un mayor número de contenidos simultáneos. También se encontró que muchas de las barreras de entrada que tenía la industria televisiva están cayendo ante la aparición de los servicios en la nube, la popularización del software libre y las redes sociales.

ABSTRACT

The television industry is going through a great change caused by technological convergence, which forces television channels to modify their business model and the technologies they use to include a transmission portfolio over the Internet, however, the picture is not clear, each television company uses different technological strategies and some of them just wait to make their decisions later. In the present investigation, a model of technological convergence of the television industry in Colombia is proposed, which allows the participants of this industry to carry out their strategic and prospective planning, linked to the business model and the value chain. The proposed descriptive model was carried out according to the state of the art, the experience of international experts, experts from different Colombian channels and the design of models of grounded theory. The model gathers the experience of the specialists from their different professional points of view and according to their joint experience in the development of the business strategies in different channels and technology providers, looking for a qualitative and predictive consensus of the current and future panorama of the industry. As a result, the presented model relates the traditional means of transmission and the new paradigm of television over the Internet, as well as the flows of content, advertising, and subscription, interaction and the main technological trends. Among the main findings was an absence of interest from television channels to invest in UHD technologies, since their transmission demands a greater bandwidth that can be exploited by a greater number of simultaneous SD or HD content.

INTRODUCCION

For many years, the television industry had not had strong competitors, there was no one who was able to displace them and disrupt their business model, so their audiovisual contents were not totally linked to the immediate preferences of the viewers. However, in recent years, new technologies have assaulted the televisual world revolutionizing the transmission mode of classic television channels (Kakpovi, 2011). At present, the Internet is capable of providing high transmission speeds thanks to technologies such as optical fiber or DSL, and it also provides a greater geographical coverage, in addition, the possibility of accessing multimedia content through mobile devices with high speeds due to infrastructure 4G. All these factors have turned the Internet into a means capable of delivering video to end users with technical characteristics that compete with traditional television, but going further and interacting with the user.

A decade ago, experts anticipated that the television would be on demand and paid, "it will be necessary to pay to see it in all its variants and the financing of television as a factory of products" (Pérez de Silva, 2002, pág. 66). Today we know that this scenario is called IPTV (Internet Protocol Television) (Del Pino & Aguado, 2012). IPTV allows the consumer to satisfy their preferences by assembling the content according to their predilection, also in terms of technology, it allows a better use of the media by its multicast transmission instead of broadcast, it offers in addition the use of digital applications such as a search on the internet, music playback, games and others. IPTV includes concepts such as video on demand (VoD) and real-time television (ALQuayed & Zaghloul , 2014).

The current scenario is the result of the combination of old and new media elements, it is composed of diverse communication products compiled in a single channel (internet) (Izquierdo Castillo, El nuevo negocio mediático liderado por Netflix: estudio del modelo y proyección en el mercado español, 2015). The debate on the convergence of television and audiovisual content on the Internet is being served, in the midst of the convulsive panorama

that emerges as a consequence of the new consumption habits of new platforms through the Internet (Del Pino & Aguado, 2012)

The Internet proposes a challenge for the consolidation of business models compatible with the consumer culture of the new internet viewer (Izquierdo Castillo, 2012). The integration of both actors (Television and Internet) implies readjustments, new approaches and new modes of distribution. That is why, the business of programming and dissemination is in full swing (Del Pino & Aguado, 2012).

The television industry faces the challenge of returning the investment made in recent years in what would be its new broadcasting technology known as DTT (Digital Terrestrial Television). At the same time, it is forced to enter the competition of IPTV. The technological transition must be carried out with extreme care due to the technological difference implied by these two means of diffusion. In addition, it must contemplate changes in business models such as the establishment of new connections with the audience and technological changes in the production and post-production phases of the contents (Del Pino & Aguado, 2012).

Due to all this, it is urgent to establish mechanisms that guide the actors of this industry in the changes of the business model and investment in technology, since the picture is not completely clear. These mechanisms should be based on the users' preferences for internet use, technological convergence and a transition from the current available technology to the technology of the future, which is in the process of being refined.

The Colombian television industry, like the entire world industry, faces the challenge of defining its transition and adaptation to television over the Internet. However, Colombia has its own peculiarities with respect to its neighboring countries. This was the only country in the region to host the European DVB standard. Additionally, the reception was given in conjunction with the release of the second version of this standard: DVB-T2, with which Colombian television companies had the benefit of avoiding investments in DVB-T and the subsequent change of technology to DVB-T2. Therefore, the evolution of digital terrestrial television in Colombia has a great influence of European developments, but in turn, its future on the Internet responds to global trends.

CHAPTER 1. PURPOSE AND ORGANIZATION

1.1.Problem Statement

The growth and the ability of coverage of the internet, together with the improvement of the computer equipment and the solidification of the use of alternative screens, have opened up the landscape of television over internet (Morales Morante, 2011). The web has allowed users, for more than one decade, the exchange of videos with qualities and acceptable, today fully competitive resolutions with regard to television. These new opportunities have been exploited by new distributors of video such as YouTube and Netflix, which have created a business model focused on the user, where is he who chooses what to watch, when and where. The basis of this new landscape are the new and increasingly improved technological resources that provides internet, the lower costs and the emergence of new technologies based on technical innovation (Herederio Diaz & Reyes Sanches, 2016).

These new competitors and this new scenario had threatened the television industry, who believed to have the scene controlled by the distribution of video based on the provider through channels such as cable, satellite and DTT. The scene is such that some authors claim that the provider-based television is dead (Toffler y Toffler, 2006, p.99). Izquierdo (2015) describes the impact in Spain of this change in the model, she indicates that the Spanish market has a small subscriber to the distribution of television content between traditional platforms of 4.8 million compared to the consumption of online video that already reaches the 85.5% of the population that connects to the internet.

Since the beginning of the so-called "digital age" in television, technological changes happen without giving time to be assimilated by the public dumbfounded attending a race between fabrics and media companies (Castillo Pomeda J. , 2015). However, the television industry does not have why die, only facing a transformation, Internet does not kill the television, but that will transform it into the e-life media (Pérez de Silva, 2002) .

Television channels had to stop to see the Internet as a medium which compete against, and begun to see as another means of distribution for their content, but with its own characteristics

(Polo & Villar, 2010). The new challenge is highlighted as a deliver to the world the content under the paradigm “any device, anytime, anywhere” (Monzoncillo & Sendrá, 2010). DTT, despite being recently technology hosted by the television industry, is not the hegemonic system. The future is hybrid, convergent and more interactive. The European Parliament, for example, invites operators to distribute their content on all platforms with special emphasis on the Internet, this will allow them to take the step to convergence, where television will be on demand and can be reproduced on televisions, computers, consoles and phones. However, the use of TV on the internet is still low. (Campos Freire, 2013). The transit to the new television by Internet will not be easy for some of the big television networks (Islas, 2008).

These changes will be for the television channels new readjustments in the technology of distribution approaches, as well as new aspects of business. At the technological level, convergence translates into tools or common to several media infrastructure to capture, edit and disseminate its contents. In the business area, the convergence is reflected through the diversification of business, according to all kinds of alliances, mergers or collaborations between companies belonging to the same group or different communication sectors (Larrondo Ureta, 2015).

In addition, this dimension is related to internal movements that made the companies to adapt their organizational structure and newsrooms. Necessary to re is organize the television industry value chain. Technological change brings with it a change in professionals, the distribution of content and the habits of consumers. (Aguado, 2011).

The problem itself lies in the way in how the industry has welcomed these changes, no theoretical guides and/or practices. Television channels have moved its resources slowly, trying to learn to trial and error, while they see the new industry placed on internet. At first, the approach that has made the television industry to digital reality has been limited to insert parts of the conventional television into a web page. Now, however, there are an incredible amount of information and videos made by citizens, of sources up to now dormant in a second line (Bañón, 2016).

Several authors have focused their research on different aspects of the transition, for example, ALQuayed and Zaghloulha (2014) have reviewed the technical challenges involved in hosting IPTV in its different degrees. On the other hand, Jenkins (2008) describes the aspects

of user participation in the increasingly interactive way of transmitting television. Eco (2010) establishes how the characteristics of these users should be taken into account in the new business model, the generational, social, economic and even gender aspects. Others like Ruano (2013), show the changes that must be made to audiovisual materials to be delivered through portable platforms as mobile devices, not only in technical aspects, such as formats, but also in aspects of content.

Although all these aspects have been assessed individually, there is not a study to collect each of these new demands and technological trends and business and that achieved relate them together. The joint modeling of transition that is suffering from industry is required. It is important to know how each of these aspects is related, starting from the technological changes that have led to them and those who are taking boom and seek to incorporate, to the needs of customers seeking to satisfy. Without a global compression of the variables surrounding this industry, the television companies risk becoming increasingly less competitive, losing its market share for the users who migrate to the internet and to make investments in technology that does not strengthen the necessary links in the new production line.

1.2. Purpose of the investigation

The purpose of this research is to design a model of technological convergence for the requirement of digital video services in the Colombian television industry, which allows to guarantee the scaling of current technology towards television over the internet.

1.3.Objectives of the research

1.3.1. Investigation questions

Does a model of technological convergence of Colombian television services towards television over the Internet allow to establish the best conditions to ensure a correct migration and technological operation and services?

1.3.1. Main objective

Design a strategic model of technological convergence for the Colombian television industry based on the study of current standards, trends in technological development and expert consulting for improving competitiveness in the modern TV industry over the Internet.

1.3.2. Specific objectives

- Analyze the business model, standards and current technologies of the television industry through a study of protocols and study of literature.
- Identify the needs and technological trends of the industry through the opinion of experts, complemented with the review of the state of the art.
- Analyze the necessary factors for the technological transition that respond to the change of business models and that will allow to maintain competitiveness.
- Recognize through the successive consultation of experts the particularities of the variables and categories of the technological convergence of the television industry in Colombia that will allow the Tv channels to maintain competitiveness.
- Develop a model of grounded theory that represents the present and future characteristics of competitiveness and technology of the Colombian television industry that responds to the analysis of the main factors of the technological convergence.

1.4. Justification of the investigation

The television industry is in a moment of transition, a moment of technological realignment and the companies of this industry are facing this change seeking to maintain their competitiveness and struggling not to disappear, making changes to their business models and large investments in technology. Despite this, there are no mechanisms that clearly guide these investments, there are no models that give guidelines on the standards and final protocols for the establishment of TV over the Internet. Investment decisions are usually guided by the experience of the managerial and engineering area and the emulation of strategies used by others. The existence of a technological convergence model that collects and formalizes the experience of the experts from different companies, will make it possible to specify a generalized trend that serves as a basis for consultation. That is why, this proposal of thesis aims to design a model for the Colombian television industry, based on the fact that

every process can be planned, directed and improved with a business focus, aligned with regulatory technical requirements.

The relevance of this work lies in the generation of a model that helps to search solutions to real problems and that contributes the efficient and effective application of the resources destined to finance technology. In addition, it will clarify the relevance of new factors such as content preference, interactivity, personalization, among others and how they relate to the new technologies available. The model that will serve as a guide to face the technological transition and the change of the business model, will allow to guide companies to make their strategic decisions to adapt correctly to the demands of the distribution on the Internet, not only to television channels, but all the players in the industry, such as manufacturers and distributors of hard technology or internet service providers.

The model will be generated in the Colombian television industry due to the convenience to find the experts in this country, also this country has directly entered the list of cutting-edge technology by hosting the second version of the DVB-T2 standard, which has been accepted by most countries in the world. Furthermore, the final model will be contrasted with the opinion of experts from two countries: Mexico and Russia. These two countries are chosen because of their great demographic density. In addition, Mexico allows to contrast the validity of the model with a country with a different standard (ATSC), while Russia allows this to be done with a country with the same Colombian technological standard. (DVB-T2).

1.5.Scope and limitations

1.5.1. Scope

- The model development of grounded theory will be generated valid only for the Colombian television industry, due to the origin of the experts consulted.
- The elaboration of the research period is understood from January 2017 to December of 2018.
- The validation of the model for the Colombian territory will be held so evaluation by the expertise of professionals in the industry as the Delphi model suggests.

1.5.2. Limits

- The greatest limitation for the development of research is the confidentiality of the information of the sector since the majority of companies (TV channels, producers, internet service providers) have restricted information and in addition experts tend to commit themselves to confidentiality clauses.
- The rigor of the generation of the grounded theory model it is given by the information that comes directly from the experts involved and includes a simulation of the benefits and impacts obtained by its implementation.
- The proposed study is not designed for another industry converging on the Internet just for the Colombian television industry.
- The created model will have a qualitative descriptive, therefore, it is not possible to make quantitative calculations or validation from it.

1.6. Organization of the study

In chapter 1 the background, problems and objectives of the investigation are described. In chapter 2 a study of the theoretical framework related to the research lines of the project is made. In chapter 3 a specialized approach to the state of the art is made related to the factors of technological convergence in the Colombian television industry. In chapter 4, the methodological research process for the development of the work model proposal is defined. Chapter 5 develops the approach and work model proposal where indicators classified by category are considered and an analysis is made of the main results obtained. In the conclusions a validation of the achievement of the proposed objectives is developed and a synthesis of the main findings and the conclusions of the model and of the future works that can be derived from this investigation is established.

CHAPTER 2. THEORETICAL FRAMEWORK

2.1.Strategic Planning

Before defining the strategic planning, it is worth asking what is planning and strategy.

2.1.1. Planning

The RAE (Royal Spanish Academy, RAE for its name in Spanish) defined planning, concerning planning, such as trace or form a work plan or making plans or projects. Ackoff (2000) has defined the planning as the decision-making process in advance, the choice of decisions in the present that will be executed in the future to achieve a desired goal. The focus of planning lies in making the right decisions in an atmosphere of uncertainty that is can't know with complete certainty the internal and external changes of the environment (Koontz, Weihrich, & Cannice, 2013).

2.1.2. Strategic

The strategy is defined according to the RAE as the art of directing military operations or as an art that allows the trace to address an issue. A third definition of the RAE gives us a wider and the Management-oriented description: "Is a process that is adjustable, set of rules that ensure an optimal decision in every moment". Hofer & Schendel (1978), raised to be the "main link between the goals and objectives that the organization wants to achieve with various functional areas policies and plans that used to guide their day-to-day activities". Weinberger (2009) says that strategy must also provide an advantage over the competition.

2.1.3. Strategic Planning

Strategic planning is a concept that has been defined by many authors from different approaches, both internal and external or local and global, some of the definitions more relevant and cited are:

- Anacleto Tomasini (1989): "A set of actions to be developed to achieve strategic objectives, defining problems, prioritizing solutions, assigning responsibility and measuring progress".

- Manso (1991): "It is the negotiation process for making decisions about conflicting objectives."
- Mintzberg (1993): "The process of defining, relating and formulating in the long term, the goals, policies and programs of an organization, as well as the execution of methods that guarantee the achievement of its objectives."
- Menguzzato and Renau (1995): "Is the analysis of opportunities, threats, strengths and weaknesses that are in the organizational environment and the selection in pairs of them to meet the objectives of the company".
- For Thompson and Gamble (2012), the strategic planning is a process of systematic evaluation of the nature of a business, defining the long-term objectives, identifying goals and quantitative targets, developing strategies to achieve such objectives and locating resources to carry out such strategies.
- Rodriguez and Pedraja (2009): "the process by which an organization seeks to achieve a sustainable competitive advantage that will allow them to succeed. This process involves achieving alignment between resources and the capacity of the institution with the requirements of the environment and of the specific sector where it competes".

It is necessary to emphasize the most cited author who is Michael Porter. He defines the strategic planning as the acquisition of a position and unique competitive advantage (Porter M. E., 1996) Later, Porter gives a more global sense to its definition through a model involving the interaction of five forces present in any industry: rivalry among competitors, threat of new entrants, threat of substitute products, power of the customers and suppliers (Porter M. E., 2008). Porter also clarifies that the improvement of the operational effectiveness is a necessary part of the planning, but is not strategy.

Strategic planning includes carrying out formalized and written activities carried out by the company and aimed at identifying objectives and goals without losing sight of the company's internal and external environment and thus having full knowledge of the company's strengths and weaknesses and the opportunities and threats generated by the environment (SWOT analysis) (García D. , 2007)

Taking into account the above, the main purpose of the strategy planning is the formulation of the strategy in an environment of uncertainty, which implies a synthesis that in turn supposes intuition and at the same time, the use of different techniques by the strategist, who should handle the ambiguity and the possibilities of negotiation (Garrido, 2006).

2.1.3.1. Elements of strategic planning

Although most authors often include various elements within the strategic planning, they all agree that to have a good strategy for at least the objectives, scope and benefits should be included. The objective will indicate where the company wants to go, while the scope be limited strategy or where the company should not go (Rukstad, 2006). These elements must be balanced, identified and founded with Porter (2008) strategies. Collins and Rukstad (2008) add the value to the customer, innovation and competitive advantage as important elements of strategic planning. They indicate that the strategy should deliver value customer while it remains with an attitude of innovation in processes, products or services in order to create a competitive advantage.

The previous approach reinforces an element that Porter (1996) already mentioned and it is the unique position. Porter indicates that the objective of strategy planning is to achieve a unique position within the industry, doing the activities in a distinctive and different way to the competition and interrelating these activities in a stronger way. Porter also adds leadership as a fundamental element in strategic planning, since it is the leaders who must decide how to respond to changes in the industry and the needs of consumers to maintain the strategy.

A different approach is offered by Johnson, Scholes and Whittington (2006), who mention that strategic planning is composed of three elements:

- Understanding of the strategic position of the organization.
- Strategic choices for the future
- Conversion of the strategy into action.

These three elements could also be named as the formulation, implementation and evaluation of the strategy.

2.1.3.2. *Types of strategy*

There are different classifications of the strategy, beginning with the most known and exposed by Porter (1996) as generic strategies, on the way to gain a strategic position:

- Strategy of price or volume: offer the product with the cheapest price in the market.
- Differentiation strategy: offer a product different from others.
- Strategy of fragmentation or approach: offer a product to a distinctive or particular group of customers.

The strategy can also be classified according to their level within the organization. Hermida, Serra, and Kastika (2004), propose three different levels:

- Corporate strategies: it determines what business the organization wants to participate, it focuses on the scope and the allocation of resources mainly.
- Business strategies: it sets how to compete in a market and business in particular and it emphasizes in the competitive advantage and the allocation of resources.
- Functional strategies: it is developed for a functional area in particular, such as marketing, production, finance, among others.

2.1.4. Competitiveness

2.1.4.1. *Definition*

The OECD (Organization of economic cooperation and development) defines the competitiveness of nations as the degree to which a country can produce goods and services that are accepted in international markets, under free and transparent market conditions, while maintaining and increasing the revenues of the population in long-term. The term can also refer to countries, companies, industrial sectors and even people (Restrepo & Londoño, 2003). Restrepo and Londoño add that competitiveness influences bidirectionally on multiple factors such as technology, trade, productivity, management, human talent, infrastructure, etc. The way in which these factors are organized can lead to different models that explain competitiveness.

Competitiveness in terms of company is "the ability to compete in world markets with a global strategy" (Porter M. , 1990). In addition, it is the measure in terms of value-added and innovation of new products (Álvarez Falcón, 2013). Competitiveness depends on the ease of

adaptation to changes, the management capacity and the strategic capacity of the organization which involves at the same time the technology management and research and development (Fred, 2013). Theodore (1996) adds operational insight stating that competitiveness is the ability to get customers to choose your product or service over competitive alternatives on a sustainable basis.

2.1.4.2. *Competitive advantage*

Competitive advantage is the attribute that allows an organization to outperform its competitors or to have a superior performance relative to the industry average. It may include access to natural resources, such as high-grade ores or a low-cost power source, highly skilled labor, geographic location, high entry barriers, and access to new technology, (Porter M. E., 1985). Porter says that companies obtain competitive through acts of innovation advantage. Addressing innovation in its broadest sense, including both new technologies and new ways of doing things, organizing and carrying out discrete activities that create value in the company (Porter M. , 1990). The competitive advantage is often suffering transformations with the changes in the industry, for example, when buyers get new needs or change their priorities, when changes are generated in the costs, when there are governmental changes, between other, Porter (1990).

Jones and George (2014) state that a competitive advantage can only be established by achieving superiority in efficiency, quality, speed, flexibility and innovation, and the ability to respond to customers. Only in this way, the client will prefer the products and services of the company.

Villareal and Van der Horst (2008) state that there are 3 types of competitive advantage:

- The basic competitive advantage: it resides in the ability to achieve improvements in cost, quality and service. It allows the company to enter the market, but it does not guarantee its permanence.
- The revealed competitive advantage: it seeks global positioning and it is only obtained by matching the operational effectiveness, market penetration, and other qualities of the other companies that compete in the market.

- The sustainable competitive advantage: it seeks to be in the leadership positions of the industry overcoming competitors in the long term. This advantage is achieved only through the constant innovation that comes from research and development.

2.1.5. Innovation

2.1.5.1. Definition

Among the first applications and definitions of the word innovation appears the author Schumpeter (1951), who stressed the importance of technological phenomena in the economic growth. In its classical definition of innovation, this covers the following five cases:

- The introduction to the market of a new product or service, either with which consumers are not familiar or a completely new one.
- The introduction of a new methodology of production, which means based on a new scientific discovery. You can also talk about a new way of treating a product commercially.
- Opening of a new market in a country, regardless of whether it already exists in another.
- The use of a new source of supply of raw materials or semi-finished products, regardless of whether they were already used by others or if they are universally new.
- The implementation of a new structure of market, such as the creation of a monopoly position.

Montejo (2006) adds that innovation is supported by three axes; value as a goal, change as its path and knowledge as its basis. In addition, innovation causes society to contribute to a greater and better use of knowledge for economic growth and a broader interpretation of technology by its behavior of the exact, natural, socioeconomic and human sciences (COTEC, 2010).

Innovation also includes the combined application of concepts such as imagination, creativity, ideas, practical and theoretical experiences, research and development centers and centers of innovation in business, management and organizational transformation, among others (Garnica, 2012). The maximum potential is achieved by aligning these concepts to

solve major challenges of a global demand environment. Innovation imposes pressure, necessity and even adversity, highlighting that the fear of loss is often more powerful than the hope of winning (Escorsa Castells & Valls Pasola, 2003).

Some companies consider innovation as an irregular process that arises from sporadic moments of inspiration and therefore is impossible to systematize. Leading companies, on the other hand, generate processes that ensure a regular flow of innovations, although there will always be a risk due to the associated uncertainty (Garnica, 2012). Innovation is not a simple or one-dimensional process; on the contrary, it implies a great variety of interconnected factors. Through an in-depth analysis of the opportunities that arise both inside and outside the company (Drucker, 2002).

2.1.5.2. *Classification of innovation*

There are three classifications generally accepted by the Academy and business practice, these are due to their innovation, their degree of novelty or the object or area that is innovated.

According to Rothweel and Dogson (1994), the processes of innovation can be classified depending on its cause, that is the motivation that has to initiate the creation or substantial improvement of a product or service. According to the above, there are two types of innovation:

- Innovation pushed by technology: It arises by a new scientific or technological discovery that enables the development of a new product that tends to have completely new features to the already-known by the customers.
- Innovation pulled by demand: Arises from the identification of the needs of the client and the subsequent technological response to meet it. Commonly used existing technology, but in different ways.

According to Hitt, Ireland and Hoskisson (2008), innovation can be classified according to their degree of novelty, so different is the proposal of innovation in comparison to existing products and technology. In this way, there are two types of innovation:

- Radical innovation: It is the one that creates new knowledge and gradually applied in processes, as consequence of it, are new processes, products, services or technologies.

- Incremental innovation: Part of already existing knowledge and generates small technical improvements of a process, product, service, or previously existing technology.

Other relevant classification is provided by the OCDE using the Oslo Manual (2005), which indicate that innovation in the business sector can be categorized according to the subject of innovation in four different types:

- Product innovation: can be divided into incremental, small change technician of a product or existing service; synthetic, combination of existing technologies for the creation of a new product or service; and discontinuous, creation of a new product or service by means of technologies or new ideas.
- Process innovation: new ways to generate a product or provide a service in search of greater efficiency or lower cost.
- Organizational innovation: produces changes in the organizational structure with significant benefits for the company. It can consist of changing values, methods of management and leadership, etc.
- Marketing innovation: involves new methods of marketing the product or service, as a change in design or packaging, promotions, logistics, etc.

2.1.6. Business Model

There are multiple definitions of who is a business model, but all of them focus on the description of how to generate value for the customers and the company. Some of the most relevant and cited definitions are:

- Linder and Cantrell (2000): "A business operating model is the central logic of the Organization to create value. The business model of a company focused on the benefits explained how this makes money".
- Amit and Zott (2001): "A business model explicit content, the structure and the Government of the designated transactions to create value by exploiting business opportunities".

- Winter, S. and Sulanzki, G. (2001): “A business model is a complex set of interdependent routines that are discover, adjust, and they qualified through the action”
- Osterwalder, Pigneur and Tucci (2005): “A business model is a conceptual tool that contains a set of elements and their relationships and allows us to express the logic of a specific company's business. It is the description of the value that a company offers one or more segments of customers and the architecture of the enterprise and its network of partners to create, market, and add this value to generate a profitable and sustainable revenue stream”.

Although the authors do not explicitly mention the role of technology, it is important to consider it tacitly in the definition as one of the elements that helps in the creation of value in each of the stages and instances of the business model.

In conclusion, the business model must explain how to generate value through strategic choices that are reflected in the network of collaborating organizations that explain the creation and capture of value. According to Casadesus-Masanell and Ricart (2007), these elections can be grouped into three categories: Policies, which indicate how things should be done; assets, which indicate how money should be invested; Government, which indicates the legal, contractual and organizational conditions for the control of policies and assets.

It is important to clarify the abstraction of the reality that the business model performs, as well as the word "model" refers. "Every organization characterizes a set of choices made and these clearly result in consequences. The union of these sets identifies the business model. However, the analyst, the external observer, can hardly observe and explain the entire business model. It is necessary to select a set of choices that are especially critical for the organization "Joan (2009). Therefore, it is necessary trying to capture the model with the closest possible approach to reality, but it is necessary to be careful not to interpret it as an absolute reality.

2.1.6.1. *Elements of a business model*

The business model answers to four questions what? How do? who? how much? on how it will generate value for the customer to the company. Shafer, Smith and Linder (2005)

propose a categorization based on analysis of 12 definitions published between 1989 and 2002, they identify four common categories in all definitions:

- Value proposal
- Profitability formula
- Key Resources
- Key Processes

These categories coincide with the questions that should solve the business model.

Resources and key processes describe how that value will be delivered to customers and the company. The companies develop a more or less stable system in which these elements are linked each other consistently and complementary (Garnica, 2012). A graphical representation of the business model is shown in the Figure 1.

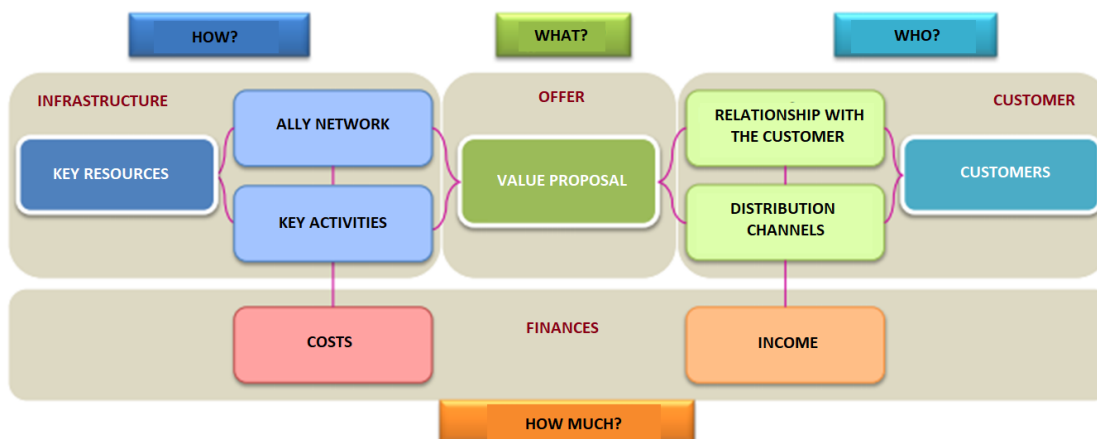


Figure 1. Business model.
Source: Garnica (2012).

2.1.6.2. Value Chain.

Since the main idea of the business model is to describe the way in which value is delivered to the client, in addition to strategically raise as seeks a position in the industry, Porter (1985) proposed the theoretical concept of value chain to contribute with this. Porter says value chain is a systematic way of examining all the activities a firm performs and how they interact to understand the behavior of the costs and the sources of existing and potential differentiation.

On the other hand, Kaplinsky and Morris (2002) say the value chain is the description of the set of activities required to lead a product or service from conception to delivery to the end user, involving combinations of transformation Physics and from inputs of different producers. The purpose is to help meet each stage of the action carried out by the company and understand it as a concatenated and successive process which add you value or wealth to the product or service, including them post sale activities (Garrido, 2006).

The value chain is made up of the union of links that represent the primary activities of the company. This begins with the acquisition of certain raw material to which value is added in each of the links (Guevara, 2014). This analysis will allow the company to see itself more than as a single entity, but as units that produce value and that can also occur outside the company itself, as the case of external R & D laboratories (Porter M. E., 1985). In addition, the value chain analysis allows the optimization of production processes, the knowledge of costs of each process and their individual capacity to generate value, which in turn seeks to reduce costs and increase efficiency.

Diaz and Hartwich (2005), guided by Porter's proposals, identify that in addition to the company's internal value chain, the company is embedded in a larger field of activities called the value system, therefore, obtaining and maintaining the Competitive advantage also depends on understanding how the company fits into this system of general value.

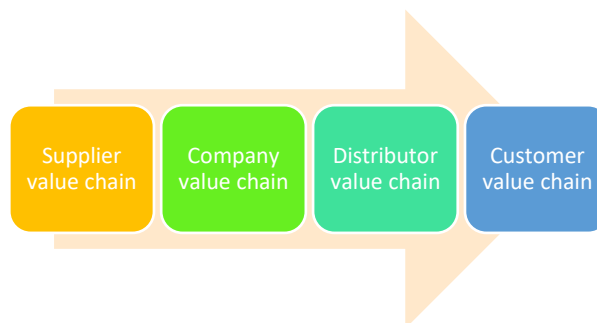


Figure 2. Value System.

Source: Made by the author based in Porter (1998) and Díaz y Hartwich (2005).

Companies tend to be present in one or more elements of the value system and often made strategic decisions facing facts as the convergence that induces them to participate in activities surrounding to their own business. This leads to acquisitions, alliances, or

horizontal mergers to share risks and bring together complementary skills, participating in the activities of the suppliers or distributors (García J. A., 2009).

Value activities

Value Chain can be used to organize all the activities of a firm into categories of primary and support activities. Primary activities constitute the processes by which firms receive inputs, convert those inputs into output, get these outputs to customers, persuade customers to buy the outputs and support customers in using the outputs (Schlie, 1996). They are divided into:

- Internal logistics
- Operations
- External logistics
- Marketing
- Sales and after sales service.

2.2. Management of Technology

2.2.1. Technology

A first insight into the definition of the word technology can be found in the dictionary of the RAE, which provides the following 4 definitions:

- Set of theories and techniques that allow the practical use of scientific knowledge.
- Treaty of technical terms.
- Language of a science or an art.
- Set of instruments and industrial processes of a given sector or product.

Usually when you talk about technology, there is a misunderstanding to associate with the knowledge only hard technology or "high tech" which refers to the technology related to computer chips, superconductors, genetics, robotics and other engineering. This limited the definition of technology to engineering, science and mathematics.

Gaynor (1996) says technology can be described in different ways:

1. Technology is the means for accomplishing a task-it includes whatever is needed to convert resources into products or services.

2. Technology includes the knowledge and resources that are required to achieve an objective.
3. Technology is the body of scientific and engineering knowledge which can be applied in the design of products and/or processes or in the search for new knowledge.

In the business field, for some authors the concept of technology is concerned associate closely with the innovation, because they consider that it is a binomial to the competitiveness innovation being the engine of growth of business projects while technology is the means to generate innovation. This is why this association is so important, given that it is increasingly important to create new products, improve existing ones or discover new ways of presenting services, introducing improvements not only in the product or service, but also in the production process that reduces the costs or improve the quality (Medina & Correa, 2008), (Sánchez, 2008).

For this reason, technology is considered the science of arts and crafts, in essence it constitutes a set of knowledge about "know-how" that a society manages to solve their problems and needs (Lara, y otros, 1998).

2.2.2. Types of technology

There is not a single classification of the different types of technology, just as it is difficult to arrive at a unified definition of the same, some classifications are based on different aspects. One of the most accepted classifications is made by Lara, Casalet, Corona, Diaz de Cossio, Lopez and Mules (1998) on the basis of the definition of technology as a set of knowledge, where the types of technology are based on the impact of the application on the problem that it is, so it has to be technology of: information, transportation, medicine, materials and manufacturing, energy or the environment.

Other relevant classification is the one generated by Pérez Moya (1996), who raises the following categories:

- Key technologies: are based on the scientific discoveries that appear in irregular intervals. for example, the electric power, machine steam circuits integrated, biogenetic or nanotechnology.

- Technology: is based on the development of microelectronics, computers, telecommunications, robotics, new materials, etc. This type of technology is revolutionizing all economic and social activities and is often seen as a state of the art or the technological vanguard.
- Technologies of rationalization: the progressive innovations are improvements of products and the constant rationalization of manufacturing methods. It originates in the constant adaptation needs of scientists to manufacture procedures.
- Generic technologies or well-known technologies: encompass the common technical skills shared by all companies in an industry. These technologies are in the field public cannot be patented.
- Proprietary technologies: It refers to fabric procedures which could be secret or which property rights are saved. Those technologies are protected by patents or secrecy agreements that provide a measurable competitive advantage
- Industrial technologies: It has as object the establishment of production in mass of standardized products, in order to transform the raw material into marketable products.
- Alternative technologies: technologies that have been born of the criticisms made against the undesirable effects of the industrial system. As their name implies, they are usually alternatives to commonly used technologies. For example, solar energy.
- Emerging technologies: technologies that are currently under consideration for future products or processes.

