Advances in Intelligent Systems and Computing 571

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Recent Advances in Information Systems and Technologies

Volume 3

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Recent Advances in Information Systems and Technologies

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Preface

This book contains a selection of papers accepted for presentation and discussion at The 2017 World Conference on Information Systems and Technologies (WorldCIST'17). This conference had the support of the IEEE Systems, Man, and Cybernetics Society, AISTI (Iberian Association for Information Systems and Technologies/Associação Ibérica de Sistemas e Tecnologias de Informação), ISCAP (School of Accounting and Administration of Porto/Instituto Superior de Contabilidade e Administração do Porto), and GIIM (Global Institute for IT Management). It took place at Porto Santo Island, Madeira, Portugal, during April 11–13, 2017.

The World Conference on Information Systems and Technologies (WorldCIST) is a global forum for researchers and practitioners to present and discuss recent results and innovations, current trends, professional experiences, and challenges of modern information systems and technologies research, technological development, and applications. One of its main aims is to strengthen the drive towards a holistic symbiosis between academy, society and industry. WorldCIST'17 built on the successes of WorldCIST'13, held at Olhão, Algarve, Portugal; WorldCIST'14 held at Funchal, Madeira, Portugal; WorldCIST'15 held at São Miguel, Azores, Portugal; and WorldCIST'16 which took place at Recife, Pernambuco, Brazil.

The Program Committee of WorldCIST'17 was comprised of a multidisciplinary group of experts and those who are intimately concerned with information systems and technologies. They have had the responsibility for evaluating, in a 'blind review' process, the papers received for each of the main themes proposed for the conference: (A) Information and Knowledge Management; (B) Organizational Models and Information Systems; (C) Software and Systems Modeling; (D) Software Systems, Architectures, Applications and Tools; (E) Multimedia Systems and Applications; (F) Computer Networks, Mobility and Pervasive Systems; (G) Intelligent and Decision Support Systems; (H) Big Data Analytics and Applications; (I) Human-Computer Interaction; (J) Ethics, Computers & Security; (K) Health Informatics; (L) Information Technologies in Education; (M) Information Technologies in Radiocommunications.

WorldCIST'17 also included workshop sessions taking place in parallel with the conference ones. Workshop sessions covered themes such as: (i) Managing Audiovisual Mass Media (governance, funding, and innovation) and Mobile Journalism, (ii) Intelligent and Collaborative Decision Support Systems for Improving Manufacturing Processes, (iii) Educational and Serious Games, (iv) Emerging Trends and Challenges in Business Process Management, (v) Social Media World Sensors, (vi) Information Systems and Technologies Adoption, (vii) Technologies in the Workplace - Use and Impact on Workers, (viii) Healthcare Information Systems Interoperability, Security and Efficiency, (ix) New Pedagogical Approaches with Technologies, (x) ICT solutions with Unmanned Aircraft Vehicles, (xi) Internet of Things for Health, (xii) Pervasive Information Systems.

WorldCIST'17 received about 400 contributions from 51 countries around the world. The papers accepted for presentation and discussion at the Conference are published by Springer (this book) and by AISTI (one issue in the Journal of Information Systems Engineering & Management) and will be submitted for indexing by ISI, EI-Compendex, Scopus, DBLP and/or Google Scholar, among others. Extended versions of selected best papers will be published in relevant journals, mainly SCI/SSCI and Scopus indexed journals.

We acknowledge all that contributed to the staging of WorldCIST17 (authors, committees, workshop organizers, and sponsors). We deeply appreciate their involvement and support that was crucial for the success of WorldCIST'17.

Porto Santo Island
April 2017

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Contents

Managing Audiovisual Mass Media (Governance, Funding and Innovation) and Mobile Journalism

Immersive Journalism Through Mobile Devices: How Virtual Reality Apps Are Changing News Consumption

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Abstract. Interactive nonfiction offers new narrative possibilities for journalism in a hybrid and developing context. Through mobile devices, in the new media ecosystem, virtual reality takes shape. Immersive journalism grows through these experiences looking for the user's engagement during the consumption of information. International reference media have recently started the exploration of virtual reality, as it is shown in this article, through mobile apps of virtual reality.

Keywords: Virtual reality · Interactive nonfiction · Digital narratives · Immersion · Cyberjournalism

1 Introduction

In the current context characterized by cultural convergence [9, 12], the Internet turns out to be a great medium where other previous media coincide. From imitation in the first stage, formats have evolved adopting their own characteristics to constitute the media ecosystem [2]. The deep transformations have led to the establishment of a net society [4] which defines new behaviours and habits in the consumer. The transmedia [11, 21] also mark a new relation between content, author and user, opening new ways for narrative expansion.

The penetration of mobile devices gives rise to a permanently connected society through a complex, but at the same time affordable, technological equipment. The evolution of cyberjournalism has been boosted by the mobiles [3, 27], as well as by innovation in digital narrative proposals. From the appearance of media in the net, interactivity has been the most singular characteristic and the one which presents a wider potential. In this article, the application of virtual reality in the news ambit is explored, studying the applications which the media offer for these new experiences through mobile devices.

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2 Theoretical Framework

With the objective of knowing the context in which the virtual reality initiatives are developed in the media, it is precise to start from a concept of interactive nonfiction applied to cyberjournalism, as well as to considerate the principal references in terms of virtual reality applied to communication. Beyond the fact that it is a technological question, narrative innovation represents an advance in the user's immersion.

2.1 Interactive Nonfiction

Taking into account the development of digital narratives as an ambit of great hybridization, an estimate differentiation between fiction and nonfiction can be established. Interactive nonfiction can be defined as a macro genre [10] of the forms of the real broadcast through the digital media with the intention of transmitting a truthful knowledge and image with the user's active participation.

Among the forms of interactive nonfiction, interactive documentary and multimedia feature can be found. The former has a wide development in its current stage of diversification, as well as a notable presence of the webdoc format has been identified in the cybermedia in the last years [25]. It has also been subject of study from the new factors which describe journalism in its current redefinition [24], taking into account the user's centrality, experimentation and collaboration.

Innovation is a challenge for the media, which in some cases is tackled through laboratories, a growing tendency [20]. Among their lines of proceeding, the new narrative proposals is one of the fields with a higher exploration. The adaptation of the feature to cyberjournalism [13] allows the display of hypertext and multimedia in the media, as well as interactivity although it shows a minor development [26].

With the arrival of transmedia narratives to journalism and the users' contribution, the new concept of transmedia journalism is presented [17]. The development of interactive narratives which imply the user introduces immersive journalism [5, 7], with strong properties for the enrichment of the news offer, the user's experience and social change, due to the commitment it requires. Due to the relation between fiction and gamification, virtual reality or immersion, interactive nonfiction is presented as a global concept given the hybridization of formats. It gathers different productions based on the reality for the digital medium and with interactive nature.

2.2 Virtual Reality

Lev Manovich introduces the idea that "software is the message" [14] overcoming the conception of medium as message. According to the author, the software is the principal medium in the current times and he is based on cultural creation from the computers to defend his idea. The virtual reality is another result of the computing evolution and software plays a fundamental role both in the production and in the diffusion or the consumption of experiences. Likewise, virtual reality is constituted as a medium of narrative construction and communication [19, 23], apart from the technological and device conception.

Ryan [18] considers narration a virtual reality and defines the different degrees of immersion according to the states of the human being. Thus, she defines virtual reality as an immersive and interactive experience where the users are placed in a space through their body and devices such as HMD or head-mounted display.

With the objective of overcoming the technological conception, Steuer defines virtual reality in terms of presence and telepresence: "presence refers to the natural perception of an environment, and telepresence refers to the mediated perception of an environment" [23]. Consequently, he proposes a definition of virtual reality without reference to hardware: "A virtual reality is defined as a real or simulated environment in which a perceiver experiences telepresence" [23]. Regarding characterization, several authors have carried out proposals. Sherman & Craig [22] identify four elements which make up virtual reality and which are synthetized below:

1. Virtual world: an imaginary space or the description of a collection of objects in a space and the rules and relationships among them.
2. Immersion: sensation of being in an environment; physical immersion is a defining feature of virtual reality; mental immersion is the aim of most media creators.
3. Sensory feedback: response of the system based on the user's physical position; in the majority of the cases it is of a visual type, exclusively in environments of virtual reality, it is of a haptic type.
4. Interactivity: the response to the user's action; it can be the capacity to affect the virtual world or to change the point of view inside the world, for instance, with the movement of the head.

Rubio-Tamayo and Gértrudix [19] integrated in the proposal of the continuum virtuality-reality the concepts of embedded and emergent narrative [15] which provide a vision of narrative within the framework of virtual productions. Embedded narrative is explicit and it corresponds with the idea of script, whereas emergent narrative comes from the user's interaction with the environment.

From the perspective of immersive journalism, De la Peña *et al.* [5] define three elements which the system of virtual reality offers. Firstly, PI or place illusion corresponds with the illusion of being present in the virtual environment. Psi or plausibility is the grade of credibility of the represented event. Finally, the virtual body allows the transformation of the person's sensations linked to the image of their own body created in the virtual world.

2.3 Immersion

Immersion as a quality of cyberjournalism finds in virtual reality an adequate medium for its development [5, 16]. Notwithstanding, the lack of specific professional profiles and the technological challenge made its arrival difficult [7]. It is a question of implying the user in a high degree in the represented reality. Gamification through newsgames also comes into play [1, 8], for its capacity of engagement. In this field, Bogost *et al.* [1] define procedural rhetoric as the application of computing mediated processes with persuasive purposes. This idea is also applicable to news and interactive products–like

virtual reality– which seek a greater user's immersion in an environment programmed to interaction and discovery.

Domínguez [7] defines immersive journalism as a narrative form which tries to find immersion with narrative and visual techniques which promote the user's active role. Among the characteristics described by the author, graphic realism and the importance of an interface can be highlighted. The user's movement, action and personification are also emphasized in the constitution of an immersive rhetoric [6] of application in journalism. In the virtual reality production, the technical and narrative development facilitates the display of these characteristics, as it also occurs in interactive documentary.

Within this context, the Immersive Journalism Lab was born in 2016 in Spain by The App Date to gather media, professionals and entities, such as Google News Lab. It is focused on the presentation, formation and production of immersive news proposals, like *Urban bekeeping* and *Campo urbano, ciudad rural*, both of them available in the VReak platform.

The sensorial perception, in the case of virtual reality, is reinforced by the presence experience through a virtual body and the use of devices such as HMD. The popularization of these initiatives is due to the wide expansion of mobile devices and the affordability of equipment like the Google Cardboard.

3 Methodology

The development of mobile apps of virtual reality in the context of the media is a recent practice which invites the analysis of immersion in the news products. The popularization of mobile devices and the convergence of the journalistic activity with new narrative proposals define the subject of study confronted in the following objectives:

1. To explore immersion through mobile apps of virtual reality in the media.
2. To analyze the development of three reference cases in the international media.

The possibility of elaborating a classification of the fundamental characteristics of mobile apps of virtual reality as platforms for the diffusion of news content is contemplated. The case study is the technique applied to the sample made up of three applications with contents published in 2016, as a result of a global exploration. The selected applications (Table 1) are: *6x9* – The Guardian (United Kingdom), *El País VR* – El País (Spain) and *NYT VR* – The New York Times (United States).

Table 1. Selection of the analyzed productions.

App	Medium	Production	Release
6x9	The Guardian	*6x9*	04/2016
El País VR	El País	*Fukushima: vidas contaminadas*	05/2016
NYT VR	The New York Times	*The fight for Falluja*	08/2016

Source: prepared by the author.

With the purpose of knowing the construction of these innovative proposals in the mobile devices, a case study is implemented regarding diverse parameters (Table 2) of

production, distribution, narrative development and immersion. The analysis of the characterization of virtual reality proposed by reference authors in the field of communication [5, 22] is also incorporated. For this research, virtual reality glasses with an iPhone 6 connected and headphones have been used.

Table 2. Parameters of analysis of the virtual reality applications.

A. Production	A1. Identification
	A2. Medium
	A3. Release date
	A4. Last update
	A5. Team of production
	A6. Model of production
	A7. Acknowledgement
B. Distribution	B1. Platform
	B2. Acquisition of the app
	B3. Requirements and resources
	B4. Channeling of the users
C. Narrative development	C1. Topics
	C2. Synopsis
	C3. Integration of the VR in the news product
	C4. Narrative structure and order
	C5. Narrative dimension (Rubio-Tamayo, 2015)
D. Immersion	D1. Elements of the VR experience (Sherman & Craig, 2003)
	D2. Elements of the VR system (De la Peña *et al.*, 2010)
	D3. Spatial
	D4. Visual (point of view)
	D5. Sonorous
	D6. User's action-participation
	D7. User's role

Source: prepared by the author.

4 Results

The mobile apps of virtual reality productions in the selected media show a growing tendency in this type of proposals. The pioneer *NYT VR* was released in November 2015 and it already has a 2.0 version; subsequently, *6x9* and *El País VR* were published in April 2016 and, despite some minor corrections, they keep their initial version. The applications belong to the media, although in The New York Times' case, some examples are available through other applications such as *Within*. The works are an own production, with the collaboration of audiovisual production companies and studios specialized in the development of virtual reality. Thus, The Guardian worked with The Mill in the production of *6x9* and The New York Times with Koncept VR in *The fight for Falluja*.

The applications are presented in two models: product and repository. The latter case corresponds to *El País VR* and *NYT VR*, where some works which implement virtual reality can be accessed. The case of *6x9* is an application specifically developed for this production. The repository model allows the user to accede to the offer of the medium without carrying out a new download of the application, favoring the audience's loyalty. In this context, the app gets to work as an own medium and with a periodic update of its offer. The New York Times started in November 2016 *The Daily 360*, a section of 360º videos daily upgraded, with Samsung's technological support. The repository modality requires the download of each production, which is around 500 MB, a difficulty to the consumption in mobility. *NYT VR* allows the streaming viewing, but the net conditions can inconvenience the experience.

In connection with the platform of distribution, the three apps are available for iOS (App Store) and Android (Play Store), and are free. The apps of El País and The Guardian also show their compatibility with the devices Samsung Gear and Oculus Rift. With the purpose of allowing the experience without using further devices, like HMD, the three apps have the option of a conventional viewing in the mobile as well as the Cardboard mode. None of the applications has reviews in the iOS platform; nonetheless, some reference data can be obtained in Android (Table 3). In the three cases, the classification of content possesses the label PEGI 3 (Android) or of an over-12 age for consumption (iOS) due to the realism and the topics dealt with.

Table 3. Opinion and downloads in Android's Play Store.

App	Opinions	Average rating	Installations
NYT VR	952	3,9	100000–500000
6x9	193	4,4	10000–50000
El País VR	13	5	500–1000

Source: Android Play Store.

Although some of the applications work as repositories, the media try to funnel the audience towards these products. Apart from the strategy of El País, which is weak concerning this aspect, the most common is presenting and linking the virtual reality application from the web in the medium. The Guardian develops a specific web page to present its innovation in *6x9* and part of its content in text format, whereas El País has a full-length textual version where there is uniquely reference to virtual reality without using a direct link to the app. The New York Times does not offer the same feature in another format. This medium has a section about the production of virtual reality with a marketing approach –it is necessary to have into account that some of the works in this medium are sponsored by commercial brands–. With the purpose of facilitating the experience of those users which do not have a smartphone, El País and The Guardian alternately offer the content in a 360º video through YouTube. Hereunder, a revision of each case is presented.

6x9 is the first virtual reality application elaborated by The Guardian. The subject matter, of a social character, is focused on the experience of confinement in a prison cell. During its nine minutes, a linear route through several phases is carried out. The

user can initially explore a space to which progressively environmental sounds, testimonies and projected thoughts are added on the four walls that contain it. The image is completely synthetic; nonetheless, the sound has a documentary nature and comes from actual prisons. The users are the main characters of the represented event through an embedded narration, which is not affected by their action in the space.

Fukushima: vidas contaminadas is the first story of virtual reality in the Spanish journal El País. It contemplates the consequences of the nuclear disaster in the Japanese region from an environmental and social perspective. Thus, the principal problems of pollution and the fight of several citizens to stay in the place are presented. Being ten minutes long, a linear and embedded narration is constructed through a series of 360º videos both in external and internal spaces. In them, the users can freely observe from their central position and know the testimony that is generally situated on each scene. There is a narrator who strings the story together and who contextualizes the shots which are seen.

The fight for Falluja is a feature of The New York Times which discovers the armed conflict in Iraq in a first person perspective. Two journalists, represented in the scenes, get infiltrated in the Iraqi forces in the first city taken by Daesh. The user, through 360º videos and a narrator, explores the situation of the city and its people in this eleven-minute long experience. It is an embedded and linear narration, made up by two consecutive parts, which combines external and internal, static and in motion shots, although giving priority to surrounding action.

In order to elaborate a characterization based on the carried out analysis, De la Peña *et al.*'s [5] proposal is chosen. The elements of the virtual reality system proposed by the authors are inclusive and adequate to the ambit of application. Place illusion is defined by the construction of a virtual world based on the spatial, visual and sonorous dimension. Realism plays the lead in these experiences, through an actual image or CGI, and it seeks the user's greater rapprochement. This results in scenes shot in the war zone or in the protagonists' dwellings; the authenticity of the spaces is a hallmark for spatial immersion. The construction of the spaces is based on a 360º video, in the case of *The fight for Falluja* the action is continually developed through the camera –which is defined by the authors of this research as surrounding action–, generating expectation and forcing the user to recurrently explore. In this manner, the consumption is more active and requires greater commitment, in contrast to the proposal of El País, *Fukushima: vidas contaminadas*, which has more static shots. In some cases, motion shots are used, for example, over vehicles and ships. The montage is based on the consecution of long shots and in a linear mode, in a way that does not allow the user to change the order, the length of the story or decision-making. In *6x9* another dimension represents the thoughts projected on the walls of the cell, thanks to the fact that it is a production of synthetic image.

The sound also contributes significantly to the sensation of feeling oneself inside the represented reality. A surrounding sound and with voice-over is identified, as well as first person testimonies and a realistic environmental sound. It also includes music which accompanies and stresses some phases of the experience. Thanks to sound, it is possible to keep the users' attention and to attract it to what is happening in the scene and that they may be missing.

The grade of credibility of the event is supported by the authenticity of several elements in the representation of reality. In the studied cases, realism is high in the spatial, visual and sonorous dimension. The capture device is hidden, as The New York Times points out in its feature, to preserve the scene. The freedom of movement to explore the space, which apart from *6x9* has been captured in actual environments, supplies credibility and the sensation of living the events in first person. This sensation is especially clear in *The fight for Falluja*, where the users go with some journalists who address them, or *6x9*, where the user is the only main character.

The virtual presence in the created environment results, mainly, in a central position in the scene. Thus, through the movement of the head when using an HMD, it is possible to explore the surrounding space visually. Another sense boosted by these experiences is hearing, which means a significant leap in the immersion. The body does not have a visible representation in the virtual world and it cannot displace its position either; for this, the principal role of the users is that of an observer. Their actions do not have a narrative or navigational impact. Nonetheless, the virtualization of the body allows the users to be placed in a privileged position for their immersion in the reality.

Virtual reality presents some disadvantages like the possibility of motion sickness. The excessive attention required can make the experience difficult too, caused by a high intensity in the story, as it occurs in *The Fight for Falluja*. If subtitles are needed, the fact that these are moved with the sight helps the monitoring of the story, as it occurs in *Fukushima: vidas contaminadas*. With a view to the future, the interaction with objects of the virtual world or the possibility of movement in the space are questions that need to be tackled. Decision-making and the possibilities of the active user, as it appears in docugames, could also reach the virtual reality apps in the media.

5 Conclusions

Virtual reality appears in the media with certain significance in 2016. The development of specific mobile apps implies a wager for new narratives thought for mobile devices. The user's immersion exhibits a trend to growth in a path which was started with multimedia feature and interactive documentary.

1. There is a growing tendency for virtual reality development in cybermedia, which is reflected in the proliferation of apps: *NYT VR, 6x9, El País VR, Life VR, Discovery VR, Ryot, VReak*, etc. The production is made by the medium itself, with the support of specialized multimedia studios or technological companies.
2. There are two models of app: product and repository, working the latter as an autonomous platform for the diffusion of content. The virtual reality applications of the media are available for the main mobile operative systems (iOS and Android) and are free.
3. The channeling of the audience of the media towards apps is irregular: there are strategies which favor the user's experimentation, opposed to the absence of connections in other cases.

4. Two viewing modalities are offered: Cardboard, compatible with HMD, and 360º video, which allows viewing with the unique use of a mobile. The average length of the experience is ten minutes.
5. The 360º space is constructed with a real or synthetic but with a realistic character image. The camera has a central position in the scene and shows static shots, mainly, or in motion.
6. The sonorous dimension is one of the most immersive aspects. It is made up of a realistic environment, testimonies and, on occasions, voice-over. It completes the visual immersion and keeps the user attentive to its environment.
7. The surrounding action represents a higher degree of immersion in the virtual world. The events take place around the user's position and this one is obliged to explore and keep the attention to all directions.
8. Virtual reality is presented as linear and embedded narration. Narrators and characters appear in the virtual world and address the user, with no possibility of interacting with them.
9. The users' role is that of an observer in the represented reality, but although the elements are displayed around them and directed to them, the users do not have any type of control or decision-making.
10. The immersion is built based on the sensation of presence in the virtual world, the grade of credibility and the representation of the body through the interface and the devices. For that, audiovisual realism, the central location in the scene and the user's empathy play a fundamental role.

The media explore the application of virtual reality through mobile devices as another field of innovation; notwithstanding, they must face some difficulties in technical terms and discover the potential of interactivity. Interactive nonfiction also presents important challenges, among them the study of reception, in its consolidation as a genre within journalism.