2.2.3. Management of technology

The Management of technology is defined mainly in the context of business administration since it plays a fundamental role in the Organization for the achievement of technological competencies, since these can generate advantages competitive through the use of scientific knowledge, technological development and innovation, particularly in companies where management of high tech technologies is vital (Dorf, 2000).

Escorsa Castells and Valls Pasola (2003) define technological management as a process through which the technological components of a system are analyzed and a technological

strategy is generated that determines the guidelines with which the profiles of R & D projects will be designed.

Cory (1993) said that Management of Technology is applicable to every phase of technology-oriented businesses. He referred that Management of Technology include:

- Research management
- Product planning and development
- Project management
- Integrated manufacturing processes
- Production control
- Quality assurance
- Information systems design and use

2.2.4. Technological Strategies

Davenport, Campbell-Hunt, and Solomon (2003) define the technological strategy as a possible means of obtaining competitive advantages based on sustainable technology. It consists of the acquisition or planned creation of technology with the objective of managing and exploiting technology. Each company executes its technological strategies according to its accumulated technological capabilities, sedimented and incarnated in routines, equipment, engineers, research and development centers in order to respond to those problems that emerge uniquely from combining their resources (external and internal) human, organizational and material (Lara A. , 2001).

Guevara (2014) indicates that the technological strategy must clearly state, but not be limited to, the following points:

- Budget distribution
- The modality of access to technology (acquisition or development)
- The choice of the competitive position in the various technologies (search for niches).
- The degree of intensity in the technological effort.
- The degree of difficulty and risk ranging from improvements in existing technologies in the institution to the development and / or acquisition of other completely new.
- The schedule of intellectual property and technology transfer.

To carry out the technological strategy, like any strategy, it is necessary to have clear but flexible objectives and comprehensive monitoring must be carried out of all the areas involved in its execution and in each of the stages of development of the action plan.

2.2.5. Technological Diagnosis

A first interpretation of the diagnostic technology term defines it as the systemic management of knowledge or studies carried out by individuals or communities, relating to techniques, crafts, skills or abilities in an organization (IICA, 1990). In the business perspective, outlined some basic elements of the technologies used by an organization and is recommended to add information from the technology that makes use of the competition (Instituto Andaluz de Tecnología, 2007). According to Cadenilla (2005), the diagnostic technology is the Act of analyzing technologies the company that used, as those not, with the vision to be able to take advantage, either by their development or acquisition to other companies.

The technological diagnosis is therefore a key function of any company, since the quality of the management of technological resources will depend on its quality (Garnica, 2012). It lies in questioning about the technologies, competences, know-how enjoyed by the organization in all its activities, such as production, marketing, collection management, after sales, among others.

2.2.6. Technological convergence

To define the general term, it is necessary to address two closely related terms which are trend and technological transition. Granados (2004) defines technological trend as "the level of use that will have any specific technology, this based on the use that has been and is at the time of issue trend. The more applicable and used the higher than trend will take the application and survival in a future short, medium or long term". On the other hand, he defines the technological transition as "the process that carries all technology from its birth to its deterioration or disuse and is defined by its lifecycle. It intervenes also its improvement or replacement through disruptive, or incremental innovation respectively".

The technological convergence is the spontaneous action or product of a conscious strategy of the companies to integrate the old or traditional technologies, with the new, emerging ones or technologies that are trend. This implies the coordination and exploitation of multiple technological competences existing within the industry, which is usually an extremely

difficult task (Yoffie, 1996). It is expressed, in particular, in the search for new products that integrate new technological fields. This process of technological transition is confronted not by a single company, but by groupings of them (Greenstein & Khanna, 1997).

Technological convergence involves costly investments for companies, due to the process of transition that causes infrastructures used until a specific time to become obsolete and required an expenditure resulting from the creation of new products and services (Salaverría & García Avilés, 2008). However, the involvement of technological convergence goes beyond the technical aspects and expands very diverse and promotes integration of tools, spaces, working methods and languages previously fractured. The convergence is developed, at least in five areas: technological, business, content, users and media professionals (García J. A., 2009).

2.3. Traditional Televisión

Television has undergone major transformations in terms of technology use, from video capture to the reception on the screens. Martinez, Olmedo and walls (2017), say "main developments in television, was the change from analog transmission to digital, whose remarkable improvements include additional services that can be offered as: EPG, interactivity, optimization of the" radio spectrum (transmission of signals multiplexed of the same or different definitions), among others".

In recent years the analysis has been directed the television market by cable and DBS (Direct Broadcast Satellite) (Shishikura, Kasuga, & Torii, 2005). Additionally, transmission broadcast via terrestrial transmitters, that is known as terrestrial television, is made. This technology has been the way of transmission since the beginning of television stations.

2.3.1. Digital Terrestrial Television (DTT)

Digital terrestrial television represents the evolution of the transmission of analogue television, broadcasting a signal through an antenna in UHF (Ultra High frequency) band receiving domestic, without using satellite or cable (Muñoz, Martínez, & Paz, 2009). Video signal digitizing allows to improve the quality of the audio and video transmitting video in High Definition (HD), as well as the transmission of a greater number of channels in much

less than the occupied bandwidths by analog transmission, which has increased the available supply and the versatility of the system allowing adding multiple audio channels and also incorporate interactive services that television did not like Teletext in multiple languages, electronic program guide, channel radio and others (Osorio Montoya, 2011) y (Tabares Ossa & Torres Arboleda, 2012).

2.3.1.1. Applications and services

The DTT has made it possible to deliver services and applications to customers beyond the mere conventional transmission of audio and video. Some of these services allow the Viewer to interact in different ways such as adding subtitles or audio in other languages, receive reviews or even send feedback data to the application-specific television channel, although this last option requires a different return as a broadband connection channel (International Telecommunication Union, 2016).

The services and applications offered by each channel depends on its purposes and capabilities, however, may be appointed as follows within the most common (International Telecommunication Union, 2016):

- **Video in qualities SD, HD y UHD:** Video of television programs transmitted in broadcast in different qualities, it is worth highlighting that, thanks to the digitalization of the signal within a same TV (6 MHz or 8 MHz) channel can go several video signals with different qualities.
- **Audio:** The audio of television programs previously mentioned, which may be available in different grades, from stereo (2 channels) to surround (5.1 channels) and in different languages.
- **Subtitle:** Closed caption TV programs transmitted, which may be available in different languages.
- **Radio:** Within the services DTT multiplex can be included the transmission of audio from one or more radio programs
- **Service information:** Schedule of television programs and other tables.
- **Interactive applications:** Within this space, different applications with different degrees of interaction are usually envisioned, such as meteorological information, traffic information, digital teletext, job offers, among others.

An example of a television multiplex in DTT along with their bit rates is shown in the Figure 3.

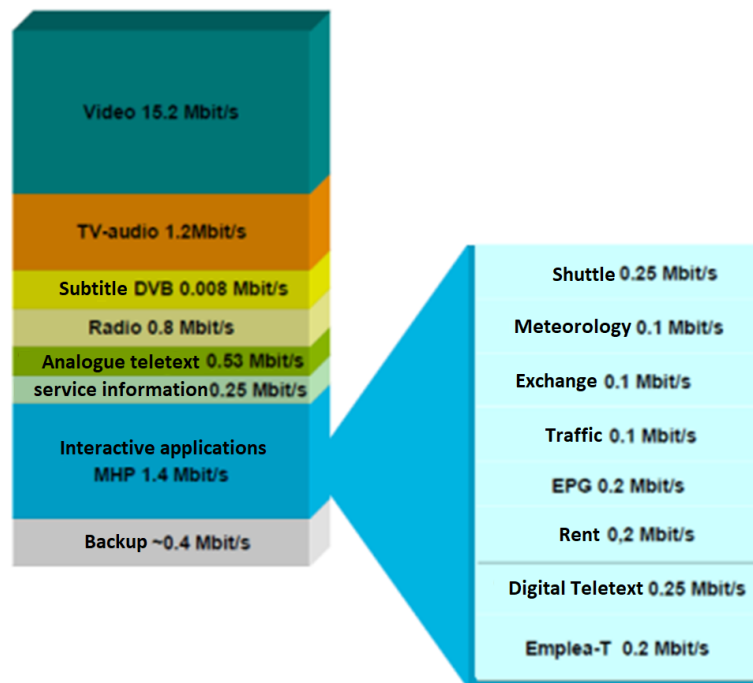


Figure 3. Example of a TV channel multiplex.
Source: (Comisión de Regulación de Comunicaciones de Colombia, 2012)

2.3.1.2. Technical characteristics

Transport and control protocols.

For DTT systems, have been created four main standards around the world (ATSC, DVB-T, DTMB, ISDB) which have small differences between them, each country weigh the alternatives and defines which is best suited for its environment (see the Figure 4) (Olmedo, Martínez , & Paredes, 2017). Within the most important decision criteria are:

- Geographical layout: standard neighbors, topography of the country, size of the country.
- Dependence of inherited aspects of analog TV: as the bandwidth of Channel TV which is 8 MHz in Europe, 7 MHz in Africa and 6 MHz in some Asian countries and in America, and the number of images (frames per second), which are 25 in Europe (PAL system) and 30 in America (System NTSC-M) (Comisión de Regulación de Comunicaciones de Colombia, 2012).

- Political and economic provisions: as free trade agreements with producers of technology such the case of Mexico, Canada and other Central American countries who hosted the same United States standard given its proximity and trade agreements (Arias Carbajal, 2008).

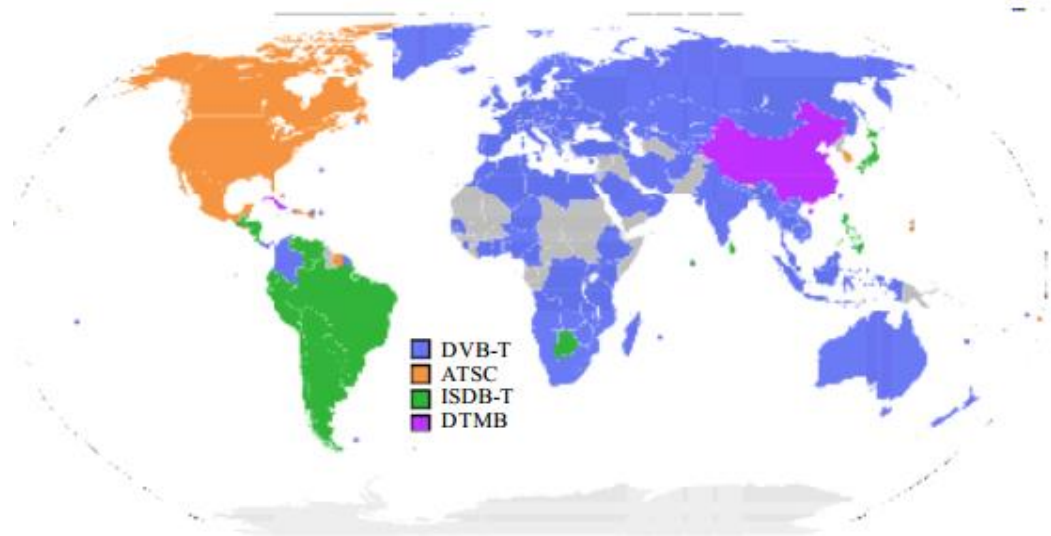


Figure 4. Status of introduction for digital television standards (September 2016).
Source: (International Telecommunication Union, 2016)

The four digital terrestrial television standards are described below:

- **DVB-T (Digital Video Broadcasting – Terrestrial)**

This standard was created by the European Organization, although it was adopted by other countries in the rest of the world, including Colombia. DVB-T initially allowed the transmission of audio, video and data through the MPEG-2 protocol, using a COFDM modulation (Osorio Montoya, 2011). The greatest advantages of using this protocol are technical advantages in terms of robustness, quality and efficiency of the DTT system (International Telecommunication Union, 2016).

Currently the standard is in its second version, DVB-T2, which presents improvements in the use of the electromagnetic spectrum, improvement in the handling of transmission errors and includes high-definition video encoding protocols such as MPEG-4 and H .265. In addition, it includes the DVB-T2 Lite version designed for the efficient delivery of television and radio services for mobile devices such as phones and tablets (Osorio Montoya, 2011).

- **ISDB-T (Integrated Services Digital Broadcasting Terrestrial)**

This standard was developed in Japan, although it is currently used in most of South America. It is the only one of the four standards that makes use of a system of four signal interleaves that provides greater robustness against transmission noise and also uses OFDM modulation. This system focuses on the sending of a High Definition signal for fixed devices and a low-density signal for mobile devices (Osorio Montoya, 2011) .

ISDB is optimized for mobile devices allowing to receive a signal by a device that is moving at a speed of up to 100Km/h. In addition, it uses a service called "one seg" that segments each channel of 6Mhz in 13 small spaces through which it transmits signals in suitable resolutions for these mobile devices. (Olmedo, Martínez , & Paredes, 2017).

- **DTMB (Digital Terrestrial Multimedia Broadcast)**

DTMB is a transmission standard for fixed and mobile devices. This was developed by China and later hosted by Hong Kong and Macao. This standard supports HD video, audio, multimedia and data transmissions (International Telecommunication Union, 2016).

The second version of this protocol is called DMB-T/H (Digital Multimedia Broadcast Terrestrial/Handeld) and it uses the modulation standard TDD-OFDM (Time Domain Synchronous - Orthogonal Frequency Division Multiplexing). The main problem with this standard is the lack of compatibility with many devices that are purchased abroad and use other standards (Osorio Montoya, 2011).

- **ATSC (Advanced television Systems Committee)**

This standard was developed by the committee that bears the same name and is used in the United States, Canada, Mexico, South Korea and Honduras, among other countries. It allows the delivery of video, audio and interactive data to fixed and mobile devices supporting high definition. It has some optimizations made for mobile devices focused as the efficient use of energy due to the limited storage capacity of such devices (International Telecommunication Union, 2016).

The characteristics of the protocol are oriented to guarantee a free television financed by advertising and using a single transmitter to cover the largest possible area, also seeks to achieve a high level of interactivity (Osorio Montoya, 2011).

2.3.1.3. Quality of Service (QoS)

Within the most relevant parameters and taken into account in the industry are (Tache, 2017) (Uganda Communications Commission, 2017):

- **Picture quality**

This parameter seeks to measure the quality of the image perceived by users. It is measured in a subjective manner, but using a scale in which a score from 1 to 5 is assigned as follows:

- 5 – Excellent signal without interferences.
- 4 – Good signal with non-disturbing interference.
- 3 – Fair signal with slightly annoying interference.
- 2 – Poor signal with annoying interference.
- 1 – Bad signal with very annoying interference.

- **Bit rate per program stream**

This parameter indicates the bit rate which the audio and video are transmitted in the stream thereby providing a guide to the quality of the image that is transmitted. With MPEG-4, the signal distributor can choose between sending a signal with a fixed or variable bit rate, allowing greater versatility to the encoders, this choice depends on the application and the infrastructure of the DTT system.

- **BER (Bit Error Ratio)**

It is the main parameter that describes the quality of the digital transmission link and is defined as the bit rate with error over the total number of bits transmitted. It is expressed as a negative power of 10, for example, a BER rate of 10^{-9} .

- **MER (Modulation Error Ratio)**

It is a measure used to quantify the performance in the modulation of a digital broadcast transmitter, that is, how well defined the digital constellation is with respect to the expected values.

- **Carrier Power to Noise Ratio C/N**

This parameter measures the relationship of the power of the signal with respect to the noise present in it and is expressed in decibels (dB), the higher the Carrier to Noise ratio, the better the signal quality.

2.3.2. CATV

The CATV or cable TV is a technology for the dissemination of video and additional services through coaxial cable, fiber optic or networks hybrid. It is capable of transmitting video in SD, HD and Ultra HD (4K) making use of the same types of modulation that terrestrial emissions. Compared with the networks of satellite broadcasting and terrestrial, CATV presents great advantages when propagation problems since the signal is transported confined within the coaxial cable, so it is not distorted by other signals, or interfere with other systems, obtaining a higher quality of signal and allowing to use all of the available spectrum and thereby increase the number of usable channels (Telefonica, 2003).

In this type of technology, an integrating company called "headend", has the necessary technological infrastructure to take signals from different sources and multiplexes them into a single medium (cable) and distributes them through a private wired network to its subscribers. Currently, these cable television broadcasting mechanisms are strongly linked to the diffusion of the internet by the same service provider since the same wired networks are used to transport both contents (television and data). This also facilitates the transition to services such as "Triple play" that also distribute TV services, but under the IPTV scheme (Prado, 2009).

Due to the use of the same types of modulation of terrestrial television, cable television is subject to its same QoS evaluation parameters.

2.3.2.1. Services and applications

Cable TV allows to deliver the same services of television via satellite, but this mechanism of cable television broadcasting is also strongly linked with the expansion of the internet by the same service provider since they are used the same wired networks to carry both content (television and data). This also facilitates the transition to services as "Triple play" also distributing TV services, but under the scheme of the IPTV (Prado, 2009).

2.3.2.2. *Technical characteristics*

Cable transmission networks use hierarchical structures of point to multipoint distribution from regional headers, through local headers and reaching the homes of subscribers. These networks can be hybrid, starting from the head with transmission in optical fiber and being replaced at some point in the network for copper cabling. The use of optical fiber, due to its low attenuation and useful broadband, allows to increase data transmission speeds and achieve greater distances of propagation.

These networks use conventional frequency slots for 6 MHz or 8 MHz for the issuance of the television channels in MPEG-2, MPEG-4 or H.265 formats and, in addition, provided the existence of a return channel that allows to add different types of services, being the most important internet access. Currently, digital television transmission by cable along with the transmission of internet data is performed by using a protocol of access to the medium known as DOCSIS, which uses mechanisms used previously by the transmission by cable as MAC) medium access control), CDMA and TMDA.

Due to the better performance of the cable transmission, compared to the attenuation of the signal in the terrestrial and satellite transmission, it is possible to use modulation types with greater spectral efficiency, for which CATV carries out transmissions in QAM a greater number of constellation points. According to the bandwidth of the channel and the type of modulation, speeds of more than 40Mbps per channel can be achieved, which for example means the transmission of approximately 7 television channels in MPEG-4 format (Telefonica, 2003).

Transport and Control Protocols

DOCSIS

Currently, the digital transmission of cable television together with the transmission of Internet data is done using an access protocol called DOCSIS, which uses mechanisms previously used by cable transmission as MAC (Medium Access Control), CDMA y TMDA. The evolution of this protocol has included its versions 1.0, 1.1, 2.0, 3.0 and the current 3.1 published in the year 2013. In comparison with its predecessors, DOCSIS 3.1 includes the LDCP protocol and OFDM modulation. These improvements manage to provide total transmission speeds of up to 10Gbit/s uplink and 1Gbit/s downlink. Additionally, this

protocol offers a greater possibility of including carriers in a frequency range by expanding the used slot of 6Mhz or 8Mhz. Table 1 summarizes the technical characteristics of this protocol (Rohde-Schwarz, 2018).

Table 1. Characteristics of the protocol DOCSIS 3.1

	Canal de bajada	Canal de subida
Versión	DOCSIS 3.1	DOCSIS 3.1
Ancho de banda de canal	De 24 MHz a 192 MHz	De 6,4 MHz a 96 MHz
Modulación	OFDM	OFDM
Orden QAM	hasta 4096 QAM	hasta 4096 QAM
Método de acceso múltiple		OFDMA
FEC	LDPC/BCH	LDPC/BCH

Source: (Rohde-Schwarz, 2018)

By making use of the DOCSIS protocol it is possible to carry out a broadcast transmission of a greater number of digitally encoded channels for each conventional spectral space and together to include higher data exchange rates for Internet access.

STB (Set Top Boxes)

STBs have been devices key for the reception of the signal by cable or satellite, even when reception was analog. These devices allow the user access to services that are shared with the television cable as the storage of video with DVR (Digital Video Recorder) technology. On the other hand, the STB also allow to have greater control of the subscribers to the service providers, since they allow them to send payment with some sort of encoding content that it is only possible to decode using the STB (Prado, 2009).

With the use of the DOCSIS Protocol, it is necessary to use STBs that support this technology, allowing separate television and internet access services in the destination.

2.3.3. DBS - Satellite television

Television over satellite or DBS (Direct Broadcasting by Satellite) consists of the transmission of data with television content from satellite antennas located in the header, to satellite synchronized geo (which retain the same position with respect to the Earth). This

signal is then re-broadcast by satellite on a particular and limited geographical space called the satellite footprint. (Dulac & Godwin, 2009). The objective of transmission can be delivering to other headers satellite television signal or carry a television service by subscription to a series of user, what is known as DTH (Direct to Home).

According to Cuevas and Lago (2002), Some of its advantages are:

- Wide range of channels
- Flexibility (a satellite can work several standards)
- Low cost of ownership.
- High reliability of the system
- Large coverage area.

In contrast, its main disadvantages are:

- High initial investment.
- Impossibility of repairing technical faults or system corrections.
- Cost of reception equipment.

2.3.3.1. Services and applications

Applications and services provided by the satellite television are driven by its large bandwidth and ease of access, but at the same time, are limited by the absence of a direct channel of communication from the end user to the supplier. The complication is that a common satellite receiving antenna low any medium cannot up transmission to the satellite. To compensate for this absence, are often used to return information about the DSL network systems or internet network, however, this limits the possibility of offering services as "triple play" and obliges operators to focus its services on the ability of transmission in a downward direction (Prado, 2009).

According to the above, the main services offered by DBS are (Dulac & Godwin, 2009) and (Cuevas & Lago, 2002):

- Subscription TV: Users pay a subscription to the service provider.

- PPV (Pay Per View): Enables the display of a content specific for a defined time, usually payment for exclusive television channels. To do this, set-top boxes must be connected to a network of return.
- Pay Per Event: To view a particular content in an hour and date.
- Digital Video Recorders (DVRs): They allow the storage the transmitted content. They are usually included in decoders or STB provided.
- Near Video on Demand (NVOD): It is the transmission of the same program in different time zones, usually separated by less than an hour, giving the possibility to the user see that content when he prefers within the possibilities.
- Interactive television: It is limited to the delivery of personalized content as guides, programming and information related to the location such as weather, news, financial information, results of the lottery, etc.

2.3.3.2. *Technical characteristics*

As mentioned previously, the satellite headend is responsible for multiplexing different audio and video signals in a single transport stream that is sent to the satellite. To get the signal to the satellite it is necessary to use an up converter block that is responsible for modulating the signal on a frequency in the order of GHz and then pass it to an HPA block (High Power Amplifier) that gives it the power needed to support the attenuation of the medium and get to be received by the satellite, this signal is sent by parabolic antennas of large dimensions (diameters greater than 2 meters) properly oriented to the satellite that provides the service. Once the signal is received on the satellite, it is responsible for making a change in frequency of the signal (remaining in the order of GHz) and amplifying it again to send it on the downlink. Subsequently, the signal is received by means of antennas with smaller dimensions (depending on the operating band), amplified and demodulated by high sensitivity devices LNB (Low Noise Block) and subsequently decoded, demultiplexed and decrypted by STB to finally be visualized in a digital television, this process is illustrated in Figure 5 (Dulac & Godwin, 2009).

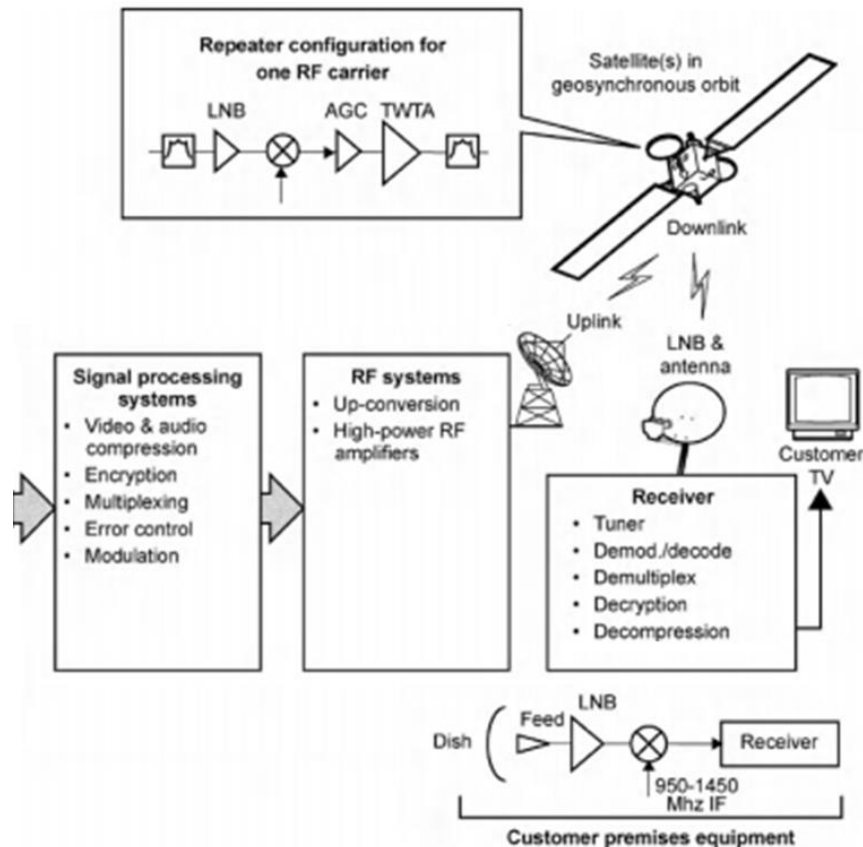


Figure 5. Satellite DTH system
Source: Edited from (Dulac & Godwin, 2009)

The high distance on which satellites are (orbits of 36,000 km from Earth) originates a means of transmitting with a strong attenuation and limits the power of the signal reception, with which transmission over satellite faces great challenges with regard to delivery of the signal forcing the use of resistant to attenuation modulation for QPSK transmission with few symbols. In addition, since transmissions are performed using frequencies in the GHz range, satellites have bandwidths very large in comparison to DTT and CATV, allowing to deliver more content. According to this and adding (Telefonica, 2003), the main features of the DBS transmission are:

- Low signal to noise ratio
- High-bandwidth
- Absence of reflections or echoes (due to the transmission with antennas)
- System strongly non-linear, so there are different bands of satellite transmission.

Although there are different protocols for satellite transmission, the most popular worldwide is the DVB-S. This protocol uses the encoding of the video signal in MPEG format, which is subsequently modulated over a QPSK constellation with a low number of symbols and also uses a technique called FEC (forward error control) that provides protection against data loss by means of redundancy (repetition of information). The latest version of the modulation protocol is DVB-S2, which supports encoding of the video signal in MPEG-4 (Telefonica, 2003; Dulac & Godwin, 2009).

2.3.3.3. Access network

Two bands are currently used for satellite sent television signals, the C and Ku bands. Each of these bands has different characteristics due to the nonlinearity of the middle and therefore offer different benefits (Cuevas & Lago, 2002). The bandwidth of the C band ranges from 3.7GHz to 4.2GHz and from 5.9GHz to 6.4GHz, while the Ku band has a bandwidth ranging from 10.9GHz to 12.75GHz. Due to these differences in frequency, the dimensions of the antennas are different, being much smaller the antennas in Ku band and for that reason, more common for the use of DTH (Burkhart, 1989).

According to Burkhart (1989), the main factors that affect the quality of the signal and degrade it in his career uplink and downlink are:

- Terrestrial interference: thermal noise generated by the Earth.
- Interference with communication systems: especially with microwave systems.
- Rain: It creates an obstacle to the signal and degrades it significantly.
- Atmosphere: signal attenuation by the elements that make up the atmosphere.
- Ionosphere: Due to the number of ions and other floating loads at low frequencies.
- Solar Effects: The Sun can generate electromagnetic discharges that can occasionally affect satellites.
- Galactic Effects: Noise produced by the Galaxy, but almost insignificant magnitude.

2.4. Television on internet

Increase in speed of internet networks allowed to implement the transmission of video, audio and images to the end users. This service allows not only to see the local channels, but also tune content available online, including real-time (Muñoz, Martínez, & Paz, 2009). The television industry is making its way through this medium in different ways, trying to compensate for the detrimental effect that has had on their traditional business models. Some of the new business models and markets are already dominated by other competitors, among them it is possible to find the VoD (Video on demand), now led by companies like Netflix (Ojer, 2012) and the direct transmission through the IPTV protocol multicast.

In comparison with CATV, satellite television and DTT, Internet television can provide customers with a greater number of services such as video on demand, video watch back, portable content, among others, although the quality of service is usually conditioned by the characteristics of the internet network (Torres, Ramirez, & Lopez, 2011). Interactivity is therefore the "magic formula" of television over the Internet, since the user goes from playing a role of passive subject to a subject who can enjoy choosing the type of programs that he wants to see (Ruano López , 2006).

2.4.1. IPTV and Television over the Internet.

The most renowned definition of IPTV is that approved by the International Telecommunications Union that specifies:

- “IPTV is defined as multimedia services, such as television, video, audio, text, graphics and data offered on IP based networks managed to provide the required level of quality of service (QoS) and experience, security, interactivity and drivability”, (Unión Internacional de Telecomunicación, 2006).

The International Telecommunication Union contributes:

- "IPTV is defined as the safe and reliable delivery of video entertainment and related services to subscribers. These services can include, for example, Live TV, Video on Demand (VoD) and Interactive Television (iTV), and are offered through a packet-switched network that uses the Internet Protocol (IP) for audio transport, video and control signals. In contrast to video over the public Internet, with IPTV deployments, network security and performance

are rigorously managed to ensure a superior entertainment experience, resulting in an attractive business environment for content providers, advertisers and customers" (Unión Internacional de Telecomunicación, 2006).

From the perspective of the Viewer, the IPTV works just like a standard pay television service, but from the perspective of the direct supplier, IPTV makes an absolute use of the IP infrastructure, which includes the acquisition, processing and distribution of content (Tabares Ossa & Torres Arboleda, 2012).

In addition to the definition, it is necessary to make a distinction as to the methods of television broadcast on the internet, since there are differences in the concepts of IPTV and television by internet or television online. Both make use of the IP infrastructure to deliver television content to the end user, but IPTV is done through a private packet network and controlled by a telecommunications operator, usually the ISP provider, while the content of television over internet is available anywhere that has access to broadband (Honzeas, 2010). O'Driscoll (2008) mentioned in addition 6 points that allow to clarify the difference:

- The geographic scope of IPTV is delimited by the ISP provider coverage, while the television over internet can reach anywhere with broadband access.
- Television over internet use as platform public Internet infrastructure, while IPTV has secured and dedicated private networks for the broadcast of content.
- The quality of television over internet service depends on the conditions of the public internet network, dealing with the loss of packages, disarmament, delays, etc.; While the IPTV service quality can be controlled directly by the supplier and thus ensure high quality.
- The IPTV service is accessed through a digital decoder which is usually supplied at the beginning of the recruitment service, while the television over internet access is usually done from a computer or screen with access to the internet and only in sometimes may require a digital certificate of purchase of the reproduction rights on the content.
- The IPTV tends to have rates of payment monthly fixed which may include other packages, while a significant percentage of the online television is usually free and open access to the public.

- The contents of IPTV are traditional TV shows and movies provided by mass media already established, while television over internet content vary from content generated by users to services of Classic TV channels streaming transmission.

2.4.2. Services and applications

Television over internet and especially IPTV offered different well differentiated services to their customers and in addition, due to technological advancement and innovation capacity, increasingly there are more new services or improvements to existing ones. Among the most nominees are (Ferro Bolívar & Hernández, 2011) (Torres, Ramirez, & Lopez, 2011) (Bustamante, 2008):

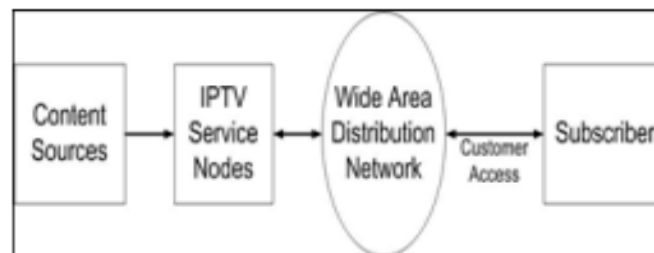
- **Triple play:** Internet service providers offer packages which include voice (fixed telephony), internet access and live television as a basic package, these packages are called "Triple Play". All three services are delivered by the supplier via a single IP network infrastructure. This model promises also the relationship of the three services as performing searches on the internet through the TV or answer calls in the same.
- **Mobil Television:** Is the download from the internet and in the local storage of content in a mobile environment such as Smartphones, tablets or personal computers in order to see them offline in the place and time that the user wants to.
- **Pay Per View (PPV):** Allows access to multimedia content live making a payment for the specific rights to view it by a certain time. This service is also known as television à la carte. Its VoD difference is that here the content is simultaneously sent to all users.
- **Video on Demand (VoD):** In this case, the multimedia content is sent to users on an individual basis and in accordance with your request. This service allows the user to have content of his choice available for playback at the user's discretion. The transmission is performed in a unicast mode (Ruano López , 2006).
- **Personal Video Recorder (PVR):** Through this service, IPTV users can record content that is broadcast live on devices provided by the service providers to make their subsequent reproduction. This device is provided by a high capacity non-volatile memory and control software and can be included in the IPTV decoding device STB (Set Top Box).

- **Games:** The IPTV architecture allows the natural integration of this type of services, for which this industry appears to have a promising future (Torres, Ramirez, & Lopez, 2011) in which manufacturers and suppliers are already experimenting with games and simple entertainment platforms, but it is anticipated that STB decoders will provide more features such as those included in video game consoles.

2.4.3. Technical characteristics

TV over internet and IPTV, to be systems that work based on internet network, depend hardly of its infrastructure, its networks of communication, its encoding formats, speeds transmission and other factors determined by the service provider, network design, internal resources of the company and its capabilities (ALQuayed & Zaghloul , 2014). However, as mentioned previously, IPTV and television over internet exhibit some differences including especially the technical aspects, but largely have major similarities.

The technical components of the IPTV can be categorized in four areas (ALQuayed & Zaghloul , 2014), as shown in the Figure 6.



*Figure 6. IPTV Network Architecture.
Source: (ALQuayed & Zaghloul , 2014)*

- **Content source:** It includes the technical aspects of the production of the video as the definition of the video (SD, HD, 4K, etc.).
- **IPTV services nodes:** This stage controls technical aspects of encoding the video for later transmission in the network of broadband to an appropriate level of QoS. At this stage also manages a subscriber system to control the distribution of the video profiles of customers who have a current subscription (Tabares Ossa & Torres Arboleda, 2012).