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Crowdfunding: A Possible Complementary Funding Model for European Public Service Broadcasting

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Abstract. This communication reviews and analyses the current situation of the public service model for the main European broadcasters, which are having problems to resist in an increasingly competitive environment. Apart from this, they also have to deal with meeting the demands of the current context, characterised by the development of new technologies as well as the requirements of fragmented audiences, among multiple platforms. As a result, many of them are suffering from financial problems and have lost viewers, thus justifying their public funding is becoming more and more difficult. Taking into account the recommendations of the different European broadcasters, based on the implication and commitment from public counterparts, this paper proposes the use of crowdfunding as an alternative to more traditional ways of funding.

Keywords: European public service broadcasting · Crowdfunding · Funding · Audiences · New technologies

1 Introduction

"Well-funded and strong public service media goes hand in hand with signs of a healthy democracy" [1]. Despite this statement, included in one of the last studies conducted by The European Broadcasting Union (EBU), European public service broadcasters are experiencing a time of multiple challenges that hamper the maintenance of the proper values of a public service Independence, excellence, innovation or diversity are now difficult objectives, mainly due to political control, funding difficulties, the high degree of competitiveness, media convergence, decentralisation or the stringency levels of audiences in the digital era.

In Europe public television has a key role within the sector and it is one of the most funded public services by both state and regional governments. Its operation varies among the different states of the region. The different models of public television, concerning functions, internal organization, funding and control [2] in the European framework, stem from the diverse systems of regulation and the traditions from each country. However, there are a set of obligations that all the European public televisions must comply with and that define their mission. Universalizing the contents, establishing

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high quality standards, preserving and promoting culture and national heritage as well as contributing to political pluralism are among their main duties [3].

Since the loss of their monopoly in the 80s, European public service televisions have gone from being protected and enjoying a certain privileged position, to dealing with a more competitive market. Nowadays, apart from fulfilling the abovementioned obligations, they are compelled to confront the continuous technological changes that entail a proliferation of the supply of audio-visual contents and, thus, increasingly fragmented audiences. Added to this are the budget cuts the different public channels have undergone, mainly since the arrival of the economic crisis to the Old Continent.

1.1 Main Political, Economic, Technological and Sociocultural Factors Affecting the Structure of European Public Television

The introduction of private channels in the audio-visual sector has given rise to the current European television market: in every country there are one or two public channels broadcasting at a national level, multiple private channels with leadership vocation, a number of channels with specialized content addressed to the different market niches and several regional and local channels. According to data provided by the European Audio-visual Observatory, in December 2015 Europe (the 28 countries of the European Union, Albania, Bosnia Herzegovina, Swiss, Iceland, Liechtenstein, Montenegro, Norwegian, the former Yugoslav Republic of Macedonia and Turkey) had a total of 9068 television channels and 400 of them were of public service [4]. These data provide us a faithful reflection of the level of current competitiveness within the European audio-visual sector.

Globalization, a phenomenon that determines the reconfiguration of the spaces for communication and digitalization, a basic requirement for technological and media convergence, have been the other key political-economic factors that have affected the restructuration of the European public television in the last decades.

The arrival of digital technologies and the phase of global spread in which we are immersed have led to a new paradigm of media convergence which Jenkins defines as "the flow of content through multiple media platforms, the cooperation between multiple media industries, and the migratory behaviour of media audiences who will go almost anywhere in search of entertainment" [5]. In this new ecosystem proposed by Jenkins, mainly based on more contents and a greater possibility of interaction on the consumer's side, who is the most benefited from the technological development of the 21st century. Nevertheless, the increase in the supply has favoured the standardization of contents and disfavoured their quality [6]. As a result, turning to public television, there has been a stagnation in consumption and a gradual loss of audiences, especially, among youngsters [7].

Finally, the great sociocultural change has also affected the European public television. Both the Internet and digitalization have meant a transformation of the old communication practices into participative practices the consumer's side. Technological convergence gives more power to a user who is no longer a passive recipient of a final product and has turned into an active consumer, taking direct part in the development of projects.

The total of the factors of change and development noted in this section turns television into a subject of discussion. The most contested feature is the funding method. In the following section, an overview of the funding model for the European public service media is provided.

1.2 Sources of Funding of the European Public Television and Budgetary Constraints

The income of the different European public televisions come essentially from four funding sources. The main funding channel is a direct tax, called television licence fee, paid by the owners of television sets. The rest of the income comes from advertising, public grants from government budgets or the sale of broadcasting rights in the international market, the latter happening only in exceptional cases.

The models of funding vary a lot between one market and the other. Public funding has been the main source of income for 23 markets. Those countries in Western Europe, such as Spain, the Netherlands or Luxembourg, are among the states in which this is the most common funding channel. This is also the case of the Baltic Region and Eastern Europe, where there is no tradition of paying the television licence fee. On the other hand, the television licence fee has been the most important source of funding in a total of 20 countries, among which four of the five main countries, France, Italy, Germany and the UK, are the most noteworthy [8]. The rates of the European television license fee in these countries in 2014 were 215.8 euros in Germany, 179.4 in the UK, 133 euros in France and 113,5 in Italy [7].

The evolution of the income obtained from the payment of this fee has been favourable in the last years, despite being removed in some countries such as Finland, Serbia and Israel. In 2014 public media obtained 66% of their funding by this channel, which means an increase of 3.5% since 2010. The second most important source of income has been public funding, representing 11.1% of the total funding. The income European public televisions obtained from advertising in 2014 was 10.2%. If we add 8.4% coming from other type of commercial revenues to this figure, it means 19% of the budget. In general terms these figures have progressively decreased until last registered fiscal year (2014) in which they have shown some recovery [8].

The reports issued by The European Broadcasting Union (EBU) we consulted for this research provided the abovementioned data and pinpoint that advertising will not be considered a strategic funding channel. Regarding this issue, European public televisions require to be informed on the way forward. If the decision is to go ahead with advertising, as it happens in public channels, they required to reduce the restrictions that constrict it from the normative point of view. Conversely, there is clear preference for keeping the contributions of public funding, but they want it to come from multiannual budgets that protect the independence of political power and, above all, they opt for the model of the licence fee, after modernizing it and expanding it to new devices and services. These two funding channels are considered instrumental to the sustainability of European public televisions. Nonetheless, as we will describe below, they have suffered cuts in the last analysed financial years.

European public service media (PSM) are the fourth broadcasting market within the audio-visual framework in the region. The total level of funding of the PSM according to The European Broadcasting Union (EBU) was 34.538 million euros in 2014. This represents an overall increase of 2.5% over the figures for last year and 1.8% over those for 2010. However, if the effects of inflation are taken into account, we can see that the total funding of the PSM has decreased by 5.7% over the last five years. This decrease is even more marked in the countries of the European Union, being 6.1% [8].

In general terms, major public broadcasters had zero growth between 2008 and 2014. In Spain and Italy there has been a decrease in funding of 48% and 14% between 2008 and 2014. This drop has also occurred in other countries such as Czech Republic, Portugal, Poland, Bulgaria, Ireland, Croatia, Lithuania, Slovenia, Estonia and Cyprus [4].

In order to solve this situation, a study conducted by The European Broadcasting Union (EBU), entitles Vision 2020, lists recommendations that would help to improve the situation of public service media. Some or the more noteworthy are the following: "Better understand your audiences" in order to design a more personalized programming, "increase engagement and diversity" so that there is a greater involvement by part of the audience, "be the most relevant and trusted source of information", "accelerate innovation and development" by adapting infrastructures and services to the technological development, "maintain universal coverage" and "fulfil as a public service" [9]. As we can see, part of them are related with a technological development that requires innovation and engagement of the audiences.

1.3 Changes in the Form of Consumption and Audience Measuring Systems

Television, from a consumption point of view, is still one of the most important mass media. The television consumption time in 2015 in Europe was a daily average of 3 h and 55 min, one minute less in comparison with the previous year. Linear television is still prevalent (95%) and deferred television has increased (5%). 86% of Europeans watch television every week and 60% of them watch public channels. Among the young people, 76% watch television and 43% watch public channels. In 2015 the average audience share of public television was 21% and 13% among young people [10].

The above mentioned countries which have suffered decreases in budget also present a negative evolution of the audience measurement of the public television over 2009–2015. For example, France shows a negative share of −115.6%, Portugal −63.4%, Spain −50.8% and Italy −9.4% among others. On the contrary, there are other countries, such as Belgium, Sweden or Denmark that present a positive evolution of 29.6%, 8.3% and 6.9%, respectively [4].

If we consult the European public television websites, we can observe an increase of the use of social networks by the main channels, both as marketing and communication tools and as institutional structures for developing new narratives. The most used social networks are Facebook and Twitter. Their popularity makes them the tools with the highest accessibility to consumers. YouTube, to present part of the television content on the web, and LinkedIn, as a cover letter of the company, are next in the popularity ranking.

The public television group with more followers in Facebook is the French television TV5 Monde, with more than 2.5 million followers, and even if it is not the French public channel with the highest ratings, their social networks are very active [11]. Regarding Twitter, RTVE is the most followed company with a million followers [12]. To a lesser extent, more recent social networks such as Snapchat or Periscope are gradually making inroads into the management of the public media networks. Therefore, Periscope is linked to news programmes whilst Snapchat is usually a resource to experiment with different ways of storytelling. Thus, their profiles are normally tied to innovation laboratories, such as the German group ZDF [13]. The use of these tools has double benefit, they can approach viewers and create new formats and innovative genres adapted to the digital ecosystem.

It is important that public service media plan Social Media strategies, mainly because young people aged 18 to 24 years use more these tools as a source of information than traditional media 44% uses Facebook as the main source of information, 19% uses YouTube, and 10% Twitter and Snapchat [14].

In the following section, we will take into account the data analysed in this section and will present a brief theoretical overview of the new funding strategy known as crowdfunding and, finally we will design a proposal for collecting funds for broadcasters among citizens based on this strategy.

2 Crowdfunding as an Alternative or Complementary Funding Channel to Traditional Sources

Currently, media are living a hybrid period in which, despite the resistance to confront the stagnation of the more classical business, new trends based on the potentialities of the Internet and directly associated with new consumption patterns. One of the most noteworthy is the emergence of the collective funding system known as crowdfunding. This term was coined by Jeff Howe on the Wired magazine in 2008 [15].

This phenomenon has experienced a marked growth in the last few years thanks to technological development and the emergence of social networks, which are also beginning to be a key tool to connect with viewers for public televisions. In the same way, the economic crisis and the "participatory culture" [5] fostered by the web have contributed to the growing interests generated by this practice. Concerning this last trend, Jenkins [16] states that it is developing taking into account all these points: the possibilities new technologies offer to consumers (file, comment, appropriate and put contents into circulation again), the promotion within the media production of "do it yourself" by specific subcultures through the use of these new technologies as well as the flow of pictures, ideas and narratives made by media conglomerates through multiple channels, which requires a much more active viewer.

Since the creation of the concept of crowdfunding at the end of the last decade, researchers, academics, institutions and strategy advisors have proposed a number of definitions for this term. In the following lines we present some of the most important for this study.

Belleflamme, Lambert & Schwienbacher state that "The concept of crowdfunding can be seen as part of the broader concept of crowdsourcing, which refers to using the 'crowd' to obtain ideas, feedback and solutions in order to develop corporate activities" [17]. In their definition this authors reflect how the creators of crowdfunding campaigns can obtain multiple advantages by using this strategy, in addition to funding. The direct contact between the creator and the user in order to interchange ideas is one of them.

Gutierrez-Rubí & Freire propose the following definition: "Crowdfunding is one more expression of the change of mentality and the model of business and social development that incorporates the logic of intelligent multitudes (crowdsourcing). Collective funding answers to an alternative model of funding as well as to a different role of the consumer or final user, who becomes a social investor from the beginning" [18]. This idea highlights the importance the role of the consumer has acquired in this system. Consumers are immerse in a new ecosystem in which the different business sectors have understood the importance of getting them actively involved.

On the other hand, the Spanish Association for Crowdfunding, as the main promoter entity of the formula in Spain, states this strategy is used "to finance efforts and initiative from other people or all kind of non-profit organizations, both private and public. This sort of funding can be used for many purposes" [19]. Therefore, any initiative, independently of its nature, can use this funding strategy even if it has to adapt to one of the modalities proposed by this funding tool, which we describe in the following section.

2.1 Different Modalities of Crowdfunding Depending on the Revenue for Patrons

The difficulty of classifying the different models within this system is related to the great diversity of projects and initiatives which a crowdfunding campaign can cover. However, the most part of the researchers studying this strategy agree on the fact that there are three different typologies directly related to the revenue the patrons obtain in exchange for their contributions.

- Equity crowdfunding: this modality is mainly addressed to start-ups. Even if it has been one of the less explored since its emergence, it is gaining importance despite the development of a regulatory framework within the legislatures in the different countries in which this formula is more settled. Taking into account that in this modality the revenue of the contributions is sharing the benefits, legislation is being enacted that favours two pillars of crowdfunding. On the one hand, the access to capital for entrepreneurs is being fostered and, on the other hand, the investor is being protected against potential frauds.
- Donation crowdfunding: in this modality there is not a financial compensation for patrons. It is the oldest type since it comprises the traditional donations and solidarity projects. In this type of crowdfunding for NGOs the value of the patrons' participation lies in the satisfaction of knowing they are contributing to a good cause.
- Rewards crowdfunding: this type is addressed to all those projects in which there is a private investment performed through the network, normally with a creative or artistic nature, in exchange for rewards and exclusive experiences for the patron.

2.2 Different Modalities of Crowdfunding Depending on the Management

Following the management approach, there are two possibilities for the creator of a crowdfunding campaign:

- Directly through a website which has been exclusively designed for the project. In this case the creator of the campaign designs its own platform and establishes the operating rules. There a cases of success related to different creative sectors. One of the most recent examples is the digital media El Español. This project closed its campaign on February 2015 after exceeding all expectations by gathering more than 3.5 million euros.
- Through specialized platforms, that can be divided into those specialised in a specific field related to the different creative sectors and generalist platforms that admit any project, independently of its nature or ideology.

There are examples of projects that have turn to both modalities proving that they are not incompatible. The decision for one or the other way lies in analysing their advantages and disadvantages.

3 Proposal to Use Crowdfunding as a Funding Channel for Public Service Broadcasters

Collective funding has become the only way in which numerous projects have been able to come to light in the last years. This has been possible thanks to the impulse of a vast number of entrepreneurs which have managed to raise funds through the 1.250 active crowdfunding platforms existing in the world [20]. Among them, there are web models that impulse projects with a free and/or open nature in a collaborative way, namely the so-called "crowdfunding the commons", which allow to share or reuse the results of a project [21].

Likewise, this sort of portals represents an alternative or a supplement to public administration or private enterprise funding; reactivating the co-responsible role of civil society [22]. On the other hand, in addition to individual rewards, it offers the possibility of generating collective returns.

If we consider these platforms and their methodology based on their ability to manage fund raising, we present hereby an experimental proposal of an alternative funding model to those already existing for public service broadcasters in the European context. In order to design it, we have taken into consideration proposals presented by other academics in similar contexts, such as Cagé [23] or, more recently, Italian authors Bonini & Pais [24].

First of all, it should be clarified that the proposal is intended to be implemented in countries where public service broadcasters are funded through a license fee. In we obtained successful results, it could be extended to other markets in order to substitute other funding channels such as state subsidies which, as we have mentioned above, are becoming increasingly lower.

The first step would be designing an ad hoc platform for each of the public channels managed by crowdfunding experts and installing it in every web of these operators.

The information contained in this platform must be complete, clear, transparent and accessible to every web user. This way, it would fulfil the basic principles of strategy as well as of public service. Basically, it will be related to the total funding the channel needs. Therefore, this information will become, in crowdfunding terms, the economic objective this media needs to work as a public service broadcaster.

Depending on the country and its license fee, there will be on the one hand a fixed amount that all contributors will have to pay but that will be different depending on the market. For example, in the UK the fee will be higher than in Portugal or Italy, since in these countries the license fee is lower. There will also be a standard programming selected by the channel programmers. On the other hand, a variable fee that will increase the fixed amount between 5% and 30%, depending on the contributions, will be established. Apart from this, a set of programmes will be created, designed by a committee of experts in the field of public media. They will be funded with the abovementioned percentages if viewers decide so.

In order to establish these fees, a reward system will be designed based on several levels that will range from 5 euros, the lowest level, to 30 euros, the higher level, e.g. in those markets with the highest license fees. This will be performed differently in every country depending on the required fee for the complete funding of the media. There will be a 10-euro gap between each level except from the last level in which the increase will be of 5 euros. The reward will depend on the chosen amount and will proportionally improve.

Once the number of contributors increases, a virtual community will be created. The channel, using an appropriate communication strategy through social media, will try to increase the number of participants and therefore the funding.

Therefore, in exchange for 5 euros patrons will be mentioned on the channel's social media. They will have access to photos and updates from the program they chose to finance. In exchange for 15 euros they will receive privileged information about the contents of the community-funded programmes, as well as weekly drawings in order to get to talk on the phone with a host or a programme's guest.

Statistically speaking, the 25-euro reward is the most common in the platforms specialized in this strategy. Therefore, it is important to design an attractive reward that, in this case, will be based on obtaining the rewards from the first and the second levels. Apart from this, it will also grant the right to take part in decisions related to some aspects of the programme that will be discussed between all the members of the community who have contributed this same amount. They will also participate in a monthly drawing for the possibility of taking part face-to-face in some of the task of the programme. Finally, in exchange for the 30-euro contribution, patrons will be granted the right to obtain the rewards corresponding to the two first levels and they will also take part in a drawing for having a private meeting with the guest of the programme of their choice.

Therefore, the fixed fee will allow to have a standard programming, compulsorily funded and a variable programming that will fund those programmes the community of patrons decide.

4 Conclusions

The current situation of public service media is being difficult for almost all the European Markets. A review of the audio-visual legal framework of the different countries, as it is the case of Spain, should stabilize the funding system by opening new income channels.

This change in funding should keep the mixed funding model and consider new alternatives, such as the pay-per-download, mainly due to the bad results over the last years. The budgets of the European public service broadcasters were stagnated between 2008 and 2014 and only grew 2% in the fiscal year 2013–2014, owing to the budget cuts that stemmed from the economic crisis in 10 countries. The televisions of the northern European countries are those withstanding this situation, since they have not suffered the same financial problems and they are still ratings leaders.

The most stable corporations include in their new multiannual strategic plans the idea that innovation is the key to renovation. Moreover, they propose to open up more to society, more transparency, accountability as well as better communicating the social profitability of the public service through new narratives and the use of social networks.

Taking into account all these considerations, a new proposal of crowdfunding is presented as a complementary funding model to the existing channels, precisely because it is based in the same values of collaboration and transparency. Its approach is basically addressed to those markets in which there exists a license fee by replacing it by a fixed fee that would ensure the funding of the standard programming of the channel and a variable fee with different levels of contributions. In exchange for these contributions, and depending on their moral values, those citizens taking part would obtain rewards such as being directly involved in proposing programmes and taking content decisions to increase the quality of this public service. This would allow to obtain a collective revenue.

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Consumption of Audiovisual Media Among High School Students of Ecuador

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Abstract. The research aims to determine the preferences of consumption of audiovisual media and trends of use of Internet by teenager high school students of Ecuador in 2015, in order to do it, qualitative and quantitative methodology is employed through a survey to students from public and private high schools of Ecuador as well as interviews with experts in digital content production, teachers and parents as well as focus groups. Internet and social media are information and entertainment alternatives, according to the parents the network is used in homework. Young people use the open signal and paid television, their consumption is in relationship to the digital possibilities associated with Internet and it provokes changes in households but they can't stop recognizing and demanding local content that meet their needs.

Keywords: Media consumption · Television · Radio · Young viewers · Internet

1 Introduction

Since the beginning, the researches in the field of communication focused on the critical analysis of the media but reduced importance to the audiences. By the end of the eighties of the XX century, the reception work intensified and changed the concept of "passive receptors" for "critical or active viewers". Lozano [1] says that at the end of 1980 researches about media reception with emphasis on the relationship between television, communication and audience proliferate, these studies are based on the premise that viewers are active subjects in the communicative process, able to give meaning and use media and television programming from their individual perception of reality.

David Morley [2], specialist in the analysis of the reception and audience from the view point of the viewer and its environment says that "the messages that we receive from the media do not find us isolated, because we all carry with us, at the time of receiving them, others speeches and other set of representations with which we are in contact in others spheres of the life". In those years, according to Alcocer [3] there highlight the works of Jesús Barbero (Spain), Guillermo Orozco (Mexico) and Néstor García Canclini (Argentina), which are articulated with cultural and qualitative studies of audiences and are the premise for the conceptualization of the active reception from a Latin American perspective.

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Martín-Barbero says that in the media, not only ideologies are reproduced, but also it makes and remakes the culture of the majorities. Barbero proposed to change the method of communication research focusing on the study of mediations and not of the medium as it used to be in earlier decades. For this theorist, mediations are "the place where the sense of communication is given" [4], he also postulated that such mediations have their origin in everyday family life, social temporality, and cultural competence.

Continuing with the perspective of Barbero, Cancliani and Orozco [5] developed research around the reception framed in the context of each of their countries. In Argentina Florence Saintout and Natalia Ferrante [6] talk about the new trends in the study of the reception. Those who in the 1980s worked specifically the issues of the public, today are building new research objects in which it is incorporated the communication approach not as linear information transmission, but from the social construction of meaning. On his side, Valerio Fuenzalida analyzed the influence that the television has on children. This allowed understanding the way of socializing of each family member and involving public and private institutions in the transformation of programming giving boost to children to be critical viewers.

Moving from the study of children to teenagers is a challenge that deserves to be assumed to reveal elements that prepare the media to new forms of consumption in environments of digital convergence.

Watching television, cinema, Internet and listening to music, among other activities, are the preferred by young people, however the ones that concentrate most of the time are the use of mobile phones, television and the Internet, this was revealed by an investigation conducted by Crespo [7] in Ecuador. According to Bautista [8] young people are easily seduced by attractive messages and contents that are found on the Internet and then in the media especially on television. Long time ago it was common to see teenagers watching television, but today the landscape has changed, attracted by the screen of the mobile phones or computers the teenagers "surf" through cyberspace. Why do social networks attract teenagers? It seems that the answer is in the need to interact with others; in the social network a group of people appoints members forming a great systemic family.

To learn more about the consumption of media by young people from Ecuador the Consejo de Regulación y Desarrollo de la Información y la Comunicación conducted a study about the "concerns and proposals from young people about Ecuadorian television". This was one of their conclusions: "the use of screens is not restricted to television as studies of previous years, in fact the studies indicate a trend of change in which television will not be the favorite screen for the youngest people in the coming years" [9].

It is becoming more common to see young people disconnected from reality and connected to the Internet. "This has become a natural tool for them in their day to day: they spend hours on social networks like Facebook, Twitter and Instagram, to stay online contact with friends and establish new relationships, share products and services, follow brands and find information and diverse content" [10].

There is a shift of television consumption towards Internet in Ecuador, aspect introduced by the Fundación Andina de Medios; Internet is the medium to which publics go to get informed, after the TV [11]. Internet is setting aside television as the favorite medium of youth.

The objective of research is: Determine the preferences of consumption of audiovisual media and trends of use of social media by teenagers, who are high school students of Ecuador in 2015. The hypothesis are: (1) young people consume television in open signal and paid television primarily to entertain. The consumptions of information, sports and educational programs are minimal. (2) The young students of high schools in Ecuador consume radio minimally and when they do it is through Internet. (3) Young people consume in a simultaneous way television in open and paid signal and Internet; and, (4) Young people tend to consume the media individually.

2 Methodology

The methodology used is qualitative and quantitative. On the quantitative side, a survey was conducted to students from the public and private schools from Ecuador of the following cities: Quito, Guayaquil, Cuenca, Alausí, Santo Domingo, Azogues, Puyo, Cariamanga, Tena, Chunchi, San Cristóbal, Loja and Zamora. A questionnaire was applied through the platform Survey Monkey. The population that was studied according to the projection of the Instituto Nacional de Estadísticas de Ecuador in 2015 was of 1.556.256 inhabitants. According to the statistical formula for finite populations with a 98% of confidence and a 2% margin of error, 7,542 surveys were conducted in 30 schools in the period September-November of 2015. Qualitative instruments correspond to an interview to three experts in producing content for digital media, three teachers from high schools and three parents, in addition two focus groups each composed with eight students aged 14 to 18 years of old of schools from Quito in Ecuador.

3 Results

The quantitative results are presented in the following eight graphs.

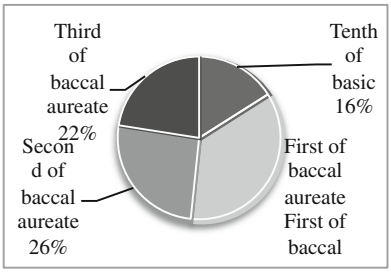

Fig. 1. Origin per academic year

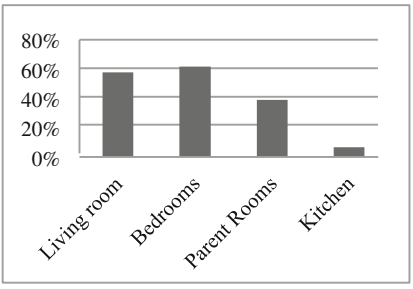

Fig. 2. Location of TVs at home

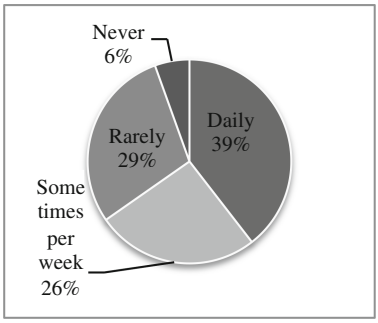

Fig. 3. When watch open signal TV

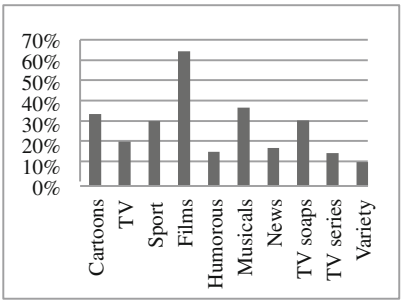

Fig. 4. Preferred programming on TV

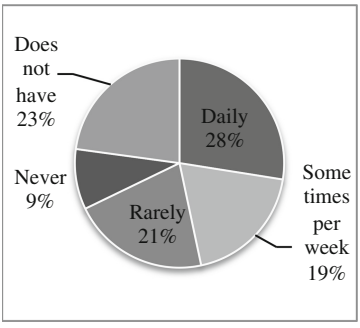

Fig. 5. When watch paid TV

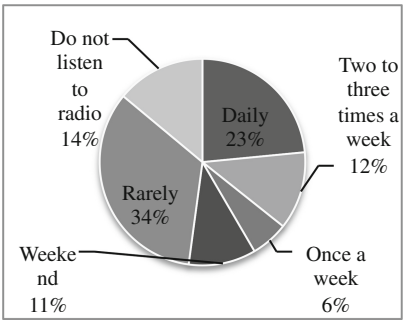

Fig. 6. Listen to the radio

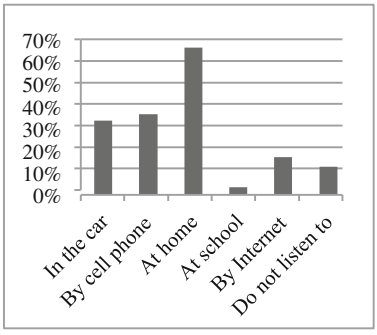

Fig. 7. Where does he/she listen to the radio

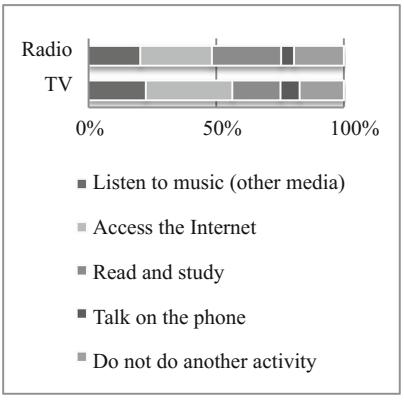

Fig. 8. Simultaneous consumption

In the interviews, parents point out that Internet and social media are information and entertainment alternatives, in their opinion the network is used with the schoolwork of their children, they know that they do searches on Google. Todays' young people is informed by the capsules that media emit by the networks, they do not expect long news,

they want concrete data. In what refers to music, young people download songs according to their likes and in this way have more diversity that in the open signal radios. Another element through which parents define the profile of their children is the frequent use of computers and mobile phones in homes and Internet cafes. In terms of preferences of traditional media parents point out that young people want to watch television without commercials or advertising and for this reason they rather cable television.

In the opinion of experts the social networks are not only for young people but for all people who want to interact with technology, for example in Facebook there are people of all ages, although the majority are between 18 and 35 years. Some time ago young people consumed magazines, television programs or music on the radio programs, today they are found online, in social networks like YouTube and Twitter. Experts say that there should be generated content dedicated to young people to get to them with the appropriate messages with large educational or informational content. In addition, experts say that the use of mobile phone is vital to the young due to they can do several things without moving from a site, for example they can be chatting with their friends, commenting on photos or videos as well as changing TV channel without getting up, all thanks to the Internet.

Experts also remind that television was created to inform and entertain, however it has been achieved to transmit a series of negative values that now seems to be reinforcing with social networks when people only see headlines and give likes or conveys an emotion only reading the headline but does not enter to the information, in the case of young people they are the ones who decide what they want to see.

Finally, the focal groups allow to know that the teenagers and young people from high schools from Ecuador:

- Consume open signal TV, primarily local channels, but also access to paid TV channels for the varied offer of content.
- The kinds of entertainment consumption are musical videos, horror movies, Internet series and videos on social networks.
- Some young people point out that social networks are very useful due to through them they communicate with family members who are outside of the country, moreover, the cost is low and communications are really good.
- Young people make use of Internet to download games, send and receive messages, keep updated with international news or celebrities, look up for information, researches or ask for tasks.
- The young people who do not have paid television replace those programs that they not can see by Internet.
- The educational program that they like the most is Educa TV from public television since they get to know there about innovative and scientific topics of great interest.
- The majority of young people do not consume radio because they have their own music and when they want to listen to it. Moreover, some young people listen to the radio via Internet for comfort.
- Young people express that they like to use the computer while watching TV, but mostly they use the phone, in addition, they have a schedule for the use of such equipment, for example they watch television at night, use the phone on the day, and in the morning they listen to music before going to high school.

- Both parents and young people have their favorite shows for that reason each one sees what they like on separate TVs.
- The young people watch movies through Internet or D.V.D.
- Finally the young people state that national programs should innovate because they are repetitive and that bores them.

4 Conclusions

Young high school students from Ecuador use the open signal and paid TV, and even there are two or more TVs in each home, however, television is losing space in front of Internet. The mobile phone is the screen that is capturing more the attention of young and Ecuadorian teenagers because it integrates services that other screens offer: Internet, video games and television. The use of the technology has become an educational need, since young students from high school need the technological media to make research, projects, school tasks and communicate with their educational and social environment. Due to the great amount of information existing in the means of communication youths and teenagers have powerful tools for their education (Figs. 1 and 2).

The first hypothesis is verified, young people consume open signal and paid TV mainly for entertainment as it is shown in Figs. 3, 4 and 5. The consumption of information, sport and educational programs are minimal, it gets the attention the preference of consumption of open signal television, conclusion that is also supported in the interview with parents. The second hypothesis is not accepted, the teenagers and young people from Ecuador consume open signal radio and Internet, consumption is daily and in households even though there are significant trends to consumption in movement both in smart phones and vehicles (Figs. 6 and 7).

The third hypothesis is accepted, while young people watch TV and listen to radio, they access to Internet and to related options as e-mail, it is configured a stage ready to a virtual world, this can be seen in Fig. 8, in the opinion of the parents and in the results of the focus groups. The fourth and last hypothesis is accepted, the young people consume individually the content of the media of communication, Internet has changed the custom of watching television in family, now the young decide the content and the schedules of viewing according to their spaces and needs. From the conducted focus group is known that parents and young people make independent and individual consumption.

One aspect that is getting the attention to the youth consumption of media on the Internet is the recognition of the value of local communication and point out that they use open signal and radio television to reach to what is near them and to what is different from what is on the Internet. The consumption of media of communication from high school students from Ecuador is in relationship to the digital possibilities resulting from Internet and are causing changes in households, but they can't stop recognizing and demanding local content according to their needs.

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Advertising in the Prime Time of the Ecuadorian Television

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Abstract. In this research it is analyzed the existing advertising in the prime time of the Ecuadorian television. Through a quantitative methodology it is intended to measure the percentage and index that occupy the advertisements within the televise programming, using a monitoring form utilized in the prime time Ecuadorian programs of Ecuavisa, TC Television and Ecuador TV, from September 12 to 16 of the year 2016. It can be determined that advertising in the slot with bigger audience varies in the three television stations analyzed, in the same way it is modified between the days of the week, denoting that the transmission of advertising on channels responds to certain interests in the audience or specific objectives that it seeks to achieve.

Keywords: Television · Communication and television · Advertising · Televisual advertising

1 Introduction

From its origin, social media affects in the behaviors and opinions of audiences, even it is said "media are important shapers of our perceptions and ideas, they are companies of awareness that not only provide information about the world but also ways to see and understand it" [1].

Among the mass media, television is the one that has captured most attention in the population, "with primacy over other media such as press or radio. Since its massive implementation, there has been a general agreement both at the level of opinion and specialized circle, about the influence that television has on the receiver" [2].

In this scenario, it is ideal for the development of the advertising, which seeks to inform, persuade and to remind. The advertising in television is "one of the most powerful tools that companies have not only to let to know their products and services, but also to generate a massive need and consumerist" [3].

The LGCA (Ley General de la Comunicación Audiovisual – España) defines the advertising message as all form of message of a public or private company of a physical person in relation to his or her activity either commercial, industrial, handmade or professional, with the aim to promote the supply of goods or provision of services, including real estates, rights and obligations. In short, the sense of the concept hardly varies from the generic offered in the LGP (Ley General de Publicidad), assuming an

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alternative definition adapted to the context of the particular media of emission treated in the LGCA [4].

However, and even though the commercials have become icons of contemporary culture, it seems that man is currently bombarded by thousands of visual and auditory impacts, even from the moment where he gets up and turns on the television.

There arise questions from the population and the authorities of regulation when is affects to children and young because the commercials and series of television broadcast wrong models of socialization. "The different programs and television series offer to the child receiver models that are reinforcing in itself and that, in general, are highly effective to get the attention and favor the adoption of certain attitudes and patterns of behavior" [3].

It is this careless handling of advertising in television that viewers consider that the presence of advertising in television programming is summed up in one word: excessive. This widespread sense of having overrun the line is applied with greater irritation to the spaces that are emitted from 21 to 24 h, the so-called "prime time", due to which, on several occasions, has exceeded the 20 min with continued advertisements [5].

Another core element to take into account in advertising is "there is a deep imbalance between presence advertising and demographic weight by sex; and is used the stereotype of gender to represent to women and men" [6].

The top moment of the television is the "prime time", it is the timetable of greater audience "where it is emitted the programs of greater success, being the most expensive for the advertisers, where more spectators are accounted and therefore where advertising reaches to more consumers" [3].

Being the "prime time" the space of more audience and the more valued is also the one which should meet a set of criteria that guarantee to meet the commercial purposes of sustenance of the medium of communication but also of respect to the audiences, without being only showcases of products but also delivering useful content. "The broadcasting of advertising is, today, the necessary resource to maintain that free." "Except for state funding, there are not other alternatives: or advertising or hook fee and pay-per-view" [5].

As a part involved in these processes of management, the advertising is presented today as a complicated system of communication and marketing whose borders are each time more diffused (…) The ways of consuming advertising have been modified according to the practices of the consumers, more involved and demanding with the economic and social activities of the organizations and systems of communication [7]. However, the possibility of synchronizing advertising and contents will open to broadcasters a new channel for advertising revenue and the audience measurement will also contribute to get to know better the needs of the spectators, therefore retain audiences and to innovate in the television formats [8].

The current situation of massive inclusion of advertisements has generated in viewers an attitude of immediate flight in the presence of advertising. This is not good neither for advertisers, who lost most of their investment by the low efficiency of insertions, nor for the channels, that will be forced to low prices towards the drift of budgets to events and other alternative formulas [5].

In Ecuador in June of the year 2013, after a long debate, it was approved the Ley Orgánica de Comunicación -LOC- (Assembly national, 2013) that in Sect. 5 is specifically addressed the regulation of the advertising in the media, from the article 92 to the article 96 [9].

With these parameters, Ley Orgánica de Comunicación tries that there is not a monopoly in the advertising market, defined as powerful companies with a captive demand that control the supply and price [10].

The objective of the research is to determine the percentage and rate covered by the advertising within programming of the prime time, with reference to three leading channels in the Ecuador, a private (Ecuavisa), a taken away (TC Television) and the public channel (Ecuador TV). Research hypotheses are: (1) The space destined for the advertising in the prime time is modified and alters in the course of the week; (2) The themes used in the advertising spaces present variations between the analyzed channels in the research: private, taken away and public.

2 Methodology

For the research it was made an analysis of week type, "tool that serves to collect information from a full week in a channel of television, generally it is used in advertising, to determine the impact of an advertising campaign." [11]. For the analysis and gathering of information it was used a monitoring form (Table 1).

Table 1. Monitoring form of advertising in the prime time

CHANNEL: DATE:																						
				Type of advertisement																		
Hour	Program Name	Total duration	Duration advertising	Telephony	Education	Governmental	Politics	Banks	Business Premises	Restaurants	Products of first necessity	Home appliances	Health	Channel promotional advertising	Vehicles	Travel agencies	Pay tv	Promotion films	Mass media	Fashion and beauty

Elaboration: Own.

The advertising spaces of four programs of the prime time were analyzed for a week (12–16 September) to determine the percentage of advertising per time slot of the channels selected for research (Ecuavisa - private channel, Ecuador TV - public channel and TC Television – taken away channel). The monitoring form also allowed establishing what are the most used themes in the advertising spaces, those that occupy a greater index and time within the transmission of television.

3 Results

Ecuavisa (Fig. 1): In the slot time from 18:00–19:00 the percentage of advertising varies during the week, on Monday only a 5.40% of the total space of the program is destined for advertising, being the day with less commercial guidelines. The highest point in relation to the advertising space is Friday with the 17.16%.

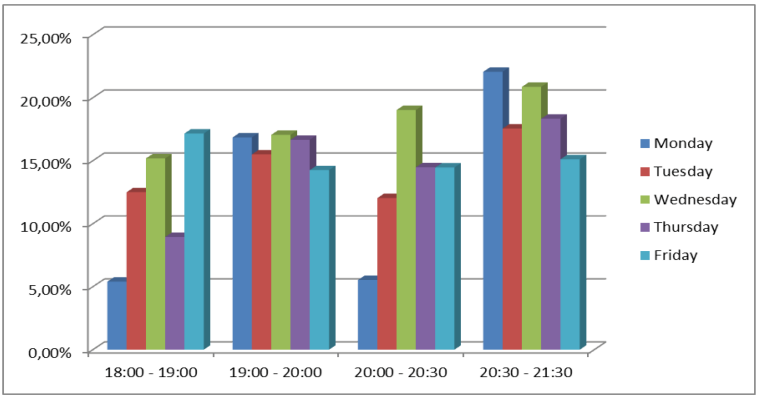

Fig. 1. Advertising rate by time slot – Ecuavisa Elaboration: Own

Between 19:00–20:00 the percentages increase and vary substantially regarding to the previous slot, being Friday the day with the lowest advertising load with 14.25%, while on Wednesday the percentage rises to 17.05%.

In the slot from 20:00–20:30, the lowest percentage of advertising occupies again Monday with 5.53%, on Wednesday the percentage rises to 19.02%.

The slot that closes the prime time presents its lowest percentage of advertising on Fridays with 15.11% and Monday keeps the higher space with the 22.06%.

The themes that predominate in the advertising spaces correspond to promotional ads from the channel with 54.11% and products of basic necessity with 18.82%. The rest of themes do not exceed the 5% (Table 2).

Table 2. Most used advertising themes in the prime time – Ecuavisa

Advertising Type	September 12		September 13		September 14		September 15		September 16	
	N°	%	N°	%	N°	%	N°	%	N°	%
Telephony	2	2.35%	2	2.06%	5	4.80%	4	4.39%	2	2.53%
Education	2	2.35%	1	1.03%	1	0.96%	0	0%	1	1.26%
Governmental	1	1.17%	1	1.03%	2	1.92%	2	2.19%	1	1.26%
Banks	2	2.35%	2	2.06%	1	0.96%	2	2.19%	0	0%
Business Premises	3	3.52%	2	2.06%	0	0%	0	0%	0	0%
Restaurants	1	1.17%	2	2.06%	1	0.96%	2	2.19%	1	1.26%
Products of first necessity	16	18.82%	19	19.58%	24	23.07%	34	37.36%	21	26.58%
Home appliances	1	1.17%	2	2.06%	0	0%	2	2.19%	2	2.53%
Health	3	3.52%	5	5.15%	7	6.73%	6	6.59%	5	6.32%
Channel promotional advertising	46	54.11%	50	51.54%	52	50%	31	34.06%	37	46.83%
Vehicles	1	1.17%	2	2.06%	1	0.96%	1	1.09%	2	2.53%
Travel agencies	1	1.17%	2	2.06%	1	0.96%	2	2.19%	0	0%
Pay TV	0	0%	0	0%	0	0%	0	0%	0	0%
Promotion of films	1	1.17%	1	1.03%	2	1.92%	1	1.09%	1	1.26%
Mass media	0	0%	1	1.03%	1	0.96%	1	1.09%	0	0%
Fashion and beauty	5	5.88%	5	5.15%	6	5.76%	3	3.29%	6	7.59%

Elaboration: Own.

TC Televisión (Fig. 2): The space between 18:00–19:00 changes during the week. On Monday the advertising reaches only the 15.70%, while on Thursday gets to its highest point with 44.10% of the total space of the programme destined for advertising.

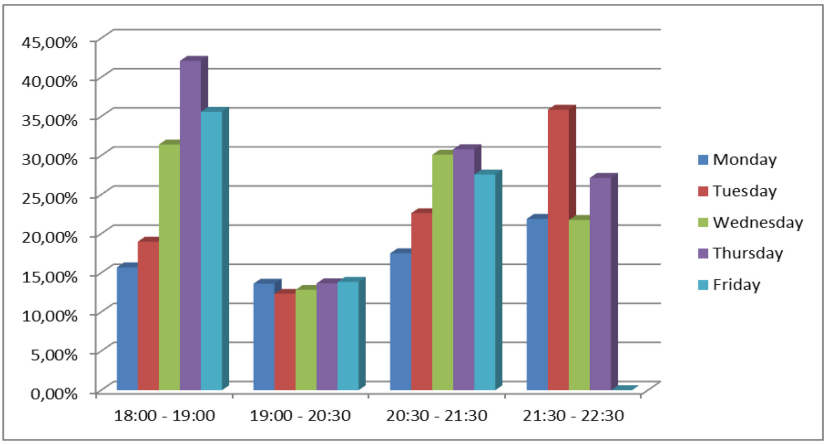

Fig. 2. Advertising rate by time slot – TC Televisión Elaboration: Own

Between 19:00–20:30 it is observed that the percentage of advertising is reduced considerably, presenting on Tuesday a minimum rate of 12.33% and ascending to its highest peak on Friday with 13.64%.