- Wide area network distribution: comprises different types of infrastructure of network (copper, optic fiber, etc.), each with different abilities and levels of QoS (Ferro Bolívar & Hernández, 2011).
- Subscriber equipment: this section includes the layer in direct connection with the user being the STB, which is provided by the supplier of the service and is responsible for decoding the video frame and provide different functionalities to the user in the case of IPTV.

In the IPTV all these aspects are established directly knowing initially addresses the transmission destination multicast and its location, creating dedicated networks of low-latency and high security.

On the other hand, television over the Internet, working on an open platform such as public Internet, does not provide security over data or ensure a level of QoS, but works on the principle of best effort, which is why they are often used here plugins installed on the PCs to help control the loss of packages and the reassembly of them for their reproduction.

At the point of production and broadcast of the video, the formats mentioned above are used in the content source of IPTV, but the second and third stages, being embedded in the public internet, will depend on the different possibilities of internet connection (O'Driscoll, 2008). This is, for example, the case of the television channels that carry out their streaming transmissions coding and compressing the video in multiple packages and transmitting it through the public internet networks to the client's computer.

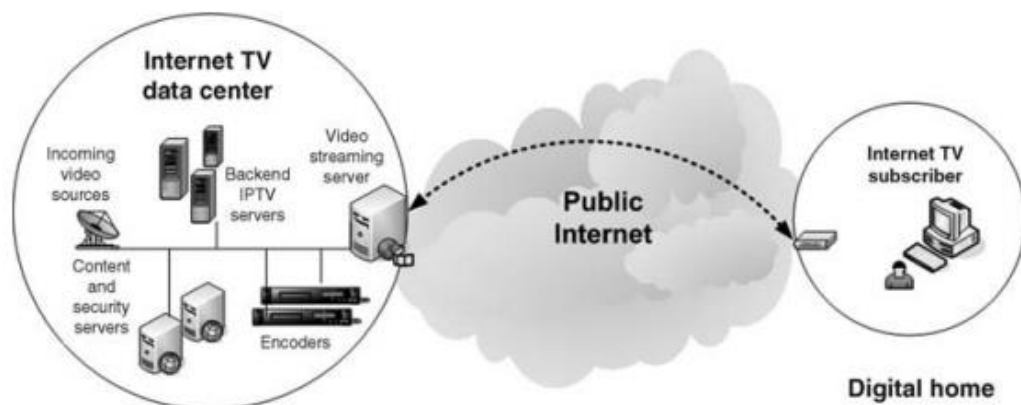


Figure 7. Internet TV channels network infrastructure.
Source: (O'Driscoll, 2008)

2.4.3.1. Access network

The access network allows providers to transport content from servers to homes. This segment is often referred as “the last mile” and can be made through different physical technologies compatible with IP data transport, in fact, corresponds to the physical layer of the protocol. The access technologies that can be used are:

Access by copper wiring

For the year 2011, DSL (digital subscriber line) was the most used technology by telecommunications operators (Ferro Bolívar & Hernández, 2011), although there is currently a migration towards fiber optic transmission technology. This technology allows operators to provide broadband services over existing copper telephone lines. The first DSL standards were inefficient for the transmission of high-speed video, which has generated new standards with greater capacity (Alcudia León, 2005). According to Torres, Ramirez and Lopez (2011), some of the main DSL protocols oriented to IPTV transmission:

- **ADSL:** Asymmetric channel (download speed higher than the upload speed) that is capable of reaching 10Mbps and 1Mbps respectively. Its use is residential and allows users to make calls and access the internet simultaneously (Tabares Ossa & Torres Arboleda, 2012).
- **VDSL:** Asymmetric channel that supports download speeds between 13Mbps and 52Mbps and between 1.3Mbps and 2.3Mbps in the reverse direction.
- **HDSL:** It is a type of symmetric infrastructure, used mainly to connect servers. Allows rates up to 4.6Mbps.
- **ADSL2 y ADSL2+:** These are the most commonly used type of copper technology for residential applications, since they are the enhanced version of ADSL. The speed goes between 8Mbps and 12Mbps of upload for ADSL2 and up to 16Mbps for ADSL2 +. With the appearance of this protocol, due to its greater bandwidth and less interference, it is possible to access multimedia services such as games and VoD, among others. (Ferro Bolívar & Hernández, 2011).

Coaxial cable access

Another type of cable access is coaxial, which is also used for CATV subscription cable services. Internet operators use a protocol called DOCSIS (Data Over Cable Service Interface Specification) to bring broadband services to users through the use of these coaxial cabling, which simultaneously allows conventional television transport. This protocol uses a type of modulation QAM (Quadrature Amplitude Modulation) to modulate the signal and transmit it through the wired network (Ferro Bolívar & Hernández, 2011).

As the DOCSIS protocol is transmitted on the same cable with the conventional CATV channels, their speeds vary depending on the transmission characteristics of the channels, however it can be said that version 3.0 of the protocol can reach downlink speeds of up to approximately 160Mbps, while supporting uplink speeds of up to approximately 120Mbps (Méndez M., 2014).

Fiber optic access

The reduction of fiber optic costs, its immunity to electromagnetic interference, the high transmission speeds and the progressive increase in coverage have made fiber optics the preferred medium for the implementation of broadband networks and for the delivery of IP services (Tabares Ossa & Torres Arboleda, 2012). The network architectures used combine the use of optical fiber from the IPTV data center to a specific point and the copper wiring to the user, in the following way:

- **FTTRO (Fiber to the regional office):** Fiber links to the nearest regional office of the telecommunications company and copper link to reach the end user.
- **FTTN (Fiber to the neighborhood):** Fiber link to the end user's neighborhood (less than 5000 feet), the remaining link is again completed with copper cabling under DLS protocols.
- **FTTC (Fiber to the curb):** This infrastructure carries the fiber optic link to a distributor in the street of the end user. This type of infrastructure is usually planned during the construction period of the neighborhood.
- **FTTH (Fiber to the house):** This link carries the fiber during the entire route from the IPTV data center to the home of the end user. The FTTH is able to handle very high data volumes and because its installation cost comparable to copper wiring is

preferred in new neighborhoods. In addition, it is capable of handling full-duplex links, which allows it to support the interactive nature of IPTV.

- **FTTA (Fiber to the apartment):** This type of network carries the link to a central gateway located in the apartment or office building, this plant has its own fiber cabling to each of the apartments.

PON network topology

The PON (Passive Optical Network) network topologies are those used by the FTTx infrastructures to transport data in point-to-multipoint transmissions and are supported by optical components between a central OLT (Optical Line Termination) node and the equipment in the ONT field (Optical Network Terminal) (Torres, Ramirez, & Lopez, 2011).

Most IPTV systems are converging to PON topologies because only active components are required at the ends of the link, while both splitters and fiber cables are passive components. In addition to the physical component of the fiber, three different wavelengths are used on the network, which allows having three independent channels for high-speed internet, video over IP services and interactivity data traffic (O'Driscoll, 2008).

According to Barahona (2010), O'Driscoll (2008) and Torres, Ramirez, & Lopez (2011), the most relevant variants of the PON topology are:

- **BPON:** This type of topology, based on the ITU-T G.983 standard, supports speeds of up to 622Mbps of upload and 155Mbps of download. It uses ATM (Asynchronous Transfer Mode), which is a protocol known for its orientation to the delivery of data, voice and video applications in high speed because it is a protocol oriented to the connection, which means that the receiver and the sender establishes a connection before starting the data transfer in order to reserve a bandwidth.
- **EPON:** This type of topology, developed by the IEEE EFM subgroup (Ethernet in the First Mile), is aimed at the exclusive use of PON over Ethernet. Supports downlink speeds of up to 1.5Gbps and 1.25Gbps uplink.
- **GPON:** Called thus by the abbreviations "Gigabit PON", is based on the ITU-T G.984 standard, this is the upgrade of the BPON topology. It supports downlink

speeds of up to 2.5Gbps and 1.5Gbps of Uplink with links of up to 20Km. Supports protocols such as Ethernet, ATM and SONET (Synchronous Optical Network).

Satellite access

Due to its greater bandwidth capabilities over other terrestrial standards, the satellite infrastructure is widely used by some ISP companies to provide Triple Play services to users and also as a means of direct acquisition from content providers. However, it must be borne in mind that, due to the high prices on frequency licenses, the use of this infrastructure implies higher operating costs (Torres, Ramirez, & Lopez, 2011).

The contents are received, added and encoded in MPEG-2, MPEG-4 or Windows media formats and encrypted in the satellite operator's video operations center, this content is uplifted to the satellite in its respective frequency of operation (C band, K or Ku) and retransmitted to several hubs' videos (Tabares Ossa & Torres Arboleda, 2012).

IPTV transmissions generally comply with one of the following three standards (O'Driscoll, 2008):

- **IPoS (IP over satellite):** This is the standard proposed by the TIA (Telecommunication Industry Association), which makes use of the DVB-S2 satellite transmission technology, used for conventional digital satellite television transmission, which supports transmissions up to 120Mbps.
- **DVB-RCS (DVB return channel via satellite):** This protocol was proposed by the ETSI (European Telecommunications Standards Institute) and based on DVB. It allows direct link transmission rates of up to 40Mbps and adds a return channel that supports speeds of up to 2Mbps.
- **DOCSIS over satellite:** It is based on the same DOCSIS protocol for coaxial cable, but differs in the type of modulation since the satellite protocol uses QPSK (Quadrature Phase Shift Keying), while the cable protocol uses QAM (Quadrature Amplitude Modulation). The rates of transmission surpass by little in their first versions the 1.5Mbps.

Access via mobile networks.

The latest standards for data interchange for telephone networks looking to watch streaming video and especially the broadcasting of television from the traditional point of view (point-multipoint transmission) and from the point of view of the streaming and the VoD (transmission point to point). Most progress has been done through the development of a technique known as MBMS (Multimedia Broadcast Multicast Service), which was included in the mobile 3G in the year 2005 (Calabuig Gaspar, 2015).

Currently, 4G LTE technology includes an improved version of the MBMS called eMBMS (Evolved Multimedia Broadcast Multicast Services), which allows to transmit approximately 16 TV channels simultaneously (Calabuig Gaspar, 2015). On the other hand, the VoD can be seen through the internet connection offered by the LTE network offered a theory of downlink up to 120Mbps and 50Mbps uplink peak, however, since these channels are not dedicated, and depend on the characteristics of use of the NET, can be completely disabled in speed before saturation of the network (Van Der Velde, Hus, & Baker, 2011).

2.4.3.2. Formats of video compression on Internet and IPTV

Due to the large amount of information which includes the newly digitized video signal, is necessary to compress it and encode it in such a way that a balance be found between the image perceived by the user and required bandwidth quality as small enough to be able to be transmitted over the network (Sabogal Alfaro & Vega Stavro, 2006). The greater the reduction, the lower the bandwidth necessary for sending it and, therefore, its transmission will be faster (Torres, Ramirez, & Lopez, 2011).

Additionally, working with a compression standard has benefits for the technical and economic development of the industry, since it fosters competitiveness in the development of compression and coding equipment, reduces production costs, generates compatibility between devices, among others (Ferro Bolívar & Hernández, 2011), although on the other hand, it increases the complexity of the devices and adds delay times by processing the algorithms.

The most relevant video compression standards or formats for the transmission of video over Internet and IPTV are:

MPEG-2 format

This standard is built on the technical basis of its predecessor MPEG-1, which was developed in 1988 by the Moving Pictures Experts Group, hence its name. This standard is capable of compressing videos up to a 1.5Mbps ratio and is still important because it is the basis of the MP3 standard, which is used to transmit music over the internet (O'Driscoll, 2008).

The MPEG-2 standard was developed to compress and encode audio and video into signals for DTT, CATV and satellite television, although with some small modifications, it became the standard used to store movies on DVD discs. Although this format is not optimized to work with low network speeds, it is capable of compressing videos at a ratio of 2Mbps to 1000Mbps with compression ratios of up to 50: 1 (Sabogal Alfaro & Vega Stavro, 2006).

This format uses several stages of compression taking advantage of the limits of the capacity of distinction of the human eye in terms of the quality of the image. Some of the means of compression used are the reduction of frames or frames per second, the elimination of bits with the same information within a block of a frame and the sending of information differentiated between frames. This last method takes a frame as a reference and eliminates the information that does not change in the next frame (O'Driscoll, 2008).

MPEG-4 format

The MPEG-4 format was developed by the same group Moving Pictures Experts Group in order to provide greater interactivity in video compression and achieve a higher possible image quality. Due to this, this standard had a great reception for the transmission of video over the Internet, in addition to other applications such as in 3G networks and in the digital television broadcast (Torres, Ramirez, & Lopez, 2011). Its compression algorithms are optimized for the compression of data, audio and video in order to achieve greater storage, coding and distribution capabilities in networks and supporting HDTV data streams, but without being optimal for working with them.

This format differs from the previous ones in that, instead of performing the compression by frames, it is done by the capable, with special emphasis on the recognition of the objects in the scene, this video processing allows to handle video flows from 5Kbps up to 5Mbps, besides being useful for the administration and protection of intellectual property (Ferro Bolívar & Hernández, 2011).

The MPEG-4 format became the compression standard used by IPTV due to its functionalities, also introducing a specialized decoding technology called IPTVDC due to its use in the "IPTV Data Center".

H.264 format

The H.264 format, also known as MPEG-4 part 10, presents the advantages of the previous formats, but is also an optimized format to provide high performance in compression and greater robustness to transmission errors. According to Torres, Ramirez, & Lopez (2011), this format is capable of achieving the same MPEG-2 performance using only half of its resources. Ferro Bolívar and Hernández (2011) also mention that this format achieves 1.5 times greater performance than previous versions in different test sequences.

Some of the improvements made in the algorithm include the addition of a scene prediction algorithm, binary speed control or variable bit rate, useful in the delivery of VoD; prediction by motion compensation to reduce temporal redundancy, coding of entropy, to reduce static correlation, among others these improvements are also accompanied by an increase in the complexity of the implementation (Ferro Bolívar & Hernández, 2011), however, the protocol was developed with a simple syntax that allows integration with different protocols (Muñoz & Muñoz, 2010).

H.265 Format

Due to the beginning of the demand for the use of UHD (ultra HD) 4K and 8K video that is currently being presented and will be coming in the future, it was necessary to develop a format oriented to such purposes. As a result, a working group was formed between the ITU-T and MPEG development groups, creating a group called JCT-VC (Joint Collaborative Team on Video Coding) which released the compression format called H.265 / HEVC (High Efficiency Video Coding) (Grois, Marpe, Mulayoff, Itzhaky, & Hadar, 2013). This new format was officially recognized by the ITU-T in 2013 as MPEG-H, part 2, which has practically all the applications of its predecessor H.264 plus a high processing capacity of UHD video (Pan, Lei, Zhang, Sun, & Kwong, 2016).

The H.265 allows to save bitrate rates by up to 50% compared to H.264, maintaining the same visual quality, but drastically increasing the processing capacity required by the encoders by 5.2 times and decoders 2.1 times (Ju, y otros, 2015).

2.4.3.3. *Transport and control protocols*

Internet television mainly uses non-connection-oriented transmission protocols, which means that there are usually no strict controls on packet loss because this represents long waiting times and results in latency or delay times. the video, however, in some applications are usually included optionally control protocols. Among these protocols it is necessary to mention the TCP, UDP transport protocols. RTP and RTCP and the RTSP and DSP control protocols (Muñoz, Martínez, & Paz, 2009), which are briefly explained below:

TCP y UDP

These two protocols are responsible for handling the basic functions of packet transport within an IP network, as well as multiplexing, flow control and error functions. However, the TCP protocol (Transmission Control Protocol) generates large delays in the network due to its nature oriented to prevent the loss of packets, so in real-time video transmissions, the use of the UDP protocol is always preferred (User Datagram Protocol) (Torres, Ramirez, & Lopez, 2011).

RTP

The RTP protocol (Real-time Transport Protocol) provides a more stable medium within the IP network through its functionalities of temporary dialing, numbering of sequences, identification of type of load and identification of source (Ferro Bolívar & Hernández, 2011). It is used by IPTV to provide temporary information and synchronization of multimedia streams and because it is a session protocol, it does not generate delays due to control in the sending of packages.

RTCP

RTP Control Protocol (RTCP) is a protocol that seeks to complement the control of packets in real-time video and audio transmissions that use the RTP protocol. It consists in the periodic transmission of an RTP packet without load data to all the participants of the session in order to gather information about the quality of the information received, since it collects connection statistics such as the number of lost packets, the delay from the last one package, among others. Thanks to the feedback, the issuer can change the characteristics of the transmission to adapt them to the conditions of the network and improve the QoS (Velásquez Rivera, 2010).

RTSP

RTP Control Protocol (RTCP) is a protocol that seeks to complement the control of packets in real-time video and audio transmissions that use the RTP protocol. It consists in the periodic transmission of an RTP packet without load data to all the participants of the session in order to gather information about the quality of the information received, since it collects connection statistics such as the number of lost packets, the delay from the last one package, among others. Thanks to the feedback, the issuer can change the characteristics of the transmission to adapt them to the conditions of the network and improve the QoS (Velásquez Rivera, 2010).

SDP

The SDP protocol (Session Description Protocol) is responsible for initiating the negotiation of the different parameters of the session as content type, format and others known as session profile. It is important to clarify that SDP is not responsible for delivering any content if not for the initialization of multimedia streams (Ferro Bolívar & Hernández, 2011).

2.4.4. Quality of Service (QoS) in IPTV systems

The QoS parameters are the way in which the performance of the television system over the Internet in relation to the quality that the client appreciates is evaluated quantitatively and through technical measurements. The QoS is directly related to the QoE (Quality of experience), although the latter is the subjective quality of the service that the end user appreciates (Ferro Bolívar & Hernández, 2011). The mechanisms of QoS over television transmission systems over the Internet are key to the competition of this industry against traditional television because such transmission may depend on variable factors of the network, therefore, a bad planning of the same can affect in a great way the way in which the user conceives the reception of the service.

ALQuayed and Zaghloul (2014) and Ferro Bolívar and Hernández (2011) agree on mentioning some of the most relevant parameters such as network bandwidth, packet loss, Jitter, latency, link time and delays for control; According to these authors, these parameters are described below.

2.4.4.1. Bandwidth

The bandwidth of the network is the main factor that can limit the quality of the client's service, since this interposes the speed limit of the video streaming that can circulate on the network. This factor is controlled mainly by the capacities of the transmission medium of the network (satellite, optical fiber, coaxial cable, etc.).

2.4.4.2. Loss of packets

Packet loss occurs when one or more data packets traveling through the access network do not reach their destination. It can be generated by network congestion, link errors, bandwidth limitations and / or transmission errors. It can cause errors as inappreciable as the loss of a pixel in the video or as serious as the degradation of the video for a long period of time. The magnitude of the error depends a lot on the transmission protocol used, in the case of UDP, the loss of a packet generates a corrupted or pixelated image, while in TCP, the loss of a packet causes image freezes (Joskowicz & Sotelo, 2005).

2.4.4.3. Accumulated jitter

It refers to the variation in the arrival times of the packets to the receiver node due to the management of the network. This is an effect experienced by non-connection-oriented networks, since the packets can take different routes and, according to this, present different delays. The Jitter value is calculated from the sum of the variation of the delay in a time interval (Cachinero Pozuelo, 2009).

2.4.4.4. End-to-end delay (latency)

It is defined as the time it takes a packet to go from the sending end of the packet (Server) to the receiving end (STB). These delays include the transmission times of the packet and the delays in its propagation (routing times of the routers) (Velásquez Rivera, 2010).

2.4.4.5. Bonding time

This parameter represents the time that the user must wait from the moment he issues a video request until the moment when he starts to receive the first video frame. Although the concept is the same, this parameter has different interpretations in VoD and in multicast video. In VoD, it represents the waiting time from the issuance of the client's first TCP packet to play a video to the first RTP packet with data it receives. In the case of multicast video, it

represents the time from the sending of an IGMP join by the member until the reception of the first multicast packet for the subscribed group.

2.4.4.6. *Delays in control*

This parameter contemplates the time a user must wait from the moment of a video control request until it is reflected in the STB. It considers the transport time of the control packets, the response time of the server and the data packets of the response. In these control options for the case of VoD, pause, resume, forward, backward and other times are included. For multicast video it is possible to include options such as channel change, among others (ATIS, 2005).

CHAPTER 3. CONTEXTUAL FRAMEWORK

3.1. Technological trends in Television

Technological factors, advances and new technologies have enormous implications for the television industry, although political and commercial factors should not be downplayed. (Izquierdo Castillo, 2016). It is enough to observe the challenges that were caused by the digitalization of television, such as the analog blackout movement, to understand the impact of technology on audiovisual business models. Therefore, it is fundamental to understand technology as a fundamental element of television production, but avoiding technological determinism, since each television channel designs and redesigns its technical tools to adapt and respond to changes in the environment (Bergillos Garcia, 2015).

Understanding some technological trends, allows us to propose possible scenarios on which television could develop, after all, this is the convergence technology, the influx of technologies on the same niche. Bergillos Garcia (2015) states that in recent years the main technological investments have been made in digitalization (analogue switch), the improvement of the image (HDTV) and 3D and the transition to a multi-platform context. According to this, it is necessary to make a review of the art in these areas, as well as some that already have some influx to television.

3.1.1. Portable Television or Mobil TV.

For a long time, the reception of television ceased to be exclusive of traditional television sets, fixed in different parts of homes. The convergence has produced that the contents can be received on mobile platforms with the technology enabled for reception, devices such as laptops, tablets, smartphones, mobile monitors, etc. (Bergillos Garcia, 2015). These devices can be connected through an analogue or digital television (DTT) signal receiver or through a network connection to the internet (Bao, 2010).

The mobile reception or mTV allows the user to see the audiovisual content from basically anywhere, even in places where there is no signal reception, thanks to the possibility of off-line viewing. This has influenced the preferences of end users, who can now watch television

on the way to work, on the train, while they wait for the bus, etc. This has produced that this type of users demands contents with different characteristics to the contents of traditional television (Kalba, 2009). Kalba (2009) assures that although the preferences can vary according to each country, there is a tendency of these users for the short contents (less than 5 minutes).

Another factor that has contributed to mobile television is the rapid evolution and massification of smartphones, which has produced the user preference for an unlimited number of services, among which are mobile commerce, social networks, internet, etc. Therefore, users also search their phones for an alternative to watch TV for information, relaxation or entertainment (Wong, Tan, Hew, & Ooi, 2015).

The signal can be received through a DTT television receiver incorporated in the mobile receiver according to the device's manufacturing protocol, such as DVB-T2. Researches as (Hadjadj-Aoul & Ksentini, 2011) and (Wong, Tan, Hew, & Ooi, 2015) seek to increase the QoE of users on these devices through technical improvements. It is important to note that this type of receivers is not very common in devices such as tablets and smartphones.

According to Kalba (2009) the mTV business tends to focus on three factors:

- Signal quality and channel capacity: it involves aspects such as screen size, signal compression, channel latency, etc.
- The type of content that users are looking for: short duration of content and interactivity such as 360 ° videos, content that takes advantage of the touch screen.
- The type of financial model: pay per subscription, pay-per-view, content based on advertising, etc.

Bao (2010) identified some challenges that are still present today:

- High battery consumption for video viewing and short battery life of mobile devices.
- High internet connection costs in the case of television viewing over the internet.
- Absence of television material made specifically for these media because the existing one is only an adaptation of the material made for conventional televisions.

3.1.2. Data mining

Data mining or Big Data Analysis is a technique used to analyze large volumes of data and collect relevant information such as trends or preferences. This technology is applicable to the television industry, where large volumes of data are produced by means of STBs or internet television viewing (Yuwen, Cao , Lin, Li, & Tan, 2017).

According to Yuwen, Cao, Lin, Li, & Tan (2017), data mining applied to television could contribute to the identification of user preferences and, in this way, contribute to the creation of adequate programming grids where the television programs are transmitted in the bands where they can have a greater rating. Currently this process is performed from the analysis of small samples of the customers' STBs, which may not represent the general tastes of the viewers, and is complemented by work experience (Zhang, Shi, Hong, Shang, & Yan, 2016).

Another aspect that data analysis could contribute to is to show the right publicity to the right viewers. This type of applications is already visible in Internet television financed by advertising, where there is a continuous bidirectional exchange of data between the user and the provider. In traditional broadcast television, however, there is no closed loop of the same magnitude as on the internet that allows the providers to have a greater amount of data from the viewers to process it and thus have a better focused advertising (Yuwen, Cao , Lin, Li, & Tan, 2017).

With all the above, traditional television faces different challenges, such as the collection of an adequate amount of information from STBs or even smart screens, the creation of suitable algorithms for the processing and analysis of such information, the assurance of the sensitive data that it collects from customers, without going beyond the limits of its personal security and the creation of new competitive advantages through Big Data Analysis (Zhang, Shi, Hong, Shang, & Yan, 2016) y (Yuwen, Cao , Lin, Li, & Tan, 2017).

3.1.3. Computational intelligence and Neural networks

Neural networks are highly adaptive mechanisms and equipped with the ability of non-linear modeling and prediction. These can improve their computational capacity and learn for themselves, despite this, its creation is not so complicated (Zheng, Zhang, & Zheng, 2015). Its implementation has become popular in recent years and is useful for data processing.

Some experts like Ryan McCabe (Senior Data Scientist at Spotify), Friederike Schüür, (Senior Data Scientist and Researcher at Fast Forward Labs) and Christopher Whitely (Senior Director of Applied Analytics at Comcast) agree that computational intelligence or machine learning projects great applications in the Media industry (Towards Data Science, 2018). They mention some applications such as content recommendation systems, neural networks for the identification of copyright, translation systems between languages in live content and personalization of content platforms for users, among others.

Some academic research such as that carried out by Gao, Wei, Zhuang, Huang, & Diao (2017) propose a system based on neural networks that predicts QoE in IPVT and thus improve the conditions of signal transmission. On the other hand, Hmayda, Ejballi, & Zaied (2017) propose a recognition system for the type of streaming content where the neural network is able to learn from previous contents and classify a program that is being transmitted and thus give way to possibilities such as restriction by age or suggestion to a specific public. It is worth mentioning that computer intelligence usually requires extensive databases, which can be easily obtained in the television industry through Data Mining.

One of the main challenges of the implementation of the computational intelligence in the Media Industry, according to Christopher Whitely, is the correct implementation of the needs of the industry and how to integrate these needs to the capabilities of machine learning, this is increased in that there is not a wide range of research and developments in this industry (Towards Data Science, 2018).

3.1.4. Cloud Computing

Na & Pin (2012) define cloud computing as resources, hardware and software, which can be packaged and delivered as on-demand services to users who access them through the Internet. Prakash, Lamdharia, & Chandra (2013) add that the use of these services allows organizations to focus on their key activities, main objectives or services, instead of spending manpower, capital, etc., on maintaining and supporting platforms and infrastructure. In their research they include the phrase of Al Kovalick, Senior Fellow of Avid, who says “you don’t own it you don’t manage it, you don’t maintain it, you don’t upgrade it; you don’t patch it, you just use it”.

Cloud computing is perfectly adapted to the production requirements of television channels because in the channels there are many jobs with computers where each worker must access the files to view, download and modify them. The way in which the television channels usually work implies the installation of specialized software in each of the computers for its edition, having a decentralized system. Cloud computing would help television move the power from workstations to the network (Na & Pin, 2012). Some additional benefits are (McNevin, 2017) (Na & Pin, 2012) :

- Scalability to handle spikes in workload, including live events, and sudden increases in the popularity of new services.
- Promote continuous service innovation through agile development, constant iterative experimentation and a culture of "fail quickly and fail cheaply, then move forward".
- Faster marketing speed, have the contents on the Internet and thus be ready to transmit them to end users through VoD or streaming.
- Eliminate the cost of integration, installation, maintenance, technical support, upgrading and expansion of hardware and software (Prakash, Lamdharia, & Chandra, 2013).
- Reduce energy consumption by IT infrastructure.
- Pay only for the use of the services that are consumed and not for owning the equipment.

An example of how the cloud computing can work in the channels is in the collaborative edition. A video that is located on a central server can be edited by several users connected to the network through the browser of each computer. These users can edit the video without having to move it to the computer from which the editor works. Immediately the video is edited, another user can use it in a larger project that is also stored in the central server.

currently it is already possible to find video delivery companies that have implemented these systems in the cloud. In 2016, Netflix culminated the migration of its transmission system to a cloud service system provided by Amazon called AWS (Amazon Web Services). In 2017, the BBC had already transferred some of its loads to the cloud. As well as the AWS service, nowadays it is possible to find commercial services such as Avid Media Central Platform,

which is a set of services in the cloud oriented to the management of audiovisual content (McNevin, 2017).

3.1.5. IPV6

IPV6 is the next generation of Internet Protocol (IP) that will replace the current IPv4 protocol. This new version of the protocol was developed to support greater technical performance, such as a greater number of IP addresses on the Internet, and offer greater services to users (Internet Society, 2018).

Mongay Batalla & Krawiec (2011) state that the Internet protocol since its inception was not created to support the transmission characteristics of streaming video, VoD or IPTV, starting with the fact that it does not support multicast protocols. In response to this, it is these services that have adapted to the facilities and restrictions of IPv4. However, many of these technical limitations are improved with the IPv6 protocol. Torres, Ramirez, & Lopez (2011) state that the main advantages of IPv6 over the sending of content are:

- Facilitate, support and improve mobility.
- Multicast addressing unlike broadcast, which facilitates the implementation of PPV.
- Provide identification of quality of service and class of service.
- Because it is a self-configuring protocol, it resolves the scaling in the routing and makes the addition of Television over IP users easier.
- Faster transmission speed thanks to the expansion of the size of the package that can be transported without fragmentation; which would improve the quality of experience in VoD services.
- Suitable for new applications such as video games and other interactive functions.
- Boosts the subscription of IPTV on all types of devices, due to the large number of addresses that IPV6 has.

Although this protocol update was proposed a long time ago, currently only about 25% of all networks connected to the Internet claim to have IPv6 connectivity, only 49 countries have more than 5% of their infrastructure in IPv6 and only 24 of them exceed 15 %. As of today, it is possible to say that IPv6 has gone from the stages of early adoption to the early majority (Internet Society, 2018).



*Figure 8. Countries with IPv6 deployment greater than 5%.
Source: (Internet Society, 2018)*

Some important cases of the adoption of IPV6 are for example Facebook, LinkedIn and Microsoft that have declared to be in the process of deactivating all their IPv4 networks. In the audiovisual industry there are cases such as Comcast (a conglomerate of American media that offers cable television services) which claims to have more than 66% of its network over IPv6 technology. Similarly, British Sky Broadcasting (pan-European media and telecommunications company) has an IPv6 deployment of approximately 86%.

The current challenge of the industry is focused on the transition process of these two versions of the protocol, which implies changes in hardware and software, which translates into investment and work.

3.1.6. 3DTV

3D technology refers to those different technological mechanisms that are used to generate images with a sense of depth (visual sensation of distance on the z axis), allowing also capture in a film or television scene other aspects such as size, texture, among others (Castillo Pomedá J. , 2015).

This type of technology has been in the development and commercialization phase during the last decade. The first commercial 3D television "free-glasses" was launched in 2011 at the convention of the CES (Consumer Technology Association), in the same year the first 3D TV broadcast on DTT was made in Italy (Kunic & Šego, 2011). However, it is a

technology that seems unable to position itself in the market, in the words of Castillo Pomeda (2015), 3DTV is a technology that "every so often reappears to never stay".

Technologically there are several ways to achieve the effect of depth in television and 3D cinema, then the most common 4 are mentioned (Kunic & Šego, 2011):

- **Color Separation:** Two superimposed images are shown in the same scene, but each one with a base of a different color, for example, red and cyan. The user uses passive glasses that consist of a crystal of one color of the base in one eye, and the other crystal of the other color in the other eye, this allows to visualize in each eye only the desired image. This is considered the original 3D technology, which was used in the cinema at the birth of this technology. This method is very cheap, but it generates a rather unsatisfactory visual quality and is not competitive with current technologies.
- **3D technology with passive polarized glasses:** This technology has been used in recent years by the film industry. It consists of transmitting two images from the same screen, but with different light polarization. In turn, the user must use passive glasses, which have different polarization in each of its crystals, in this way each eye observes a single image, because the other is filtered by the lens. Among the advantages of this technology are the low price of the glasses, the absence of distortion of the color of the image and the good perception of the 3D sensation. Among the disadvantages are the reduction in the resolution of the video, necessary to transmit the two images; the need for a special screen with a more complex technology and the absence of a standard, which causes non-compatibility between different brands.
- **3D technology with obturated active glasses:** This type of technology uses active elements on the screen and in glasses. The image sent to each eye is transmitted alternately from the screen, that is, one at a time. Simultaneously, the screen sends an infrared signal to the glasses causing it to opaque one of the crystals and allow the passage of light only to the correct eye. This process is performed at a high frame rate (100 frames per second or more). Among the advantages are the high resolution that allows the technology, the good quality of 3D perception and there is no color disturbance. Among the disadvantages are the high cost of glasses and the

incompatibility between brands due to the absence of a standard. Currently this is the preferred option by manufacturers.

- 3D technology without glasses: This technology makes use of a screen that angularly separates the two images through a parallax-barrier in front of the screen or using lenticular lenses. This causes the user to visualize each of the images depending on their position with respect to the screen. However, this technology makes the user have to be sitting in an exact place to perceive the 3D sensation, that is why it has not had a reception within the homes, but it is used in environments such as individual gaming on small and portable screens.