From 20:30 to 21:30, the lowest index of commercial guidelines is present on Mondays with 17.50%, in contrast to its maximum index on Thursdays with 30.11%, denoting marked differences during the five days analyzed.

As it is denoted in Fig. 2, the percentage of advertising space that closes the prime time varies between the week. Wednesday only denotes a 21.76% of advertising, while its highest point is established on Tuesday with 35.86%.

As well as in Ecuavisa, the themes that prevail in advertising correspond to promotional advertisements from the channel with 37.73% and products of basic necessity with 24.03%. The rest of themes barely exceed 7% (Table 3).

Table 3. Most used advertising themes in the prime time – TC Televisión

Advertising Type	September 12		September 13		September 14		September 15		September 16	
	N°	%	N°	%	N°	%	N°	%	N°	%
Telephony	5	4.80%	5	4.03%	8	4.90%	7	4.51%	8	7.07%
Education	5	4.80%	0	0%	0	0%	0	0%	0	0%
Governmental	0	0%	9	7.25%	7	4.29%	10	6.45%	6	5.30%
Banks	0	0%	1	0.80%	1	0.61%	1	0.64%	1	0.88%
Business Premises	5	4.80%	3	2.41%	4	2.45%	4	2.58%	4	3.53%
Restaurants	1	0.96%	0	0%	2	1.22%	2	1.29%	1	0.88%
Products of first necessity	25	24.03%	29	23.38%	41	25.15%	33	21.29%	27	23.89%
Home appliances	4	3.84%	4	3.22%	4	2.45%	6	3.87%	2	1.76%
Health	6	5.76%	13	10.48%	19	11.65%	16	10.32%	11	9.73%
Channel promotional advertising	33	31.73%	33	26.61%	41	25.15%	34	21.93%	32	28.31%
Vehicles	2	1.92%	4	3.22%	5	3.06%	4	2.58%	3	2.65%
Travel agencies	0	0%	0	0%	0	0%	0	0%	0	0%
Pay TV	7	6.73%	7	5.64%	8	4.90%	13	8.38	7	6.19%
Promotion of films	3	2.88%	3	2.41%	5	3.06%	7	4.51%	3	2.65%
Mass media	0	0%	0	0%	0	0%	0	0%	0	0%
Fashion and beauty	8	7.69%	13	10.48%	18	11.04%	18	11.61%	8	7.07%

Elaboration: Own.

Ecuador TV (Fig. 3): In the slot from 18:00–19:00 the percentage of advertisements does not exceed 10%. On Wednesday it is registered only a 0.66% of advertising, unlike on Tuesday where the advertising fee reaches the 9.23%.

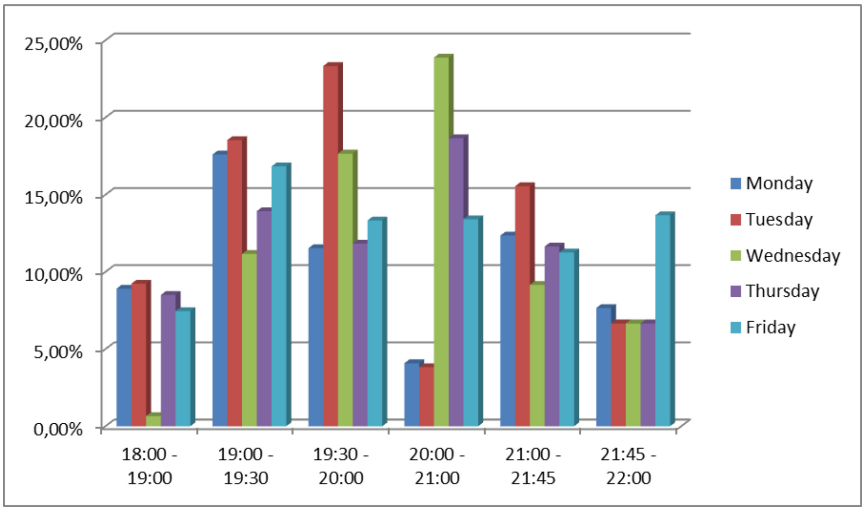

Fig. 3. Advertising rate by time slot – Ecuador TV Elaboration: Own

In the space from 19:00 to 19:30 advertising occupies a greater percentage in relation to the previous slot, from 11.16% on Wednesday, captures a 17.60% on Mondays, establishing this day as the greater generator of commercials ads.

In the slot from 19:30–20:00 it is registered a remarkable increase, Thursday and Friday shows a minimum percentage of advertisements with 13.33% and the highest point is set on Tuesday with 23.33%.

In the schedule from 20:00–21:00 the lowest percentage of advertising corresponds to the beginning of the week, while on Wednesday reaches a 23.88%.

From 21:00 to 21:45 it is registered a minimum of advertising with 9.16% on Wednesday and a maximum of 25.35% on Tuesday, ending the prime time with a minimum of 6.66% of advertising between Tuesday and Thursday and reaching its highest rate on Friday with 13.66%

In Ecuador TV advertising themes vary compared with Ecuavisa and TC Television, predominating only four and emphasizing promotional advertisements from the channel, with a 67.34% from the total space. It is highlighted that the channel presents Governmental advertisements and of public media, themes that are not presented in private channels (Table 4).

Table 4. Most used advertising themes in the prime time – Ecuador TV

Advertising Type	September 12		September 13		September 14		September 15		September 16	
	N°	%	N°	%	N°	%	N°	%	N°	%
Telephony	8	16.32%	6	12.5%	7	10.76%	10	15.83%	8	12.90%
Governmental	5	10.20%	3	6.25%	10	15.38%	7	11.11%	7	11.29%
Channel promotional advertising	33	67.34%	36	75%	42	64.61%	41	65.07%	43	69.35%
Mass media	3	6.12%	3	6.25%	6	9.23%	5	7.93%	4	6.45%

Elaboration: Own.

4 Discussion and Conclusions

The percentage of advertising varies slightly between the days of the week. However, the days with higher rate of advertising can demonstrate a particular interest of the TV channel for transmitting in that space a greater amount of advertisements, responding perhaps to the needs and requirements of a particular audience.

There are differences between the three analyzed channels. Ecuavisa, TC Television and Ecuador TV denote differences in the percentages of televisual advertising, reducing and increasing its rate of advertising in the week (Monday to Friday).

Advertising at this time recorded a remarkable percentage of transmission if it is compared with the advertisements emitted during the morning or afternoon, where the impact of advertising is reduced and the time spent on to transit ads is less than at the end of the afternoon and evening.

The following situation arises in the three television networks: In Ecuavisa the space with the biggest advertising load corresponds to 20:30–21:30, TC Television from 18:00–19:00 which presents a representative advertisement rate and in Ecuador TV the largest percentage of advertising is from 19:30–20:00 and from 20:00–21:00. There is similarity between TC Television and Ecuador TV, taken away and public stations respectively.

TC television is positioned as the channel with the highest rate and percentage of advertising during its broadcasts of the prime time. The television station emits a large number of advertisements during the week (Monday to Friday) and as it was observed during the time of monitoring, it gives a remarkable importance to transmit advertisements promoting their programming grid.

TV channels are fulfilling with which stipulates the Ley Orgánica de Comunicación (LOC) in its Article 98. Production of national advertising. - The advertising that is diffused in the Ecuadorian territory must be produced by Ecuadorian people either natural or legal (…) It is banned the importation of publicity items produced abroad by foreign companies.

5 Verification of Hypothesis

(1) **The space destined to the advertising in the prime time is modified and alters in the course of the week.**
As it could be confirmed, in the three channels that were analyzed the advertising does not keep the same during the week. The commercial advertisements are reinforced on certain days or in response to needs that the channel seeks to satisfy in the audience, according to the hour that seems to be appropriate.

(2) **The themes used in the advertising spaces present variations between the analyzed channels in the research: private, taken away and public.**
The hypothesis is verified, even though not in 100%. There are similarities between the private channel and the taken away concerning the themes treated in the ads, outstanding the advertisements with the offer of programming of the channels and those focused on products of basic necessity. The public channel exceeds the 60% with own advertisements of the channel and is the onliest one in including Governmental information.

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Proximity Communication Models: Governance and Funding of German, Belgian and Spanish Public Regional Media

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Abstract. This paper approaches three different proximity communication models, the German one, the Belgic one and the Spanish one. The regional structure of these three countries allows for a comparative analysis of both their organization and their funding. The study of their governance shows different degrees of independence of their public management. In the analysis of the financial data it is outlined the budget increase of the German and Belgic public regional media against the cutbacks affecting the autonomic Spanish media.

Keywords: Proximity communication · Regional television · Public television · Governance · Public funding · ARD · FORTA · VRT · RTBF

1 Introduction

The crisis of the traditional public broadcasting business model was intensified by these last years of recession. European public broadcasting systems were generally subjected to budget cutbacks, although the most affected countries by the economic crisis were the ones who experienced the more profound decrease on their public regional media budgets. Since 2010 the recession started to stand out through regulation changes and the implementation of structure reduction plans, which sum up to the cutbacks on staff and labour costs.

Proximity television has also been affected by this economic conjunction, leading to the rethinking of its role on the global context, as well as to the redefining of its public service mission in order to continue its effective contribution to the configuration of public opinion. To that effect, it seems to be necessary for public media to have a certain stability on the funds available, allowing for medium and long-term planning of the role that proximity media shoud play in this new and changeable media ecosystem.

This paper approaches the public regional media systems in Germany, Belgium and Spain through the study and comparison of both their structure and governing model and their funding. In order to corroborate the assignment of resources received by each of these public media organizations, available data regarding the period 2011–2014 was

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analysed. These data were obtained from the funding reports of the respective public media organizations, the European Audiovisual Observatory (EAO) database [1], the digital archive of the Flemish media regulator (VRM) and from the population statistics published by Eurostat.

2 Public Proximity Media Models

The concept of proximity television was coined in the decade of 1980, after a terminological debate on the search of the specific word that could combine «the polysemy of the local with the notions of territory, identity, but also the complicity between the sender and the audiences and, highly important, the competency framework for the new democratic audiovisual system» [2].

Nowadays proximity media had to adapt itself to the ongoing changes of the media ecosystem, assimilating the new technologies that contribute to de development of its public mission and facing a context of high global competition. In this context, regional media maintain a «special democratic significance as the relationship between regional media and persons from the areas and communities they serve tends to be closer than equivalent relationships at, for e.g., the national or international levels» [3]. In this sense, proximity is frequently expressed on in statistics relating audiences and users, as well as in levels of media involvement.

The role of proximity media is essential when it comes to guarantee coverage of regional and local matters that otherwise would be underrepresented or absent in national media. The configuration of the public opinion must count on this proximity component in order to be completely fulfilled and to contribute to the political, social and cultural public discourse.

On the other hand, the European Audiovisual Observatory has also acknowledged the capability of proximity media to assemble a communicative space for the expression of regional identities. This correlation with regional identities requires a certain economic investment. In the Spanish context, despite the 30% increase of costs linked to the differentiating cultural and linguistic factors, regional media have contributed to the symbolic settlement of the identities, to language planning, to the enrichment of cultural diversity and to the generation and projection of a regional audiovisual industry. Therefore, the relevance of strong regional media is undeniable.

A wide array of different articulations of regional media coexist among the European public sector. Campos Freire [4] lists a total of five models of organization of the public service in Europe: (1) the single model of independent institutional diversity, with the federal organization of integrated regional networks (e.g. Switzerland and the Nordic countries); (2) the confederated state dual model, composed of one state media entity and one federal organization that gathers associated independent regional networks (e.g. Germany and Spain); (3) the model of national regional diversity, like the case of Belgium, which counts with three different independent organizations, one to each of the three linguistic communities; (4) the regionalized state model, built from regional windows and opt-outs (e.g. France and Italy); and (5) the state model of institutional cooperation, in which the United Kingdom, Ireland and Holland would be included.

Following this general classification, Germany and Spain would share the same model of organization of their public media, although the differences among both communication systems are remarkable. Despite the fact that in both countries a network of retional media coexists with other organizations targeting the whole state, the way both parts emerge and organize is completely different. In Germany, broadcasting and media are a responsibility of the regions (*Länder*) [5], so each one of them is authorised to either establish their own public media organization or join forces with other *Länder* in order to create a combined network. This way, there are nowadays nine different and independent regional broadcasting organizations. German public media with a national reach, ARD and ZDF, were motivated by the initiative of the regions, which developed a strong collaboration strategy.

On the other hand, the opposite process takes place in the Spanish system. It is in the statutes of 1980 of the national public broadcaster, RTVE where it was first mentioned the possibility for the different regions (*Comunidades Autónomas*) to organize, manage and control a third channel for their corresponding territory [6]. From that point on, and along with the passing of the Third Channel Law (1983), the regional public media system begins to be created until it reaches its current shape: 13 autonomic broadcasters, 12 of which are organised in the independent institution FORTA. Therefore, while in Germany regional broadcasters converge in order to create a public media system with national reach (from the regional to the national), in Spain the process is developed in the opposite direction: from the national to the regional.

The Belgic case constitutes the paradigm of the national regional diversity model. The Belgic Constitution defines Belgium in its first article as a federal State composed by Communities and Regions [7] which are assigned with different responsibilities and duties. Public broadcasting, as a cultural issue, falls within the Communities remit and is regulated by decree. This way, the Belgic media ecosystem is fragmented into three different markets linked to each of the linguistic Communities: the Flemish one, the French one and the German-speaking one. It does not exist, consequently, a national public broadcaster that reaches the whole country, but each Community acts independently in this field.

Beyond all these different ways of organizing public regional media, it is essential to approach the distinct governing models that can be found in the European regional public media systems. Fernández Alonso and Fernández Viso [8] enumerate three government regarding political independence. First of all they mention the formally autonomous systems, characterized by the formal isolation of the management bodies in relation to government and political parties. In this system the control of the production is always on the hands of media professionals. Secondly, the authors list the systems that include politics inside the broadcaster. The aim in this cases is to replicate the sociopolitic pluralism of the nation in the composition of the Boards of Directors of the public media, integrating representatives from the different political parties and social collectives. Both Belgium and Germany fit within this model. Finally, the system could also have the politics above the public broadcaster, which would be the case of public media that are managed by political majorities through the government or the parliamentary designation of the members composing their governing bodies. This is the

model that applies to Spain, for the designation of the members of both the Board of Directors and the chairman of RTVE and the ones of each autonomic broadcaster.

3 Governance in Public Regional Media

Each of the three regional broadcasting systems analysed here counts with a particular structure, organization and governance that will be approached in the following section.

3.1 Belgium

As it was noted above, Belgium does not count with a public service media organization broadcasting for the whole country, but each of its three linguistic Communities has its own public broadcasting entity.

The French Community counts with the *Radio-Télévision Belge de la Communauté Française* (RTBF), which has been broadcasting since 1977 for the two French-speaking regions, Wallonia and Brussels. The RTBF develops its public service mission through four television channels, six radio stations and numerous new media services, including apps available in different platforms, on-demand and interactive television and thematic websites.

The Flemish Community is the territory for the *Vlaamse Radio- en Televisieomroep* (VRT), whose programming targets the population of the Flemish Region and the Flemish-speakers of Brussels. The VRT manages three television channels, three radio stations and a wide array of new media services, supporting an innovative and convergent activity that places the Flemish citizen in the epicenter of a 360º, cross-platform and transmedia strategy. The presence of the Flemish identity and culture is one of the main cornerstones of the VRT.

The last Belgic public broadcaster, and also the smallest one of the country, is the *Belgischer Rundfunk* (BRF), for the german-speaking Community. The BRF develops its public service mission essentially through its radio station, although the german-speaking population also counts with a modest television production –very linked to the collaboration with other regions- and with some new media services.

Despite the fact that each linguistic Community is free to establish and design the organization of its public broadcaster, the management of the RTBF, VRT and BRF actually share many points in common. One of the main issues connected to the governance of these public media is its link to a management contract. The RTBF, the VRT and the BRF found their legal framework through decrees and statutes, but they are complemented with management contacts that settle the objectives and guidelines to be followed in a period of four years. The organization chart of the three Belgic public media also share some similarities, as they are designed around two fundamental bodies: the Board of Directors and the Management Committee.

The Boards of Directors of the RTBF (*Conseil d'Administration*), the VRT (*Raad van Bestuur*) and the BRF (*Verwaltungsrat*) are responsible for the decision making related to the policy, management and budget of the public enterprise. Their functions are similar, but they differ when it comes to their composition. In the RTBF, it is formed

by 13 members elected by the Council of the French Community for the period equivalent to the term in office. Moreover, it also includes two commissioners designated by the Government in order to supervise the activity of the Board of Directors. In the VRT, however, the Board of Directors can have between 12 and 15 members, 12 of which are always appointed by the Government of Flanders. In the BRF, the *Verwaltungsrat* is composed by members chosen by the Parliament of the german-speaking Community for the equivalent time of the term in office, and aiming for a representation of the disposition of the different political parties in the parliamentary chamber.

As for the Management Committee, its funcrions are very similar for the three public broadcasters. The *Comité de Direction* of the RTBF, the *Directiecollege* of the VRT and the *Direktionsrat* of the BRF are responsible for the implementation of the strategy determined by the Board of Direction and they must take care of the daily management of the enterprise. In the RTBF, the *Comité de Direction* is compound by representants from the different departments of the public organization, all of them working under the instructions of the General Manager designated by the government for a 6-years period. In the VRT, the *Directiecollege* is led by the *gedelegeerd bestuurder*, who is named by the General Assembly (compound by all shareholders of the public broadcaster). Finally, the *Direktionsrat* of the BRF is led by the *Direktor*, appointed by the Board of Directors for a 6-year period.

3.2 Germany

The distribution of competences in Germany has generated a public media system based on either the stablishment of a public broadcaster in each *Land* (BR, HR, SR, WDR and Radio Bremen) or the gathering of strengths amount several *Länder* in order to create a common broadcaster (MDR, NDR, RBB and SWR). This way, there are nowadays nine independent public broadcasters, which have decided to organize themselves in the *Arbeitsgemeinschaft der öffentlich-rechtlichen Rundfunkanstalten der Bundesrepublic Deutschland* (ARD).

Each of these nine broadcasters is regulated by its respective *Länder*, although there actually is a common law that applies to all of them, the *Rundfunkstaatsvertrag*, passed after all of the *Länder* and regional broadcasters decided to collaborate also on a legal level. This allows a conjoint analysis of some aspects related to the governance of proximity media in Germany. In a general manner, the organization charts of all the regional public broadcasters follow a similar scheme, structured around three main bodies: the Board of Directors (*Verwaltungsrat*), the Director (*Chef, Intendant* or *Direktor*) and the Broadcasting Board (*Rundfunkrat*).

The number of members that compound the *Verwaltungsrat* is among 6 (e.g. BR) and 9 (e.g. HR). Their main responsability is the supervisión of the *Direktor* in order to make sure that he or she is following the objectives and guidelines of the public broadcaster.

The *Direktor* is named by the *Rundfunkrat* from a list of candidates proposed by the *Verwaltungsrat* for a period that can cover from 5 years (e.g. RBB) to 9 (e.g. the longest period allowed in the HR). The *Direktor* must lead the enterprise counting on the support and collaboration of the different section chiefs of the broadcaster.

The third essential management body in the german public broadcasting system is the *Rundfunkrat*. It is an organism that aspires to represent all the social sectors of each German region, so it is compound by members that belong to different social, cultural, political and religious groups. This way it is expected to guarantee that the functioning of public media can be held accountable to all the citizens. The composition of the *Rundfunkrat* varies from the 29 members in the RBB to the 71 in the SWR. Although it is rare, in the case of the broadcasters that cover more than one *Land*, like NDR or SWR, the *Rundfunkrat* can be divided into several *Landesrundfunkräte*, depending on the number of regions they work for. In these cases, the population of the regions will be os special relevance in the numbers of members that they will provide to this bodies. The SWR *Rundfunkrat*, for instance, is compound by 51 members from the region of Baden-Württembert, while Rheinland-Pfalz would only count with 23 members. The election of these members depend on the parliaments of each region, and they are usually appointed by the period equivalent to the term in office.

3.3 Spain

The governance of autonomic public media in Spain, in general, is characterized by its high degree of politicization. Its management is organized around, once again, two essential bodies: the Board of Directors and the General Management or Presidency. At the beginning of the autonomic broadcasting system the autonomic Government was in charge of the appointment of the General Manager, while the members of the Board of Directors were chosen in the corresponding Parliaments. In both cases, the appointments were made for a period equivalent to the term in office.

The legislative changes that were materialized through the laws *17/2066 de RTVE* and *7/2010 General del Audiovisual* modified the regulation framework for regional media, although in 2012 new changes were once again implemented, representing a step back in the pluralist reputation of the governance of public media. Almost all of the audiovisual laws renewed after 2006 introduce the election of presidents and general managers, as well as the members of the Board of Directors, through a system of reinforced majorities, even though little by little they were modified in order to be completely substituted by a designation system consisting in either three-fifths or absolute majority in the corresponding Parliament. In the same manner, it is established the parliamentary regulation of the master agreement or strategic plan (from six to nine years) as well as the programme contract, with a triennial regularity, although very few regional broadcasters maintain them actualized.

Inside the autonomic Boards of Administration it is remarkable the fact that, in a way, they reflect the representation in parliament of the different political parties. These Boards of Administration are appointed by the autonomic parliaments and its number of members fluctuates between 7 in the Canary Islands and 16 in Aragón or the Basque Country. There is still a remaining tendency for the parliamentary groups to choose candidates that have previously worked as communication consultant or that are related in some direct or indirect way to the respective political party. The members of the Boards of Directors are appointed for a period that varies in each autonomous

community, although the most common periods are the ones equal to the term in office or a bit longer, expanded until 5 or 6 years.