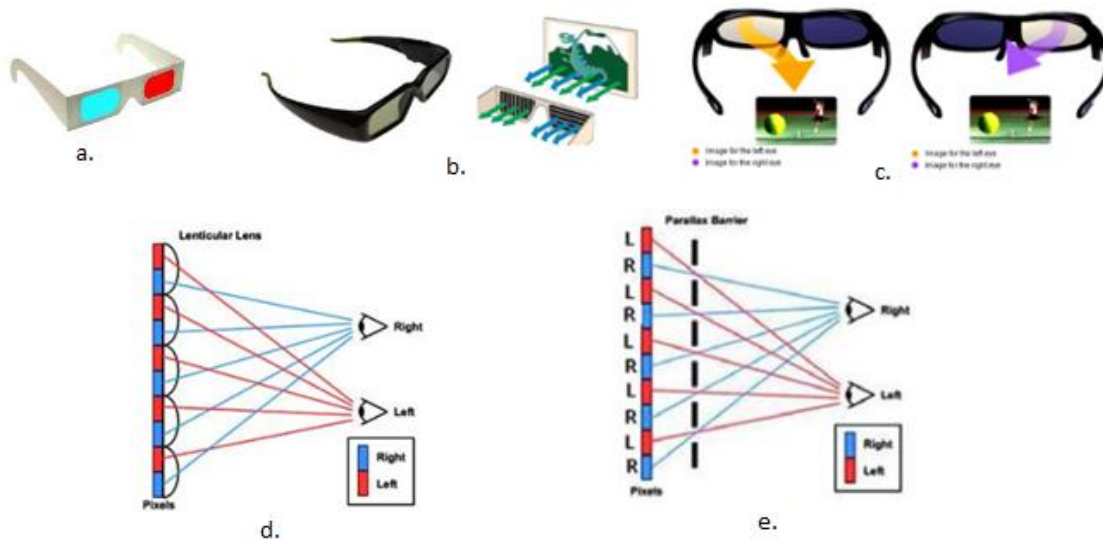


Figure 9. 3DTV technologies. a) Color separation. b) Passive polarized glasses. c) Active shuttered glasses d) Display with lenticular lens. e) Display with parallax barrier
Source: (Kunic & Šego, 2011)

Although 3DTV has often been tried as the panacea of television, there are still many challenges for the implementation of this technology. The first of these is the consolidation of a free-glasses technology with greater benefits than the existing one (Castillo Pomeda J. , 2015). The second drawback is the fact that, although such technology exists, there is a complete absence of content generated for the purpose of being transmitted on 3D screens (Sharma, Chaudhury, & Lall, 2016). What we have are 2D contents that are subsequently adapted to these screens, thus losing the ability to interact with the user that this technology offers.

In addition, the future of 3DTV is still very uncertain, although screens continue being sold in the market, some facts suggest that this technology will never be consolidated. The BBC abandoned the transmission of 3D content in 2013 stating that this technology has not taken off and that the public finds it annoying. In a similar way, Juan Carlos González Asenjo, director of TVE, said that "8K definitely leaves 3D buried, it gives a much higher image quality and depth and does not need glasses or other accessories", which would imply the consolidation of the UHD the death of 3D (Castillo Pomedá J. , 2015), however, the future is still unknown.

3.1.7. UHD (Ultra High Definition)

UHD refers to ultra-high definition video formats, product of the evolution of HD and 2K (1920x1080 pixels) to 4K video formats (3840x2160 pixels) and 8K (7640 x 4320 pixels) (Castillo Pomedá J. , 2015). The UHD formats also offer a higher frame rate, a greater depth of bit and a much wider range of colors compared to HD and 2K, in addition to the audio aspects (up to 22.2 channels in 8k) that create in the user the realistic feeling of "you are there".

The researches, tests and specifications of these two video formats have been boosted in recent years mainly by the Japan Broadcasting Corporation NHK (Nippon Hoso Kyokai) (Miki, Sakiyama, & Ichikawa, 2017). The NHK work roadmap for the development of the UHD is shown in the Figure 10.

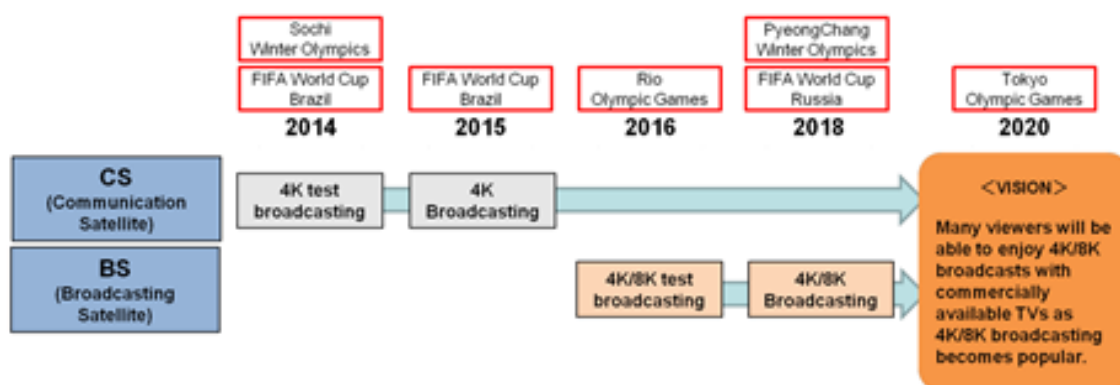


Figure 10. Roadmap of UHD.
Source: (Miki, Sakiyama, & Ichikawa, 2017)

In the case of 4K television, the first satellite tests were carried out at the 2012 IBC (International Broadcasting Convention) (Castillo Pomedá J. , 2015). Subsequently the 4K format was tested in the framework of the 2014 FIFA World Cup where commercial transmissions were also started by different companies in the media industry. Nowadays it is possible to find some production studios and television channels that already have the infrastructure capable of supporting 4K content, from their cameras, lenses, image sensors, processing and others (McCarthy, 2017).

In the case of 8K, the standard was proposed by NHK and approved by the ITU in 2012. Since that year, different tests have been developed, especially at world-wide reception events. The biggest tests have been made at the FIFA World Cup 2018 in Russia, using 7 8K cameras and 80 microphones for every football match (Miki, Sakiyama, & Ichikawa, 2017).

Although in technical terms there are many devices that are already compatible with UHD formats, there are still disadvantages in the distribution of this type of content due to the large bandwidth required for transmission (Sugito, y otros, 2017). Once this 8K signal is compressed, the bit rate could be approximately 100Mbps, due to this, for the moment, the ideal medium for such transmissions is satellite communication (Nakamura, Inoue, & Itami, 2017). Therefore, it is important to indicate that in technical terms, the main challenge of the industry is the development of codecs and signal compression systems that allow sending the signal through the existing transmission channels, which has been working in parallel with the development of codecs for the H.265 format (Sugito, y otros, 2017).

On the other hand, in economic terms, the challenge for the acceptance of 8K is the transformation of the commercial model that this implies. 8K would oblige content providers to use more bandwidth for a single content, which translates into lower income. At the same time, there is still a dilemma between the priority of investing in UHD technologies or in television technologies over the Internet (where video formats are for low resolution), this causes broadcasters to adopt the "wait and see" approach that slows the commercial advance of these technologies (Zanni, 2017).

3.2.Changes in the television business model

The challenges of technological convergence have caused the television and film industry to face other transformation processes that affect, in whole or in part, its structure, content and services, without being limited only to technological changes (Izquierdo Castillo, 2016). Therefore, media corporations must adapt to the web platform, recognizing their autonomy both at a managerial and organizational level, not only as a distribution channel, but as a means in itself. This involves the creation of a specific strategy based on a 24/7 service and the creation of multimedia content (Larrondo Ureta, 2015).

On the one hand, the changes in the industry mean the diversification of businesses, making all kinds of alliances, collaborations or mergers between companies of the same or different parts of the production chain, which in turn will involve an adaptation of production and drafting (Larrondo Ureta, 2015). On the other hand, there is a change in the audience that triggers the diversification of consumption (Morales Morante, 2011), making the mass media increasingly less relevant to personal media (García J. A., 2009).

Authors such as García García (2006), Del Pino & Aguado (2012), Castillo Pomedá J.M., (2016), Larrondo Ureta (2015), among others, coincide and complement each other by identifying the convergence variables that are explained below.

3.2.1. Value chain

Technological convergence promotes cooperation between companies from different sectors and the diversification of supports and distribution channels (García J. A., 2009), this is also motivated by factors such as audience demand for new content, the appearance in the industry of new content giants such as Netflix or the entry of telecommunications companies into the game of IPTV distribution.

Traditional companies are usually present in one or more of the elements of the value chain (content production, service and content conditioning, service provision, infrastructure supply, terminals and users) but convergence forces them to modify the chain of traditional value of the audiovisual industry, mainly in production and distribution (Izquierdo Castillo, 2012), this induces them to realize horizontal and vertical mergers to share risks and gather competences, being this type of vertical integrations the most representative of the technological convergence (García J. A., 2009). However, the benefits and capabilities

provided by new technologies are not yet fully exploited as a means of linking device manufacturers, distributors and content developers (Morales Morante, 2011). In addition, such is still the confusion that has led some companies to want to occupy all the links of the value chain (Del Pino & Aguado, 2012).

Some of the examples of the integrations are the union of mega information and entertainment companies such as ABC-Disney, Time Warner, News Corporation, Viacom, Sony, Bertelsman, nbc Universal, Gannett, Kirch, Havas, Fininvest and Pearson, among others. , that have made great strategic alliances with companies in Spain and Latin America, absorbing a good part of local and regional competitors (García J. A., 2009).

In addition to the value chain reforms in terms of existing companies, two new major competitors appear: the VoD service corporations (Netflix, YouTube, Amazon, etc.) and the telecommunications companies.

Telecommunications operators are gaining prominence due to the consolidation of the necessary infrastructure to channel the content, not only of video, but also by offering telephony and internet services in the Triple Play packages (Izquierdo Castillo, 2012). In addition, these are pressured by the loss of customers due to voice competition versus mobile services (Tabares Ossa & Torres Arboleda, 2012).

In addition, these are pressured by the loss of customers due to voice competition in the face of mobile services (Tabares Ossa & Torres Arboleda, 2012). On the other hand, technological convergence ended up providing competitive advantages to the mega global platforms of distribution and accessibility of VoD contents. These companies are favored by not having to directly face the regulations of local policies, they are also those who have better adapted to new financing systems and those who offer a greater diversity and quantity of content, even getting rid of one of the premises of traditional television, which consists of the seriality of the contents (Izquierdo Castillo, 2015)

One of the types of companies that is being hit hardest in the value chain are public television channels, according to Campos Freire (2013), the future of television is increasingly paying. This author affirms that the new audiovisual policies, the financing difficulties, the lack of flexibility and adaptation to the rapid changes of the environment of the public channels and

a greater dynamism of the private channels will cause the public channels to disappear. The challenge of these channels will therefore be to maintain funding, stay present on all platforms, achieve a restructuring without damaging the principles of public service and maintain credibility through quality cultural content.

A final element is the new role of the audience, who surpass the roles of a simple final consumer. The audience starts to have an active role by which it is empowered by accessing it through different means (including non-legal), sharing it, transforming it and even creating it (Izquierdo Castillo, 2015), (Del Pino & Aguado, 2012). This new role of the audience is described later in this chapter.

3.2.2. Financing model.

The entrance of the audiovisual industry on the Internet, the increase in the use of mobile devices and the new audiovisual consumption habits demand the establishment of monetization formulas that are coherent with these changes and that allow industry participants to adapt to the technological environment and generate profitability (Castillo Pomedá J. , 2015).

In response, the new financing models are adaptations of the payment methods used by traditional commercialization, but these have sought to orientate themselves to the acquisition of marketing rights of a wide catalog, to the combination of financing formulas that make more profitable the business even to the consumer and the flexibility of reproduction on multiple platforms (Izquierdo Castillo, 2012).

First of all, it is possible to distinguish monetization models from companies that offer IPTV services, from which they offer television services and content over the Internet. The companies that offer IPTV offer a subscription service similar to that of satellite television or cable television, where the user is obliged to pay a monthly basic fee plus an initial purchase or rental value of the STB. These same STBs represent a key element in this method of monetization, because they allow to provide additional digital services and manage premium subscriptions (Tabares Ossa & Torres Arboleda, 2012). Additionally, IPTV services are usually offered in conjunction with Triple Play by the same telecommunications company.

On the other hand, the monetization of television or video services over the internet has focused on 3 different models (Izquierdo Castillo, 2012):

- **Micropayment models:** There are two variants. In the first case, the user performs the live consumption of the content or has a specific time for viewing it, while in the second case the user acquires the content in ownership. Some companies that work with this model on a large scale are Wal-Mart through its platform VuDu and Apple through iTunes, the latter being reinforced by the use of joint hardware platforms (iPod, iPhone, iPad and Apple TV).
- **Subscription-based models:** In this model, companies offer the user the possibility of subscribing to their platform, making periodic payments that are usually monthly, to view all the available content in an unlimited way. These models are usually very dependent on network conditions such as transmission speeds, which can affect the quality perceived by users. The largest exponent of this model is Netflix, which offers monthly subscriptions of no more than \$ 15 a month depending on the quality of the video and the number of screens that can be connected to the platform simultaneously.
- **Model dependent on advertising:** This model proposes a medium of free access for the audience, but financed through advertisers. At the moment when the user wants to visualize a content, it is exposed in different ways to advertising of different products. Castillo Pomedá J. M. (2016) supports the viability of this model because the Internet is also a means to inform, communicate and have fun, and a medium where you can make many purchases.

Izquierdo Castillo (2012) states that this model, however, has many disadvantages to maintain an exclusive financing for advertising. Such is the case that Youtube, the iconic company of this financing model, does not find means to monetize the large number of users it has. However, Castillo Pomedá JM (2016) states the contrary, saying that the number of advertisers on YouTube increased by more than 40% in 2016, that the number of companies reporting income of more than 6 figures in dollars increased by 50% and other financial factors that mark a growth of this model. This difference may be due to the advertising systems that YouTube started to use during this period of time. Now YouTube offers advertisers the possibility of placing "TrueView" ads at the beginning of videos, as results of a search or as a suggestion

of following videos. In addition to using the advertising system of Google Adwords, Banners and Masthead, systems that are also implemented by other platforms based on advertising.

3.2.3. Changes in the profiles of professionals.

Multichannel strategies demand a flexible internal professional culture open to change, demanding the change of the profiles of professionals working in traditional television and thus requiring greater technical skills (use of different tools for the work of web content, editing, etc. .) and comprehension of redaction on at least two platforms, generating a horizon with "multimedia professionals" (García J. A., 2009). Those professionals who fail to adapt to this new multimedia reality are outside the audiovisual market (Heredero Diaz & Reyes Sanches, 2016).

Islas (2008) identifies three main transformations in the profiles of professionals:

- Transfer of tasks: some activities carried out by a professional are now executed by another one.
- Fusion of roles: activities that were previously carried out by two or more professionals, now executed by only one.
- Increase in work: an increase in the number of activities resulting from the generation of content for multiple platforms and the reduction of technological equipment mean that the same professional is responsible for more activities than before.

These factors cause professionals to have a lesser degree of specialization but to include a greater functional baggage, creating a "man orchestra" (Heredero Diaz & Reyes Sanches, 2016). In addition, many productions and newsrooms opt for low cost strategies supported by the reduction of equipment prices, by a cut in labor wages, by working hours of ten hours and by using temporary contracts, increasing the precariousness of job positions (García J. A., 2009; Heredero Diaz & Reyes Sanches, 2016).

The professionals that have had the greatest impact on professional convergence have been those that are directly linked to the production of content, both entertainment and information. In the first case, Heir Diaz & Reyes Sanches (2016) affirm that about 9 years ago it could be necessary to form a professional team of between 20 and 65 people for the

creation of a television program or a commercial guideline. This team was responsible for work as direction, production, art, photography, camera, styling, makeup, hairdressing, sound, etc. Currently said work is done by 1 or 2 people.

In the production of informative content, the new demands have had a direct impact on journalists, who are now forced to be polyvalent subjects in a functional way, executing different tasks, and in a mediatic way, working with contents in more than one medium (Larrondo Ureta, 2015). Many of the news channels have chosen to assign journalists the tasks of design, editing, writing, attention to readers, updates, among others, without losing sight of the multiplatform approach. This has produced a less critical journalism, more packaged and ultimately of lower quality (Islas, 2008). On the other hand, some channels have also created the professional profile of the multimedia coordinator, who is responsible for coordinating parallel and collaborative drafting for each of the platforms, minimizing the problems of internal communication (Larrondo Ureta, 2015).

The challenge of the audiovisual industry is to provide the necessary conditions to develop quality productions, encouraging the training and updating of the skills of professionals, investing in their training and compensating their work, which has been increased by the requirement to produce content for various platforms (Islas, 2008).

3.2.4. Content

Information technologies and the modification of audience preferences also influence the way content is produced. On the one hand, television must accept that it must modify formats and contents based on digitization and convergence, taking advantage of the innovations offered by the technique (Ruano López, 2013) and on the other hand, television must evolve from an offer approach to a demand approach (García J. A., 2009).

At first, the television networks opted for a technique of offering their traditional television programs over the internet for free after their transmission by conventional media, trying to gain customers on this platform (Ruano López, 2013), however, the channels were able to observe the limitations of this method and managed to advance the creation of content designed for the web, which will take advantage of all the benefits it offers (Bañón, 2016).

Corporations in the audiovisual industry must opt for multimedia or multiplatform strategies identifying the types of content suitable for each of the transmission channels and supporting mutual cooperation and the adaptation of content between these platforms. The companies that have started to operate in this way adapt formats transmitted by television to then communicate them in a different way on the network. The reverse process is less common, but it is usually seen in those cases where material produced by the audience is taken and the contents are included in some way (Larrondo Ureta, 2015). Ruano López (2013) describes this multiplatform strategy as "all the contents in all the windows".

These new contents consider different factors produced by convergence such as:

- Increased protection of content against piracy: This threat is supported by new information encryption systems. In the case of IPTV, telecommunications companies use STBs to use DRM (Digital Rights Management) (Tabares Ossa & Torres Arboleda, 2012). On the other hand, in Internet television is faced with a greater threat because of the ease that the network supposes to violate the Copyright, which continues being one of its biggest challenges (Castillo Pomedá J. M., 2016).
- Multiplicity of technical formats: The contents transmitted by traditional media have different technical formats than those used by the network, so audiovisual companies are forced to transcode the formats and manage multiformat systems that allow them to respond quickly to the immediacy that it requires. To do this, MAM (Media Asset Management) systems are used, which allow versatile work on different contents and which allow companies to have a single system for registering all these materials, even revaluing them as digital assets (Larrondo Ureta, 2015).
- Personalization of content: The content offered by companies must be adapted to the characteristics of each audience, such as age differences, language differences, preferences of more sophisticated viewers, among others (García J. A., 2009). Ruano López (2013) indicates that for example the internet audience are usually young people interested in seeing capsules of between 3-5 minutes and who can also remain "satisfied" with only incorporating 2 hours of new content per week. In addition, the personalization must include the interaction with the audience in different instances,

for example Netflix and YouTube use content suggestion systems according to the previous interactions with the user.

Regarding the content of the entertainment programs, innovation is still sought in the theme of the programs, proposing new series, however, there are many cases of remake that have been successful in the audience, as it is the case of House of Cards reproduced and distributed by Netflix. Netflix has also broken the paradigm of seriality where the user had to wait a certain time to see the next chapter, Netflix launches series with full seasons available (Del Pino & Aguado, 2012; Ruano López, 2013).

On the other hand, referring to the informative content, Heir Diaz & Reyes Sanches (2016) state that technology has produced an additional burden of information on journalists, a demand for immediacy of information and a boom in citizen journalism, which has resulted in a loss of quality content since immediacy reduces the time for analysis and reflection and consequently generates a trivialization of content that is nothing more than flashy headlines lacking critical content.

3.2.4.1. Audience

With the aging of traditional television, users also age, and the existence of multiple platforms drives a complete change over the new audiences that consume it, producing in them a fragmentation in different aspects (López García , Soengas Pérez, & Rodríguez Vázquez, 2016). This fragmentation can go from sociological and psychological aspects such as age, sex, socioeconomic level, individual habits, schedules, hobbies, identity signs, social role, etc. (Osorio Montoya, 2011); till aspects related to the management of technology such as digital natives, digital immigrants and digital illiterates (Del Pino & Aguado, 2012). At the same time, the tastes and tendencies of these types of audiences are increasingly volatile and difficult to predict, which hinders their classification and increases this segmentation. (García J. A., 2009).

Television and video content on the internet are visualized mainly by people between 13 and 49 years old, with users between 13 and 17 years old having the highest level of activity (Castillo Pomedá J. M., 2016). These so-called digital native users (who were born after 1995), develop skills to use new technologies in a prevailing digital sociocultural

environment, with greater capacity for consumption, diffusion and creation of content in second and third screens (Izquierdo Castillo, 2015) (Del Pino & Aguado, 2012).

The new preferences of the users focus on immediacy, participation, personalization, deepening and non-linear narration. Companies that have been receptive to these new needs have incorporated advantages, new content and business models (García J. A., 2009). This is the case of YouTube, which is presented as a place of consumption of easy-to-use audiovisual media, where the user can satisfy the mentioned preferences.

The case of YouTube also serves to illustrate the new role of the audience to produce and share content. Thanks to the reduction in hardware and software costs, it is feasible to create professional technical quality content, without even incurring a minimum part of the cost of a television production (Heredero Diaz & Reyes Sanches, 2016). This fact is used by users to produce content. In the case of YouTube these users have been called "youtuber", who are users that generate high visualization content and receive an economic return for it (Castillo Pomedá J. , 2015). In addition, it is important to mention the role of social networks where the audience can share content on the internet of all kinds and can even make it "viral".

3.2.5. Interactivity

With the change of the unidirectional broadcast television model focused on the masses made a personalized television with a two-way communication, the audience gains an active role participating in stimulating an interactive communication (Shagrir, 2018). The technological convergence facilitates this interactivity that was not possible with the other transmission media (satellite, DTT and CATV) due to its low capacity to support messages in audience-provider direction.

Continuing with the above, according to Osorio Montoya (2011), interactivity is the fact that it involves both parties of the communicative process, that is, it is the moment in which the sender of the message sends certain information, in this case a content audiovisual, that when processed by the receiver generates a response; which in turn is returned in the form of a reply. This interactivity plays an important role in cutting-edge television as a measure of audience engagement with the content that complements previously used measures (circulation, rating, etc.) and also it allows the broadcaster to know the needs and the reactions that this content generates (Bignell, 2018).

Based on interviews with TV makers, Shagrir (2018) managed to identify 3 relevant aspects of this interactivity: the way or means of interaction, the temporal and spatial dimension of the interaction and the level of response that the transmitter can give. On the other hand, Ksiazek, Peer, & Lessard (2014) found, through empirical research, three main motivations of the audience to generate interaction: the search for information, socialization or social interaction and entertainment.

Ksiazek, Peer, & Lessard (2014) propose a distinction of interactivity over videos on the internet, emphasizing the news, in two different ways:

- User-content interactivity: refers to the interaction of the user with the content and with the producers or issuers thereof, such as posting an initial comment to a video thread. This serves the producer as a medium of feedback.
- User-user interaction: how to comment on a comment before a video or share the content with another user.

One of the platforms that best interprets this interactivity role is undoubtedly YouTube, due to its communicational context and the very personality of the platform. YouTube allows the circulation of its contents through thousands of different platforms, in addition it always encourages the audience to actively participate in the creation, circulation and evaluation of the contents (Castillo Pomeda J. M., 2016).

3.3.Colombian Panorama

3.3.1. ICT (Information and Communication Technologies) industry

3.3.1.1. General conditions of digital commerce

Colombia is a developing country, which also includes all its telecommunications infrastructure. This means that there are a large number of challenges and opportunities for the different industries involved, as well as for the government in its role as regulator. In general, Colombia has some strengths such as a rapid acceleration in the growth and use of information technologies, especially in the use of the internet. This is driven by a good culture of use, especially in social networks, music applications, etc. However, compared to developed countries, Colombia must seek strategies to improve the number of subscribers to

mobile internet, fixed internet in homes and increase in broadband speeds (Comisión de Regulación de Comunicaciones, 2017).

Using the classification by means of the digital transformation index of Arthur D. Little, which relates variables such as price, use, speeds and number of internet connections, it is possible to compare the ICT development position of Colombia with other countries (Comisión de Regulación de Comunicaciones, 2017), as shown in the Figure 11. According to this classification, Colombia is still in the group of developing countries in terms of ICT development.

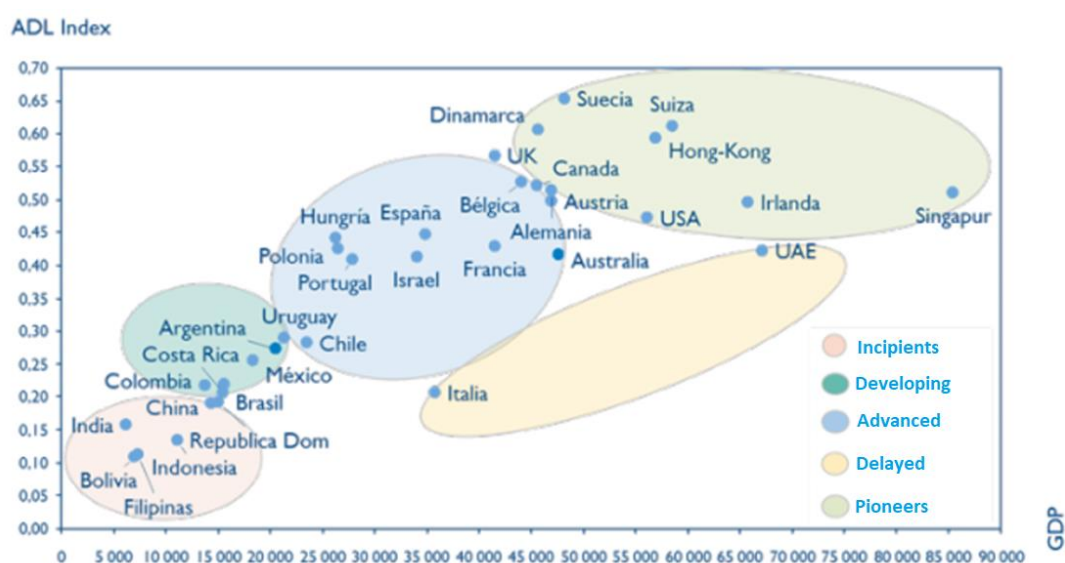


Figure 11. Arthur D. Little's E-capabilities index
Source: (Comisión de Regulación de Comunicaciones, 2017)

According to a qualitative analysis carried out by the CRC in the report “Análisis Marco Regulatorio en un entorno de Comercio Electrónico” (Regulatory Framework Analysis in an Electronic Commerce environment) (Comisión de Regulación de Comunicaciones, 2017), The main difficulties that the country has in digital industry issues are:

- There is a distrust in electronic commerce due to a strong rootedness of consumers to use traditional forms of commerce and payment. Additionally, the absence of a direct and physical interaction between the buyer and the seller increases their distrust to use these alternatives.

- As in traditional commerce, there is a wide problem of tax evasion and smuggling of digital products.
- There is a large knowledge gap in users between large cities, intermediate cities and the most remote areas of the country, due to the lack of digital access education.
- There is an absence of human talent for software design, web design, content production or personnel with experience in electronic commerce.
- Electronic commerce does not have a clear strategy to generate content, products and services.
- There are still many technical factors of the infrastructure that must be improved, such as the regularity of the quality of the internet signal on mobile devices, access to mobile terminals, which is limited in some regions; low fixed internet coverage, among others.

In order to advance with the challenges facing the country, the CRC makes a comparison of the best practices developed in the countries that present better progress in this sector of media and practices that are considered in Colombia, this comparison is shown in the document “Hoja de ruta regulatoria para el desarrollo de la economía digital en Colombia” (Regulatory roadmap for the development of the digital economy in Colombia in English) (Comisión de Regulación de Comunicaciones, 2017) and summarized in the Figure 12, here is an idea of the approaches that should be taken by government and business the industry.

	MEJORES PRÁCTICAS	SITUACIÓN EN COLOMBIA
Clasificación del servicio	✓ Los servicios no son de telecomunicaciones y en consecuencia no se regulan específicamente	✓ Los servicios no son de telecomunicaciones, sino servicios en línea no sujetos a regulación
Presión competitiva nuevos jugadores	✓ Los nuevos jugadores ejercen presión competitiva en los servicios tradicionales de medios audiovisuales	● La presión competitiva de los nuevos jugadores está en fase de desarrollo
Neutralidad de red	✓ Se aplica neutralidad de red, y se evalúan nuevos modelos de negocio caso a caso	✓ Se aplica neutralidad de red y se evalúan nuevos modelos de negocio caso a caso
Régimen tributario	✓ Se aplican impuestos estatales y a las ventas, según lugar de residencia consumidor	● En definición sistema de impuestos a aplicar en impuesto a las ventas
Control de contenidos	✓ Medidas de protección a menores tanto en TV tradicional, como en medios audiovisuales digitales	● Medidas de protección a menores en medios audiovisuales digitales aun en desarrollo
Cuota producción nacional	✓ Medidas de apoyo a la financiación de producción nacional para medios audiovisuales digitales.	● No existen medidas de incentivo a la producción nacional relacionadas con medios digitales
Inversión contenido propio	✓ Prioridad a la inversión en contenido propio y análisis de Big Data. Líderes USA y UK	● Depende de negociaciones con líderes globales
Conectividad > 10Mbps	✓ Alta penetración de banda ancha con velocidades de al 10Mbps	✗ Necesidad de mejorar la velocidades y calidad de la banda ancha
Impuesto de renta	● Por el momento no hay una propuesta acordada a nivel OECD. Chile realiza retención alta en pagos al exterior	● Sin definición
Nuevos modelos VR y AR	✓ En desarrollo con apoyo de capital de riesgo	● Por definir apoyo a nivel de programas de innovación y fuentes de capital de riesgo globales
	✓ Reto con decisión de apoyo ✗ Reto con decisión restrictiva ● Reto sin decisiones	

Figure 12. Comparison of best practices with the situation of Colombia in the media sector.
Source: (Comisión de Regulación de Comunicaciones, 2017)

3.3.1.2. Fixed and mobile Internet

The outlook for the growth of internet use in Colombia is encouraging and marks the global trends in the replacement of mobile, fixed and messaging services by fixed and mobile internet, which confirms the importance that the internet has gained as a convergent communication medium. In general terms, according to the report “Reporte de industria, sector TIC 2017” (Industry report, ICT sector 2017) of the CRC, 62.3% of Colombians are Internet users. This number should be interpreted together with the increase in the number of mobile internet subscribers from 48.7% in 2016 to 52.4% in 2017 and the increase in subscribers of the fixed internet of 12.1% in 2016 to 12.8% in 2017, it should be noted that this 12.8% of subscribers reflects a fixed internet coverage of 50% of the houses.

Although the Colombian panorama of internet access grows considerably, the percentage of the population that has access to the internet is still very low compared to developed countries, but slightly higher than in developing countries, see Figure 13 y Figure 14. This fact could mark a first barrier to entry that protects momentarily the Colombian television industry from losing its market drastically against VoD service providers, as Colombian internet networks have yet to develop better to host these services.

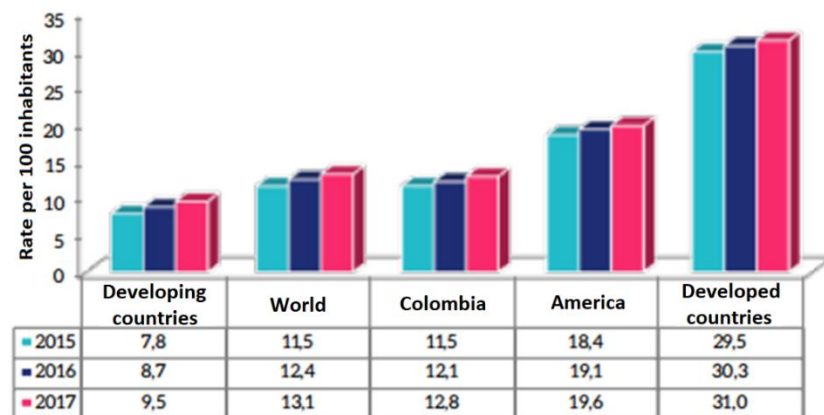


Figure 13. Number of fixed broadband internet subscribers per each 100 persons.
Source: (Comisión de Regulación de Comunicaciones, 2017)

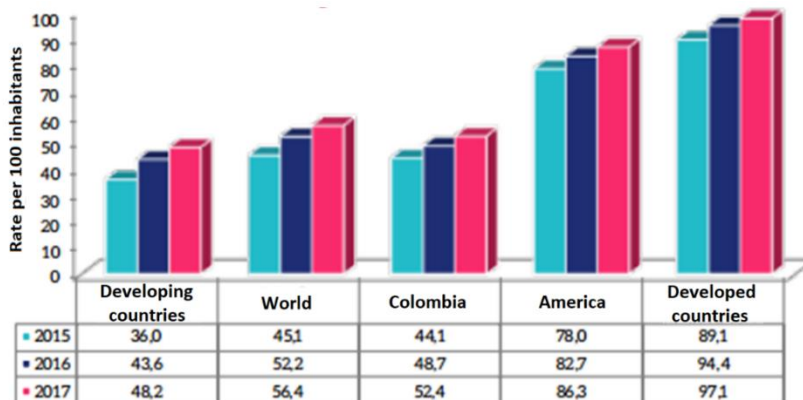


Figure 14. Number of mobile internet subscribers per each 100 persons.
Source: (Comisión de Regulación de Comunicaciones, 2017)

By performing an analysis of the technical evolution of fixed connections it is possible to notice that users are changing the type of connection they acquire to those with speeds higher than 5Mbps, as shown in Figure 15. This is also reflected in a decrease in about 12% of connections to xDSL type networks between 2015 and 2017 and in an existence reached for the first time of more than 10% of fiber optic connections, as shown in Figure 16. These factors indicate that the Fixed Internet service in Colombia is in a process of technological renovation, a situation that allows users to experience higher download and upload speeds when connecting to the Internet and better quality.