4 The Funding of Regional Public Media

The three most common funding sources of public broadcasting in Europe are the direct licence fee (depending on the possession of reception devices), the direct assignment of funds by the state for the development of an audiovisual public service and the incomes originated by the commercial activities of the broadcaster (advertising, product sells, merchandising…).

Germany constitutes one of the most paradigmatic exemples of licence fee. The german licence fee must be paid for each family unit (household), regardless of the number of members of the family or the number of reception devices they own. By the end of 2015, each german household must pay 17.5€ per month to finance *Deutschlandradio,* ZDF and ARD. The distribution of the licence fee among the different public broadcasters is proposed by the Commission for the Identification of Funding Needs (*Kommission zur Ermittlung des* Finanzbedarfes, KEF), that should take into account efficiency and rationalization principles and whose proposal must be approved by the respective regional parliaments. The commercial activity of public broadcaster is also part of their funding, although in a much more reduced way. Advertisement incomes of the ARD, for instance, make only the 6% of its total budget, while the income coming from the licence fee represents the 85%.

The three Belgic public broadcasters are funded mainly through the direct assignment of funds by the state for the development of an audiovisual public service. This assignment of public money is included in the management contract and represents around the 75% of the total budget of each public broadcaster, while their commercial activity comes to the remaining 25%. Belgium also counts with a licence fee for public media funding, although it is merely complementary.

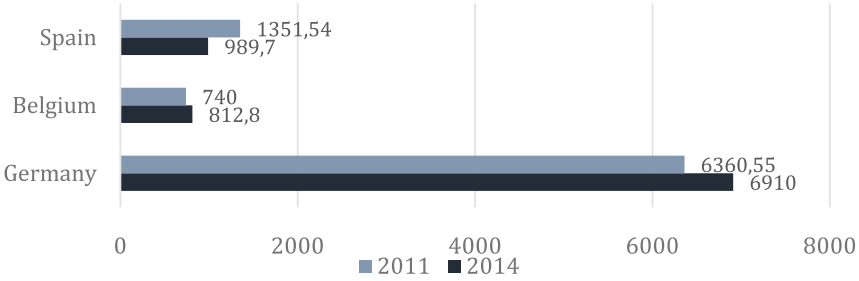
The Spanish autonomic broadcasters are funded through a mixed system combining the direct assignment of funds by the state and the incomes derivated from their commercial activities. While the nationwide public broadcaster RTVE has eliminated all commercial advertisement from its media services, the autonomic broadcasters are still basing an important part of their incomes in this kind of source. In a general way, the assignment of public money that every regional broadcaster receives through represents between the 75% and the 80% of the total budget, while the incomes from commercial activities represent between the 15% and the 20%. It is remarkable how the autonomous communities that have a differentiating cultural and linguistic factor (Basque Country, Catalonia, Galicia, the Balearic Islands and Valencia before its broadcaster was shut down) increase their costs by a 30% in relation to the other regional broadcasters.

The financial data regarding the public regional media systems in Germany, Belgium and Spain are presented and compared next, both from the perspective of their budget evolution from 2011 to 2014 and from the consideration of them in relation to the Gross Domestic Product (GDP) of each country. It must be noted that the BRF was excluded from the economic information from Belgium due to its minor budget.

4.1 Budget Evolution of Regional Media (2011–2014)

The three public regional media system studied in this paper have developed different budget evolutions between 2011 and 2014. In Germany, the ARD has experienced a remarkable increase on its budget, going from 6.360 million euros in 2011 to 6.910 million euros in 2014, which means a growth of 8.65%. In relation to 2013, ARD also had a 7.5% increase in its budget. Belgic public media have also experienced a budget raise, growing 4.55% from 2011 (740 million euros) to 2014 (812.8 million euros), and with a 2.04 increase in relation to 2013. On the contrary, the Spanish autonomic broadcasters associated in FORTA (a private organization that encompasses 12 out of the 13 autonomic broadcasters in order to gather strengths to gain rentability in their activities) have been the target of strong budget cutbacks. This way, with a budget of 989.7 million euros in 2014 (and of 1.513,8 millions in 2015), Spanish regional public media lost 29.6% of its budget in 5 years (Table 1).

Table 1. Budget Development of regional public media (in millions of €)



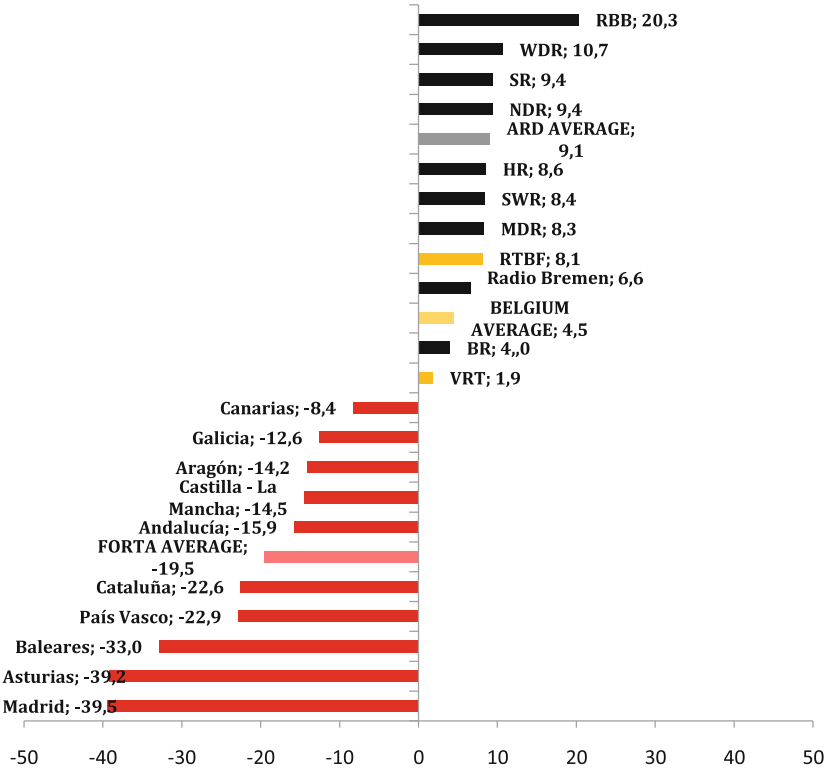
In Germany, the broadcasters that experienced a greater percentage increase in this period were RBB (+17.66%) and HR (+12%), while the one with the most modest growth was Radio Bremen (+3.90%). In Belgium, the RTBF increases its 2014 budget 8.11%, while the VRT grows just 1.86%. From the Spanish autonomic broadcasters only the Canary Islands grows slowly (0.83%), while in Madrid (−42.95%) and Asturias (−40.64%) the decrease between 2011 and 2015 is hugely drastic.

If these budget data are analysed in relation to the respective Gross Domestic Product (GDP), the same tendencies of growth in the Germand and Belgic regional media systems and the strong decrease in Spain are once again shown (Table 2).

While in Germany 2.37€ out of each 1.000€ of GPD are dedicated to the public media system, and in Belgium the number is around 2€ out of each 1.000€ of GPD, the Spanish average in 2014 was 1.23€ out of each 1.000€ of GPD. These numbers show that the budget assignments in relation to the PIB of the Germand and Belgic regional public media triple and duplicate the one of the Spanish autonomic broadcasters. As an exception, only the Basque (2.13€) and the Galician (1.92) broadcasters get close to the numbers of their Central European counterparts. The budget dropping tendency of the FORTA broadcasters is over 21% between 2011 and 2014, while the opposite situation can be found on the light growths of ARD (3%) and the Belgic broadcasters (1%),

numbers that widen the gap between the budgets of each public regional broadcasting systems.

Table 2. Variation on budget in relation to GDP (2011-2014)



5 Conclusions

Proximity media represents a fundamental cornerstone of the communication ecosystem, specially in these three countries that have been analyses in this paper, as they are strongly linked to the development of a regional culture and identity. However, evidence has been provided that shows quite different ways of governing public regional media, diverging in aspects like the collaboration among regions (non-existent in Belgium, but essential in Spain and Germany) or the degree of political independence on its governance.

The financial data that were presented in this paper shows two opposite tendencies. The budget increase on German and Belgic public regional media contrasts sharply with the strong cutbacks experienced by the Spanish autonomic system. The great increase of the German budgets seems to contribute to the reputation of the licence fee as one of the funding sources that guarantees more stability, independence and freedom to the management of public service media.

Research Recognition. The results of this work are part of the exploratory research activities of the project of the "Programa estatal de Fomento de la Investigación Científica y Técnica de Excelencia, subprogram estatal de Generación de Conocimiento del Ministerio de Economía y Competitividad de España" about "Indicadores de gobernanza, financiación, rendición de cuentas, innovación, calidad y servicio público de las RTV europeas applicables a España en el contexto digital". (Reference CSO2015-66543-P), promoted through the Red XESCOM (R2014/026) of media management research.

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Comparative Study of Web Pages as a Second Screen Information: Review of Cases of the Main National Television Channels of Member Countries of the Andean Community

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Abstract. The research focuses on the study of the websites of TV channels that have more audience of the countries of AndinaComunity. The sample consist in channels with national coverage in Ecuador. Ecuavisa and Ecuador TV; in Colombia: Caracol TV and Signal Colombia; in Peru: America TV and TV Peru; Bolivia: Bolivia ATB and TV Bolivia. The methodology used is qualitative and integrates the Evaluation Model of Web pages. The aim is to know the structure of the sites facing the main identification pages components, usability, accessibility, interactivity and mobility. The comprehensive evaluation of all indicators to determinate if the sites in consultation are the digital version of the medium as a second screen information; taking into account that an attractive design and effective management of the sites offer the user a flexible and interactive service, allowing access to content from any electronic device.

Keywords: Internet · Information · Digital television · Production · Audiovisual contents · Interactivity · Mobility

1 Introduction

The denominated Society of Information cannot be understood without a rigorous analysis of the media of communication and the technologies of information as a whole and of each media and technology in particular [1]. The televisual industry is immersed in a transformation originated by two factors: the explosion of Internet and the digital revolution. The synergy produced by these events routes us towards a new life, an era of audiovisual conjunction between different sectors, television and PC, from which the viewer will benefit [2].

As it happens in the other media, the television does not escape to the changes induced by the generalization of the new technologies of the communication and information. The large progresses registered in the field of the production, the transport and the broadcasting of the image have seen increased today by the introduction of the digitalization and the comprehension techniques [3].

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The television channels have extended their presence in Internet through the web pages and thanks to the technology development; these sites can be used as video and audio distributors [4]. "The synergy between the traditional media of communication and their on line models as a new support for the broadcasting of content begins to be very successful and in fact, behind the initial skepticism, the majority of broadcasters or television chains are present in the network" [5].

The development of technology and Internet is affecting to the contents and to the uses of entertainment. Technology is the content, and now more than ever it is true the prophecy of Marshall McLuhan, the medium is the message [6]. "The broadcasters at the beginning thought that Internet was going to serve them as an advertising showcase and they have not lacked reason, the majority of the broadcasters of all the world have opted for creating web sites, to offer information and services that permit to make profitable its brand through these portals" [7].

The unquestionable trend to the multiplatform distribution from the media of communication suggests the need of parallel research to the technological evolution that resolve the mode in that each media should adapt their content to the form in that their audiences will consume or receive the messages [8].

In this context, Ruano [9] said the network has become a new channel where one can enjoy the television programming, but now it have important advantage, it's about watching what one wants and not what is imposed. In Internet, each user can set their televisual schedules in accordance to their personal likes and shape its prime time without media interference. The general television will coexist with new ways of watching television as a creative force.

In this case, Latin America and particularly the Andean area experience a process of change the management of websites and the content created to meet the demands of a digital audience. The television channels are aware that the success of a website is determinant to keep an audience and capture a new one, which expects to find diversified content, that contributes an adds value to the traditional model of information. The tools that the web offers are infinite; however, questions aries, such as: Are the web pages of the Andean channels constituted as a second screen of information? Do they maintain rates of performance according to the requirements of a digital user?

This research aims to determine the functionality of the web pages of the main channels of the Andean area (Ecuador: Ecuavisa and Ecuador TV; Colombia: Caracol TV and Señal Colombia; Peru: America TV and TV Peru and Bolivia: ATB and Bolivia TV). Through a quantitative evaluation of their websites, to establish their management regarding to the total performance of their web pages, identification, usability, accessibility, interactivity, and mobility. These results will also allow evaluating the design and administration of the websites and their level of acceptance within the audience, detecting strengths in its management.

2 Methodology

The sample selected for this study was the web pages of the main television channels of the countries of the Andean community: Ecuador, Colombia, Peru and Bolivia. These

countries with exception of Bolivia were and that are object of study in the yearbooks of the Ibero-American Observatory of Television Fiction OBITEL [10, 11]. But Bolivia was selected based on the Ranking of Web pages published by Alexa [12], this ranking measures the popularity that has every websites. It is calculated by combining the average number of daily visits and the pages seen for a certain period. The date of creation of the sites was obtained through the use of the digital tool *Whois Lookup* of open access (Table 1).

Table 1. Sample of webpages of national television channels of the countries of Andean Community

Canal	Link	Fecha de creación
Ecuavisa	http://www.ecuavisa.com/	1996-09-20
Ecuador TV	http://www.mediospublicos.ec/television	2015-08-26
Caracol TV	www.caracoltv.com	1996-11-15
Señal Colombia	http://www.senalcolombia.tv/	2006-02-03
América TV	http://www.americatv.com.pe/	2005-11-04
TV Perú	http://www.tvperu.gob.pe/	1997-03-31
ATB	http://www.atb.com.bo/	1998-01-20
Bolivia TV	http://www.boliviatv.bo/sitio/	2009-07-23

Source: Own elaboration starting from the card for viewing

In the gathering of information it was used a file card, methodological instrument with which the variables were evaluated by: identifying elements of the webpages, the usability, the accessibility, the interactivity and the mobility.

The observation and collection of data was conducted on August 2016. For the processing of the data it was used the Model of Evaluation of Web sites made by Tuñez, Altamirano and Valarezo in 2015 [13], which consists in assigning the value of one point to each variable as relative values for obtaining absolute values, that allow in terms of percentage to measure the performance of the web pages based on the defined variables.

3 Results

3.1 Effectiveness of the Web Pages

The performance of a web page is submitted to an important set of variables which allow a suitable and effective experience by users, providing countless possibilities in terms of visual appeal, content choice, interaction, additional resources, among others. Counting with a representative number of people that visit a web page, does not mean that it is successful, its efficiency can only be measured in the movement and actions made by the users.

In this sense, the television stations of the Andean area reflect total percentages of performance that do not exceed the 60%, indicating that there is work to be done in aspects such as identifying elements, usability, accessibility, interactivity and mobility.

These variables constitute the support of a website and become the central point that according to their practicality determine their success or failure.

Within the region, there are differences between the public and private television. In Ecuador, the efficiency of pages reaches 57,80% in Ecuavisa and 42,10% in Ecuador TV; in Colombia the percentages increase with 60,90% for Caracol TV (higher rate among all the analyzed television stations) and 40,60% for Señal Colombia; in Perú, America TV maintains a 45,30% efficiency, lower to the percentage of TV Peru that reaches a 51,50%; Bolivia has 50% effectiveness in ATB and 51,50% in Bolivia TV (Fig. 1).

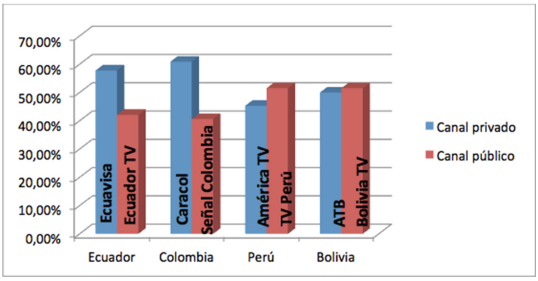

Fig. 1. Performance of webpages of channels Andean area

3.2 Identifying Elements of Webpages

The identifying elements that constitute the identity of a web page allow **users** to familiarize with the content and tools exposed in a portal. This becomes an access window, which depending on its functionality, determine the level of acceptance of a web page.

In this context, the TV channels bet by functional web portals. It is a second information screen to be positioned as a means of communication.

In the eight channels investigated the results indicate that the private media have a better management of the parameters that make up the first screen when entering the web page. The state channel in Peru compared to the other countries analyzed presents a higher rate of effectiveness in the management of the time that users dedicate to navigate and open the contents that are presented in the web page.

The private television Ecuavisa (Ecuador) has a rate of effectiveness of 77.7% in its identifying elements. Ecuador TV, public channel hasa percentage of 55.5%. The website need to improve in social networks, contacts and slogan. This channel shares its site with other public media and works as an informative website.

In Colombia, Caracol TV (private channel) and Señal Colombia (public channel), present similar percentages to the Ecuadorian channels. The first reaches a percentage of 77.7% in management of the identifying elements in their web page. The channel doesn't have a corporate portal; it doesn't have the channel's slogan. Señal Colombia obtains as a result the following number 55.5%. The website doesn't have a social networks, option of live streaming, slogan and corporative information.

In Peru, America TV (private channel) obtained a percentage of 55.5% in effectiveness of management of its identifying elements, in comparison to the state channel that exceeds the private channel, obtaining a 77.7% of efficiency in these aspects.

The private channel of Bolivia (ATB) presents a remarkable management of its identifying elements (77.7%). Your website is suitable in relation to the established elements. Bolivia TV, the public channel presents an effectiveness of 66.6%. The website should improve in different aspects: It needs a browser, indispensable to facilitate searches of content to the user; and the slogan, is necessary to be recognized on the web (Fig. 2).

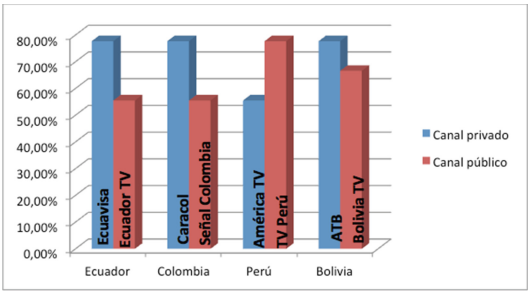

Fig. 2. Identifying elements of the web pages channels Andean area

3.3 Usability of the Web Pages

Usability focuses on simplicity and effectiveness in a web page. The main feature of websites is the ease in reading texts, immediate access to information, menus that optimize the user's time, navigability and search of new themes that are of his or her interest.

In Ecuador, Ecuavisa shows a level of usability of 62.5%, representative rate taking into account the total of variables analyzed by each parameter. Ecuador TV presents a 41.6% of usability, which means that there are factors that must be reinforced to improve the experience of the user at the time of entering the website and approaching the content.

In Colombia, Caracol TV presents a rate of usability of 62.5%. Señal Colombia reaches only a 29.1%, percentage that indicates the shortcomings around the aspects that compose the usability in a web page. Only seven variables are met from the 24 parameters analyzed. This results don't satisfy user needs.

The Peruvian channels (public and private) show the same percentage of usability, 41.6%. They have deficiencies in the management of web pages. This index presents a light increase in ATB from Bolivia with 45.8% and in Bolivia TV with 54.1%, percentages that are not enough to establish that these web pages have good practices of usability and familiarity in the handling of the proposed tools (Fig. 3).

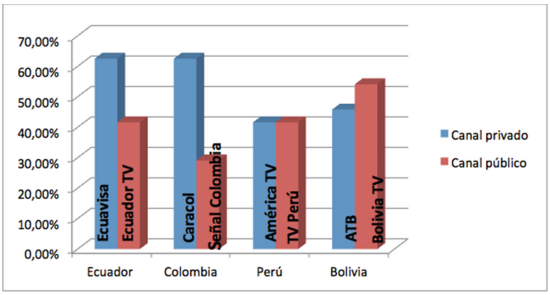

Fig. 3. Usability web pages channels Andean Area

3.4 Accessibility to the Web Pages

The majority of initiatives for promoting web accessibility are oriented towards the design of accessible web sites. These efforts include, for example, guidelines for web design, accessibility evaluation software for checking web page compliance with guidelines, etc. [13].

The influence of a web site lies in its universality, in the strategies set out for an Internet page to be visible for all the people, regardless of the browser that is used for entering the page, the language, or if the user presents some type of disability.

While the factors mentioned above are key points to provide effective accessibility, it is not common for television web pages to have functional internet portals, created from the real needs of users.

The channels of the Andean area have an accessibility of 44.4%. These web portals are accessible from any browser. But the language is only presented in Spanish. The content offered for people with visual or hearing disabilities is null.

The only thing that differentiates the analyzed channels is the updating of its content. Of the eight channels, six presented an update of information daily, Ecuavisa, Caracol, America TV, TV Peru, ATB and Bolivia TV. The public channels of Ecuador and Colombia present a weekly update. This factor can remove the web surfer from the web.

The alternatives presented by the Andean television channels in terms of content aimed at people with disabilities are not reflected in the web pages (Fig. 4).

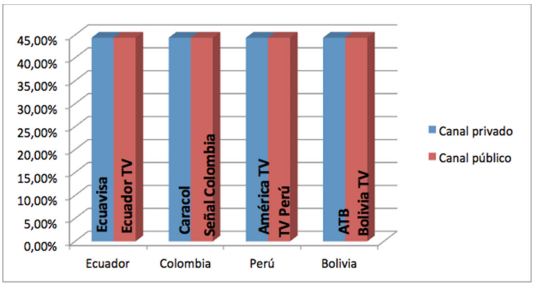

Fig. 4. Accessibility web pages channels Andean area

3.5 Interactivity of the Web Pages

An interactive web site is composed of forums, comments, social media and other platforms. The interactivity can be made when a dialogue takes place between the medium and the user, when there is a feedback between both parts and the proposed contribution does not stay only in a comment without response.

The Andean channels attempt to apply the interactivity in their web pages. In Ecuador, Ecuavisa reports a 45.4% in interactivity. The website does not allow to comment content, give them an assessment and carry out subscriptions. Ecuador TV reaches just 18.1%. It is the lower percentage of all the Andean channels. Only Facebook is present in the portal, this social network does not include option that allows interacting with published content.

Caracol TV from Colombia has the higher percentage with 63.6%, limiting only in the use of YouTube. Its portal does not allow giving a "like" to some content, it can be possible to access to comment news and give a rating that will be registered. Señal Colombia presents a 36.3%, presenting deficiencies in social media as YouTube and Instagram, it also does not allow rating the news or performing actions as "like" or subscriptions.

America TV from Peru and the channels from Bolivia (public and private) keep a percentage equal to Señal Colombia and present similar deficiencies, especially in interactive resources. TV Peru reaches a 54.5%; this channel demonstrates a better management of interactive variables presented in the website (Fig. 5).

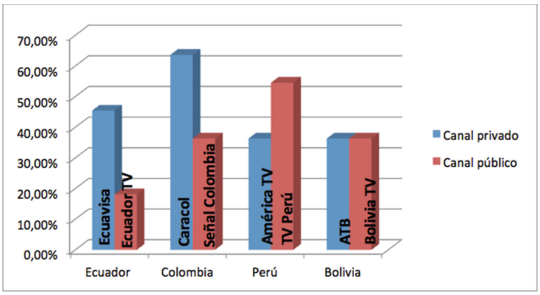

Fig. 5. Interactivity web pages channels Andean area

3.6 Mobility to Web Pages

In television, the mobile versions of its portals on Internet represent the ideal alternative for establishing a dialogue with the viewer from any geographical point. The different alternative elements present on mobile telephony invigorate the interactive process with the user and become a functional platform, capable of capturing the attention of whoever is on the other side.

The applications for phones constitute one of the main interactive tools that the user has to its reach and some in a free way.

The Andean television is not separated from these technological changes. The studied channels adapt its content to new forms of presentation that allow to its audience to have access to its programming offer and content in a different way. The eight channels analyzed allow displaying its offer in Android devices with free applications that give to the television stations an optimal percentage of mobility concerning the digital platforms used.

4 Conclusions

The web pages of the Andean television stations should improve the management of their portals. This allowing greater accessibility to the users and giving hyperlinks those allow the audience to access to different contents. Although the television stations have adapted to the changes induced by the social media, it is necessary to make a greater updating of content that attracts to the user with varied information.

It is necessary to promote the portals of public television stations. It should have a greater functionality in their web pages, in a way that the user find information and hypermedia content that reflect in a graphical and updated form relevant events. The design of the web pages is fundamental and on this depends to get and keep the audience's attention.

The websites of Andean television stations present an optimal level of accessibility from different browsers. However, still should be worked in tools that allow the access to people with visual or auditory disability. The Andean channels should create applications (Apps) that grant feasibility in the access to the content posted in the portals.

Although the social networks are established in the web pages of the channels, its management does not reflect an appropriate use. Not all the social media are integrated in the web sites; their content is not displayed when the pages are opened.

A point to be improved in the web pages of the Andean channels is the feedback with the users through comments, ratings or content shared. These aspects are established as fundamental if the channel wants to know of first hand what points should strengthen or what themes are interesting for the audience, that may or not be the same of the television.

With the results obtained, it can be established that the web pages of the Andean channels should strengthen its management and structure to be considered as a second screen of information. It is necessary to establish mechanisms through which they diversify the way of presenting informative material or of any other type.

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New Technologies and New Experts

An Insight on the Idea of Expertise in Relation with New Media

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Abstract. Have new media and new technologies brought new conditions to what we understand as media expertise? How do these apply to journalism? The traditional idea of expertise is being contested in relation to the changes brought by new technologies. Some processes in the production of information have been shortened by new media, making epistemological expertise and technical expertise converge in the definition of the multimedia journalist. The relation between the author and the public has also morphed the meaning of authorship, now that the audience plays an active role in the stories. The state of the expert as an authority determines the professional relation that governs the newsroom; in a moment where the multimedia journalist harnesses a larger responsibility in the stories, this must be managed through dialogue and recognition by higher-ranked professionals. With all, the expert acts as such when it uses its knowledge and skill in order to adapt.

Keywords: New experts · Media expertise · New media · Multimedia journalist · Mobile journalism · Social media · Online authorship

1 Introduction

Mobile technology and social media have brought the journalistic profession to a whole different level, reinventing its storytelling formats, platforms and practices, as well as redefining the figure of the journalist itself. In the practice, newspapers and journalist are still struggling to make the transition to this new era in the media, and most of the people we considered experts in this field come from a different environment (traditional journalism, understood as the pre-digital era). So how has this figure of what we understand as an expert morphed with the arrival of new technologies?

There are 3 elements associated with the idea of 'expertise': knowledge, as to how professional experience needs to be increasingly complemented by technical expertise, specially regarding the constant update in storytelling formats, which have become more dependent to social media's sensibility; authorship, and how the contents generated by new media journalists are no longer unidirectional, but they now find continuity and depth in the feedback received by the reader, which diffuses the traditional relation between author and content; and authority, looking at how the hierarchies in the newsroom are being contested, as the new journalist is occupying more steps in the narrative

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process in what we call 'role convergence' (Flew) [1], which forces the expert (understood in this case as a higher-ranked professional) to engage in a deeper, more meaningful conversation with other professionals in order to maintain his status. Professionalism also plays a big role in the idea of the 'new expert' as the pace in which new formats appear implies agility in developing new practices, and new codes. With all, the expert is now not only judged by his experience and understanding of the media universe, but is also challenged by his ability to adapt.

2 What's an Expert?

The concept of 'expertise' is a much discussed one, as it is difficult to draw the line as to where one leaves its previous status of knowledge or skill to become an expert. In the professional and academic spheres, both the requirements and the process are questioned, but in the end, the privileges of expertise can only be exercised if an individual has being recognized as such by other experts (Wai) [2]. This is how we're going to understand the concept of 'expertise' in this paper, treating it as a *status* gained through the recognition of equals. At the same time, knowledge and skills only gain meaning within the context of the social system where the expert is regarded as such (Stein 1997 as in Gobet) [3]. This relativizes expertise to be applied generally as a comparative title or in specific contexts as a figure that holds a position as a reference, one that is supported by its mastery in a particular field and its *intention* to become an expert.

> *"Everybody knows amateur tennis players or pianist who fall short of expert performance despite having practiced their favorite activity for years. In fact, there is direct empirical evidence from research on clinical expertise (Meehl, 1954) and chess (Gobet, et al. (2004) indicating that the correlation between expertise level and the number of years spent in a field is weak". (Gobet, 2015)* [3].

This intention is the difference between the conscious application of knowledge in its different forms and the simple accumulation of it through time. An expert tests its knowledge in every situation where it has to act as one.

According to Weinstein, there are 2 types of expertise: the epistemic expertise and the performative expertise (Weinstein) [4]. In order to allocate these in a modern newsroom we're going to understand the first one as knowledge based on professional experience and the second one as technological expertise.

But what are the implications of being an expert? Marshall McLuhan associated 3 elements that constituted his idea of an expert: knowledge, authority and authorship. By analyzing these in the context of new media journalism (in particular mobile journalism and mobile video-journalism) we will try to portrait an idea of how the concept of expertise has and is still changing in this area. We will also talk about the changes in the practice and how this affects the experts through the idea of 'professionalism'.

3 Knowledge and New Technologies

Knowledge is the basic element of expertise from which the rest of the features of the expert (authority and authorship) derive. It's the base of every professional practice and

particularly in the case of journalism it doesn't work as much as a pre-requisite than it does as an ongoing process in which this is gained through the exercise of the profession (professionalization). This means that knowledge in this case is fundamentally conformed by experience. Experience in developing stories, gained through the exploit of the journalistic formats. The essence of news coverage and storytelling is static: they will always be related to a time and space. All of the rest has changed. The way we gather stories in the digital world, with a strong social media influence; the way we precise the formats we use depending on our audience (writing for the web, twitter, snapchat); and the thing that challenges 'traditional experts' the most: the technologies we use to create our content.

> *"Digital expertise might not be considered important any more; computers have automated various cognitive tasks, 'people' are 'becoming native', and the speed of change means that nobody is, or can be, expert. Indeed, expertise can be left to others". (Basset, Fotopoulou, Howland 2015)* [5].

The speed with which technologies in media production develop requires a constant update and revision both in software and hardware; here, what we know as a digital native has an advantage over the non-native, as the first one has conformed his epistemological cosmos around the digital culture, which makes new technologies more of a condition than an acquisition. Take for example mobile video-production in contrast with traditional forms of video editing, considering that "it is now possible to edit a video on a phone with broadcast quality with a very intuitive software" (Montgomery) [6], and that this technologies cover a bigger part of the cognitive process involved in more complex editing. The point of being a mobile video-producer is not only to be an editor, but also the reporter, the scriptwriter, everything. This role convergence is what defies the expertise of the traditional editor, as it questions the real world applications to his work. The question with which we could illustrate this discussion is: how long until mobile technologies completely eliminate the need for a professional editing equipment (and a professional editor) in order to produce a standard newscast? If we take into account that back in 2009 there were no mobile editing softwares, and 7 years later we're already capable of editing 4K footage on an iPhone 6S, I would say not that long.

Inval Klein-Avraham and Zvi Reich wrote about the 'deskilling effect' that photojournalist suffered in Israel in the transition between analogical and digital:

> *"The set of subtle skills (similar to playing music or performing a surgery), necessary for capturing publishable frames under pressure of uncertainty that characterized the chemical period, has now been replaced by a set of crude skills (like walking and driving) of digital photojournalism, which constitutes almost ubiquitous competencies of any owner of a smart phone who happens to be in the right place at the right time" (Klein-Avraham, Reich 2014)* [7].

What's interesting about this quote is that it illustrates pretty accurately how the two kinds of knowledge that we considered in journalism are overlapping each other, as the technical expertise is taking ground on the experience of the journalist in the professional routine. Klein-Avraham and Reich go a bit further with this:

> *"Still, even if photojournalists were able to harness the new technologies for re-skilling or up-skilling, and even if their organizations were not entirely blind to their professional superiority*

compared to amateurs, in practice, they demonstrate a growing reluctance to pay for the added value of professional photojournalists." (Klein-Avraham, Reich 2014) [7].

This adds up to the discussion over whether the quality of the products developed by new mobile technologies are good enough to compete with those made with studio-based equipment in a professional environment. However, what's clear is that the tendency of 'expertise' in the newsroom is to dilute and converge into a multidisciplinary professional, as particular processes in the creation of news are being simplified by new technologies, and journalists are now asked to take part in more steps of the production.

4 Authorship and Social Media

The traditional relation between the author and the public in journalism was simple: stories were told and projected unidirectionally to an audience, whether that was in print media or TV, and this facilitated the recognition of the author as a unified voice. "The journalist found the information, shaped it into an accurate story and transmitted it as quickly as possible to a mass audience via a mass medium" (Donica Mensing 2012, as in Franklin) [8]. With the arrival of the digital era and the profusion of social media, that has changed completely. Now, stories are projected towards an audience that has the ability to give instant feedback to the author and the rest of the community, which contributes to the story both in content, depth and reach. We have now grown used to reflect and put interest on what the reactions are to a story at the same time we sink in the news.

The author, in this new dynamic, is the responsible for the start of the conversation, but the contents of the same now belong to multiple authors, meaning that the audience can now interfere in the same platform with its own contents, dissolving the original meaning of authorship.

Journalists themselves are not the only ones being affected by the changes in authorship, news companies also see their authorship as a brand compromised by content aggregators and social media. In the 2016 Digital News Report, Nic Newman states the following about news brands:

"The growth of news accessed and increasingly consumed via social networks, portals and mobile apps means that the originating news brand gets clearly noticed less than half the time in the UK, and Canada. In countries like Japan and South Korea, where aggregated and distributed news is already more widespread, the brand only gets noticed around a quarter of the time when accessed through news portals." (Newman 2016) [9].

This is specially sensible in the case of Facebook, the meta-aggregator of news, or aggregator of aggregators, as the rate at which stories are copied from one site to another dilute the traces of authorship. With the threat of fake news becoming a reality in the online conversation, authorship needs to be protected and projected in order for media companies to preserve their status of expertise.

We can conclude then, that social media has definitely had an impact in authorship, as not only its users have diluted the author in bigger conversations, but at the same time

dilated the stories to fit more authors in them. On the other hand the platforms themselves, whilst facilitating the access to news, the lack of editorial intervention has also contributed to cover the original source of the content in what refers to user awareness.

5 Authority and Dialogue

New technologies such as mobile phones have brought more independence to the new journalists, as they are now able to cover more steps in the production of their stories. In video production, for example, a mobile journalist equipped with a smartphone is able to shoot and edit their stories on their own device and present it in the newsroom as a more elaborate piece. This forces editorial managers (as the experts) to engage in a deeper conversation with the journalist in order to maintain an efficient work relationship.

> *"News organisations, as 'experts', are in need to find the appropriate structures to harness innovation, or they will struggle in the knowledge age". (Quinn, 2012)* [10].

The technical and the epistemological aspects of the story are inextricably linked in the editing process when this is reduced to a single agent. Therefore, the ability to maintain a dialogue with the journalists at a more conceptual level, delegating an amount of responsibility equal to the narrative possibilities of their devices (this is, acknowledging and requiring them as experts), is what's going to preserve the authority of the editors and their status as experts. The expert editor as an authority is, in this case, increasingly more connected with its task through the expertise of others.

> *"Certainly considering questions of cultures, communities and expertise, in relation to digital transformation, it was not possible to presume that expertise itself was a given, stable category." (Basset, Fotopoulou, Howland 2015)* [5].

This can be illustrated as well through the example of digital photography. As Klein-Avraham and Reich stated in his article Out of the frame: a longitudinal perspective on digitization and professional journalism:

> *"Unlike their chemical predecessors, who had to send their superiors entire assignments for selection, including frames that viciously expose poor performances and limited skills, digital photojournalists can not only send a small subset of what they consider as best frames, but also Photoshop at least some of their technical mishaps easily and quickly." (Klein-Avraham, Reich 2014)* [7].

Editors have in this way lost some control over the materials that are managed in the production, as new technologies have enabled new journalists to hand-pick the footage they send to them, which ultimately forces the editor to engage with the (empowered) creators in a different way, in order to maintain a stable professional relation. As they quote in the same article about the pre-digital era, "the editors kept asking for more and more pictures, and ended up publishing the ones I didn't want them to" (Klein-Avraham and Reich) [7].

6 Conclusions

Being an 'expert' in a newsroom is probably one of the most contested status in the professional world. If we take Ingrid Bejerman's words: "there's never been a single unified activity called 'journalism'." (Bejerman) [11] we will understand that being an 'expert' in the journalistic area implied a high level of specificity. That specificity has now being contested by the rise of the multimedia journalist, therefore, the 'expert' in the newsroom is now not only someone with a strongly experienced background and a deep understanding of the practices, but also one that's able to adapt to the fast changing circumstances in the profession, sometimes assuming the role of an explorer of new possibilities, in an environment which both journalists and readers are still struggling to define.

For the online journalist, its expertise is constantly being contested by other voices in the space where this role is assumed through authorship. This is, as an author, the journalist also needs to be an expert 'moderator' and 'debater', securing it's arguments throughout the extent of the conversation, sometimes beyond the boundaries of it's own publications.

The figure of the knowledgeable expert collides with technology in the context of the newsroom when put into practical terms. This means that the gap between the added value of knowledge and the automatization of some technological processes is closing in for some professionals. Technical expertise is in this case the one challenged by the pace of technology and a possible future where in the routinely journalistic practices this expertise is taken for granted, or left for more specific applications outside the narrative aspects of news production.

This eventual convergence of the technological expertise could change the landscape of the newsroom significantly, narrowing the amount of steps in production and the number of agents involved.

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Instant Messaging Networks as a New Channel to Spread the News: Use of WhatsApp and Telegram in the Spanish Online Media of Proximity

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Abstract. In the areas of proximity, local and hyperlocal media reinforce the link with the community in which they operate and open more and more channels for citizen participation. In a context in which smartphones and tablets are already the first device to access the Internet and consult online news for much of the population, this research pursues the objective of knowing which are the uses that the Spanish online media of proximity make of instant messaging networks to spread the news and keep in contact with their users. For this, the content of the messages sent by five media outlets through WhatsApp and Telegram networks is analyzed, taking as sample period the week between November 28 and December 4 of 2016. The results obtained show a diversity of strategies and contents for the spreading of news, without any initiatives of real conversation with the readers.

Keywords: WhatsApp · Telegram · Social networks · Online media · Mobile journalism

1 Introduction

In the globally connected environment of the network society, the community – understood as a geographic, social and identity entity – needs public spaces of communication to share common interests [1]. Proximity information is then revalued as a meeting place of the local community, which on the Internet strengthens its connections [2], and promotes the growth of local online media, understood as "that transmitter of contents about the local entity that has the will to mediate between facts and the public, basically

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uses techniques and journalistic criteria, uses the multimedia language, is interactive and hypertextual, is updated and published on the Internet" [3].

In the last decade, the media ecosystem of proximity has been renewed with the rise of hyperlocal media, a global phenomenon that has its predecessors in the United States [4]. The reasons for this transformation are several, highlighting the crisis of the traditional local press, the low cost of the tools of production and dissemination of content in the Internet or the change in the behavior of audiences towards more active roles [5]. Hyperlocal media are characterized by operating in small, defined geographical areas – such as a town, village or single postcode – [5], being web-natives, producing original content and covering gaps forgotten by traditional media, maintaining a clear community orientation and promoting citizen participation [6].

The conformation of these new networks of media of proximity occurs in a complex process of transformation in the communicative and media system as a whole. Immersed in the culture of convergence [7], and especially in technological one [8], as well as in participatory culture [7], the media explore new channels and formulas for communication and interaction with their audiences. In a system in which mass self-communication [8] is imposed, so-called prosumers [9] increasingly play a more relevant role, reinforced through social networks [10] and the ubiquity of mobile devices.

2 Theoretical Approaches

2.1 Mobile Devices as a New Medium for the Production and Distribution of News

In recent years, mobile devices have transformed production routines, distribution channels and the ways for information consumption [11], so that the media is no longer a support and becomes a multi-platform service adapted to the user's needs [12]. The characteristics of smartphones (portability, ubiquity, personal use, multimediality, hypertextuality and interactivity) allow multiple possibilities of customization of the informative offer, depending on the geographical location of the user or the activity that it is performing [13].

In the areas of proximity, the increasingly relevant use of smartphones by journalists and citizens allows new collaborative forms of production and consumption of news. Community members can share what is happening in their environment in real time and this information can be immediately reviewed and edited by journalists [14].

As an informative medium, mobile devices have multiple advantages [15], which can be summarized as: interactive capacity, adaptability to consumer conditions and user context; linkage to the identity and personality of the user; incorporation of content produced by users and by media institutions or organizations; values of simultaneity and sequentiality.

These possibilities began to be explored by the media in the nineties, with alert services via SMS, MMS and the first WAP portals. Following the chronology of Aguado and Castellet [12], the development of mobile broadband and the lowering of data rates made it possible for the media to distribute their content through the mobile web, without depending on the operators' portals. The beginning of the third stage was determined by the launch of the iPhone in 2007, which imposed the standard of the smartphone with

touch screen associated with an applications platform [12]. Since then, the media have launched their own APPs, in which they simplify and make the relationship more direct with their users, basing their information services on immediacy, proximity, personalization and socialization [12].

In addition to the applications, the use of mobile social networks has favored this more direct and participatory relationship with the audience, since they allow the transmission and reception of news in real time [16], the development of SoLoMo strategies (Social, Local and Mobile) [17] or exploring the possibilities of transmedia narratives [18].

2.2 Penetration and Uses of Mobile Devices and Social Networks in Spain

In Spain, according to data from the report *La sociedad de la información en España 2015* [19], 78.8% of the population between 16 and 74 years of age has used the Internet in the last three months and 64.3% did it daily. On the other hand, according to the results of the *Estudio Mobile 2016* [20], 94% of the population between 16 and 65 years old owns a mobile phone, which is mostly a smartphone.

Mobile devices are the most used access point to the Internet and the smartphone already surpasses the computer, with 88.2% compared to 78.2%. This trend is intensified in the case of the youngest (14–19 years), with a difference of 17.1 percentage points [19]. The mobile phone plan that combines voice and data services is still the majority way of going online (86.4%) and the combined use of Wi-Fi and data rate is increasingly frequent [19].

On average, users connect to the Internet 2 h and 34 min a day through their smartphones [20] and regularly use an average of 9.1 applications, although they have up to 17.8 APPs installed on their devices. According to the *Digital News Report 2016* [21], 34% of Spanish citizens use mobile phones to access online news, a percentage that rises to 50% and outperforms the computer among adults under 45 years.

As to social networks, IAB Spain's latest annual report [22] reflects that they are used by 81% of Internet users in Spain between 16 and 65 years, which means more than 15 million users. The smartphone is the second device for online activity (91%), behind the computer (94%). The main use of social networks continues to be to chat and send messages (79%), followed by videos and music (57%), see what contacts do (48%), publish content (36%) or follow influencers (36%). Commenting the news occupies a seventh position with a 29%.