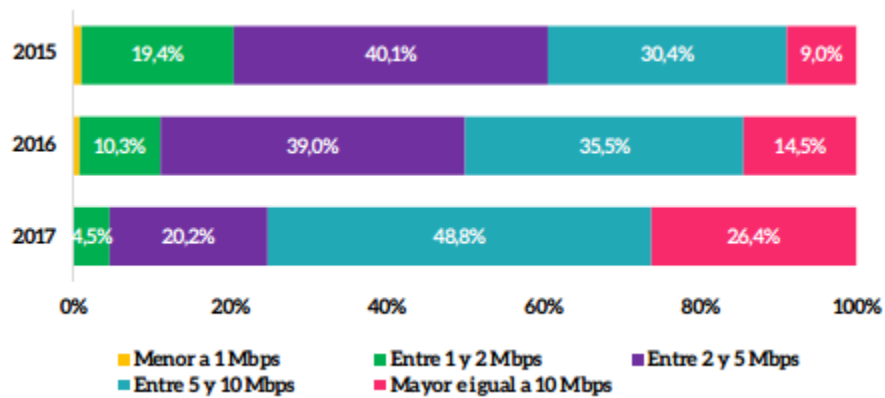


Figure 15. Participation of subscribers of fixed internet access by speed range.
Source: (Comisión de Regulación de Comunicaciones, 2017)

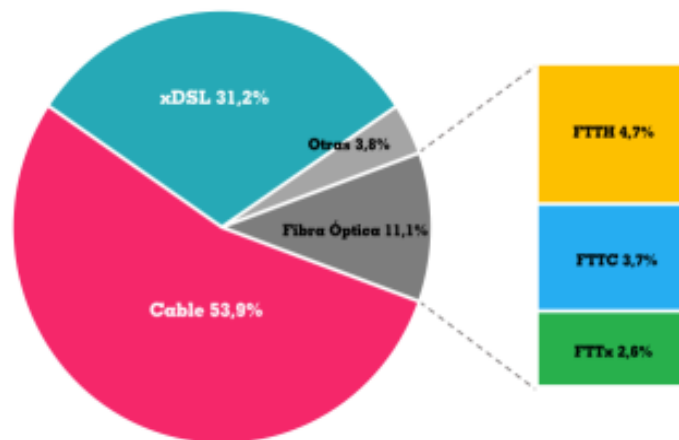


Figure 16. Participation of fixed connections to Internet by type of technology.
Source (Comisión de Regulación de Comunicaciones, 2017)

Regarding the particular growth of the mobile internet subscription, as shown in the Figure 17 , it is evident that Colombia presents a significant growth in the number of devices connected to the 4G networks and in turn it is perceived a decrease in the 2G and 3G connections, this represents a quite favorable scenario for the ICT industries since the 4G technology, allowing greater navigation speeds, facilitates access to greater and better services (Comisión de Regulación de Comunicaciones, 2017).

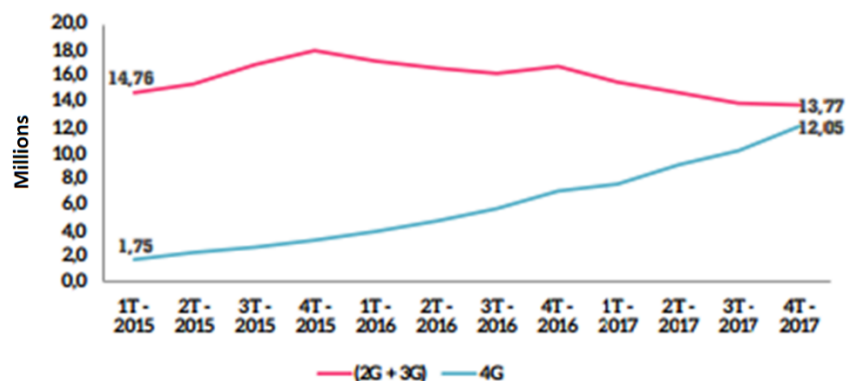


Figure 17 Number and type of connections on mobile devices.
Source: (Comisión de Regulación de Comunicaciones, 2017)

3.3.1.3. Television by subscription

According to the last definitive report of the CRC with a cut in the year 2017 (Comisión de Regulación de Comunicaciones, 2017), Between the fourth trimester of 2015 and the fourth trimester of 2017, the number of connections increased by 8.5%, increasing from 5.13 million to 5.57 million connections. However, the rate of growth that had been recorded began to be increasingly smaller, the average quarterly variation for 2015 and 2016 was 1.3%, while the average variation of 2017 is only 0.6%. These factors show that Colombia still does not present the characteristic that many authors predicted and that were mentioned in this investigation before, where customers began to cancel the services by satellite and cable subscription and replaced it with Internet services, however, the variation in the rate of growth could indicate that such behavior would soon find itself happening.



Figure 18. Evolution of the number of television connections per subscription.
Source: (Comisión de Regulación de Comunicaciones, 2017),,

The partial report of the year 2018 (Autoridad Nacional de Televisión, 2018) shows that the growth trend of the number of users subscribed to television is conserved and that by July of this year approximately 5.7 million users registered. These users are reported according to the licenses that the cable, satellite or single license operators have, as shown in the Figure 19.



Figure 19. Number of cable television subscribers - July 2018.
 Source: (Autoridad Nacional de Televisión, 2018)

If the analysis of the individual growth of each of these medium of transmission is carried out according to the income they have represented for the companies, the subscription to the cable has increased by 17%, the subscription by satellite by 3% and the subscription by a unique license of 10%, all of them between the years 2016 and 2017.

Table 2. Television revenue by subscription

Medium	Income 2016	Income 2017	Increase
Cable TV	\$ 176,127,308,390	\$ 205,528,454,879	17%
Satellite TV	\$ 1,205,487,016,998	\$ 1,241,972,147,993	3%
Unique license TV	\$ 1,506,030,876,870	\$ 1,657,088,178,157	10%

Source: Own elaboration based on the report of the ANTV (Autoridad Nacional de Televisión, 2018)

3.3.1.4. ICT service providers

According to ANTV, users in Colombia began 2018 receiving subscription television service through 59 different operators. Despite the high number of companies providing the service, 5 companies accumulate 89.62% of the total connections to ICT services by subscription in the country. As can be seen in the Figure 20, Claro - Telmex maintains the largest participation in each of the services, although Movistar maintains a significant participation of 22.4% of the mobile internet services and also TIGO - UNE and DIRECTV have a participation of 20.6% and 17.1% of television by subscription. Regarding the fixed internet

service, the clear leadership of CLARO - TELMEX is evident with 37.5% of the connections, but there is an important participation of Movistar, TIGO and ETB.

Service / Operator	Mobile Internet	Mobile Telephony	Fixed Internet	Fixed Telephony	TV subscription
	56,9%	47,2%	37,2%	30,4%	42,8%
	22,4%	23,4%	15,3%	17,9%	9,9%
	12,7%	18,4%	20,2%	21,7%	20,6%
	1,5%	1,0%	10,2%	16,9%	2,3%
	0,0%	0,0%	2,3%	0,0%	17,1%
Others	6,6%	10,0%	14,8%	13,1%	7,4%

Figure 20. Participation of operators in ICT services according to the number of connections and lines 2017.
Source: (Comisión de Regulación de Comunicaciones, 2017)

Regarding the relationship that the evolution of these ICT services has had and the income received by suppliers due to the change in user habits, it is possible to say that Colombia is evolving in the same direction as countries with higher levels of development are advancing, although at a slower pace. In the Figure 21 is showed, for example, how the income received by the service providers in terms of mobile telephony was surpassed in 2016 by the income received by the mobile internet.

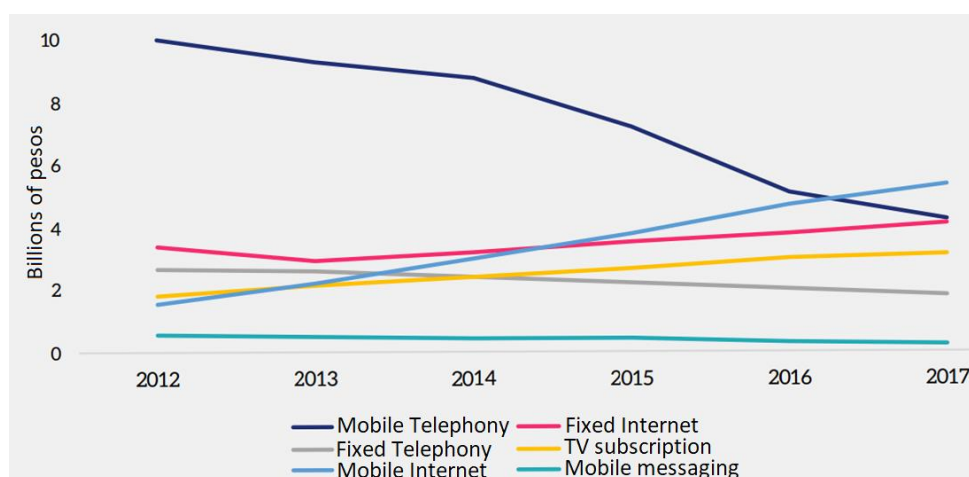


Figure 21. Evolution of income for ICT service in Colombia.
Source: (Comisión de Regulación de Comunicaciones, 2017)

3.3.1.1. *Related Government Entities*

In Colombia there are three directly governmental entities linked to the production and transmission of television throughout the country, the ANTV (National Television Authority in English), the CRC (Communications Regulation Commission in English) and the ANE (National Spectrum Agency in English). It is important to mention that there are entities such as the Ministry of Information Technology and Communications (MINTIC) that are related to the exercise and function of television over the Internet and open television, but its actions are carried out through the first three institutions mentioned.

ANTV (Autoridad Nacional de Television or National Television Authority in English):

The ANTV was born as a governmental entity to assume the functions and competences that CNTV (National Television Commission) had been exercising. Its creation is given by Law 1507 of 2012, which aims to:

- Provide the tools for the execution of plans and programs for the provision of public television service, in order to ensure access to television, ensure informative pluralism, competition and efficiency of service.
- Be the main interlocutor with users and public opinion in relation to the dissemination, protection and defense of the interests of viewers.

Through the same Law 1507, the FONTVC (Fund for the Development of Television and Content in English) was also created, which aims to strengthen the public operators of the television service, the financing of educational and cultural programming in charge of the State and support for the generation and dissemination of public interest television content developed by non-profit operators, in addition to financing the operation of ANTV.

CRC (Comisión de Regulación de Comunicaciones or Commission of Regulation of Communications in English):

The CRC is the body in charge of promoting competition, avoiding the abuse of a dominant position and regulating the markets of networks and communications services; in order that the provision of services be economically efficient, and reflect high levels of quality.

The CRC was born as a government agency through Law 142 of 1994, assuming the administrative, technical and patrimonial responsibilities of the previous CRT (Commission of Telecommunications Regulations). Among its functions mentioned by said article and in relation to the present investigation are:

- Promote and regulate free competition for the provision of telecommunications networks and services, and prevent unfair conduct and restrictive business practices, through general regulations or specific measures, and may propose differential rules of behavior according to the position of the suppliers, previously has determined the existence of a failure in the market.
- Issue all regulations of a general and particular nature in matters related to the competition regime, the technical and economic aspects related to the obligation of interconnection and the access and use of essential facilities, physical resources and software necessary for interconnection; as well as the remuneration for the access and use of networks and infrastructure, wholesale prices, the conditions of billing and collection; the regime of access and use of networks; the quality parameters of the services; the efficiency criteria of the sector and the measurement of sectoral indicators to advance in the information society; and in terms of dispute resolution between network providers and communications services.
- Regulate the access and use of all networks and access to markets for telecommunications services, with the exception of networks intended primarily for broadcast television services and sound broadcasting, towards market regulation.
- Propose to the National Government the approval of technical plans and standards applicable to the Information and Communication Technologies sector, taking into account the interests of the country, according to the norms and recommendations of competent international organizations and administering said plans.
- Determine standards and certificates of international and national homologation of equipment, terminals, goods and other technical elements essential for the establishment of networks and the provision of telecommunication services acceptable in the country, as well as indicate the entities or national laboratories authorized to approve goods of this nature.

***ANE (Agencia Nacional del Espectro or National Spectrum Agency
in English):***

The National Spectrum Agency is the entity that is responsible for strategically planning the use of the radio spectrum, as well as its surveillance and control throughout the Colombian national territory. It has a special relevance in the regulation of the television channels that carry out the broadcast of its analogue and digital open signal.

Among its main functions are:

- Study and propose, according to the tendencies of the sector and the technological evolutions, optimal surveillance and control schemes of the radioelectric spectrum, including satellite, except for the provisions of article 76 of the Political Constitution and in accordance with the regulations valid.
- Carry out the technical management of the radio spectrum.
- Study and propose valuation parameters for the right to use the radioelectric spectrum and the structure of contra-benefits.
- Ensure the availability of the spectrum necessary for the massification of mobile internet and the extension of coverage and services as obligations to do by operators.

3.3.1.1. Challenges, actions and governmental regulatory projects

In terms of technological convergence and digital services, the aforementioned government entities have been in charge of identifying the challenges that the country faces in order to generate the policies that best suit and adapt to its panorama. For the creation of the document "Regulatory roadmap for the development of the digital economy in Colombia" (Comisión de Regulación de Comunicaciones, 2017), the CRC made a detailed study of the situation in the country and brought together experts from different television channels , companies and entities related to the television industry, recognizing, among others, the following challenges and actions:

- Determine criteria to define and / or classify information services vs. the telecommunications services.
- Define rules and criteria for the analysis of the corresponding markets in information and telecommunications services.

- Look for a regulatory balance between traditional services and new services (e.g. Telecom / media vs. OTT).
- Understand the role that Big Data plays in competition and regulation in dynamic markets
- Facilitate the access of companies to data, without generating favorable competitive positions for some companies.
- Ensure user protection in the use and application of Big Data.
- Ensure that network neutrality is not an impediment to the development of new business models, investments and innovation, without harming consumer rights.
- Generate incentives to promote investments in quality broadband.

The actions mentioned in the document that are taken to advance the challenges are:

- Analysis of the value of the contributions for the contributions of the TV operators by subscription and contributions of the audiovisual online services.
- Analysis of regulatory / deregulatory measures of telecommunications and information services when they operate in competition or are classified as substitutes.
- Definition of balanced charges between audiovisual online services and subscription TV services.
- Review of the tax regime for the digital economy, taking into account the competition of new services with traditional services.
- Regulation analysis and incentives to improve investments in the broadband internet access network.

For the development of these actions, the following projects were proposed among others:

- Regulation for broadband incentives, projected for the third quarter of 2019
- Market analysis of audiovisual and TV online services, projected for the first to third quarter 2018.
- Net neutrality and for business models, projected for the second to fourth quarter 2018.
- Creation of a public policy for the digital economy, projected for the first semester 2019.

- Contribution analysis of audiovisual online services and subscription TV, projected for the first semester 2018.
- Creation of digital Hub of copyright, projected for the second semester 2019.
- Tax regime for the digital economy, projected for the second semester 2018.
- Labor regime for the digital economy, projected for 2020.
- Promotion and competitive analysis of the Big Data market. Projected for 2020.

3.3.2. Open television

Open television is one in which the terrestrial signal can be freely received by any person located in a service area covered by a specific station or antenna. In Colombia, this service is currently provided in an analogue and digital manner by public and private television operators, as well as regional or national ones. In this television scheme, the user does not need to pay for any service to receive the signal, as long as it has a compatible receiving device.

3.3.2.1. Colombian television channels

According to the ANTV, in Colombia there are 32 providers of open television service divided as follows:

- Private national channels: 2 television channels called “Caracol Television” and “RCN Television”.
- National public channels: There is a public manager called RTVC (“Radio y Television Nacional de Colombia”, National Radio Television of Colombia) that operates three public channels called “Canal Uno”, “Canal Institucional” and “Señal Colombia”.
- Public regional channels: 8 public regional channels called “Canal 13, Telecaribe, Canal Capital, Telecafe, Canal TRO (Television Regional del Oriente), Teleantioquia, Telepacifico and Teleislas”.
- Local TV: 20 local non-profit channels and a local for-profit called “CityTv”.

Private television channels

Private national channels appear after the issuance of article CNTV No 1 of Law 182 of 1995 "Television is a public service subject to the ownership, reserve, control and regulation of

the State, whose provision will correspond, by concession, to public entities to which this law refers, to individuals and organized communities ", which subsequently triggered the creation of CNTV Resolution No. 429 of 1998" By which tariffs are set for the allocation and use of frequencies for the Channels Nationals of Private Operation ". According to these two articles, television is seen as a public service, but can be provided by private entities and this is how Caracol Television and RCN Television operate by paying concession to regulator ANTV to use the electromagnetic spectrum regulated by the ANE (Autoridad Nacional del Espectro, National Spectrum Authority) (Autoridad Nacional de Televisión, 2018).

According to García Ramírez (2015), the characteristics of private television operators are their financing based on advertising, the generation of content aimed at attracting as much audience as possible and a market-oriented control. García, as well as other authors, mentions that this commercial orientation of the private television channels has led him to breach the expectation that his creation maintained to make diverse contents and has led him to "reduce his offer to telenovelas and series on drug trafficking, realities repeated over and over again and sensational newscasts in which political expediency prevails over the right to information. " In confluence with this, according to the ANTV, these private channels concentrate around 62% of the audience, distributing equitably at 31% each private channel (Autoridad Nacional de Televisión, 2016).

The annual television report of 2017 (Autoridad Nacional de Televisión, 2018), it indicates that the income of private television operators had a reduction in their income for 2017, going from \$ 1,229,989,375,251 in 2016 to \$ 1,149,143,154,531 in 2017, that is, 7% less.

Public television channels

According to the resolution ANTV No 2005 of November 28, 2017, public television is defined as "the public television service that satisfies the general interest over the commercial, especially in regard to the promotion of cultural and educational values, that understands television as an articulating axis of the construction of citizenship from the local, regional and national levels, aimed at guaranteeing in an ideal, effective and impartial manner, informative, cultural and social pluralism, the strengthening of the national entity, democratic and participatory training of citizens, and access to knowledge "

In Colombia, public channels are divided according to the scope of the broadcast of their signal in regional and national. The regional channels are constituted as Industrial and Commercial Enterprises of the State (in Spanish, EICE), which means that they must manage a part of the resources they need for their operation and are little dependent on the money assigned to them by public means. These channels have a mixed financing system composed of monies allocated by the FONTVC (Fondo para el Desarrollo de la Televisión y los Contenidos - Fund for the Development of Television and Contents), contributions from partners, advertising and marketing (García Ramírez, 2015). According to García, this television model is outside the parameters of public television, because if public television is talked about in terms of financing, control structures and contents, it should be financed merely by the state, controlled by an independent body and with diverse educational and cultural content.

As for the 3 national public television channels (“Señal Institucional”, “Señal Colombia” and “Canal Uno”), all were part of the same technological infrastructure, content and administrative management of RTVC (formerly Inravisión), who also has direct responsibility for administration of “Canal 13”, these channels also maintain the figure of EICE.

During the course of 2017, a contract was signed for a concession with Plural de Comunicaciones S.A.S. with the object of "The use and exploitation at its own risk, of the television spaces of the national channel of public operation, subject to the purposes and principles governing the public television service" with a term of 10 years and with possibility of extension by converting it into a private administration channel that makes use of the public transmission infrastructure of the national public channel RTVC.

3.3.2.1. *Broadcasting technological infrastructure.*

Analogical infrastructure

Colombia currently has analogical open television transmission infrastructure using the NTSC standard. The available infrastructure is organized as follows (Autoridad Nacional de Televisión, 2016):

- National Public NTSC Network: distributes the signal of “Canal Uno”, “Señal Colombia” and “Señal Institucional”. This network is deployed and managed by RTVC. This infrastructure has a coverage of 92% of the country.
- Public regional NTSC networks: regional transmission infrastructure for the Telecaribe, Teleantioquia, TRO (Regional Television del Oriente), Telepacífico, Telecafé, Canal 13, Canal Capital and Teleislas channels. A large part of these regional stations is located on stations owned by RTVC. This infrastructure has a coverage of 86.5% of the country.
- National private NTSC network: distributes the signal from Caracol Television and RCN Television, but is deployed and managed by the CCNP (Consortio de Canales Nacionales Privados, in English Private National Channels Consortium). This infrastructure has a coverage of 92.7% of the country.

Once the digital standard was chosen and regularized, it was established as the date of the analog blackout on December 31, 2019, hoping to complete coverage of more than 90% of the digital television transmission, however, due to delays in technological change On the part of the audience and other additional factors, the regulatory mechanisms have begun to study the possibility of elaborating a plan of progressive shutdown by means of partial shutdowns (Autoridad Nacional de Televisión, 2016).

Digital Infrastructure

Through the CNTV Agreement No. 8 of 2010 "By which the DVB-T digital terrestrial television standard is adopted for Colombia and the general conditions for its implementation are established", Colombia chose the DVB-T standard and determined the date of the blackout analogical. The technical specifications agreed by this agreement defined a channel frequency of 6Mhz, an encoding system for ITU-T H.264 or MPEG-4 AVC.

In 2011, industry participants, represented by ACIEM (Colombian Association of Electrical and Mechanical Engineers), held meetings with the regulatory bodies in order to modify agreement 8 of 2010 to take advantage of the fact that even RTVC did not deploy its DTT infrastructure and thus opt for the DVB-T2 standard, which was the most developed standard in that year and nowadays (Martínez, Sánchez, Barquero, & Cardona, 2015). This change is made and regularized through the CNTV agreement No 4 of 2011, making Colombia the first

country to develop a DTB-T2 network with 6Mhz channeling, in addition the infrastructure should have started from scratch, without going through a previous DVB-T infrastructure (Autoridad Nacional de Televisión, 2016).

The DTT infrastructure of the country is arranged as follows:

- National DVB-T2 network publishes: it distributes the digital signal of Canal Uno, Señal Colombia and Señal institucional.
- Public regional DVB-T2 networks: regionally distributes the signals of Telecaribe, Teleantioquia, Televisión Regional de Oriente (TRO), Telepacífico, Telecafé, Canal 13, Canal Capital and Teleislas, partially deployed and managed by RTVC.
- Private national DVB-T2 network: distributes the signal from Caracol Television and RCN Television, partially deployed and managed by the CCNP.
- Local network DVB-T2 CityTV: network that distributes digital television of this channel in the city of Bogotá.

According to the partial report of the ANTV, for the beginning of the second semester of 2018, the public DTT network has a coverage of 85.85% and the private one has a coverage of 88.44% of the country.

Mobile or portable television DTT.

Through Article 5 of the CNTV agreement No. 8 of 2010, a reservation was made to grant mobile TV concessions, however, there are currently no mobile television services offered in Colombia because their development was not initially maintained as one of your priorities. Some of the operators have their television services available on the Internet, which can be tuned by mobile phones and additionally, some of them already have Android and IOS applications specific to their content, also transmitted over the Internet.

The ANTV showed interest in the promotion of the work of television in mobility DTT with the television channels due to the fact that during 2015 commercial mobile devices with the capacity to receive the DVB-T2 Lite mobile television signals began to appear, however in currently, there is still no infrastructure that emits signals for these devices in the country (Autoridad Nacional de Televisión, 2016).

Internet video services

In Colombia, the majority of open television channels have had Internet platforms for a few years where they began to transmit their streaming content and where they have recently begun to publish their VoD content that has already been broadcasted. Some of these platforms, such as the private channel Caracol, have access through subscription. In the case of public channels, it is usual to have open platforms where the content is completely available and sometimes only a registration or Login is requested to view it.

In Colombia, in addition to the platforms of the television channels, it is possible to access international VoD platforms such as Netflix. The growth in the number of users subscribed to these platforms began to generate dissatisfaction on the part of traditional audiovisual content providers due to the unequal situation that disadvantages television channels. This was caused by the lack of regulation of these online platforms and that they had no obligation to pay taxes. In response to this, the government filed a regulation project that sought to increase the costs of OTT platforms and generate an equitable picture for television channels (Autoridad Nacional de Televisión, 2016).

Through the draft of Law 004 of 2015 and the tax reform issued in December 2016, all users of OTT platforms that are located inside or outside the country, are required to pay a tax of 19% that will be automatically charged at the time of the purchase.

3.3.3. Reception of users

According to the report “Conocimiento y tenencia de sistemas para sintonizar televisión” (Knowledge and possession of systems to tune television in English) presented by the National Consulting Center (2017), in Colombia there are around 11 million television receivers that cover 98% of households in the country. Through these televisions, users receive the services of open analog, open digital and closed television, as shown in Figure 22.

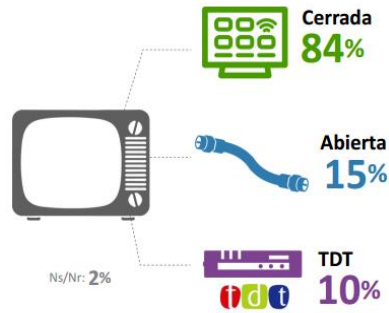


Figure 22. Reception of traditional television in Colombia.
Source: (Centro Nacional de Consultoría, 2017)

These data are a strong sample of the little relevance that open television has to the audience in Colombia, who prefer to pay a closed television service. These data are a strong sample of the little relevance that television has open to the audience in Colombia, who prefer to pay a closed television service.

Regarding the preferences of the audience to visualize traditional content, there is a tendency to visualize private national content and content from international channels. Within these contents, the most viewed by the audience, in order of relevance, are the news, documentaries, films, sports and soap operas. The report coincides with the global trend regarding television consumption through internet platforms and mobile devices as a preferred medium for young people.

On the other hand, the study carried out by the international company Nielsen (2016) on VoD, mentions that 62% of Colombians watch some kind of content on demand, either for a long or short duration. This study also highlights that 25% of Colombians pay subscription services to video platforms over the Internet, an important figure that is still much lower than the 71% of those who pay for cable TV subscription or the 17% of those who pay for satellite TV subscription. This scenario, as mentioned earlier, is depending on age, as shown in the Figure 23.

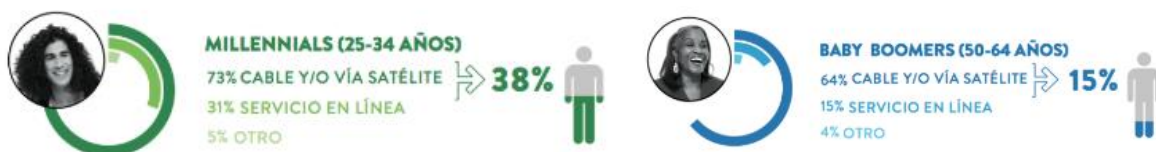


Figure 23. Comparison of television consumption means according to the audience.
Source: (Nielsen Holdings plc., 2016)

CHAPTER 4. METHODOLOGY

The development of the research is guided by three main axes that seek first, to identify the variables or factors of technological convergence; second, evaluate or put them to trial in the television industry in Colombia and third, generate a model that describes such convergence. Therefore, the first tool used is the study of the state of the art, where the variables that different authors mention about convergence are recognized at a global level, this information serves as a starting point for the interview of the experts. Subsequently, through a combined methodology between the Delphi method and the theory of informed theory, industry experts are interviewed, the data is analyzed and the model is generated from them.

In this chapter, the methodology of the Delphi method, its characteristics and its application in investigations is described, as well as the description of the methodology of grounded theory and its application.

4.1.Delphi method

4.1.1. Definition

The Delphi method is a consensus tool that seeks to generate statistical estimates from qualitative approaches, therefore, it is classified as a qualitative or subjective forecasting method (Astigarraga, 2008). Mitroff and Turoff (1975) affirm that “Delphi may be characterized as a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem. To accomplish this “structured communication”. The method systematically collects the opinions and judgments of experts on a specific problem, to later process them by statistical methods and in this way build a general agreement of the group as a higher collective judgment that seeks to forecast an event or future scenario (Suarez & Garcia, 2013).

That said, Delphi is defined as a method of forecasting based on the evaluation of future scenarios, built with information from an initial consultation with experts and additional information available, and its estimation through questionnaires that are circulated among this same set of experts repeatedly to reach a consensus on proposed hypotheses (Castaño &

Velasquez, 2009), therefore, the method seeks to highlight the convergence of opinions and deduce possible consensus (Astigarraga, 2008). The interviews or the application of questionnaires are designed to focus on problems, opportunities, solutions or forecast. Because its application is done in several rounds, each questionnaire is developed according to the information of the previous round. The process stops when consensus is reached, theoretical saturation is achieved, or when sufficient information has been exchanged (Skulmoski, Hartman, & Krahn, 2007).

The Delphi method does not require that the experts be physically in the same place to reach a consensus, since they can answer the questionnaires and / or interviews through means of remote communication such as email or Skype. Besides this, one of the principles exposed by the method is the anonymity of the experts, which means that an expert does not know that other experts are participating in the process, however, if he knows the general opinion of the group and is of according to her who makes his observations. This seeks to avoid the generation of leadership effects, the influence of dominant individuals, for example, the one who speaks the most; semantic noise that interferes with communication; and the pressure of the group towards conformity where a subject can follow the response of the others when considering them with greater expertise (Linstone & Turoff, 1975; Landeta, 2006).

Pawlowsk and Okoli judge the Delphi method as a solid methodology for the rigorous consultation of experts and interested parties. They make a comparison of the traditional survey methods and the Delphi method, mentioning the following strengths and weaknesses (Pawlowsk & Okoli, 2004):

Table 3. Comparison between traditional surveys and the Delphi Method.

Evaluation Criteria	Traditional Survey	Delphi Method
Representativeness of sample	Using statistical sampling techniques, the researchers randomly select a sample that is representative of the population of interest.	Virtual Panel of experts gathered to arrive at an answer to a difficult question.
Sample size for statistical power and significant findings	The researchers need to select a sample that is large enough to detect statistically significant effects in the population to generalize results. Power analysis is required to determine an appropriate sample size.	The Delphi size does not depend on statistical power, but rather on group dynamics for arriving at consensus among experts. The literature recommends 10 to 18 experts on a Delphi panel.
individual vs group response	It is necessary to average out individual's responses to determine the average response for the sample, which is generalized to the relevant population	Studies have consistently shown that for questions requiring expert judgment, the average of individual response is inferior to the average produced by group decision processes; research has explicitly shown that the Delphi method bears this out.
Reliability and response revision	Researchers typically assure this by pretesting and by retesting to assure test-retest reliability	Test-Retest reliability is not relevant since research expect respondents to revise their responses.
Construct Validity	It is assured by careful survey design and by pretesting.	Delphi Method can employ further construct validation by asking experts to validate the researcher's interpretation and categorization of the variables. The fact that Delphi is not anonymous (to the researcher) permits this validation step, unlike many surveys.
Anonymity	Respondents are almost always anonymous to each other and often anonymous to the researcher. In addition, the identity of the respondent may not be relevant to the researcher.	Respondents are always anonymous to each other (Original Delphi) but never anonymous to the researcher. This gives the researchers more opportunity to follow up for clarifications and further qualitative data.
Non-response issues	Researchers need to ensure that the sample remains representative of the population in case of non-responses.	Non-response is typically very low in Delphi surveys, since most researchers have personally obtained assurances of participation.
Attrition effects.	For single surveys, attrition (participant drop-out) is non-issues. For multi-step repeated survey studies, researchers should investigate attrition to assure that it is random and non-systematic	Similar to non-response, attrition tends to be low in Delphi studies and the researchers usually can easily ascertain the cause by talking with the dropouts.
Richness of data.	it depends on the form and depth of the questions and the possibility of follow up, such as interviews. Follow-up is often limited when the researchers are unable to track respondents.	In addition to the richness issues of traditional surveys, Delphi studies inherently provide richer data because of their multiple iterations and their response revision due to feedback.

Source: (Pawlowsk & Okoli, 2004)

The previous scientific foundation that allowed to develop the method was provided by Kaplan, who in 1949 developed an experimental research that proved the superiority of results of a consensus of the opinion of a group on the individual effort of experts (Landeta, 2006). Additionally, Helmer and Rescher published an article in 1958 that exposes the scientific basis of the method and Listone and Turoff published their highly recognized book or compendium "The Delphi Method, Techniques and Application" where they expose in detail the characteristics and applications of the method and make known the result of 489 studies guided by the Delphi method for 20 years.

Although the main purpose of the method is to predict or forecast events, this has also been used in cross-sectional studies, this being the purpose of its current use, especially when it is required to describe an object, phenomenon or situation where there is no enough information or when the evidence is insufficient or controversial (Suarez & Garcia, 2013).

For Cabero (2014), the types of study that adapt to the use of the Delphi method are those in which:

- There is a lack of information available.
- There are problems in which the use of precise analytical techniques may be inadequate and, on the contrary, collective subjective judgments are very helpful.
- There are problems of cost and time (availability) of the participants.
- Heterogeneity of the participants is desired in order to ensure results.

4.1.2. Basic principles

Since it was conceived, the Delphi method comprises four basic principles that guarantee its operation (Dalkey & Helmer , 1963):

1. **Participants' anonymity:** It allows the participants to express themselves freely without having any social or professional pressure for their opinions on behalf of the other participants. This also ensures that the experts' opinions are evaluated by their merit and not by who generates it. The coordinating group is the one that always maintains the communication between the experts, knowing who is each one of them (Díaz, García, & Varela, 2012).
2. **Iteration:** Because the Delphi method is carried out in multiple rounds and in each of them the results of the previous round are shown, the experts have the opportunity to give their opinion in front of the previous forecasts offered by the other experts, this provides an iteration between their answers and allows the experts to validate their opinions. Minority positions give rise to emerging scenarios that may be valuable for the study (Moreno, 2008.).
3. **Feedback:** Consists of informing the experts of the joint opinions of other experts on the problem and highlighting the relevant contributions, discordant positions or additional information requested by an expert (Díaz, García, & Varela, 2012). This feedback process starts from the coordinating group towards each one of the experts.
4. **Statistical aggregation of group response:** Its purpose is the construction of a consensus through the statistical processing of the differences and coincidences of the opinions offered by the experts. The statistical detail is shown later in the description of the stages of the method.

According to these principles, there is a distinction between the Delphi Classic method, that which complies with the basic principles and the modified Delphi method, when any of the principles is changed for convenience. Some of the parameters that are usually modified or chosen at their convenience are the selection methodology of the experts, the number of rounds, the characteristics of the questionnaire, the way of performing the feedback, the statistical processing, among others (Suarez & Garcia, 2013).