Paying special attention to the instant messaging networks analyzed in this study, WhatsApp and Telegram, it is observed that WhatsApp is the network most valued by the users, while Telegram occupies the fifth position [22]. WhapsApp also leads the frequency of use, with an average connection time of 5 h and 14 min a day, compared to 2 h and 52 min of Telegram [22]. As for the frequency of visits, WhatsApp is also the most consulted network (48%), followed by Instagram (47%) and Telegram (41%) [22].

The growing preponderance of use of instant messaging networks is being exploited also by the media. In 2011 the BBC started some experiences of information dissemination through this type of APPs [23], and since then many international and national

media have opened channels in applications such as WhatsApp, WeChat, Facebook Messenger or Telegram, both for the broadcast of its news as for the citizens being able to send information [24]. Examples of this new trend are the Quartz application [25], which provides information to the user through a conversation, or the use of bots through Facebook Messenger by the New York Times [26].

3 Objectives and Methodology

The main aim of this research is to know which are the uses that the Spanish online media of proximity make of the instant messaging networks. Specifically, pretend to identify distinct kinds of strategies and forms of relation with the users through the applications of instant messaging. Furthermore, it pretends to check if these APPs work only like a new channel for the informative diffusion or develop other forms of participation and dialogue with readers.

To this end, five Spanish online media outlets with active channels in WhatsApp and/or Telegram networks – the most used messaging applications by the Spanish citizens [23] – have been selected. The next generalist online media of proximity, born through traditional newspapers, have been selected after an exploratory work in which we check it if they keep active instant messaging networks or not: *Diario de Mallorca* (diariodemallorca.es), *El Comercio* (elcomercio.es), *Faro de Vigo* (farodevigo.es), *Las Provincias* (lasprovincias.es) and *Sur* (diariosur.es) (Table 1).

Table 1. Features of selected online media outlets based on own exploration

Online media	Owner group	Geographical area	WhatsApp (launch date)	Telegram (launch date)
Diario de Mallorca	Grupo Editorial Prensa Ibérica	Insular (Mallorca)	Yes (Feb. 2015)	No
El Comercio	Grupo Vocento	Autonomous (Asturias); municipal (Oviedo, Gijón, Avilés)	Yes (June 2016)	No
Faro de Vigo	Grupo Editorial Prensa Ibérica	Regional (Louriña, Redondela, Baixo Miño, Val Miñor, Condado Paradanta); municipal	Yes (March 2015)	No
Las Provincias	Grupo Vocento	Provincial (Valencia); regional	Yes (May 2016)	Yes (May 2016)
Sur	Grupo Vocento	Provincial (Málaga); regional	Yes (Aug. 2016)	Yes (Aug. 2016)

We established a time frame that goes from Monday 28th November to Sunday 4th December both 2016, both included. During those seven days we captured all the messages sent by media through WhatsApp and Telegram, later they have been reviewed by a content analysis. In order to this, a factsheet from a previous essay has been used, [27] it contains variables to the message analysis, the purpose of the discourse, the news value of the sent news pieces and the elements present on the dispatch. In the following section, the results of this analysis – expressed in percentages – are presented. For some variables the total of the percentages of its categories can be greater than 100 for the same media outlet, because each news can be associated to one or more categories.

4 Results

During the sample period, 84 shipments were registered through WhatsApp and 33 through Telegram. In each of these shipments it is frequent that the media include several headlines or news, whose content we analyze individually. Following this criterion, the total number of news studied and received through WhatsApp is 250 and 52 through Telegram.

The newspaper *Sur* send a total of 27 notifications by WhatsApp (30 news) and 27 by Telegram (31 news); *El Comercio* 13 by WhatsApp (77 news); *Las Provincias* 6 sends by WhatsApp (21 news) and 6 others by Telegram (21 news); *Diario de Mallorca* 16 shipments through WhatsApp (80 news); and *Faro de Vigo* a total of 22 (42 news) by WhatsApp.

For the first of the variables studied, 'analysis of the message', four categories have been analyzed (information, opinion, clarification and advertising). The newspaper *Sur*, the 93.3% of WhatsApp news is informative, while in Telegram the percentage is 93.5%. In this same media, 3.3% of the news in WhatsApp and 3.2% in Telegram have an opinion value. Data are repeated for the 'clarification' category and no results are reported for 'advertising'.

On the other hand, the total of messages in *El Comercio* corresponds to the category 'informative'. This same result is repeated in the case of *Las Provincias*, both in WhatsApp and in Telegram, as well as in *Faro de Vigo*. *Diario de Mallorca* is the only analyzed online media that registers some 'advertising' message, in 1.3% of the cases. All other messages are 'informative'.

As for the second analyzed variable, 'purpose of the speech', for the WhatsApp channel of the online media Sur, 83.3% of the news is recorded as 'news event', amount that increases slightly up to 83.8% in Telegram. The news corresponding to the categories 'show the point of view of the media', 'call to participation' and 'clarification by mistake or extension' recorded a percentage of 3.3% in WhatsApp and 3.2% in Telegram. To these we have to add a 6.7% in WhatsApp and a 6.5% in Telegram corresponding to the news of 'agenda setting'.

In *El Comercio*, 98.7% of the news has a purpose based on 'news event'. In addition to this, only a 1.3% is registered with the purpose of 'call to participation'. In the online media *Las Provincias*, the total news in WhatsApp and Telegram correspond to the category 'news event'. In *Diario de Mallorca*, 92.5% of news items have the same

character, while, to a lesser extent, information is recorded concerning 'agenda setting' (6.3%) and 'call for participation' (2.5%). Lastly, in *Faro de Vigo*, 97.6% of the news is identified as a 'news event', a 4.8% that shows the 'exaltation of the media', 2.4% for 'agenda setting' and another 2.4% 'call for participation'.

The third variable of the analysis corresponds to the 'news values', whose categories are reduced to 'actuality (breaking news)', 'proximity' and 'public interest' (Table 2).

Table 2. Distribution of news according to analyzed news values (%)

Online media	Actuality	Proximity	Public interest
Sur (WhatsApp/Telegram)	16.7/22.6	86.7/90.3	53.3/54.8
El Comercio	22.1	84.4	24.7
Las Provincias (WhatsApp/Telegram)	19.1/9.5	90.5/90.5	33.3/33.3
Diario de Mallorca	10	91.3	28.8
Faro de Vigo	23.8	88.1	23.8

In the last analyzed variable a count of the different elements that include each shipment is made. The newspaper *Sur* stands out because of the higher number of emoticons. The percentage of use is 123.3% in WhatsApp and 119.4% in Telegram. On the other hand this media makes a relevant use of the links, 106.6% in WhatsApp and 103.3% in Telegram. This happens because some news have two links. This is important because the implementation of these new distribution channels responds, among other objectives, to the need to increase traffic to the web. So, other elements used to a lesser frequency are images and videos, with a 3.3% in WhatsApp and 6.5% in Telegram, in both cases. The online media does not use hashtag in its notifications.

El Comercio uses a link by news and 41.6% of the messages add emoticons. As for the other analyzed elements it does not use them. Furthermore, *Las Provincias* uses them in all news links and stands out for being the only online media outlet of those analyzed that makes use of hashtag, in 9.5% of their messages in WhatsApp and Telegram. The messages lack video and image content.

It draws attention to the regularity of the use of a single emoticon and a unique link by news in the messages of *El Diario de Mallorca*. In addition, in a small percentage, 1.3%, uses the hashtag. The other elements analyzed are not present in the news reported by these channels. Finally, *Faro de Vigo* only makes use of the links, one for news, and emoticon. It can be said that the percentage of these is very high, up to 192.8%. The cause of this strategy may respond to the idea of the image of relaxation and dynamism that wants to show the media and also to attract attention.

The last category analyzed is the one referring to the theme of the news sent by the online media outlets (results in Table 3). In addition to the classification by topic, the geographical ascription of each news item has been identified, observing whether they deal with an international, national, regional or local issue.

Table 3. Theme and geographical ascription of the news by online media outlet (%)

	Sur (WhatsApp/ Telegram)	El Comercio	Las Provincias (WhatsApp/ Telegram)	Diario de Mallorca	Faro de Vigo
Crime	0/0	33.8	23.8/23.8	16.25	19
Culture	16.7/19.4	0	23.8/23.8	5	2.4
Economy	10/9.7	11.7	14.3/14.3	7.5	9.5
Education	3.4/3.2	1.3	0/0	2.5	0
Employment	3.4/3.2	0	0/0	2.5	4.8
Environment	0/0	0	0/0	1,25	0
Health	10/9.7	2.6	0/0	5	0
Justice	3.4/3.2	0	4.8/4.8	5	0
Law	3.4/3.2	1.3	0/0	0	0
Meteorology	33.4/35.5	16.9	14.3/14.3	2.5	2.4
Opinion	3.4/3.2	0	0/0	0	0
Politics	0/0	11.7	4.8/4.8	11.25	7.1
Social	3.4/3.2	1.3	4.8/4.8	25	21.4
Sports	0/0	11.7	9.5/9.5	15	29.2
Town planning	6.7/3.2	7.8	0/0	1.25	7.1
Treasury	3.4/3.2	0	0/0	0	0
International	0/0	9.1	4.8/4.8	8.8	16.7
National	10/9.7	14.3	4.8/4.8	2.5	9.5
Autonomous	6.7/6.5	22.1	52.4/57.1	26.2	11.9
Regional	83.3/83.8	54.5	38.1/33.3	62.4	61.9

5 Conclusion

The observation and analysis of the messages sent through WhatsApp and Telegram by the online media outlets analyzed allows us to observe some common trends. The volume of sendings – 2.4 a day on average – is sufficient to keep the users informed of the most relevant and breaking news of the day, without it becoming invasive for the user.

In the analyzed media outlets, two different strategies for the diffusion of news are observed: on the one hand there are some online media that generally send two notifications a day, one in the morning and another in the afternoon, in which they concentrate the most important news, as does *El Comercio*; and on the other hand there are those who carry out a progressive sending of the most relevant news throughout the day, such as *Faro de Vigo.*

The results of the content analysis allow us to conclude that most messages are informative and spread the most important news events, which mostly correspond to the news value of proximity. Although the news value of breaking news is the least relevant of those considered in the analysis, during the week of the sample highlights the sending

of notifications of this kind to monitor the floods suffered in Malaga and the Chapecoense's air crash in Colombia. In addition, almost all news are accompanied by links and emoticons – adapting to the possibilities of the language of these platforms – while hardly using hashtags, photographs or videos.

Although there are notable differences in the most relevant topics of the news diffused by each online media outlet, among the most recurrent are culture, economics, meteorology, politics, social, crime and sports. In addition, most of the news are ascribed to a local territorial area, following the character of proximity of the online media outlets.

Finally, it is possible to conclude that the instant messaging networks WhatsApp and Telegram are used by the studied online media outlets like a new channel to spread its news and attract traffic towards its websites. The media outlets that use both networks repeat the same content in them, so it seems that they don't have a differentiated strategy adapted to each channel. Although these applications are designed for the dialogue between their users, the media are using them as a one-way communication channel, without any initiatives of participation and real conversation with the readers.

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Transparency and New Technologies: Accountability of Public Television Broadcasters in the Andean Countries

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Abstract. One of the distinctive features of the current citizenry is its growing demand for an increasing ethical commitment and transparency from its political representatives and the public or private institutions related to them. This growing demand should also apply to public television broadcasters, since they are usually funded by state resources. Moreover, they play an important role in the citizens' full enjoyment of their right to information, thereby favoring a formed public opinion and, in consequence, having an impact on the quality of democracy in their countries. Therefore, this paper proposes 29 indicators aimed at generally analyzing and assessing the transparency of television broadcasters and being applied to state-level public televisions in the Andean countries: Bolivia, Colombia, Ecuador and Peru.

Keywords: Transparency · Public television · Andean countries · Political communication · Public information · Accountability

1 Introduction

The social transformation which has been identified in the Andean Community over recent decades due to the principles of the free market has caused a series of changes in the economic, political, social, technological, legal and cultural structures of this region. It has been precisely from a cultural perspective that the Andean countries have faced enormous challenges that force them now to reconsider their previous scenarios.

The media and culture globalization is oriented towards the identification of the information and knowledge society, in which cultural industries play a key role. This situation calls for an analysis of the special features of the broadcasting providers in the Andean countries, "the cultural industry is becoming a strategic sector for competitiveness, employment, consensus-building, the style of politics and the circulation of information and knowledge" [1].

The hegemonic role of the audiovisual processes and, especially, of the television in the cultural industry is not only linked to the societal needs, but also to all other industries. Meanwhile, the broadcasting providers have assumed new digital processes, leading to the creation of paradigmatic scenarios on traditional communication.

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2 Theoretical Framework

This paper arises from the understanding that information and knowledge technologies provide new opportunities for the bilateral relationship between organizations and citizens. This relationship is established from a liberal or corporate perspective and is based on total transparency and favorable conditions when it comes to accessing or having any type of information [2]. Thus, communication is creating spaces for participation that allow a better access to public information and a permanent control, offering the possibility of expansive accountability.

Table 1. Transparency indicators on institutional information

Indicator	Ecuador TV	Bolivia TV	TV Colombia	TV Perú
Is there a section containing any information about the channel's history?	X	√	X	√
Is there any information provided about the legislation applicable to this entity?	√	√	√	√
Is there any information on the method of appointing members of the Management Board or similar body, its structure and remuneration?	X	P	P	P
Is there any information given about the leading manager of the entity?	X	P	√	√
Is there any institutional agenda established for this leading manager?	X	X	X	P
Is there any basic information provided about the organization chart and are the functions clearly defined?	P	P	P	P
Is there any report on work positions including the remuneration based on categories?	√	√	√	√
Is there any information available on the working conditions or the applicable collective agreement?	P	P	P	√
Is there a clearly defined and accessible directory?	√	√	√	√
Is there an accountability report published?	P	√	√	√
Is there a clearly defined section with the name "Transparency"?	√	√	P	√

√ = fully met indicator, P = partially met indicator, X = non met indicator
Source: own compilation

There is an ongoing transition process in the television industry, moving from traditional approaches to digital television. It is here that digital platforms become the new

trend due to the content immediacy and versatility. The Andean countries are experiencing changes in terms of audience, that is, there is a more critical, active and technological consumption.

In accordance with Abel Suing [3], the new television in the Andean countries is emerging as interactive, since it allows participation through the Net and technology. It is a fact that the convergence of digital media and multimedia systems shapes the processes of interactivity (Table 1).

The public television channels have been gaining ground in Latin America, striving to create an own identity mark for the people and countries concerned. "The public television implicates the audience, including the consumers, as citizens. It was paradoxically during the rule of economic neoliberalism that Latin America's democracies referred to themselves as being participatory in the future, by means of new constitutions or parliamentary reforms" [4] (Table 2).

Table 2. Transparency indicators on economic information

Indicator	Ecuador TV	Bolivia TV	TV Colombia	TV Perú
Is there any information provided about the assigned amount to the entity from the State budget?	P	X	P	X
Is there any information given about subsidies or any other contribution granted to the entity?	P	X	P	X
Are the annual accounts published together with their audit report?	√	X	P	P
Is there a monthly report offered on budgetary implementation?	√	X	√	P
Is there any information about the outside production costs?	√	X	X	X
Is there any place available on the website for the contractor's profile?	√	X	√	√
Is there a list of companies which are beneficiary of contracts?	X	√	√	√

Source: own compilation

Public television has exceeded a strategic scenario that allows the recreation of a more inclusive and representative vision of the nation, meaning a public television that is able to overcome the audience fragmentation and addresses all citizens. In this regard, Barbero [4] points out that "the first public television will be marked in Europe by an elitist conception and a highly proactive bias: intellectuals and artists think they know what the masses need and therewith they recreate the national culture. In addition, until the mid-1970s, when the process of deregulation starts, the public model will deliver excellent results both from the cultural point of view and at the political and economic level".

According to the Obitel 2016 Yearbook [5], the year 2015 "boasted countless technological, narrative and programmatic changes in the television industry. The large

number of transformations at all levels resulted from the fact that media corporations have undergone structural changes by expanding their reach to new markets. This has led them to home their strategies in the digital field, even though this occurred amidst the crisis caused by a drop in television ratings in most of the countries" (Table 3).

Table 3. Transparency indicators on information production and content access

Indicator	Ecuador TV	Bolivia TV	TV Colombia	TV Perú
Is there any basic information provided about the Drafting Committee or any other similar body in the field of contents?	√	√	P	P
Is the editorial approach of the medium expressed, as well as the existence of a clear and accessible code of ethics?	P	P	P	P
Is there a data protection policy?	√	√	P	√
Are there effective channels for the audience participation/consultation?	X	P	X	√
Is there any specific place on the website for the figure of the viewer defender or similar role?	X	P	X	X
Can the right of access to public information be exercised?	√	√	P	√
Is there a content archive?	√	√	√	√
Are there self-regulation codes on contents and children?	√	P	P	P
Are there information treatment codes on vulnerable groups?	√	√	√	P
Are there mechanisms provided for the program and content assessment?	√	P	√	P
Are there operational social networks?	√	√	P	P

Source: own compilation

All these changes at conceptual, content and structural level bring new dynamics and habits in terms of audience consumption. The trends focus on the boost given to telecommunications, computing and leisure industries. Changes are also prevailed by the users themselves, by setting alternative ways of interaction and interactivity from the perceptual processes.

Such is the case of Ecuador, were after the application of the Organic Law of Communication and its Regulations, a paragraph was added to Article 38 in December 2015 to provide that "communication as a public service will be provided by public, private and community means". In this manner, it is established that communication is a public service, that is, competence of the State. The Constitution also establishes that communication is a right, that is, the citizens' competence [5].

This new provision has caused uncertainty as to what definition prevails in the decision of the media and under what circumstances remains the concept of "communication as a public service", thus generating tensions between the State and the citizenry.

In accordance with the Ibero-American Observatory of Television Fiction [5], in Colombia, communication policies debated on the definitive expansion of 4G mobile telephony, the implementation of greater coverage for Digital Terrestrial Television, the development of Plan Vive Digital and the presence of new actors, such as Netflix, in content transmission.

The same observatory confirms that Peru had an increase in ICT access in 2015 and grew 2% in respect of the previous year. Contrariwise, cable television showed a 3.5% decrease in respect of 2014. Part of this decreasing tendency is due to a greater offer in the country from services such as Netflix, compounded by a rise in prices and a constant reduction in the services offer [5].

Latin American countries are experiencing important changes in their audiovisual production, resulting in an audience evolution towards a more critical and active consumption, also in terms of content production. The media entities are increasingly aware of the uses that they give to the media, as they turn their communities into spaces where different narratives converge and expand in multi-platforms. It is the age of *high-tech*, the implementation of the excess-image [6].

Therewith, the ECLAC's experts [7] make it clear that all reflection on the future of Latin America and the Caribbean should consider the important role that the cultural industries may play in the improvement of competitiveness, employment and cultural exchanges democratization.

Parallel to these analyses, the need for rethinking the audiovisual sector is evident, placing the television as the carrier medium for education and culture, able to overcome the barriers of empty content. This medium must remain as a model for the nations and their people.

3 Methodology and Objectives

The main objective of this research is to assess the degree of transparency that the state-level public televisions in the Andean Community reveal through their websites or the ones from the entities composed by these televisions: Ecuador TV (http://www.medios-publicos.ec/), Bolivia TV (http://www.boliviatv.bo/), Radio Televisión de Colombia (http://www.rtvc.gov.co/) and TV Perú (http://www.irtp.com.pe). The secondary objective is to make a proposal for an improvement in the field of public communication for these four broadcasters.

For that purpose, a qualitative analytical methodology is used, applying 29 indicators designed on an *ad hoc* nature in order to analyze the information available on the websites belonging to public or private radio and television providers. These 29 indicators were presented for the first time in the experimental analysis executed by López-López, Puentes-Rivera and Rúas-Araújo [8] on the Spanish and Chilean televisions. Moreover, these indicators were selected from a literature review [2, 9], from the

UNESCO Recommendations [10], from the European Broadcasting Union [11] and other sources.

The countries of the Andean Community are selected as an object of study since it is a defined area, they have similar economic development parameters, they have recently driven laws concerning transparency and access to public information and they are placed in the middle to lower stretch in the Corruption Perception Index (CPI) from Transparency International [12].

Lastly, in order to be able to score the transparency in each evaluated television broadcaster with a number on a 0 to 100 scale, being 0 no transparency and 100 the maximum possible, a value of 3.448 is allocated to met indicators, the half (1.724) to those partially met and 0 to the non respected indicators.

4 Results

In the first place, the 11 indicators referring to transparency on institutional information regarding the evaluated televisions are analyzed.

In the field of institutional information, Ecuador TV, through RTVECUADOR, meets to a high level of detail some of the indicators. There are among them indicators related to the legislation applicable to the entity (a detailed and extensive set of standards: regulations, organic laws, codes and decrees), as well as a very complete directory (name, surnames and e-mail of each employee) together with the report on work positions. On the negative side, it is not indicated who takes part in the entity's management; a "does not apply" sign (English translation for the original *no aplica* in Spanish) with no other explanation appears on the information about the working conditions; the organization chart is poor, and there is an obsolete accountability report, dated from 2014. As a general consideration, the information should be more accessible, since no interactive maps or similar sources are included and available, only PDF documents.

Concerning the Bolivia TV website, it not only provides the legislation applicable to the entity, but also enables access to it. This entity meets all the indicators, although they are partially met in some cases and the institutional agenda for the leading manager is not published. There is a list containing the position and the name of the authorities (with no photo or contact details) in the file called "Payroll" (English translation for the original *Nómina de autoridades* in Spanish), and their studies, category, type and wage level are specified in a second document called "Position profiles" (English translation for the original *Perfiles de cargos* in Spanish). Nevertheless, there is no information available over the election procedures and the functions of each authority. There is also a detailed report on work positions and their remuneration, but the organization chart is poor and vague. It is important to point out that there is a comprehensive list of legal documents in which the working standards affecting the entity's employees are partially reflected, but this list is neither accessible nor understandable. Lastly, there is a contact list, although not very long, and the accountability is available in audiovisual and written formats.