4.1.3. Scope and limitations

The Delphi method has a broad scope that covers all levels of research in disciplines that are not exact and in situations of uncertainty, where objective information is not enough (Díaz, García, & Varela, 2012). As part of its scope it is worth exalting the following virtues:

- The method has a mixed nature in the disposition of the processing of data collected from the experts, this aspect allows you to establish a rich understanding of the data, the context and the details, besides the qualitative research allows to give a sense or interpretation of the phenomena in terms of the meaning of the participants on them (Creswell J. , 1994). Therefore, the Delphi method in this aspect can be seen as a structured process where qualitative, quantitative or mixed methods are used.
- The method has proven to be flexible and useful in problems where consensus is sought in environments full of uncertainty (Pill, 1971).
- One of the most attractive scopes of the method, according to Astigarraga, is the quasi-certainty of obtaining a consensus, clarifying that this may take several rounds of questionnaires: However, he warns that convergence may not always be coherent (Astigarraga, 2008).
- The Delphi Method has been used and continues to be used as a research methodology in Doctoral and Master research and projects. Astigarraga finds for the year 2008 in the ProQuest Digital Dissertations database more than 280 dissertations guided by the Delphi method, of which he analyzes 40 for his article. The majority of the analyzed theses revolved in the field of the education and the health care, although he affirms that "it can be used indifferently so much in the field of the technology, the management and the economy as in the one of the social sciences" (Astigarraga, 2008)

On the other hand, within the different limitations indicated by the authors, are the following:

- The Delphi method requires an extensive amount of time to be carried out, which can vary according to the agenda of the experts. Díaz, García, & Varela (2012), state that it takes around 45 days for a single document exchange to be carried out (answer the questionnaires of a round).
- Astigarraga (2008) found in his study about the dissertations that used the method, that this can be even costly, annoying and intuitive, rather than rational due to the pressing procedure (survey in several batches) that falls on the experts.
- A delicate point of the method is the selection of techniques that allow to summarize the opinion of the experts in the information collection stage and in the questionnaires with open questions. In addition, these ideas and information must be synthesized to be shown in the next round (Díaz, García, & Varela, 2012). In addition, special care must be taken when balancing the number of open and closed questions in the questionnaires to motivate alternative points of view and to enrich the process.

4.1.3.1. Using the Delphi method in model generation

According to Reguant-Álvarez and Torrado-Fonseca (2016), one of the possible objectives of using the Delphi method is the search for a consensus aimed at the construction of common positions that allow to build a model, due to it is done by collecting data from different starting frames. Okoli and Pawlowski (2004) add that the use of the Delphi method within the construction of theory implies both generalization and validation. The generalization of the theory is given because the information comes from experts, who have a wide range of experience. On the other hand, the validation is given by the sequential debate of the initial ideas proposed in the first round, because each individual idea provided by each expert is submitted to a common judgment of the panel of experts who validate whether the idea or the postulate is true or not.

Okoli and Pawlowski (2004) also show different investigations where the Delphi method was used as a methodology for the construction of models and frameworks from the expert interview. As additional examples it is possible to cite the investigation of Mercado-Caruso, Puerta del Castillo, and Pérez (2017), who using only the Delphi method with a development of 3 rounds generated a conceptual model to estimate the software costs, also the research de

Cho & Lee (2013), who combine the Delphi method with Fuzzy AHP approach for Development of a new technology product evaluation model for assessing commercialization opportunities.

4.1.4. Stages

The process of operation of the Delphi method is flexible and subject to modifications depending on its implementation, it is desirable to fully respect the basic principles of anonymity, feedback, iteration and statistical analysis. Each application of the method contemplates variations that include the composition of the sample, the size of the sample, the methodological orientation (qualitative or quantitative) the number of rounds and the mode of interaction (Skulmoski, Hartman, & Krahn, 2007). However, Skulmoski Hartman and Krahn (2007), through their research of different master's and doctoral studies, manage to find the generalized stages that this method follows and fragment them into 11 steps that usually contemplate 3 rounds of questions and that start from the development from the research question to the sample of the results. Suarez and Garcia (2013) describe 9 stages, but leave open the generalization for the number of rounds that are necessary. Based on these two models, the Figure 24 shows the typical development process of the Delphi method.

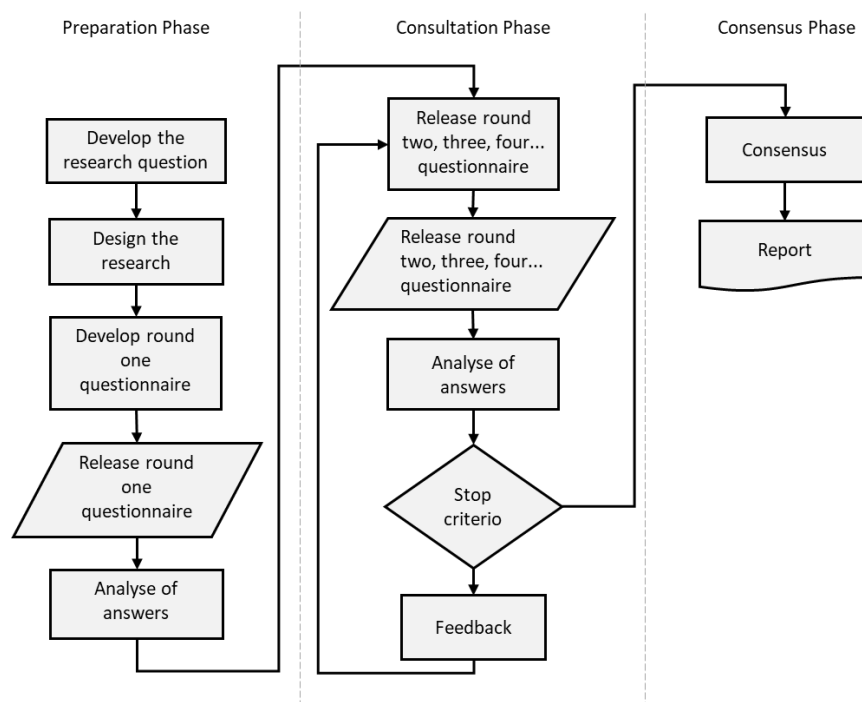


Figure 24. Stages of the Delphi Method.
Own elaboration based on (Skulmoski, Hartman, & Krahn, 2007) and (Suarez & Garcia, 2013)

4.1.4.1. Preparation phase.

This first stage of the method contemplates the planning of the investigation and each one of the factors that will be involved in it. It describes from the objective of the investigation, to the first round of questions of the Delphi method, where it is desired to perform a first collection of information. The importance of this stage lies in the clear approach of the orientation, the limits and the scope of the investigation, therefore, its good execution will minimize the setbacks that may arise during the subsequent stages.

Develop the research question

The problem to be attacked must be chosen, being very concise and focusing the study towards specific objectives, which are manifested in the research question, the purpose of the study. This question, in the case of master's or doctoral research, it is usually raised and developed by the student and his supervisor, and must be based on a thorough review of the literature (Skulmoski, Hartman, & Krahn, 2007). Usually the experience of the researcher in their own industry usually contributes to the interest of the research area. The definition of the field of research will determine future factors such as the area of knowledge of the experts to recruit, hence its great importance (Astigarraga, 2008).

Design of the investigation

In this stage, the development aspects of the investigation must be decided, selecting the panel of experts, the coordinating group, the consultation route with the experts, the number of consultation rounds or the criterion of stopping the rounds of questions and other details. which are described below.

Coordinating Group.

The coordinating group, as the name says, will be in charge of coordinating each phase of the research development, some authors such as Castaño and Velasquez (2009) state that this group can be comprised of only one researcher, although on the other hand, Díaz , García, and Varela, (2012) state that due to the multiple functions that this group has, it should be made up of 2 to 5 people.

The main tasks of the coordinating group are:

- Carry out the research design (selection of experts, schedules, etc.)

- Prepare the questionnaires.
- Encourage the participation of experts.
- Analyze the answers of the experts.
- Perform the feedback of the results.
- Supervise the progress of the process.
- Interpret the results.
- Take corrective action when necessary.
- Selection of experts.

Selection of experts.

The group of experts that takes part in the study is called "panel of experts", the selection of individuals belonging to this group is key to the research and the results obtained. The determining factors for the preparation of the panel are basically the number of experts and the criteria with which they are selected (Suarez & Garcia, 2013).

The criterion of selection of experts can be a bit confusing, because the term expert can be ambiguous or subjective (Díaz, García, & Varela, 2012), therefore, it is necessary to establish requirements that allow classifying the subjects that can be part of the panel. Adler y Ziglio (1996) mention 4 requirements to be part of the panel:

- Knowledge and experience in the subject under investigation: this aspect can be evaluated according to factors such as profession, position, years of work experience, scientific category and even according to the type of rigidity of the investigation could be considered aspects such as quantity of investigations, publications, citations, among others (Suarez & Garcia, 2013).
- Capacity and interest: motivation to participate both at the beginning of the research and during the course of the research, since, due to recurrence in response to the questionnaires, it is common for some experts to abandon the process in advanced rounds since Time is losing motivation (Sinha , Smyth, & Williamson, 2011).
- Sufficient time available to answer the questionnaires.
- Effective communication skills.

Although there are no rules or calculation methods to obtain an exact number of participants, there are some criteria that should be taken into account for this estimation:

- The greater number of experts, the more successful the consensus will be, which implies a reduction in error or a better quality of the forecast, however, it should be understood that there is a threshold over which the additional management of each expert does not justify the contribution or difference that he can make. According to this criterion Astigarraga (2008) suggests that the number of experts should be between 7 and 30 participants, beyond that, the improvement in the consensus does not compensate the research costs.
- Skulmoski, Hartman, & Krahn (2007) indicate that if the research is done for a master's degree, a small group is more than enough, but if it is for a doctorate, the group should be larger, due to the rigor of the research and the time available for it.

Wynekoop & Walz (2000), propose two additional criteria:

- If a limited number of experts is established, greater rigor should be exercised in the formulation and evaluation of the questionnaires
- In case of any doubt with the level of expertise of the members of the panel, whatever the situation that induces that, the number of experts should be increased to compensate for the possible error.

One way to find potential candidates, once having an initial group of experts, is using the "Snowball" method, this will help find experts that were not previously contemplated with the help of those already selected (Mason, 1996). Additionally, future dropouts should be considered, so the number of initial experts should be a little higher than the desired number (Astigarraga, 2008).

Consultation channel of the experts.

Communication with experts can be done through different means, however, due to the current availability of IT communication means, it is usual to communicate with experts through telephone, email or video calls. The selection of the most suitable channel is according to the convenience in terms of the geographical distribution of the experts and the

number of them (Suarez & Garcia, 2013). It is worth highlighting the emergence of different platforms that allow answering questionnaires online, such as Google and others.

Consultation rounds or stopping criteria.

There is no single criterion established regarding the decision of the number of rounds to be made, however, many authors agree that a large number of rounds can exhaust the authors and cause their demotivation to participate in the process (Astigarraga, 2008; Moreno, 2008; Skulmoski, Hartman, & Krahn, 2007). One possible option is to leave the number of rounds open and establish a stop criterion that indicates when there is a consensus, this was done, for example, in the research done by Rivera and Lainez, (1996), where consensus was reached by finding 70% agreements of the panel in closed questions and 50% in questions with multiple answers, in case of not finding consensus in some questions, a new round became necessary.

Another alternative as stop criterion is to apply a stabilization criterion. One resource used for this is the coefficient of variation, which consists in calculating the standard deviation of the experts' individual answers and dividing it in the mean and prefixing an arbitrary level of reduction as a reference to initialize it. When after two consecutive rounds the coefficient has been reduced and is lower than the prefixed, it is determined that a satisfactory stability has been reached to complete the process (Díaz, García, & Varela, 2012).

Landeta (1999) suggests that a possible way to execute the Delphi method is the choice of a number of fixed rounds, in this way, the members of the panel will know at what stage the study is and its defection will be avoided. This parameter is used for example in the research done by Moreno, (2008) in which 2 rounds of questions were established. However, the number of rounds must not be decided a priori, because the quality of the study is compromised, there must be rigor in their selection (Astigarraga, 2008). Delbecq, Van de Ven and Gustafson (1975) suggest that for quantitative investigations, if the experts are homogeneous, 2 or 3 rounds are sufficient, but if they are considered heterogeneous experts, up to 3 or more rounds will be necessary. In qualitative research, 2 rounds of questions can be more than sufficient (Skulmoski, Hartman, & Krahn, 2007).

Design of the first-round questionnaire

The first round of the Delphi method is aimed at exploring the topic of discussion through generally open questions where individual experts are allowed to make information contributions that they consider relevant (Rivera & Lainez, 1996; Moreno, 2008). The coordinating group should postulate impartially and without bias and according to the previous academic research, the possible events or scenarios for these to be considered by the panel of experts (Tseng, Cheng, & Peng, 2009). The first round of the Delphi method can also be treated as individual interviews with each expert brainstorming (Schmidt, 1997)

The questionnaire should also be prepared taking into account the following approaches (Tseng, Cheng, & Peng, 2009):

- The objective of the interview.
- The degree of knowledge or amount of information that experts have on the subject.
- The level of motivation of experts to communicate the subject (there may be issues of a confidential nature that the experts refuse to answer).
- Concise questions and avoid deviations and misinterpretations of experts (Skulmoski, Hartman, & Krahn, 2007).
- Avoid carrying out a very extensive questionnaire that may diminish the interest of the panelists. In turn, bear in mind that a too short questionnaire can hinder the achievements of the exercise (Rivera & Lainez, 1996).

Before completing the elaboration of the questionnaire, it may be necessary to evaluate its operation exposing it to a pilot group of experts (these may be experts not considered in the main panel), especially if the research is done by a researcher with little experience (Astigarraga, 2008). The objective is to determine that the questions are clear, that the objective of each of them is identified and that the desired information will be obtained with its application, the results per se of this pilot are not relevant for the following rounds of the method (Feixas, 2006).

Launch of the first-round questionnaire

In this phase, the questionnaire is sent to the experts selected to be part of the panel, although previously the objective of the study has been explained to them, it is necessary to attach a note explaining how the Delphi method will be carried out, its objectives, the conditions practices such as response time, guarantee of anonymity and others (Astigarraga, 2008).

It is necessary to be as clear as possible with the time the experts have to answer the questionnaire since, depending on their type of work, they may have little time available and may give low priority to the questionnaire. Powell (2002) suggests that experts should be given around 45 days to answer the questionnaires, however Skulmoski, Hartman and Krahn (2007) found that in many of the investigations they usually take around 15 days or two weeks to the experts for each of the rounds of questions, including the first, even if it is a direct interview. This is the case of the investigation carried out by Rivera & Lainez (1996) where it was delimited within two weeks granted to the panelists to send back the first questionnaire already filled out.

Analysis of the answers of the first round

The information collected in the first round must be treated according to the objective it has had. If totally open surveys were carried out in order to gather information, graphic representation with reality maps could be useful (Skulmoski, Hartman, & Krahn, 2007). These maps will illustrate interactions, causes and effects, process flows and other aspects of reality. These maps can increase understanding and facilitate the collection of experts' experiences and make it useful in the following rounds (Linstone & Turoff, 1975).

4.1.4.2. Consultation phase.

The consultation phase includes successive questionnaires in order to find consensus through the reduction of dispersion measures of the experts' answers. Each new questionnaire should be more specific in the questions by means of the closed questions. The process will be carried out the number of times established in the design stage of the investigation.

Generally, the second questionnaire allows the understanding of the subject and the first position of the experts, in the third phase the disagreements are explored and the origin of the differences is sought. In the fourth phase we proceed to a more in-depth analysis of the information and the search for agreements or final consensus, if necessary, more rounds are

prepared according to the criteria of the researchers. Although the theoretical approach involves several rounds, in practice, several authors have proposed 2 rounds in their studies as sufficient to reach a consensus (Moreno, 2008; Martino, 1993).

Design of the questionnaire for round two, three, four ...

From the second round, the questionnaires should be designed according to the responses of the previous round and presenting increasingly focused questions in order to reduce the inter-quantile space typical of the standard deviation and to specify the median of the answers (Skulmoski, Hartman, & Krahn, 2007). If the objective of the first round was to generate a list of events or scenarios, the subsequent rounds will aim to reduce more and more the list of possible scenarios (Schmidt, 1997).

According to the above, the design of each questionnaire should take into account the following parameters:

- Communicate the information obtained to those who have contributed with their knowledge.
- Consolidate and endorse the results obtained in the previous rounds.
- Show the mean and median, as well as the typical dispersion in the questions that make sense to do it, however, you should try to communicate these results in a clear way to facilitate understanding by the experts.
- Evaluate the degree of agreement of the expert with the general tendency of the group and in case of disagreement, argue their reasons.
- As the rounds progress, new questions can be generated on the same approach to verify the results and understand where the results can be extended.

Díaz, García, & Varela, (2012) suggest taking into account the following actions in the closed responses:

- Hierarchize, with precise indications, in order of importance in relation to the situation of the study.
- Value, offering scores according to a defined scale.
- Compare, offering different possibilities for a question.
- Quantitative estimates, for example, provide the percentage of a fact happening.

Launch of the questionnaire for round two, three, four ...

the questionnaires in round two and later must be sent through the previously selected communication channel. In this case, it is not necessary to include the descriptive note of the objectives of the questionnaire, however, it is worth remembering the experts the time available to send their answers. In these rounds, the panelists receive the respective questionnaire together with the clear and statistical description of the responses from the previous round.

Analysis of the answers

In the second and subsequent rounds, it is necessary to be more rigorous in the calculation of the measures of central tendency and dispersion of the answers of the experts, since they should seek to narrow these data to seek consensus. However, care should be taken to give special importance to those responses by experts who disagree with the general opinion of the panel, since such responses will allow generating alternative scenarios or formulating alternative future hypotheses (the future is not unique and determined) (Astigarraga, 2008). Such is the importance of these divergent opinions that Suarez and Garcia, (2013), supported by other authors, consider more interesting than those that fall in the range.

According to the type of question posed and the orientation of the research (qualitative or quantitative), other types of analysis of the answers can be carried out, for example, Torres, Dandicourt, and Rodríguez (2005) and Cuesta (2010) uses the Kendall W concordance coefficient to analyze responses of ascending and descending weights of the items. In (Tomasik, 2010) and (Palter, MacRae, & Grantcharov, 2011) use the Cronbach alpha coefficient and the Wilcoxon test. In the research carried out by Moreno (2008), the use of all the descriptive statistics mentioned did not make sense because the answers were opinions, reasoning and prospects that lacked quantifiable numerical equivalence, so the only statistical treatment was the calculation of frequencies that indicated the answers of obtained greater adhesions.

Stop criterion

In this stage, the stop criterion established in the design stage of the study is evaluated, it must be evaluated if an additional round of surveys is necessary or if the consensus generation stage should be continued.

Feedback

In each subsequent round, it is necessary to inform the experts of the panel's answers, for which the coordinating group must send the questionnaire to each expert with their previous response, accompanied by the statistical analysis of the group response (Suarez & Garcia, 2013) allowing the participants see where their response is compared to the group the statistical analysis should be shown in an understandable way that facilitates the interpretation of the experts (Keeney , Hasson, & McKenna, 2005). The feedback can be even purely qualitative, informing the responses and comments of the participants.

According to Díaz, García, and Varela (2012), it must be ensured that the feedback is made up of:

- The information provided by the experts.
- Additional information provided by the coordinating group.
- Quantitative analysis information.

4.1.4.3. Consensus phase.

This is the final phase of the Delphi method where the consensus obtained is defined and the information is exploited according to the objectives and the research questions that motivated it.

Consensus building

In this phase, the coordinating group should evaluate if the objective of the investigation was met, which should have included the consensus of the experts in a particular area. Although there has been a previous verification in the exploitation of the results of the last round, it is necessary to make a more rigorous verification in this stage, even if the stop criterion was a predetermined number of rounds.

The final consensus indicators should be processed, as is done in previous rounds. In this way we have the final statistical values and are contrasted against the desired ones to determine if they were overcome. Although the literature does not specify specific values for the acceptance of a consensus, depending on the ethical implications of the study, the value can range from 70% to 100% (Suarez & Garcia, 2013). Other verifications that have not been taken into account in the stopping criterion can also be carried out, but they can enrich the

rigor of the study. As is evident, the coordinating group is quite free to conclude its consensus, because this stage does not include a strict definition, but it can use similar research that provides sufficient criterion (Suarez & Garcia, 2013).

Document the results

The documentation process should detail each of the phases in a broad and precise manner, facilitating the assessment and verification of the veracity of the study for which they would like to consult it. It must include all the graphic and textual description of the results, including the statistical analysis of the experts. If there has been any difficulty, it must be presented in a clear and honest manner and the process with which it has been solved must be explained (Suarez & Garcia, 2013).

The final report of the investigation must contain (Díaz, García, & Varela, 2012):

- Description of the study (Objectives, methods, questionnaires).
- Description of the panel of experts.
- The evolution of the panel's responses in each round.
- Wholesale opinions.
- The level of consensus reached.
- Significant divergent positions.

One way to document the results and increase the rigor of the research is to leave a trail of audit of the process performed, one way to do it is to use dedicated journals to present the advances and the final result of the research (Skulmoski, Hartman, & Krahn, 2007). Efforts should also be made to validate the results, although this is one of the great limitations that the authors manifest, due to the size of the sample used (Hartman & Jugdev, 1998). Many authors recommend carrying out additional studies to verify and refine the results, which can be done through a verification of the results by additional experts from another geographical location (Brungs & Jamieson, 2005).

4.2. Grounded theory designs.

4.2.1. Definition

The grounded theory was proposed by Glaser and Strauss in 1967 in a book called "The Discovery of Grounded Theory" in which they expose the symbolic modeling. This methodology of design through grounded theory makes use of a systematic procedure of collecting qualitative data that allows generating theories that provide a conceptual explanation of an action, interaction or a specific phenomenon. Its purpose is to develop theory based on empirical data and apply to specific areas (Sampieri, Fernández, & Baptista Lucio, 2010).

The theory originated by this method is distinguished from the "formal theory" by having a perspective of mid-range or substantive, because it is applied to a more concrete context, while the formal theory has a greater perspective (Glaser & Strauss, 1967). Although their substantive theories are "local", they provide an interpretative richness and contribute to new perspectives of a phenomenon.

In the grounded theory, the theoretical propositions do not arise from previous studies, but from the data collected during the investigation, therefore, it is the same procedure studied in the investigation that generates the understanding of the phenomenon, consequently, the grounded theory is particularly useful in those scenarios where the available theories do not explain a phenomenon or when they do not cover all the participants or factors of interest (Creswell J. W., 2009).

The grounded theory presents a solid understanding because it "fits" in the study situation (Sampieri, Fernández, & Baptista Lucio, 2010), in its development it works quickly and concretely, being sensitive to the expressions of the individuals of the study context and seeks to represent all the complexity discovered in the process (Creswell J. W., 2009).

4.2.2. The systematic design

One of the designs that is born from the grounded theory is the systematic design, which allows the use of determined steps in the data analysis. it is based on the procedure described by Corbin & Strauss (2007), which is shown in the Figure 25. This procedure allows to go

from a data collection process to the modeling using coding processes, which are described below.

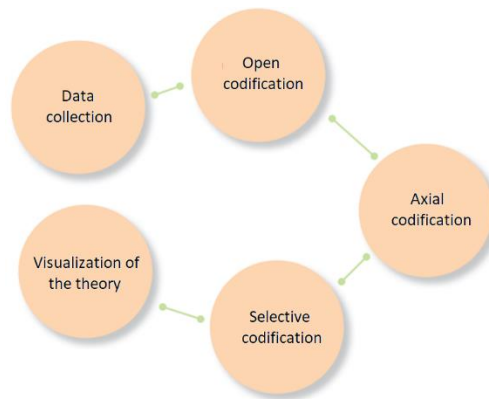


Figure 25. Process of a systematic design.
Source: (Sampieri, Fernández, & Baptista Lucio, 2010)

4.2.2.1. Open coding.

The researcher or group of researchers generates and analyzes the initial categories of meaning using this coding process by means of constant comparisons (similarities and differences between the units of meaning), reviewing all the segments of the material. Additionally, this process allows to eliminate the redundancy and to develop the sufficient evidence for the categories by raising the level of abstraction (Sampieri, Fernández, & Baptista Lucio, 2010).

The initial categories of meaning are based on the data that is collected from the interviews. These categories are also represented by subcategories, which are coded to provide details of each category.

Sampieri, Fernández, & Baptista Lucio, (2010) mentions that these categories are "topics" of basic information in which the data are grouped to understand the phenomenon referred to.

4.2.2.2. Axial coding.

In this step, the researcher takes all the categories created in the open coding and analyzes them with the aim of creating connections between categories and themes. Usually a central category is chosen and it is sought to create connections with the other categories that can be of type:

- Causal conditions: these influence the central category.
- Actions and interactions: these are the result of the central category.
- Consequences: these are a result of actions and interactions and use of strategies
- Strategies: categories of implementation of actions that influence the core category, interactions and consequences.
- Contextual conditions: categories that mark the context of the environment surrounding the central category.
- Intervening conditions: categories that influence others and that mediate the relationship between the causal conditions, the strategies, the central category, the actions and interactions and the consequences

Once the relationships and characteristics of the categories have been identified, a diagram or model called "codified paradigm" is made, which seeks to show the relationships between all the aforementioned elements, although it is worth clarifying that not all the investigations derive all of them. In the Figure 26, the process of refining the categories through the interviews and the subsequent creation of the model or diagram of the codified paradigm is shown.

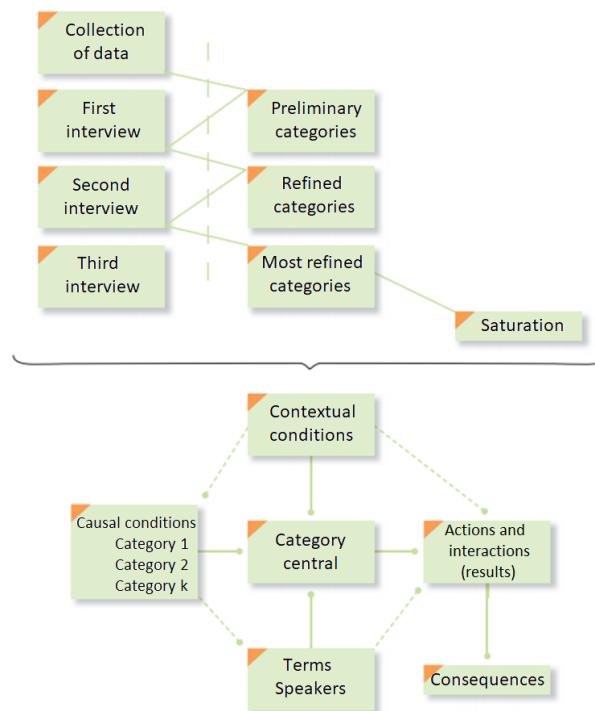


Figure 26. Sequence and product of grounded theory.
Source: (Sampieri, Fernández, & Baptista Lucio, 2010)

4.2.2.3. *Selective coding.*

In this stage of coding, the researcher performs an additional analysis of the units and segments and compares them with the emerging model in order to base it, this comparison must also generate the theoretical proposals that establish the relationships between the themes or categories, this process gives the researcher a sense of understanding.

In this process the researcher seeks to cite phrases or textual ideas expressed by the interviewees in order to support the relationships made and provide any reader with a better understanding and association with the phenomenon, this is known as "living codes". At the end of this process, the grounded theory model, presented at the stage of visualization of the theory, should include the emerging diagram, the set of propositions and the narrative of the model through the "living codes" (Creswell J. W., 2009).

CHAPTER 5. DEVELOPMENT

The development phase of the research is based on the analysis of the state of the art, the subsequent consultation of experts, using the Delphi method and the systematic design of grounded theory. According to this, in the present chapter, the study of the variables involved in the technology convergence identified from the literature review is shown first, these variables are later taken as a basis to develop interviews to the for the data collection process.

5.1. Identification of variables from the literature

The identification of the variables and factors involved in the technological convergence is carried out from the study of the state of the art presented in chapter 3, deepening in the identification of the articles and authors that make reference to the technological and business trends of the television industry worldwide. According to this, the Table 4 was built, this briefly mentions each of the topics mentioned by each author.

If the information is organized in order to make a constant comparison and eliminate redundancy, adding each of the topics that the authors deal with, it is possible to find initial categories of meaning (Sampieri, Fernández, & Baptista Lucio, 2010), which allow to generate the initial questions of the expert interviews. The comparison and categorization are done in Table 5, where the variables previously mentioned in Table 4 and their belonging to the initial categories are appreciated.

Now, having the initial categories and the variables, we proceed to the development of the expert interviews, in order to obtain categories abstracted from the reality of the Colombian environment.

Table 4. Variables of the technological convergence from the literature

Authors	Variables	UHD	3DTV	IPv6	Cloud Computing	Computational Intelligence	Data mining	Mobile television	Restructuring of industry players	Change of financing	Change of profiles of professionals	Content	Audience	Interactivity
Bañón, 2016												1		
Bao, 2010								1						
Bergillos Garcia, 2015								1						
Bignell, 2018														1
Campos Freire, 2013									1					
Castillo Pomedá J. , 2015		1	1							1				
Castillo Pomedá J. M., 2016										1		1	1	1
Del Pino & Aguado, 2012									1			1	1	
Gao, Wei, Zhuang, Huang, & Diao, 2017						1			1					
García J. A., 2009											1	1	1	
Hadjadj-Aoul & Ksentini, 2011								1						
Herederó Díaz & Reyes Sanches, 2016											1	1	1	
Hmayda, Ejbali, & Zaied, 2017						1								
Internet Society, 2018				1										
Islas, 2008											1			
Izquierdo Castillo, 2012									1	1				
Izquierdo Castillo, 2015									1				1	
Kalba, 2009								1						
Ksiazek, Peer, & Lessard, 2014														1
Kunic & Šego, 2011			1											
Larrondo Ureta, 2015											1	1		
López García , Soengas Pérez, & Rodríguez Vázquez, 2016													1	
McCarthy, 2017		1												
McNevin, 2017					1									
Miki, Sakiyama, & Ichikawa, 2017		1												
Mongay Batalla & Krawiec, 2011				1										
Morales Morante, 2011									1					
Na & Pin, 2012					1									
Osorio Montoya, 2011													1	1
Prakash, Lamdharia, & Chandra, 2013					1									
Ruano López, 2013												1		
Shagrir, 2018														1
Sharma, Chaudhury, & Lall, 2016			1											
Sugito, y otros, 2017		1												
Tabares Ossa & Torres Arboleda, 2012									1	1		1		
Torres, Ramirez, & Lopez, 2011				1										
Towards Data Science, 2018						1								
Wong, Tan, Hew, & Ooi, 2015								1						
Yuwen, Cao , Lin, Li, & Tan, 2017							1							
Zanni, 2017		1												
Zhang, Shi, Hong, Shang, & Yan, 2016							1							

Source: Own elaboration based on the cited authors

Table 5, Part 1. Factors of the technological convergence from the literature

Topic	Categories	Variables	Author	Main ideas, references or topics
New technologies	Portability	Portable Television	Bergillos García, 2015	>Trend on mobile devices (tablets, smartphones, monitors, etc.)
			Bao, 2010	>Through Internet Connection or DTT
			Kalba, 2009	>Specialized content for mTV. >Technical and financial factors of this model.
			Wong, Tan, Hew, & Ooi, 2015	>Development of smartphones as a catalyst for demand for mobile services such as TV
			Hadjadj-Aoul & Ksentini, 2011	>Methods of QoS improvements in mTV
			Wong, Tan, Hew, & Ooi, 2015	>Methods of QoS improvements in mTV
	Technologies	Data mining	Yuwen, Cao, Lin, Li, & Tan, 2017	>Data mining is applicable to large volumes of TV data.
			Zhang, Shi, Hong, Shang, & Yan, 2016	>How data mining improves the grill programming process. >Privacy of user data usage.
		Computational Intelligence	Towards Data Science, 2018	>It projects innumerable applications on TV as a recommendation of contents, copyright, translation, etc.
			Gao, Wei, Zhuang, Huang, & Diao, 2017	>Predict QoE in IPTV
			Hmayda, Ejbalí, & Zaied, 2017	>Identification of type of content to generate user protection policies
		Cloud Computing	Prakash, Lamdharia, & Chandra, 2013	>Improvement of the use of resources
			Na & Pin, 2012	>TV includes many jobs that are likely to be transferred to the cloud. >Technical and business advantages of transferring work to the cloud.
			McNevin, 2017	>Technical and business advantages of transferring work to the cloud. >Audiovisual media companies that have transferred their work to the cloud.
	Technical evolution of the transmission medium	IPv6	Internet Society, 2018	>Improving the quality and possibilities of services that work on the internet.
			Torres, Ramírez, & López, 2011	>Improvements of television over Internet with IPv6.
			Mongay Batalla & Krawiec, 2011	>Gaps in the IPv4 Internet TV and improvements in IPv6.
	Presentation and technical quality of the content.	3DTV	Castillo Pineda, 2015	>It is a technology that always appears and reappears in different phases of the industry. >I could die before the UHD.
			Kunic & Šego, 2011	>Analysis of different 3D technologies.
			Sharma, Chaudhury, & Lall, 2016	>Absence of 3D TV content.
		UHD	Castillo Pineda, 2015	>4K, and 8K image resolution trends and their features.
			Miki, Sakiyama, & Ichikawa, 2017	>RoadMap and UHD development.
			McCarthy, 2017	>Update of the HW and SW that this implies.
			Sugito, y otros, 2017	>Compression of the UHD signal >Protocol H.265.
			Zanni, 2017	>Broadcasters' strategy to face the UHD.

Source: Own elaboration based on the cited authors

Table 5, Part 2. Factors of the technological convergence from the literature

Changes in the business model	External value chain	Restructuring of industry players	García J. A., 2009	>Fusion of companies, diversification, vertical and horizontal integration. >Large companies absorb small companies as part of their strategy.
			Izquierdo Castillo, 2012	>Vertical and horizontal fusions of the chain. >Integration with other industries such as telephony and internet.
			Morales Morante, 2011	>Could exist better integrations between companies that take advantage of technology in a better way.
			Del Pino & Aguado, 2012	>Some companies seek to occupy the entire chain in response to the convergence. >Change of power and roll of the audience.
			Tabares Ossa & Torres Arboleda, 2012	>ISPs enter into the TV business with IPTV.
			Izquierdo Castillo, 2015	>Changes in the chain by VoD providers. >Change of power and roll of the audience.
			Campos Freire, 2013	>Affectation to chain participants (public broadcasters).
	Structure of costs and income	Change of financing	Castillo Pomedá J. , 2015	>The change of model requires a change of monetization model.
			Izquierdo Castillo, 2012	>Form of financing of the television on Internet.
			Tabares Ossa & Torres Arboleda, 2012	>Role of STBs in the new monetization models in IPTV.
			Castillo Pomedá J. M., 2016	>Monetization model based on YouTube advertising.
	Internal value chain	Change of profiles of professionals	García J. A., 2009	>Multimedia professionals. >Lack of good working conditions.
			Herederó Díaz & Reyes Sánchez, 2016	>Multimedia professionals. >Professional as "orchestra man". >Lack in good working conditions. >Impact on the personnel needed for production.
			Islas, 2008	>Transformation of professional profiles. >Lower quality in journalists' performance due to saturation.
			Larrondo Ureta, 2015	>Change in the profile of journalists. >Multimedia coordinator profile.
	Value proposal	Content	Ruano López, 2013	>Modification of contents according to technological features. >Evolution of web content.
			García J. A., 2009	>Modification of the contents according to the audience.
			Bañón, 2016	>Creation of contents that exploit the internet facilities.
			Larrondo Ureta, 2015	>Multimedia strategies for content production. >Multiplicity of video formats.
			Ruano López, 2013	>Multimedia strategies for content production. >Preference of the contents on internet.

Source: Own elaboration based on the cited authors

Table 5, Part 3. *Factors of the technological convergence from the literature*

Changes in the business model	Value proposal	Content	Tabares Ossa & Torres Arboleda, 2012	>Reinforced protection against IPTV content piracy.
			Castillo Pomedá J. M., 2016	>Copyright measures in the network.
			Del Pino & Aguado, 2012	>Novelty in content and Remakes. >Complete series available.
			Herederó Díaz & Reyes Sánchez, 2016	>Loss of quality of the informative contents.
	Customer negotiation power	Audience	López García , Soengas Pérez, & Rodríguez Vázquez, 2016	>Fragmentation of the audience. >Aging the audience and new audiences.
			Osorio Montoya, 2011	>Different habits of the audience.
			Del Pino & Aguado, 2012	>Different classification depending on the use of technology.
			García J. A., 2009	>Audiencias cada vez menos predecibles. >Comprender a la audiencia brinda ventajas competitivas.
			Castillo Pomedá J. M., 2016	>Digital audience (digital natives) >The audience has new roles in the value chain.
			Izquierdo Castillo, 2015	>Digital audience (digital natives)
			Herederó Díaz & Reyes Sanches, 2016	>Audience as a content generator.
		Interactivity	Shagrir, 2018	>Broadcast television as unidirectional communication >TV over television as bidirectional
			Osorio Montoya, 2011	>Why is interactivity on television important?.
			Bignell, 2018	>Interactivity as a connection measure.
			Ksiazek, Peer, & Lessard, 2014	>Motivations of interactivity. >Different types of interactivity on the internet.
			Castillo Pomedá J. M., 2016	>Role of platforms and social networks in interactivity.

Source: Own elaboration based on the cited authors

5.2. Identification of variables from the experts.

The data collection phase and the analysis of the data is guided by a combined methodology based on the Delphi method and the grounded theory due to the objective is to conduct successive interviews or surveys to experts focused on obtaining useful data for the construction of the model.

5.2.1. Preparation phase.

The preparation phase of the investigation contemplates in the first instance the choice of the problem, general and specific objective and the limitations and scope of the investigation, aspects that were manifested in section “Introduction”, where it is worth highlighting that the main objective of the investigation is “Design a strategic model of technological convergence

for the Colombian television industry based on the study of current standards, trends in technological development and expert consulting for improving competitiveness in the modern TV industry over the Internet”.

Due to the development of the research is guided in the consultation of experts, the interview criteria offered by the Delphi method are taken as a basis (Mitroff & Turoff, 1975), this method is specifically designed to work with them. It suggests, within its preparation, the formation of a coordinating group and the creation of a panel of experts for the interviews, as explained below.

5.2.1.1. Coordinator Team.

The research coordinating team consists of a principal investigator and two advisors, as shown below:

- Principal researcher: Eng. Cesar Echeverry, 4 years of work experience in the Colombian public and private television sector as a support engineer.
- Advisor 1: Dr. Carlos Vega, research advisor in general terms.
- Advisor 2: Dr. Juan Carlos Perez, research advisor in terms of data processing, interviews, surveys, etc.
- Advisor 3: Dr. Sergei N. Polbitsyn, research advisor in general terms

The principal investigator should be a person who knows the research environment in advance and who, preferably, has the facility to interact with the panel of experts, especially if they have had prior contact with them. This criterion is met before the work experience of the researcher Cesar Echeverry, which facilitates the approach and contacts of possible experts suitable for the panel.

The three additional members of the coordinating team support the activities of carrying out the research design, preparation of the questionnaires, monitoring the progress of the process and interpreting the results.

5.2.1.2. Expert Panel

The determining factors for the preparation of the panel are basically the number of experts and the criteria with which they are selected (Astigarraga, 2008). Therefore, the experts must

be chosen according to their level of knowledge and experience, their ability and interest to participate, their availability of time and their communicative ability.

Selection criteria

Due to the objective of the research involves the identification of the technological and business parameters that mark the convergence of television, the profiles of the experts should be focused on the use, acquisition, sale or support of these technologies and / or the strategic planning of using them in the television business. This level of knowledge is specific to engineers, heads of technical areas and managers or directors of television channels or producers; this knowledge can also be found in supplier companies of electronic equipment for production and transmission of television on staff with the same charges mentioned.

In addition, due to we are talking about the analysis of a problem that is occurring precisely in the present and therefore the channels are just developing the strategies to face it, it is not necessary to have experts who know the distant past of television, if not those who are completely involved in the changes that are taking place during the present years, therefore, they are proposed as experts for the research to those who comply with the following factors:

- Electronic, electrical, telecommunications or similar engineers, preferably with postgraduate studies in administration, management, management, or similar.
- More than 4 years of Experience in the television industry.
- Production, post production, broadcast, broadcast, address or sales areas.
- Experts who currently work in channels, production companies or supplier companies of equipment.
- A greater preference for those experts who are involved in academically or work with administrative functions.

The aspects of interest and availability of the experts are parameters that the same expert will give in response to the invitation to participate in the panel of experts of the research, however, to have a greater response capacity in the participation, the experts invited are those who have had some kind of working relationship with members of the coordinating committee.

Number of experts.

According to Astigarraga (2008), there is no way to calculate the number of experts that should conform the panel, however, it is recommended that this be between 7 to 30 experts.

It is important to emphasize that in this industry there are not too many experts with the conditions mentioned above, due to the following factors:

- Few large television channels (3 national and 8 regional channels).
- A small number of engineers, technical coordinators and managers within the channels.
- Low interest of the experts to collaborate with academic studies due to limited availability of time and contracts with confidentiality agreements.

Due to the previous points, the initial invitation was extended to approximately 15 Colombian experts and later, using the "snowball" method, another 5 experts were invited. 11 of the invited experts accepted the invitation, which accomplish the required parameters.

The profiles of the experts that make up the panel and the invitation letter to conform the panel are shown in the Appendix B. Members of the Panel of Experts. of this work.

Consultation channel of the experts

Communication with the panel of experts is done as follows:

- Invitations to participate in the panel through email.
- Interviews open through Skype.
- Questionnaires of closed questions through the Google survey platform.

Consultation Rounds

Two rounds of expert consultation were taken into account, the first round sought to identify the most relevant variables of technological convergence using open interviews, while the second round sought to validate and agree on the information collected in the first round, in order to have more accurate information and with a lower degree of dispersion (looking for a higher degree of saturation) to subsequently generate the model.

5.2.2. Phase of data collection.

5.2.2.1. *first-round questionnaire.*

Based on the variables and initial categories found in the review of the literature, the construction of a guide for the interviews was made, which aimed to "identify different variables and relevant factors in the convergence of television to Internet, both in terms of business, as in technology ", so it was necessary to evaluate aspects of traditional, current and the following years television.

The interview is presented in a semi-structured and open manner (Sampieri, Fernández, & Baptista Lucio, 2010), so the constructed guide is previously adapted to the knowledge of each expert, adding or eliminating questions that do not present any relevance with their knowledge or experience. In addition, a questionnaire with trigger questions and support questions is used, this allows the questions to be made during the interview and in the case that it is required to deepen the expert's response, the support questions are asked.

Each interview is conducted to have an average duration of 1 hour, following the guide found in the Appendix C. First-round interview guide of this work. This questionnaire is sent to the experts before the interview in the case in which they require it, since this allows them to have greater confidence that no confidentiality issue will be violated and also allows them to prepare a response to be more agile and accurate in the interview.

For the test of the questionnaire and its refinement, the interview was conducted to a pilot group of two people, consisting of an external person and one of the members of the panel of experts, so the final questionnaire was applied in Colombia only to 10 experts.

5.2.2.2. *Launch of the interviews.*

Once the interview guide was defined and tested with the pilot group, a meeting was agreed with each expert via Skype, scheduling the interviews of the first round in a period of approximately 40 days. The interview durations were between 60 and 120 minutes and these were recorded for further drafting and analysis and as evidence if it would be necessary to demonstrate the rigor of this work.

Each interview had, according to the interview guide, the following stages:

- Description of the research: Objective of the research, members of the coordinating group, characteristics of the panel of experts, anonymity and feedback conditions and future participation.
- Objective of the interview.
- Description of the stimulator material: (example of the identification of variables that implies the transition of the automotive engine industry), (Sampieri, Fernández, & Baptista Lucio, 2010).
- Expert identification questions: Name, position, company, academic background, professional experience.
- Questions regarding the Delphi method.

5.2.2.3. *Analysis of the first-round answers using open codification.*

The information collected in the interviews is treated according to the main objective of the investigation, filtering the aspects that do not contribute to its development. In addition, the experts' answers are organized in a matrix similar to that of Table 5, where the rows are located according to the variables and columns according to the expert. This matrix is initially organized according to the identified categories of the study of the state of the art, however, when performing the constant comparison process (Sampieri, Fernández, & Baptista Lucio, 2010) the categories are refined, modifying them according to the reality described in the interviews by the experts.

This matrix allows to find aspects in which the opinions of experts agree, disagree and those in which additional ideas are proposed by a minority of experts that are relevant for the variables and deserve to be taken into account as they give continuity to ideas identified in the state of the art. According to this, a synthesis of the ideas put forward by the experts is made, which is shown in Table 6. In addition, this synthesis allows the further development of axial codification.

Table 6, Part 1. Synthesis of results of the first round of the Delphi method.

Categories	Variables/Experts	Synthesis	Expert 1	...	Expert 10
Traditional transmission technologies	DTT	*C: Low availability of channels broadcasting on DTT. *I: DTT will not host interactivity services. *I: DTT will not host portability services. *DI: DTT will disappear due to its low competitiveness.	*Idea 1 *Idea 2 ... *Idea n		*Idea 1 *Idea 2 ... *Idea n
	Television by satellite or cable subscription	*DI: Television by cable or satellite subscription will disappear in the future and will be replaced by subscription services to internet platforms.	*I1, *I2... ... *In		*I1, *I2... ... *In
Video over IP	IP technology for production	*C: Implementation of ASI over IP video streams from the cameras to the transmitters or the internet. *C: MAM centralized content systems. *I: Remote control by IP of equipment in events from the channel (cameras, sound, etc.). *I: IP video streams will replace microwaves and flyaway.	*Idea 1 *Idea 2 ... *Idea n		*Idea 1 *Idea 2 ... *Idea n
	Internet access	*C: The country presents great difficulties in terms of availability and speed of internet.	*I1, *I2... ... *In		*I1, *I2... ... *In
	Technological resource used by tv on internet channels	*DI: There is no consensus on the way in which channels will broadcast online, whether to buy their own equipment, rent the transmission service or simply provide the content to a third party.	*I1, *I2... ... *In		*I1, *I2... ... *In
	Tv on Internet	*DI: It is not clear the relationship of the content that will be transmitted on digital platforms and in traditional media *C: The copyright for each medium is different *C: Live content is an advantage for channels against VoD platforms. *C: VoD only threatens the production of pre-recorded content of the channels *I: A parallel production line is required for Internet content, but of smaller dimensions and quality.	*I1, *I2... ... *In		*I1, *I2... ... *In
Presentation and technical quality of the content	UHD	*I: Demand changes in additional technologies such as makeup and lighting. *DI: It will hardly include audio superior to stereo, since HD does not even use the 5: 1.	*I1, *I2... ... *In		*I1, *I2... ... *In
	3DTV	*DI: Its future existence is not clear	*I1, *I2... ... *In		*I1, *I2... ... *In
Emerging technologies	Cloud Computing	*DI: Delay in using due to distrust of the channels to change the ownership paradigm of the devices. *I: The delay in Internet development in the country still slows its use. *I: It is already used in the internal cloud of the channel with the MAM systems.	*I1, *I2... ... *In		*I1, *I2... ... *In
	Computational Intelligence and Data mining	*DI: It is not clear in which areas the channels seek to implement these systems. *C: For now, although it exists in other sectors, it is not a tool that is used in channels, because of its costs.	*I1, *I2... ... *In		*I1, *I2... ... *In

Source: Own elaboration. DI: Diversified idea, C: Idea with consensus, I: Additional ideas

Table 6, Part 2. Synthesis of results of the first round of the Delphi method.

Portability	Mobile television	*C: Portable television is not made by DTT. *DI: Portable television will be transmitted only over the internet.	*I1, *I2... *In	...	*I1, *I2... *In
Technological improvements	Future additional technological changes	*C: Improvement and greater use of optical fiber. *I: 360 TV inclusion. *C: Intensive use of automation in channels. *C: New codecs for UHD. *I: Increase in the use of free software in channels.	*I1, *I2... *In	...	*I1, *I2... *In
Chance in value chain	Restructuring of industry players	*DI: Lost of domination of private channels. *DI: Disappearance of public channels. *DI: Netflix as a partner to broadcast content over the internet. *I: Netflix will set a monopoly. *DI: It is not clear the transmission structure that the channels will have in the future (mixed, by a single platform, etc.) *DI: It is not clear the transformation of the mission of the channels in the future, if they disappear, they become merely producers, they merge, they become providers of telecommunications services, etc.. *C: Appearance of small channels that transmit only on the internet	*I1, *I2... *In	...	*I1, *I2... *In
	Change of profiles of professionals	*I: Live programs require more staff. *C: Pre-recorded programs reduce personnel. *C: Reduction of operational personnel due to automation. *I: New job positions due to the increase in UHD quality. *I: Creative staff requires greater technical skills. *I: More outsourcing job. *C: multifunctional professionals.	*I1, *I2... *In	...	*I1, *I2... *In
Structure of costs	TV Channel financing	*DI: The future role of the guidelines in the channels is unclear. *I: The channels will start with subscription systems.	*I1, *I2... *In	...	*I1, *I2... *In
Value proposal	Content	*C: Negative association of the political influence on the veracity of the informative content of the channels. *C: Predominance of international content. *C: Predominance of non-cultural content.	*I1, *I2... *In	...	*I1, *I2... *In
	interactivity	*DI: It is not clear if the general public seeks or does not interact. *I: Interactivity must be limited for the safety of the audience.	*I1, *I2... *In	...	*I1, *I2... *In
Customer negotiation power	Audience	*C: The audience is divided mainly by age. *C: Greater diversity of the audience. *C: Audience as a content generator. *DI: The role of the audience in content production is unclear. *I: Colombian audience of low economic resources delays the technological transition.	*I1, *I2... *In	...	*I1, *I2... *In
	Social networks	*C: They are the essential medium for interaction. *DI: it will predominate over digital platforms. *DI: Technical, duration, thematic and audience characteristics of the content on social networks.	*I1, *I2... *In	...	*I1, *I2... *In

Source: Own elaboration. DI: Diversified idea, C: Idea with consensus, I: Additional ideas

5.2.2.4. *Second-round questionnaire.*

The second round of the Delphi method was designed with the aim of providing feedback to the experts with the individual ideas that were collected in the first round, with special emphasis on those ideas that do not have an initial consensus and those that were ideas put forward only by one or two experts (see Table 6, Part 1. Synthesis of results of the first round of the Delphi method. Table 6). Additionally, through its evaluation, it is sought to establish a consensus on these ideas, either to validate them or to reject their validity.

According to the above, the questionnaire of the second round was elaborated with closed questions that sought to evaluate the degree of agreement of the experts through a Likert scale of 5 levels. The first version of this questionnaire was tested with the pilot group and refined according to their observations seeking to have greater clarity and relevance in the questions.

5.2.2.5. *Launch of the questionnaires.*

The definitive questionnaire was designed using the Google Forms tool (see Appendix D. Second- round survey questionnaire), subsequently, the request for answering the questionnaire was sent to the experts via email, sharing the link of it (<https://goo.gl/forms/PNJxM5mDtUriyt2>) and specifying the maximum response time, which was 2 weeks

It is important to clarify that at this stage the conditions of participation and the objectives of the investigation were not specified, since these had already been communicated in the first round.

5.2.2.6. *Analysis of the second-round answers.*

The analysis of the responses of the questionnaires of the second round focuses on identifying the ideas that achieved a consensus on the part of the panel of experts, to validate or invalidate them and to separate those approaches in which a consensus cannot be found. It is established as a consensus value of 70% as suggested by Suarez and Garcia, (2013), which means that if 70% of the experts agree with an approach, this is considered as validated by consensus, on the contrary, if 70% of the experts do not agree with a proposed idea, this idea is taken as rejected by consensus. Some of the answers are shown below.

Some approaches accepted by consensus:

- The video streams will be controlled through centralized and collaborative management systems of MAM (Media Asset Management) content, maintaining a flow controlled and directed through the network at all times.

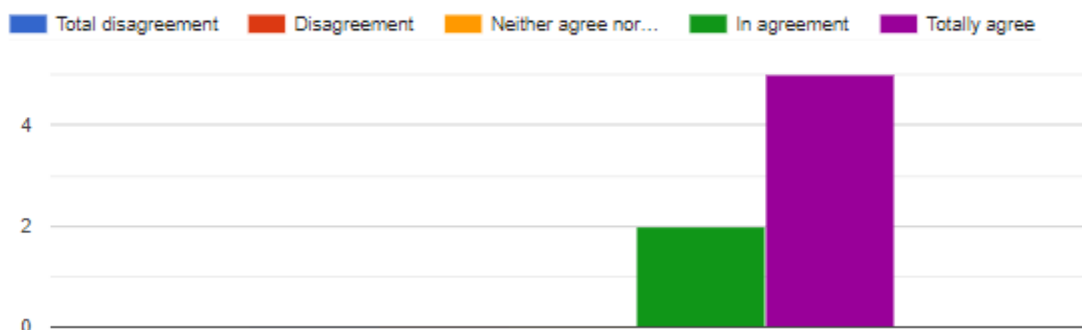


Figure 27. Approach accepted by consensus about the use of centralized managed systems.
Source: Own elaboration

- The television channels will transmit their content over their traditional media (DTT, Cable and satellite) and sell or offer their pre-recorded content (series, reality shows, novels) through the international VoD platforms owned by third parties or large platforms created by the association of several channels.

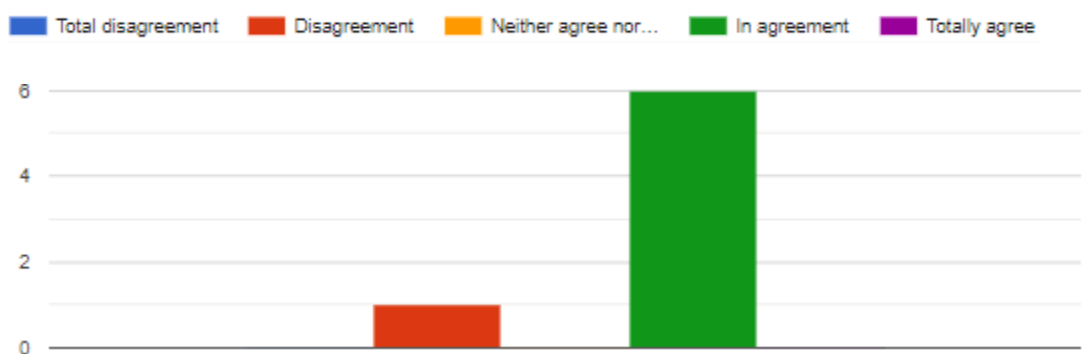


Figure 28. Approach accepted by consensus about selling the content to VoD platforms.
Source: Own elaboration

Some approaches rejected by consensus:

- Live events-type programs (soccer games, concerts, races) will require a greater number of personnel for their production.

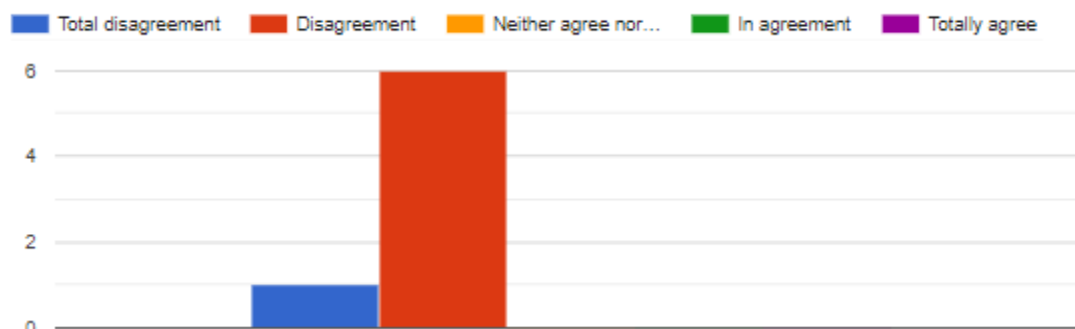


Figure 29. Approach rejected by consensus about a greater number of personnel for live production.

Source: Own elaboration.

- About the relationship of the content transmitted by the channels through traditional media (open TV, cable, satellite) and through the internet: the contents will be exactly the same, streaming and VoD (regardless of the rating it had in traditional media).

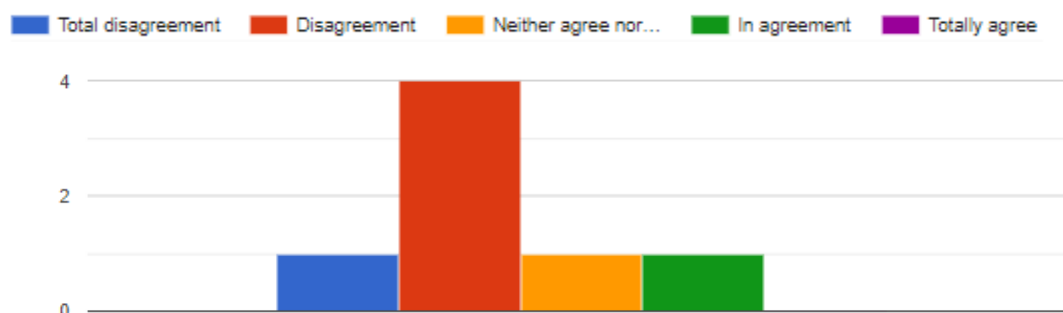


Figure 30. Approach rejected by consensus about broadcasting and offering the same content throw traditional TV and internet.

Source: Own elaboration.

Some approaches without consensus:

- The subscription service to cable or satellite TV channels will disappear, being replaced by the streaming and VoD visualization of the web platforms, with which the cable operators will only offer Internet services.

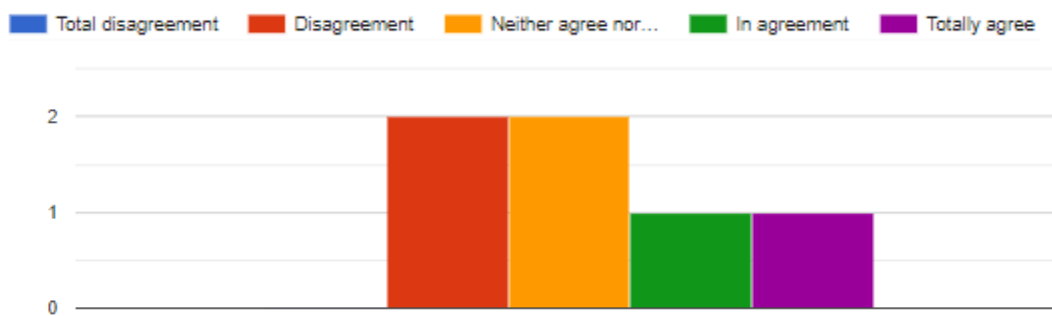


Figure 31. Approach without consensus about the replacement of cable and satellite TV subscription service with VoD subscription.

Source: Own elaboration.

- It will begin to implement the television protocols for mobile devices in DTT generating a mixed reception between internet platforms and DTT in smartphones, tablets and laptops that will include television receivers.

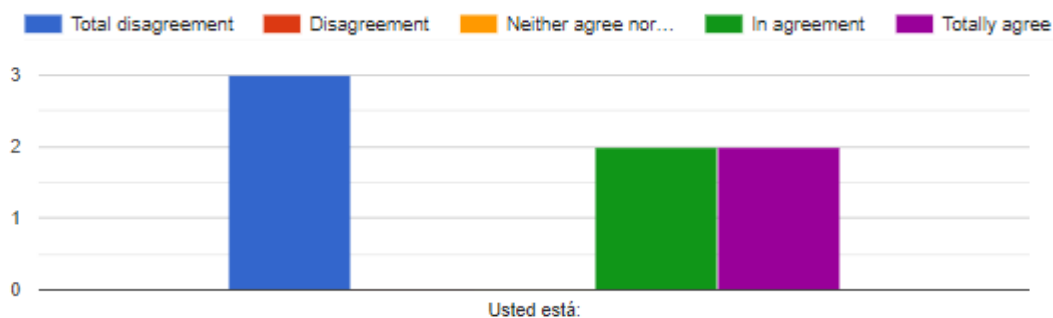


Figure 32. Approach without consensus about mobile Tv through DTT.

Source: Own elaboration

The rejection or validation of these ideas also contributes to the initial open coding process and provides additional support for the description of the selective coding stage model.

5.3.Design of the grounded theory model

5.3.1. Axial codification.

Once the variables and categories are identified in the open codification process, it is necessary to find the relationship between each of the variables. To find this relationship it was necessary to make a matrix locating each variable and category in the rows and also in the columns, with the intention of comparing each category with the others, part of this relationship matrix is shown in Table 7. With these results, the codified paradigm model is made, which is shown in Figure 33.

Table 7. Relation Matrix of the variables result from the open coding

Variables	DTT	Television by satellite or cable subscription	IP technology for production	Internet access	Technological resource used by tv on internet channels	...
DTT	x	Same content	IP entry to Tx			
Television by satellite or cable subscription	Same content	x		*ISP *Better speeds *More coverage *IPTV, triple play		
IP technology for production	IP entry to Tx		x	*needs better speeds and access	*Necessary	
Internet access		*ISP *Better speeds *More coverage *IPTV, triple play	Yes	x	*limits, needs more speed	
Technological resource used by tv on internet channels				*Necessary	x	
...						x

Source: Own elaboration.

CHAPTER 6. ANALYSIS OF THE RESULTS.

The grounded theory method allows an analysis and description of the proposed model through selective coding, detailing the results of each of the variables and factors identified in the model.

6.1.Selective codification.

In accordance with the process of research development and the final result of the fundamental theory model, the synthesis of each of the categories and their evaluation in the context of the convergent television industry in Colombia is described below.

6.1.1. Traditional Transmission Technologies

The most important change factor in the transmission of television in Colombia is the analog blackout that is contemplated for the year 2019, however, many experts say that this blackout is not made in a total but progressive or that can even be extended for years This is due to the fact that part of the audience has not had the necessary economic resources or the motivation to change from analog TV receivers to DTT receivers and, on the other hand, because the public television channels have not finished updating all their technological infrastructure. An additional factor that could delay the channels to turn off their analog transmitters is that there is still a large audience connected to it, which means advertising revenue.

Other additional factors that are highlighted in the theory, but that do not occur in practice in Colombia are the absence of portable television transmission and the interactivity in DTT. According to the interviewed experts, no television channel carries out content transmission by DTT with the characteristics to be received by a portable receiver such as a smartphone and this is due to the fact that Colombia does not sell receivers of this type. It should be noted that the government included in its road plan for 2020, the development of strategies to promote this technology. In terms of interactivity by DTT, the channels do not have any direct mechanism that works under this technology to include interaction, beyond that, what they have are content formats that involve the viewer's interaction through telephone calls, voting by internet, among others.

The content that is transmitted through this channel is SD and HD formats and according to experts, the option of transmitting UHD formats, even if they are produced, are distant options.

In terms of cable and satellite television subscription services, the experts do not reach a consensus on the existence of this service in the future, but they did agree that the channels will continue broadcasting DTT television, despite the low audience that it currently has, and they will also provide their highest rating content through internet. Additionally, television channels will also sell the rights to broadcast the most successful series and programs on traditional television to international VoD content platforms such as Netflix.

6.1.2. Video over IP and Internet.

The transmission or transport of video over IP involves its use in various ways and in different places in the industry's value chain. First and in a more general sense, it allows television channels to deliver video to the audience through an additional transmission medium with a business model completely different comparing with traditional television. This delivery of content can be done depending on the objectives and economic resources of the channel, a first option is providing VoD content or “On Air” content through social networks at a zero cost and obtaining data of audience satisfaction. Another way is by selling the content to an external VoD platform, such as Netflix, by giving up the rights to the content. A third option is to pay an external company for the administration of technological resources to transmit the content on the internet without losing its authorship, so the channel no longer worries about the purchase and maintenance of this equipment. A final option is buying the equipment and software necessary to have an OTT platform owned by the channel, through which it can transmit VoD and streaming content.

Regarding the relationship of the content provided by each channel through these medium, the differences vary in terms of the visual quality of the content, the possibilities of receiving the content on a Smart TV or in a mobile device and the conditions of the network itself. Experts mention that, in Colombia, the contents transmitted on digital platforms are the same as those transmitted on traditional television, only using different strategies, such as making available on the internet only the content that had the highest rating on traditional TV. A point that is rescued and that does not mention the literature is the existence of a small process

of parallel production that is responsible for generating low quality content, recorded mainly with Smartphones and that makes a process of supporting the main content, promoting it and measuring the reception that this has for the audience in social networks.

According to the consensus of the experts, VoD platforms and social networks should be considered as the main mechanisms of interaction of television channels with the public, both to promote their content, and to receive information about the audience's engagement with the broadcasted programs or content. Social networks in particular will allow viewers to communicate directly with the channels, interact with their content, share and comment on it, so the channels must develop all the mechanisms that allow the analysis and treatment of these data. According to experts, the content of social networks will come from fragments of the content of traditional networks plus a content produced especially for this medium and also all the content of social networks will tend to be content of short duration.

The experts also mention, as highlighted in the articles studied that the internal video flows of the channel will change from being handled with ASI protocols to IP protocols, this means that all the equipment, from the cameras to the transmitters, will have network functions and features such as remote control and accessibility over the internet or ethernet. In addition to this, there will no longer be a linear flow of the video in terms of hardware, but all the content will be centralized in a MAM central storage system and the linear production flow will be in terms of software. It is necessary to mention that experts consider that regardless of the progress of IP networks, they will not completely replace the microwave or satellite transmission systems within the production of the channels.

A contextual theme that the experts frequently highlighted was the low development of the internet infrastructure that the country has, given that the ISPs do not handle the high speeds of the internet that the video requires, in addition, there are many places where there are still no Internet access points. Internet access or those that are available do not reach broadband. This delay in the development of the Internet has given an additional time to television channels to react to convergence and generate effective strategies.

6.1.3. Presentation and technical quality of the content

Currently the content that is provided to the audience varies from analog quality to HD content, with most of the channels producing in this last format. Some television channels

and production companies have already started recording 4K content, however, they are limited to storing it and transcoding to HD. These channels trust that this content will allow them to transmit productions in maximum quality when the transmission network allows it. Additionally, by consensus, the experts state that, in the medium future, transmissions will continue to be in HD, the use of 4K will have a positive and probable outlook, but regarding the use of 8K technology, the experts do not have a consensus but propose a negative panorama for its use, this due to the costs of technology change and the low profitability that would be faced when using a greater bandwidth to transmit the same content, although this has a higher quality. The experts also mention that the improvement of the quality of the video signal should be accompanied by the improvement of studio technologies such as lights, makeup and others.

Experts mention that the qualities provided on the internet do not usually have a resolution higher than 720p, due to the low capacities provided by the internet network, but due to the progressive increase of the capacities and speeds of the Internet networks, the experts believe that the contents of television on the network will have HD and UHD qualities, but this will take a considerable time. Additionally, they confirmed that, in Colombia, there is no significant possibility that the channels begin to make 3D content, since the experience offered to the user can be overcome with UHD content.

In terms of audio quality, it is worth mentioning that no television channel is producing or transmitting content with audio qualities higher than stereo, therefore, the experts mention that the channels are a little bit far from reaching productions 5: 1 or productions with more than the 20 audio channels offered by the UHD.

Regarding other technologies that are directly related to the image, an increase in the use of augmented reality technology is expected within the channels and there is a positive future panorama but not a consensus regarding the use of technologies such as 360 video and virtual reality.

6.1.4. Emerging technologies

The main technologies contemplated by the television industry in Colombia are cloud computing technology and the joint use of computer intelligence technology and data mining.

The experts mentioned that there is still a distrust of the television channels to hire cloud services instead of buying the equipment, although it is more expensive, the channels prefer to invest in the technological equipment and perform maintenance and control of the equipment by themselves. However, this technology has begun to be exploited by small new producers and television channels of low operating cost that hire such services for projects or special transmissions. The experts also stated in a consensual manner that in the future most channels will acquire Cloud computing services as centralized file systems (MAM systems), which is considered as an internal cloud; Remote employee work facilities from any physical location using the services in the cloud and many channels have opted to purchase cloud services to transmit their signal through online platforms. It is worth mentioning that the cloud services that channels require are still limited by the current internet speeds.

Regarding the use of computer intelligence and data mining, the television channels are based on the success of the large companies of VoD, which has begun to interest in investing in these types of technologies in their OTT platforms, However, the costs of these technologies still cause these acquisitions to be delayed, although the uncertainty of knowing whether there will be a return on the investment. Other fields in which the experts visualize the use of computational intelligence and data mining are the translation systems between languages in live and VoD content, in the programming of the content grid and perhaps the most important could be the optimization of advertising right publicity to the right viewers.

It should be noted that the main consequence of the emergence of new technologies and their reduction in costs is the appearance of new participants in the industry due to the fact that many entry barriers are demolished due to the costs implied by traditional technology.

6.1.5. Portability

There is a consensus among experts that mobile television will only be guaranteed through the Internet using Wi-Fi networks or telephony networks (3G or 4G) as a physical means of connection, therefore, experts rule out the use of DTT networks to transmit television to mobile devices. This approach implies that different aspects must be improved, mainly in mobile telephony networks, because according to experts, there is not yet enough coverage in 4G and the costs of this service are still expensive for users.

Experts have highlighted the importance of VoD platforms and social networks to visualize audiovisual content, with which the use of APPs in mobile devices that allow access to these platforms become more important. These APPs should take into consideration that for mobile devices it is not necessary to view videos with UHD qualities, which also reduces the need to spend large resources on processing and in turn helps to maintain a low power consumption in these devices. In addition, it is necessary that these APPs seek constant data collection that allows the channels to identify different trends and relevant information through Big Data.

6.1.6. Technological improvements

The experts mention that the main improvements of the existing technology are the improvement of internal workflows, which is done through MAM centralized storage systems; the adoption of optical fiber as an IP data transport medium, the use and popularization of free software of similar qualities to the payment software and the use of automation systems. This last factor produces a cut in the necessary personnel within the channels, especially in the operating personnel, additionally, it will facilitate the participation of new small producers, since it eliminates the cost of software as a barrier to entry.

Another technological improvement that is already causing great changes within some channels and that the experts agree in saying that it will happen in the other channels is the use of automation systems such as the automation of the cameras for the recording studios or the automation of the systems of audiovisual content intake, which will reduce response times and optimize production and post-production processes, but will greatly reduce the number of staff working in the operational part of the channels.

6.1.7. Change in value chain

In Colombia, the main change in the external value chain occurs in the loss of the power of private channels due to the diversification of the audience. Another important change is the appearance of small producers, which was mentioned above and the strengthening of existing production companies, due to a demand for more content.

In addition to this, the audience in Colombia is qualified by the experts as an active audience and with the intention of producing content, which has allowed the channels to take advantage of this content in their favor for their productions, but this also means that many

users stop to see content from channels and see content on social networks, produced by other users.

As for television channels that aim to generate profitability, they must add different strategies to their business lines to see the Internet as an opportunity, an additional channel through which they can transmit, but with its own characteristics. In the same way, they should promote partnerships with the large VoD platforms to make their content more accessible. On the other hand, there is no consensus on the future existence of cable operators, so the channels should generate long-term strategies to prepare for any possible scenario.

An additional change in the internal value chain of the channels is the profile and number of professionals working within the channels. Due to the automation processes, the channels are tending to have a smaller number of workers and the few that remain must learn to manage new equipment in multiple platforms in an almost experimental way, since they are new technologies. In addition to this idea, experts agree with the fact that in the future many channel workers will be able to work remotely due to cloud facilities and improvements in internet speeds, which will make contracts and types of work begin to reform.

6.1.8. Financing structure

The main change in the financing structure of television channels is the change of paradigm from advertising to subscription television, however, experts mention that the outlook in television channels in Colombia is still traditional, having its highest income per medium of those companies that look for a space to promote their products. Some experts added that, although it is possible to have income from part of the transmission on the internet due to the pattern, the operating costs of digital platforms are even greater.

It is necessary to add that the portion of the market that corresponded to television channels is increasingly smaller, because there are now direct or indirect competitors such as small producers that transmit directly over the Internet, the global VoD platforms and the generating audience of content for profit. In addition to this, advertisers have found on Internet platforms new spaces where they can publish their advertising in an interactive and smart way, focused directly on the users they need at a level that traditional television cannot reach.

6.1.9. Value proposal

The main product of television is and will be the content and its delivery to the audience. The significant change in the content is the visual quality, which each time provides a video flow with higher resolution. However, the experts say that the majority of productions will remain in HD, only a few VoD productions in 4K and there is no positive picture in the use of 8K. According to experts, the topics of the productions has not changed significantly and the subject of such content is increasingly homogeneous. The most popular television channels use content formats that have been successful in other countries and replicate it in Colombia, therefore, according to the experts, there is a predominance of international and non-cultural content, thus offering realities shows, novels, among others.

It is also a reason why a large part of the audience has moved towards VoD content, where they can find a more diversified amount of content and according to the particular tastes of each user segment. In addition to this, the audience begins to focus on finding increasingly interactive content, as this interactivity keeps them more engaged. Even, the experts mention that progressively there will be a greater participation of the contents produced by the audience in the programs that produce the channels.

The main medium of audience interaction is and will be the social networks, where they can rate, share or even transmit their own content. The content that television channels should maintain on these platforms should be short-time content, taking the most important fragments of traditional media productions and even generating their own content for these platforms. An additional point that the experts highlight is that this content does not have to be exclusively focused on the millennial audience, but it must be inclusive and it must seek to meet the needs of other users.

An additional negative factor of the content generated in the country is its remarkable political focus, which has led many users to stop following some television channels.

6.1.10. Customer negotiation power

According to experts, the bargaining power of the audience is growing, because it has more and more substitutes for traditional television. In turn, the audience is increasingly fragmented, separated into groups by factors such as age, level of education and technological management. In addition, as in the rest of the world, the change of a passive audience to an

active audience and the ability to interact with the content, has allowed it to be more critical, supporting or disqualifying the content according to its quality.

The main reason for changing the role of the audience has been social networks, where the quality of content is low, advertising is controlled by the same social network, the income is not significant for the channel, but it involves a great approach with the audience, especially the young one, allowing them to interact in a totally new way, which in turn allows the television channels to obtain data of said interaction.

Again, it is necessary to highlight that in Colombia there is still a large number of the population that is considered to be of low economic resources and that does not have access to video platforms on the Internet, so their bargaining power is low and their only way of viewing television is through traditional media, especially free media, such as open terrestrial television.

CONCLUSIONS, RECOMMENDATIONS AND FUTURE RESEARCH

Although the global panorama of the television industry seems to be negative in the face of the arrival of the worldwide VoD platforms, the experts mention that the television channels will remain in the industry and they will take advantage of these new medium as a channels where they can reach more audience, but they recognize that they will have to change aspects such as the labor roles linked to production and they will have to use different strategies to make themselves profitable, they also affirm that the future of television will be multiplatform, television broadcast by traditional mediums will not cease.

It was evidenced that the Colombian television industry, although at a slower pace, follows in general terms the global tendencies of use of video services over the Internet, focusing on new variables such as interactivity with viewers, which allows not only to have a greater engage with the audience but optimize the delivery of content and advertising. However, practical differences were identified in relation to the portability and interactivity that terrestrial digital television could offer, since Colombia does not contemplate these variables within the industry.

The developed model and the panorama described by the experts indicate that television channels should concentrate part of their technological investments in generating technological strategies that allow them to transmit content over the internet, with proprietary or third party platforms, without neglecting traditional media and without having to make considerable technological improvements in terms of video quality (acquisitions of UHD systems) as in traditional media, this demands a greater bandwidth that implies a lower number of television programs for each frequency space. In addition, in terms of transmission over the internet, there is not yet adequate fiber optic deployment to handle these video qualities.

It was identified that the technological development that has allowed factors such as services in the cloud, social networks, the cheapening of production equipment such as cameras and lights, the improvement of free software for video production and advertising financing indirectly controlled by search engines have disabled many of the entry barriers that kept the production of audiovisual content as an exclusive business of television channels. Due to this, content producing companies of all types that use Internet platforms as a medium of transmitting live or on-demand content are beginning to appear.

Finally, we must mention the complete internal technological transformation suffered by television channels, having to turn their video flow into centralized, collaborative and focused on IP instead of video, which means a change in the professionals, in the technology and in the scope to work more quickly and also more focused on the audience. As happened with the other industries that suffered the convergence, only those who know how to interpret the complete system and develop the correct strategies, they will have a chance to survive.

As part of future research, the following topics are proposed:

- Because the Delphi method was limited by a number of two rounds of consultation, not all approaches could be agreed upon. A future work could involve a third round of questions that seeks to find a consensus in those approaches in which it was not achieved, such as determining the future role of cable and satellite television subscription service operators. This will allow building a much richer and more detailed model.
- It is proposed to carry out an investigation aimed at the statistical verification of different hypotheses that arise from the approaches made in this research, such as the increase of small audiovisual production companies and how these companies use cloud technologies, software free and social networks to overcome barriers to entry to the industry.
- We propose a research that seeks to scale the model developed at an international level using two different methodologies. The first one, developing a new model with the methodology exposed in this research, interviewing experts from the main television channels of different countries. The second, validating by international experts the final model developed for Colombia.

- It is proposed as future work of the study of the implementation and evaluation of the model carried out within a Colombian television channel to determine the specific strategies and possible results that lead to a continuous improvement of the model.

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Appendix A. Letter Conditions of Participation of the Panel of Experts



Conditions of Participation of the Panel of Experts

Interviewer: Cesar Echeverry Moreno.

Introduction:

The interview is part of the development of the research carried out by the UrFU University (Ural Federal University) of Russia and the UPAEP University (Autonomous Popular University of the State of Puebla) of Mexico and financed by the CONACYT (National Council of Science and Technology). The research aims to *“design a model of technological convergence of the Colombian television industry through the study of technological development trends and the consultation of experts”*

The characteristics of the research and participation of the experts are mentioned below:

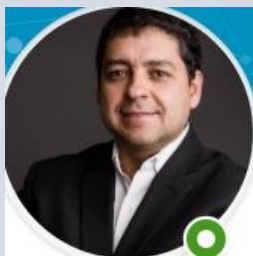
- **Coordinating committee:** the research has a coordinating committee made up of researchers from the Popular Autonomous University of the State of Puebla (Mexico), Ural Federal University (Russia) and by a Colombian researcher, the engineer Cesar Echeverry, who, in addition to other roles, has the role of interviewer.
- **Panel of experts:** the panel is made up of professionals and academics from the television industry of Colombia, Mexico, Russia and Spain.
- **Anonymity and confidentiality:** the participation of the experts will remain anonymous during the entire investigation process, as well as their personal and professional opinions, therefore, none of the experts will know who the other members of the panel are, the staff of the coordinating committee will be the only one who knows the identity and opinion of the experts. The participation of the expert as part of the panel will be recognized in the publications made, unless the latter requests otherwise.
- **Interviews:** The participation of the panelists involves three different stages. The first consists of an individual interview with a duration of around 40 minutes, using Skype, WhatsApp or the medium that best suits the interview. The second and third participation consists of questionnaires of closed questions (with multiple options), with a duration of less than 20 minutes. The questionnaires can be answered by Skype or sent and received by mail. The three participations will be distributed during the time involved in this phase of the investigation, which is approximately 2 months. In each participation, open or closed questions will be asked about the subject of the research, where the expert is expected to respond according to their academic knowledge, professionals and experience in the sector, but no type of sensitive information will be requested from the expert's place of work.

Contact: cesar.echeverry@upaep.edu.mx

Appendix B. Members of the Panel of Experts.

Only the most relevant experience of the experts is mentioned, with an emphasis on the audiovisual and television industry, the extended experience can be consulted in the links of the LinkedIn profiles.

Javier Cerquera



Position: Project Manager at Power Digital Electronics: Media & Broadcast technology projects - 10 years.

Experience: - Independent consultant in Broadcast Technology with dozens of projects in public and private television - 25 years.
- Operational Director at Canal Capital - 2 and a half years.
- Master of Broadcast at Canal RCN - 1 year

Education: - Electronic Engineer, Javeriana University, Colombia
-Magister en Ingeniería Industrial de la Universidad de los Andes, Colombia.

<https://www.linkedin.com/in/javier-cerquera-6351824/>

Camilo Calvache



Position: Production Engineer at Fox Sport Colombia - 2 years.

Experience: - Television technical support engineer in Presidencia de la Republica de Colombia - 2 years.
- Technical Support Engineer in Canal Capital - 2 and a half years

Education: - Electronic Engineer, Universidad Nacional, Colombia.
- Specialist in Telecommunications Project Management, Universidad del Rosario, Colombia.

<https://www.linkedin.com/in/ernesto-camilo-calvache-ortega-13534147/>

John Carlos Hurtado Gamboa



Position: Director of the Technical and Systems Area of the TV channel Telepacífico - 11 years.

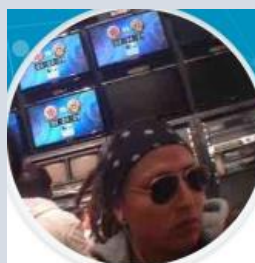
Education: - Electronics and Telecommunications Engineer, Universidad del Quindío, Colombia.

- Magister in Engineering, Universidad del Valle, Colombia.

- Magister in Business Administration, Universidad del Valle, Colombia.

<https://www.linkedin.com/in/jhon-carlos-hurtado-gamboa-5178a466/>

Camilo Fajardo



Position: Production and Transmission Engineer in Televideo - 5 years.

Experience: - Production engineer of TV at Claro Colombia - 6 months.

- Technical support engineer in Televideo - 2 years.

- Technical Supervisor in Canal Caracol - 3 and a half years.

Education: - Electronic Engineer at the Universidad Santo Tomas, Colombia.

- Specialist in Project Management at the Universidad de la Salle, Colombia.

<https://www.linkedin.com/in/camilo-fajardo-8bb47055/>

Pablo Lizarazo



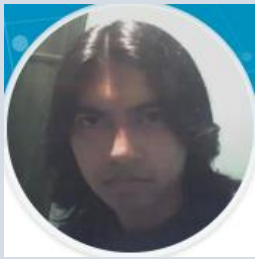
Position: Support Engineer at Avcom (Audio, Visual, Lighting, Staging, Technical Support for TV Events) - 1 year and 10 months.

Experience: - Digital Media Manager, Canal RCN internacional - 7 years and 5 months

Education: - Telecommunications Engineer, Universidad Piloto, Colombia.
- Technologist in Telecommunications at SENA, Colombia.

<https://www.linkedin.com/in/pablo-lizarazo-82b33a13a/>

Fabian Riascos



Position: Broadcast and support engineer at Canal Capital - 5 years.

Experience: Signal management engineer Canal 13 - 8 months.

Education: - Electronic and Telecommunications Engineer, Universidad del Cauca, Colombia.

<https://www.linkedin.com/in/fabian-riascos-72ba4230/>

David Pedraza Higuera



Position: Post-Production Engineer at Canal RCN - 4 years

Experience: - Engineering assistant at Canal Capital - 1 year.

- Post-production engineer at Canal Capital - 3 years

Education: Mechatronics Engineer, Universidad Militar, Colombia.

<https://www.linkedin.com/in/jose-david-pedraza-higuera-15ab6273/>

Natali Varela Bornacelli



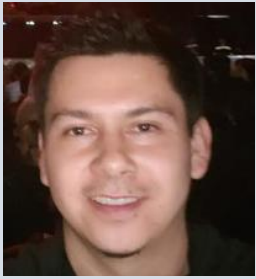
Position: Account Manager & Territory Lead in Mediastream SpA (Leading company in Latin America in streaming services for TV) - 3 years

Education: - Electronic Engineer, Universidad Santo Tomas, Colombia.

- Certified in Project Management, Universidad Santo Tomas, Colombia.

<https://www.linkedin.com/in/natali-varela-bornacelli-28690121/>

Daniel Jaramillo López



Position: Support Engineer at Canal Capital - 4 years

Experience: Additional experience of 5 years as engineer in videoconferencing and streaming systems.

Education: Electronic Engineering, Universidad del Cauca, Colombia.

Luis Carlos García



Position: Support Engineer at Canal 13 - 2 years

Experience: 6 years as technical coordination assistant of Canal Capital developing technical and administrative activities

Education: Professional technician in telecommunications

Gonzalo Hernández (Mexican expert)



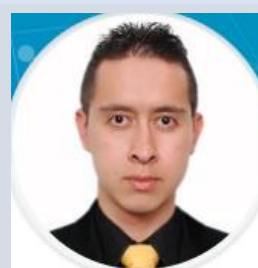
Position: Regional Technical Manager at Televisa - 2 years and 6 months.

Experience: - Support Engineer for Latin-American at GatesAir (The world leader in wireless broadcast transmitters, STL codecs, and public safety communications technology for TV and Radio) - 10 years.
- Technical Operator at Canal 11 Mexico - 3 years

Education: - Communications and Electronics Engineer, Instituto Politécnico Nacional, Mexico.

<https://www.linkedin.com/in/gonzalo-hernandez-b68a63149/>

Jhonatan Torres (Pilot group expert)



Position: Master's student in Information Technology of the Institut Mines-Télécom, France

Experience: 2 years as support engineer for Aicox Soluciones (Solution provider for TV production)

Education: Electronic Engineering, Universidad Distrital, Colombia

<https://www.linkedin.com/in/jhonatan-torres-704629143/>

Appendix C. First-round interview guide

Note: It is important to remember that each interview was adequate according to the knowledge and work area of each expert, but covering the main topics and axes of the investigation. The questions shown here were just a guide for each of the interviews. The Introduction and the stimulating material were the same for each expert.

Interview guide for the first stage of the investigation “*Strategic model of technological convergence for the Colombian television industry based on the study of current standards, technological trends and the consultation of experts*”

Interviewer: Cesar Echeverry.

Introduction:

The present interview is part of the development of the research carried out by the UrFU University of Russia and the UPAEP University of Mexico and is financed by CONACYT. This research is aimed at “*Design a strategic model of technological convergence for the Colombian television industry based on the study of current standards, technological trends and the consultation of experts*”

This is the first of two interviews and aims to identify different variables and relevant factors in the convergence of television to the Internet, both in terms of business and technology; so, it is necessary to evaluate aspects of traditional television, current or transitory and convergent or the following years.

The questions posed in this interview are open-ended and experts are expected to respond according to their professional and personal experience in the television industry. Some of the questions are of a provisional nature, of which there will never be an absolute certainty, but even so it is of great interest to know the response of the experts, for being those who can provide a more accurate vision about that future.

Stimulator material:

As an example of what the interview is looking for, it is proposed to analyze the transition from vehicles driven by gasoline to electric vehicles. Within the technical aspects of this transition we can mention first the use of fuel in the traditional cars and the use of electricity of the cars of the future, having hybrid models at present. We can also mention aspects such as changing the type of combustion engines to electric motors, along with all the technology that accompanies them (carburetor block, injector, etc.). Here we will also find some technological aspects that do not change, with this transition, such as the type and quantity of wheels, the existence of doors, handlebars, etc. We could also mention the existence of alternative technologies such as hydrogen-powered engines.

Now, if we carry out an analysis in terms of business, we can mention that this transition implies a radical change for some sectors of the industry such as the fuel sector, since there has to be a transition from gas stations to electric stations. We can add some aspects related to customer satisfaction, mentioning for example their benefit in terms of the cost to transport or the discomfort of not being able to make long trips due to the fact that there are no electric stations. Additionally, we could mention how the demand of professionals in the industry begins to change since the professionals specialized in fuel engines must update, train and innovate on alternative technologies or not to do so, new professionals could take their positions.

If we summarize this, we could realize that we identify aspects of traditional industry such as:

- Motors of gasoline
- Use of carburetion blocks
- Fully developed gas station infrastructure.

We also conclude that the relevant future aspects will be:

- Use of electric motors
- Full infrastructure of electric stations

-Saving of user money.

And finally, we will highlight the transition aspects such as:

-Hybrid cars

-Inconformity of the user due to the absence of stations.

-etc.

According to this example, similarly, we seek to identify these factors of the television industry in the following interview.

Questions:

Semi-structured interview (exploratory type).

DQ: Detonating question

SQ: Support question

Personal questions.

1. Please describe your academic background and professional experience.
2. Please describe the company in which you work and your current role within it.

Questions

3. **DQ:** I would like us to start talking about the technological panorama of Colombian television in the last 5-10 years. Could you describe to me what types of technologies have marked the evolution of industry technology in the country during this period of time?

- **SQ:** Option A. Which of these technologies have been most important for television channels to maintain their competitiveness? Why?
Option B. What types of technologies have television channels used to gain advantages over their competitors?

4. **DQ:** If we situate ourselves in the current scenario, what technologies are playing crucial roles within the channels?

- **SQ:** How is the technological panorama of transition to DTT-2?
- **SQ:** Talking about the panorama of television over the internet, what technological implications has the transmission of television on this channel?
- **SQ:** Has any type of strategy been developed focused on the transmission of television to mobile devices?
- **SQ:** What type of technological acquisitions or projects are being carried out by television channels to handle the transmissions of content on the web?
- **SQ:** Is it a matter concerning only the transmission? Are there implications for the technologies used for production and postproduction?
- **SQ:** In addition to the acquisition and technological implementation, what strategies are the television channels developing to enter the Internet content industry?
- **SQ:** What are the advantages and disadvantages of this convergence in terms of business for channels?

DQ: In addition to the change in transmission technologies, what other technological changes do you see within the television industry in the future?

- **SQ:** The production of contents in 4K and 8K qualities has been announced within the television channels. What impact will these technologies have on TV channels? Is something already being done about it?
- **SQ:** Do you know any emerging technology that, according to your opinion, has a place in the television industry?

5. **DQ:** Now, speaking of the structure of the television business in Colombia, please tell me how this industry is made, who produces, who transmits, which channels have a greater participation of the audience?

- **SQ:** Although all television channels develop strategies to stay competitive, most of the television audience has focused on 2 or 3 television channels. What do you think are the factors that have allowed these channels to maintain the majority of the audience?

DQ: Is the technological convergence affecting in any way the power of each of these companies? How?

- **SQ:** What strategies should television channels that want to excel in the following years consider?
- **SQ:** Do you think that technological convergence will have as its response the creation, merger or disappearance of some companies within the television industry?
- **SQ:** What should channels do with the migration of the audience to large Internet video platforms such as Netflix or YouTube?

6. **DQ:** How have the internal work roles of the channel been affected due to technological advances in general?

- **SQ:** What new jobs or areas can appear to respond to technological convergence?
- **SQ:** Which ones can disappear?

7. **DQ:** How is the television industry influenced due to the popularization of audiovisual content over the internet?

- **SQ:** What are the advantages and disadvantages of this convergence in terms of business for channels?
- **SQ:** Are the power of television channels changing in any way?

- **SQ:** How are the television channels taking advantage of the possibility of transmitting over the internet?
- **SQ:** What should channels do with the migration of the audience to large Internet video platforms such as Netflix or YouTube?
- **SQ:** Will there be a panorama of coexistence of traditional media and television over the Internet?

8. **DQ:** What type of technological acquisitions or projects are being carried out by television channels to handle the transmissions of content on the web?

- **SQ:** How are the television channels linking their recent investments in DTT with their now necessary investments in OTT?
- **SQ:** Has any type of strategy been developed focused on the transmission of television to mobile devices?
- **SQ:** Is it a matter concerning only the transmission? Are there implications for the technologies used for production and postproduction?
- **SQ:** Television is undeniably progressing in other aspects such as content resolution quality, compression formats, etc. How do these changes relate to the transmission over the internet?

DQ: If we think about the panorama of the next 5 or 10 years, what types of technologies will television channels need to stay in business for the next few years?

- **SQ:** Are the emerging technologies in the transmission of television over the Internet being exploited in any way?
- **SQ:** Will there be a panorama of coexistence of traditional media and television over the Internet?

9. **DQ:** Does the transmission of video over the internet open the door to new participants?

- **SQ:** Once all the actors are on the internet, what factors would the competition turn on?

10. **DQ:** Changing a bit on the subject, how is technology being used to innovate in terms of content?

SQ: Are the traditional contents different from the contents on the internet?

SQ: In technical terms, what differences can a user perceive between the signal he traditionally receives and the signal he receives over the internet?

SQ: What other changes do you expect to have in the future?

11. **DQ:** Now, speaking of the audience, our research recognizes that there is a change in the profile of viewers, from passive users to users who express themselves and interact through social networks and other media. What could you mention about this change?

- **SQ:** How is that change being used?
- **SQ:** What will be the scope of the audience in the future, to what extent can it generate an impact within the television channels and in the contents?
- **SQ:** What could you tell me about the role the audience is taking as a generator of content?

12. **DQ:** Advertising and subscription to the traditional television service have been some of the ways in which television has been financed, what can be said of the means of financing on the internet, how to generate monetization?

13. **SQ:** Finally, what new services do you think may appear because of new technologies and new ways of making television?

Appendix D. Second- round survey questionnaire

Link: <https://goo.gl/forms/PNJJxM5mDtUriytK2>



Technological Convergence of the Colombian Television Industry

Questionnaire of the second stage of the investigation

This questionnaire was conducted guided by the opinions and scenarios raised by the experts interviewed in the first round of the research, however, there are scenarios that may diverge from the general opinion or some that were not widely mentioned, because of this, we want to know your professional and personal position on them.

Please take into consideration the following elements:

- Your answers will remain anonymous..
- The questionnaire lasts approximately 20 minutes.
- The scenarios are planned for a future period of 10 years.
- If you want to skip any question, follow quietly without checking any box to the next option or question.

Name and surname

Tu respuesta

Company

Tu respuesta

Position

Tu respuesta

1. Due to the increase in transmission speeds over the internet and ethernet, to the improvements due to the IPV6 protocol and to the greater availability of the network, how much do you agree with the following statements about the video streams of the TV channels?

The video streams will be fully moved over IP technology: The video signal from the cameras will be over IP protocol and will pass through the different equipment in the production chain such as IP video switchers, IP video matrixes, etc., up to the systems of transmission also with IP inputs, whether they are DTT, cable, satellite or TV over the internet

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐ ☐ ☐ ☐ ☐

The video streams will be controlled through centralized and collaborative management systems of MAM (Media Asset Management) content, maintaining a flow controlled and directed through the network at all times.

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐ ☐ ☐ ☐ ☐

It will be possible to move only the peripherals (cameras and microphones) to cover any event, connecting them directly to the internet and controlling them from the headquarters of the television channel; due to this, large mobile units will no longer be sent and only such units will be sent along with the staff that manages it.

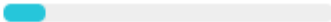
Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐ ☐ ☐ ☐ ☐

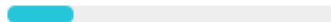
The transmission of video over the Internet (fixed and mobile) will totally replace the use of microwave and satellite systems used in television production.

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

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2. How important do you think the following media will be for the audience, with the aim of consuming audiovisual content?

	Without importance	Little importance	Moderately important	Important	Very important
DTT	☐	☐	☐	☐	☐
Television by subscription cable and / or satellite.	☐	☐	☐	☐	☐
Television by VoD payment platforms	☐	☐	☐	☐	☐
Television by free internet platforms	☐	☐	☐	☐	☐
Social networks	☐	☐	☐	☐	☐

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3. how much do you agree with the following statements regarding large cable operators and its cable television subscription service?

They will maintain the essence of their service and business by offering multiple television channels for a certain payment and offering fixed internet

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

The subscription service to cable or satellite TV channels will disappear, being replaced by the streaming and VoD visualization of the web platforms, with which the cable operators will only offer Internet services.

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

Other:...

Tu respuesta

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4. How much do you agree with the following statements regarding the tendency of television channels to use internet transmission platforms?

The television channels will use free and open access content platforms, such as YouTube, Facebook, Instagram, etc., to partially or totally transmit their content.

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

The television channels will pay a third party for the technological service of diffusion over the Internet and for the whole strategy of digital diffusion (that, when, how and where the contents are transmitted).

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

The television channels will use platforms where a third party is paid for the use of said platform, but all the management of the content, what is transmitted and how it is transmitted, will be the responsibility of the channel. Only the technological administration is the third party's obligation.

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

The television channels will use proprietary platforms of the channel where this is in charge of the technological administration and content management.

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

There will not be a usage trend defined by television channels and this will depend on the particular economic objectives and resources of each channel.

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

Other:...

Tu respuesta

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5. How much do you agree with the following statements about the relationship of the content transmitted by the channels through traditional media (open TV, cable, satellite) and through the internet?

On the internet only streaming signal taken from the live channel signal will be offered.

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

On the internet, the streaming signal and the VoD (video on demand) of the content with the highest rating of traditional media will be offered.

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

The contents will be exactly the same, streaming and VoD (regardless of the rating it had in traditional media).

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

The streaming and VoD of the content disseminated in traditional media will be transmitted over the internet, plus content produced exclusively for digital platforms.

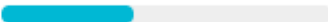
	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

Independent content lines will be maintained for each of the platforms (traditional media and internet) and in some cases they will share content, where content can be shown in traditional media taken from internet platforms and vice versa

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

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6. How much do you agree with the following statements about the stage of television production of the channels?

The production stage of the channels will not undergo any changes to allow the channel to offer content over the internet, as this is a particular issue of the transmission stage

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

The stage of production of the channels must be reformed technologically and in the way in which it produces its contents, due to the technological convergence process, to allow the channel to offer specialized content on the internet.

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

The television channels will have a production line parallel to the main production area, this parallel production line will be responsible for generating support contents, which will be of lower technical quality and will be transmitted on the Internet (especially on social networks).

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

The use of free software for the production and post-production of content within television channels will be popularized.

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

All the main production will be made and transmitted in HD production standards.

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

All the main production will be carried out and transmitted in Ultra HD 4K production standards.

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

All the main production will be done and transmitted in Ultra HD 8K production standards.

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

Along with the evolution of the recording quality to ultra HD formats, an additional change in aspects such as makeup, studio montages and lighting will be necessary.

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

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SIGUIENTE



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7. How well do you agree with the following statements about the combined use of artificial intelligence and Big Data in the channels?

The television channels will not use these technologies within their production and / or transmission chain.

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

The channels will use these technologies to implement subtitling and automatic translation systems in different languages.

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

The channels will use these technologies to improve the search for support material for production through visual recognition of the video.

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

Channels will use this technology to suggest content to users and customize their offer, as some VoD platforms do.

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

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8. How much do you agree with the following statements about portable or mobile television?

It will begin to implement the television protocols for mobile devices in DTT generating a mixed reception between internet platforms and DTT in smartphones, tablets and laptops that will include television receivers.

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

The consumption of mobile television will be made only through OTT platforms, android and IOS applications, VoD platforms and social networks through smartphones, tablets and computers, as is currently done.

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

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9. How important do you think the following media will be for the interaction of the audience with the channels?

	Sin importancia	De poca importancia	Moderadamente importante	Importante	Muy importante
Traditional media such as calls, letters, emails.	☐	☐	☐	☐	☐
Social networks.	☐	☐	☐	☐	☐

Internet
platforms of
the channels.

☐☐☐☐☐

Digital
terrestrial
television
(with IP
return
channels).

☐☐☐☐☐

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SIGUIENTE

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10. How much do you agree on the following statements about the characteristics of the content published by the television channels on social networks?

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
It will be short-lived content.	☐	☐	☐	☐	☐
It will be content of a similar duration to the traditional TV content.	☐	☐	☐	☐	☐
It will be fragments of content that had high rating in the other platforms.	☐	☐	☐	☐	☐
It will be a copy of the content produced and broadcast on traditional tv.	☐	☐	☐	☐	☐
It will involve independent content to the content transmitted by traditional media.	☐	☐	☐	☐	☐

It will be
focused only
on the
millennial
audience.

☐☐☐☐☐

It will be
focused on the
same audience
of traditional
media.

☐☐☐☐☐

It will
"uploaded"
with high
technical
qualities (HD
and UHD).

☐☐☐☐☐

It will
"uploaded"
with low
technical
qualities (lower
than HD).

☐☐☐☐☐

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SIGUIENTE

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11. How much do you agree with each of the following possible scenarios of television channels in the future?

1. The television channels will have a multiplatform television structure, transmitting content over traditional media (DTT, Cable, satellite) and over their internet platforms (proprietary OTT platform, apps and social networks). All transmission media will be given the same priority.

Total
disagreement

Disagreement

Neither agree
nor disagree

In agreement

Totally agree

You are:

☐☐☐☐☐

2. Same scenario 1, but giving higher priority to transmission over the internet (proprietary OTT platform, apps and social networks).

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

3. Same scenario 1, but giving higher priority to transmission over traditional media (DTT, Cable and satellite).

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

4. The television channels will transmit their content over their traditional media (DTT, Cable and satellite) and sell or offer their pre-recorded content (series, reality shows, novels) through the international VoD platforms owned by third parties or large platforms created by the association of several channels.

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

5. The television channels will be completely moved to different internet platforms (OTT proprietary platform, apps and social networks) transmitting their streaming content there and offering their VoD content and they will also cease transmission through traditional media (DTT, Cable, satellite).

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

6. The television channels will cease all types of transmission and will clearly become content producers for the large VoD platforms.

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

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12. How much you agree with the following statements about professional roles within the channels?

The number of production personnel in studios will be considerably reduced due to the automation systems (cameras, intake, lights, etc.)

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

The number of production personnel will increase due to the increased complexity of UHD content production.

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

The amount of outsourcing and remote work in post-production will increase due to the increase of bandwidths and cloud systems that will allow workers to work on the material from outside the channel.

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

In the generation of informative content, journalists will manage a greater technical knowledge necessary for the use of recording, transmission and / or editing equipment.

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

Live events-type programs (soccer games, concerts, races) will require a greater number of personnel for their production.

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

Programs that do not require live consumption (series, novels, documentaries) will require a smaller number of people for its production.

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

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SIGUIENTE



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13. How much do you agree with the following statements about the interactivity of the audience?

The audience will not want to interact with the contents, you will see them as a source of passive entertainment.

Total disagreement Disagreement Neither agree nor disagree In agreement Totally agree

You are:

☐☐☐☐☐

The audience will want, in general terms, to interact with the contents, either qualifying them, commenting on them, sharing them, or participating in the production of them.

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

The audience will have an influence on the production and / or transmission of content, choosing the course that some live productions take and / or pre-recorded.

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

The content generated by the audience (mainly in social networks) will have an increasing participation in the productions of the television channels.

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

The interactivity that the audience has with the channels should be limited in technological terms, to protect their privacy.

	Total disagreement	Disagreement	Neither agree nor disagree	In agreement	Totally agree
You are:	☐	☐	☐	☐	☐

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14. How probable do you think the participation and use of the following technologies or improved technologies will be in the future of television?

	Very improbable	Improbable	As improbable as probable	Probable	Very probable
3D television.	☐	☐	☐	☐	☐
360 degree video content.	☐	☐	☐	☐	☐
Augmented reality.	☐	☐	☐	☐	☐
Virtual reality.	☐	☐	☐	☐	☐
Use of video projectors, instead of screens.	☐	☐	☐	☐	☐
Audio systems superior to stereo like 5: 1	☐	☐	☐	☐	☐

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