The Colombian public television website perfectly provides all the legislation applicable to the entity and in a very extensive way. A remarkable feature of this website is

the comprehensive personal information regarding the entity's managers, although their election procedure is not stated. Furthermore, the organization chart is very simple, with no name or function on it; there is not even a basic report on work positions regarding its employees, although the remuneration is stated based on categories and there is a directory containing phone numbers (no e-mail addresses). Finally, on the positive side, the meaning of accountability is explained and both the current and former reports are available.

As for TV Perú, it meets all the institutional indicators, although three of them on a partial basis. There is also a section on applicable legislation. From the accessibility perspective, the website contains an interactive program that allows an easier search by the user, including a very complete application enabling users to search for employees based on years, months, departments, remuneration, name and surname. The entity's leading managers show their full data and a short CV on the website, but without a photo or the election procedure applied to them. On the negative side, it is to be noted that there is an outdated institutional agenda and a very simple organization chart, without roles or responsibilities. Lastly, no accountability report is available, but there are two plans for the assessment of indicators belonging to the strategic plan and the institutional operating plan, that make it possible to validate this indicator since they provide a wide range of information and data.

Regarding the economic indicators, *Televisión y Radio de Ecuador* (Television and Radio of Ecuador) fully fails to meet only one indicator, the one about identifying or revealing the names of the companies which are beneficiary of contracts. In this sense, although there is a section, inside the broader section for transparency, focusing on the ongoing and resolved recruitment processes ("contractor's profile" or *perfil del contratante* in Spanish) and providing a link to the dossier in question at the "Public Procurement Portal" (*Portal de Compras Públicas* in Spanish), those links do not work properly.

In terms of the remaining indicators for Ecuador, the accounts are published in detail and broken down by month, as well as the corresponding audits. As shown in the table above, there is a partially met indicator regarding the public funds received, as it is only provided the total amount with no distinction between ordinary contributions and subsidies.

In the case of Bolivia TV it stands out the contrary, the non-respecting of any of the indicators but the list of companies which are beneficiary of contracts. Apart from that, there are no clear income and expenditure accounts; there are some documents under the name of "audits", but they do not comply with the minimum formal or content requirements for this kind of documents, and the ongoing recruitment processes are not published, as only the resolved ones appear.

Radio Televisión de Colombia (National Radio and Television of Colombia) is highlighted on the positive side due to the detailed and clear information on its recruitment policy, reporting each process opening and perfectly identifying the successful candidates. However, the budgetary information is quite simple and not very clarifier even if it meets the requirement of breaking it down by month. In addition, it identifies the income received from the State but without any breakdown.

Instituto de Radio y Televisión del Perú (National Institute of Radio and Television of Peru) also provides detailed information about the recruitment processes and the

beneficiary companies for each contract. Regarding its accounts, there is information available on a quarterly basis without going into too much detail. Such is the case also for the information on income and expenditures, which does not make it possible to identify the public contribution. Concerning its account audit, there is no report published, only a few recommendations on alleged audits carried out by the entity.

Regarding Ecuador, the existence of a drafting committee is assumed, as the Ecuadorian television sets this parameter in its web content. The codes of ethics are not identified in a clear or accessible way and the existence of effective channels for the audience participation or consultation cannot be found as a successful and ongoing process.

There is also a content archive, as well as self-regulation codes on contents and children.

With respect to social networks, the Ecuadorian television assumes an active role and participates very actively in them.

Concerning Bolivia, the indicators are partially met, as some important achievements have been observed but others do not have a management record. The civic participation is still in process even though there is a will to allow the audience interaction.

When visiting the Bolivia TV website, there is no code regulating contents and children identified. In terms of social networks, active spaces are identified but they could be improved in terms of interactivity.

Radio Televisión de Colombia (National Radio and Television of Colombia) shows a quite different situation, since the contents are supported by a drafting committee, but the composition of the committee is not available to the web users.

The editorial approach of the medium is made explicit, but it is also true that there should be, and there is not, a code of ethics that regulates the television management.

In Colombia, a series of projects were developed to take the audience criteria into consideration, but it is necessary to go to the channels of communication established for directly connecting with the audience, thus there can be no assurance that there is a space in this television equivalent to the viewer defender. Besides, in can be concluded that the right of access to public information is promoted, and this logically creates an expectation over a trend of civic participation. Regarding the content archive and according to the review of the TV Colombia website, it can be stated that there is a news and program archive.

In terms of self-regulation codes on contents and children, this indicator is partially met, as there is a "Code of Children and Adolescents" (*Código de la Infancia y la Adolescencia* in Spanish), but it is limited. Furthermore, codes of information processing are outlined regarding vulnerable groups. Lastly, there are social networks but they could be improved concerning serviceability.

In the case of Peru, it is not clearly identified the drafting committee or any other similar body in the field of television contents. Also, an organizational definition regarding the television programming can be observed on the website, but the information about who regulates the television contents is not stated.

The editorial approach of the medium is not made explicit, nor the existence of a clear or accessible code of ethics. The Peruvian Law of Transparency and Access to Public Information (*Ley de Transparencia y Acceso a la Información Pública* in

Spanish) aims to promote transparency of acts of State and to regulate the fundamental right of access to information. Nevertheless, there is no space available on its television website for the figure of the viewer defender.

TV Perú has a content archive and, even if a number of codes on information processing are deduced, it is necessary to make the guarantee of vulnerable groups transparent. To conclude, it is to be noted that the mechanisms for the program and content assessment cannot be observed. As for the social networks, they tend to be very static and they need further updating and content management.

5 Discussion and Conclusions

Some differences can be observed concerning the transparency level in these four television public service broadcasters. Nonetheless, considering the 0 to 100 scale stated in the Methodology section, the state-level public televisions in the Andean Community get as a group a score of 63.36 points, that is, they are placed in the upper half of the scale.

If these public television broadcasters are individually analyzed, the National Institute of Radio and Television of Peru is the most transparent entity out of the four televisions, getting a score of 67.24 points, very close to the score obtained by Television and Radio of Ecuador (65.51 points). A bit further from these two broadcasters but also very close to each other, there are Bolivia TV (60.35 points) and National Radio and Television of Colombia (60.33 points), the latter becoming the least transparent of the public televisions in the Andean countries.

If, instead of considering the 29 indicators altogether, the level of transparency in each of the three analysis groups is assessed, the greatest degree of indicator meeting is reached concerning institutional information, information production and content access. In both cases, the average in the Andean Community is a score of 25.86 points out of 37.93 that can be reached at most in these analysis groups. Moreover, the televisions in this study get an average of 11.64 points out of 24.14 in transparency of economic data. Thus, there are tremendous gaps regarding indicators, being the economic ones the least respected.

The most transparent television in terms of its accounts and economic management is the Ecuadorian television (17.24 points), followed by Colombia (15.51 points), Peru (10.35 points) and Bolivia (3.45 points). RTV Ecuador is also the broadcaster that meets to a larger extent the transparency indicators referring to information production and content access, scoring 29.31 points, exactly the same as Bolivia TV and far from TV Perú (24.13 points) and RTV Colombia (20.68 points). Lastly, TV Perú leads the ranking with respect to institutional information, scoring 32.76 points and followed by Bolivia TV (27.59 points), RTV Colombia (24.14 points) and RTV Ecuador (18.96 points), the latter getting a bad score in this group and thus not being the most transparent public television in the Andean Community.

In short, an effort to meet the requirement and duty of transparency is observed in the case of the four television broadcasters, but with varying degrees of intensity and focused on different objectives. However, there is room for improvement on the

economic side (especially Bolivia and Peru), in information production and content access (Colombia) and in institutional information (Ecuador).

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Diversity and Accessibility Measures to Contents in the European Broadcasting Union's Public Service Broadcasters

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Abstract. The European Broadcasting Union (EBU) was born in the 1950s as an inclusive service for everyone. However, some groups, minorities and social communities have remained in the background of the broadcasters' programmatic offering until the beginning of the third millennium. In the last few years, this situation seems to have changed thanks to new agreements and treaties. For this reason, this research tries to observe which types and how many varieties have been considered by the public service broadcasters in the official reports from 2013, 2014 and 2015. Moreover, particular attention has been given to accessibility measures for people with visual or auditory functional diversity that each of the broadcasting entities have adopted.

Keywords: Public service broadcasters · Diversity · Accessibility measures · Functional diversity · Minorities

1 Introduction

Diversity means variety, difference and abundance of distinct elements. Nevertheless, many groups, categories or classes are included under this term, so many authors conceive diversity as a multidimensional concept [1]. One of the most common typologies is the cultural one, which tries to reflect the multiplicity of cultures or cultural groups in a global, regional or local level, and their coexistence or interaction. The aim of the initiatives oriented to cultural diversity is to establish a healthy balance among the different communities in each territory.

Policies in favour of ethnic diversity are also frequent, and they try to make visible the different peoples in a society and their distinctive features: traditions, language or clothing, for example. In some cases, these actions are associated with the promotion of the linguistic diversity in regions, nations or geographical areas of a country. Functional diversity is one of the most relevant typologies too, as long as that respect for everyone should be encouraged in order to achieve an inclusive society [2], irrespective of their disabilities, or their physical or psychological limitations. In this sense, some broadcasters work to provide suitable measures of access to information for this group.

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In recent years, the defence of sexual identity has risen, and its main goal is to achieve the respect and acceptance of every sexual orientation (heterosexuality, homosexuality, bisexual and transgender people, for instance). Biological diversity is another recent typology, and it implies the commitment to preserve animal and vegetal variety in the planet as well as the rest of elements that make up the environment. Although the public service broadcasters' policies are more worried about these previously mentioned diversities during the second half of the 21st century's second decade, there are also other less common typologies which are used by some broadcasting entities too: cinematographic diversity [3] social diversity, gender diversity, age or generational diversity or professional diversity.

1.1 Diversity in the EBU Public Service Broadcasters

The European Broadcasting Union (EBU) was born in Devon (United Kingdom) on February 12, 1950 as an entity of public service with the objective of serving all citizens, a fact that seems to reject discrimination and marginalization. However, the trend is toward "giving status and legitimacy to certain sectors of society as well as to their behaviours and activities", while "practices and meanings from the rest of the groups are excluded and marginalized in the social semantic field" [4, p.78].

The breach of the service to everyone, which was marked by the social exclusion during the first period, made the EBU readjust the multicultural policy (at its peak in the 90s) to a cultural diversity. This modification resulted in a progressive change in the broadcasters linked to this group, which advocated for the inclusion and, consequently, for a broadcast programming directed to minorities, social groups or linguistic communities of a territory, among others [5].

Coinciding with the 33rd session of UNESCO's General Conference, the Convention on the Protection and Promotion of the Diversity of Cultural Expressions took place in 2005. This meeting tried to encourage the different broadcasting entities to promote and defend diversity in their territories through appropriate policies and measures linked to the presented agreement. Supporting independent film productions, investing in local audiovisual creation, and developing international cultural cooperation initiatives are among these policies [6]. After this treaty, social and cultural integrity was defended in many different documents, such as the European Agenda for Culture, approved by the Council of the European Union in 2007 [7]. This project placed cultural diversity as the leading element of the Community policies, especially emphasizing those policies related to the public audiovisual sector.

Although the EBU has repeatedly asked its members to provide "varied and balanced programming for all sections of the population, including programs catering for special/minority interests of various sections of the public" [8, p.46], the truth is that these broadcasting entities already have frequently the legal responsibility to introduce ethnic minorities and other social groups (as an issue or as professionals) due to their nature as a public service.

The EBU affirms that the promotion of diversity is part of the duties of each public service broadcaster. Nevertheless, it does not specify how this task is going to be monitored and how to follow its compliance [8]. Consequently, this situation results in a gap

that each broadcasting entity will fulfil or not depending on their commitment to the citizens they inform.

2 Methodology

The current study was born with the goal of obtaining a detailed overview of the EBU public service broadcasters' level of promotion of the different kinds of diversity, particularly those involving accessibility measures for people with functional diversity. Firstly, the topic was contextualised in order to subsequently select the sample to study. The analysed broadcasting entities for this study were: *Radio Televizioni Shqiptar* (Albania), *Radio Télévision Belge Francophone* (Belgium), *Vlaamse Radio- en Televisieomroep* (Belgium), *Danmarks Radio* (Denmark), *Yleisradio* (Finland), *France Médias Monde* (France), *France Télévisions* (France), *Radio France* (France), *Ríkisútvarpið*[1] (Iceland), TG4 (Ireland), *Raidió Teilifís Éireann* (Ireland), *Israel Broadcasting Authority* (Israel), *Radiotelevisione Italiana* (Italy), *Public Broadcasting Services Limited* (Malta), *Teleradio-Moldova* (Moldova), *Rádio e Televisão de Portugal* (Portugal), *Norsk Rikskringkasting* (Norway), *Romanian Radio Broadcasting* (Romania), S*ocietatea Român*ă *de Televiziune* (Romania), *Radiotelevisión Española* (Spain), *Sveriges Radio* (Sweden), *Sveriges Television* (Sweden), *Sveriges Utbildningsradio* (Sweden), *Schweizerischen Radio- und Fernsehgesellschaf* (Switzerland), *British Broadcasting Television*[2] (United Kingdom).

The timeframe of this research covers from 2013 to 2015, so the reports selected for this study were the ones officially published by each of these broadcasters about this period of time. In this way, the data related to the object of this study was deduced and gathered through the use of quantitative techniques, in order to classify it in tables afterwards. Consequently, those findings were analysed to determine how much money, what measures and how much time public broadcasters dedicate to each kind of diversity and, especially, to ensure people with visual or auditory diversity an adequate accessibility to contents.

3 Results

Each of the countries that take part in the European Broadcasting Union (EBU) has specific features that identify and differentiate them, which results in a totally diverse and varied conglomerate of territories. In consequence, public service broadcasters have imposed on themselves the objective of showing how and how much different each nation is regarding the rest, even inside its own borders and society.

In order to achieve this goal, these public entities stand up for the programming as a main tool. In this way, through the broadcast content, they try to transmit to the

[1] Data covering the period from September 1, 2012 to August 31, 2013 and from September 1, 2013 to August 31, 2014.

[2] Data collected relating to the period 2014/2015 and 2015/2016, but specific months are not shown in the reports.

recipient the idea that macro-categories do not contain majorities but, in fact, they are made up of multiple minorities. However, programming needed and still needs a change to reach diversity in all its levels, so the public service broadcasters have developed policies in favour of diversity during the last years (Table 1).

Table 1. Types of diversities that the public service broadcasters considered in their policies and actions between 2013 and 2015. Own production (The abbreviations used make reference to: Ctry. for country; Broad. for broadcaster; Cult. for cultural; Func. for functional; Ethn. for ethnic; Gen. for gender; Sex. for sexual orientation; Bio. for biological; Ling. for linguistic; Soc. for social; and Prof. for professional).

Ctry	Broad	Cult	Func	Ethn	Gen	Sex	Bio	Ling	Soc	Age	Prof
PT	*RTP*	x	x	x	x		x		x		
IS	*RÚV*		x		x					x	x
IE	*RTÉ*	x	x		x			x			
IE	*TG4*	x						x			
DK	*DR*	x	x	x				x	x	x	
CH	*SRG-SSR*	x	x	x	x		x	x	x	x	x
BE	*RTBF*	x	x	x		x			x	x	x
BE	*VRT*		x	x	x				x	x	x
ES	*RTVE*	x	x		x	x	x	x	x		x
MT	*PBS*										
IT	*RAI*	x	x		x		x	x	x	x	
RO	*ROR*	x		x				x		x	
RO	*TVR*	x	x	x				x			
FI	*YLE*	x	x	x				x	x	x	
MG	*TRM*	x		x				x	x		
FR	*FranceTV*	x	x	x	x	x	x	x	x	x	x
FR	*RF*	x	x		x				x	x	
FR	*FMM*	x	x		x			x			x
NO	*NRK*	x	x	x	x			x	x	x	x
IL	*IBA*										
SE	*SR*	x	x	x	x			x	x	x	
SE	*SVT*	x	x	x	x	x		x	x	x	x
SE	*UR*	x	x	x	x	x		x	x	x	x
UK	*BBC*	x	x	x	x	x	x	x	x	x	x
AL	*RTSH*										

The public service broadcasters focus their efforts on making visible, mainly, cultural diversity of their territories (80%); problems of functional diversity suffered by many of their citizens (76%); linguistic diversity of the country (68%); social diversity (64%), where groups at risk of social exclusion and people experiencing poverty are present, among others; age or generational diversity (60%); gender diversity (60%); and ethnic diversity (60%). Diversities with smaller attention by these broadcasting entities in their

policies and actions are: professional diversity (40%); sexual orientation diversity (24%); and biological or environmental diversity (24%).

3.1 Functional Diversity

One of the essential issues of the public service broadcasters is the improvement of accessibility to their contents, an inclusive initiative so that anyone can have access to their products in any of their platforms (TV, radio, web or mobile applications). The primary focus has been placed on the collective with functional diversity, paying special attention to those recipients who suffer from visual and/or auditory difficulties and consequently, who need particular, supplementary and alternative tools to get information.

The main options that broadcasters suggest with the objective of reaching this audience are: subtitling (transcriptions in the screen of oral texts or translations from foreign productions); sign language interpretations; audio description (a support system that provides people who suffers from visual or auditory diversity with extra information about the stage, gestures, attitudes, clothing and other details of the cinematographic action that make easier their understanding of the story); improvement of the sound quality; and removing background noise.

Subtitling. Once completed the search of information, it can be noticed that only 12 public service broadcasting entities include in their published reports the total number of hours or programmes broadcasted with subtitles each year.

However, the figures obtained from this analysis shown a mixed picture as a result of the existing differences among the broadcasters, regarding the number of hours or subtitled programmes per year. This fact is derived from the resources and means that each broadcasting entity has (Table 2).

Results show a positive development, because broadcasters subtitle more and more contents each year. Furthermore, it is important to highlight that there are two broadcasters which do not quantify the number of programming hours with subtitles, but they expose relevant data regarding this issue. One of them is *Schweizerischen Radio- und Fernsehgesellschaft* (*SRG-SSR*), which committed to subtitle, at least, a third of its annual programming since 2009, and to publish subtitled contents in its official web since 2012. The second one is *Radiotelevisione Italiana* (*RAI*), which integrated a teletext platform, called *Televideo*, in its channel *Rai News 24*. There, this broadcaster publishes daily around 16,000 news pages and special services for people with visual and auditory disabilities.

Aside from the traditional service of subtitling, *Danmarks Radio* (*DR*), *Norsk Rikskringkasting* (*NRK*), *Vlaamse Radio- en Televisieomroep* (*VRT*) and *Sveriges Television* (*SVT*) offer spectators a synthetic voice that reads the subtitles shown in the screen. This option is thought for people with visual functional diversity and it is specially addressed to subtitles translated from contents whose texts are in a foreign language for the target audience.

Sign Language Interpretation. The total number of hours dedicated to contents interpreted to sign language varies drastically from a broadcaster to another. Nevertheless,

Table 2. Total hours and programs transmitted with subtitles by the European public service broadcasters during 2013, 2014 and 2015. Own production (The abbreviations used make reference to: progr. for programs and pre-re. for pre-recorded).

Ctry	Broad.	2013		2014		2015	
		Hours in total	% of progr.	Hours in total	% of progr.	Hours in total	% of progr.
UK	*BBC*			49.143		48.819	
DK	*DR*				70% pre-re. 65% live		86% pre-re. 63% live
ES	*RTVE*	58.502		57.064			
FR	*FranceTV*			15.100		15.700	
NO	*NRK*	17.858		19.382		19.862	
PT	*RTP*	4.253,52		4.510,22			
BE	*VRT*				97,30%		98,30%
BR	*RTBF*		94,70%				
IS	*RÚV*	890		790			
SE	*SVT*				100% pre-re. 55% live		100% pre-re. 62% live
SE	*UR*						100%
IE	*RTÉ*			9.282		9.462	

it is important to emphasize that only eight of the public service broadcasters include in their reports the total number of hours that they dedicate annually to programming in sign language. The case of *Norsk Rikskringkasting* (*NRK*) is quite curious. It does not only offer interpreted content, but it also has an own channel where it exclusively publishes broadcasts in sign language: *Tegnsprogskanal* (Table 3).

Table 3. Time in total and number of programs that broadcasters transmitted with sign language interpretation in 2013, 2014 and 2015. Own production.

Ctry	Broad.	2013		2014		2015	
		Hours in total	No. of programs	Hours in total	No. of programs	Hours in total	No. of programs
UK	*BBC*			2.323		2.247	
DK	*DR*			735		776	
FR	*FranceTV*			150			
NO	*NRK*					20 h/ week	
PT	*RTP*	7.653	2.282	11.009	2.586		
SE	*SVT*			107		217	
SE	*UR*					28,7	
MD	*TRM*					91	

Audio Descriptions. The total time dedicated to audio descriptions also varies widely depending on each broadcasting entity. In this case, the most striking example is the one offered by the comparative between *British Broadcasting Corporation* (*BBC*), which accumulated a total of 9.195 h using this accessibility service in 2015, and *Sveriges Utbildningsradio* (*UR*), which only broadcasted 22,3 h with audio descriptions during the same period of time (Table 4).

Table 4. Number of hours and programs with audio descriptions that public service broadcasters transmitted during 2013, 2014 and 2015. Own production.

Ctry.	Broad.	2013		2014		2015	
		Hours in total	No. of programs	Hours in total	No. of programs	Hours in total	No. of programs
UK	*BBC*			8.512		9.195	
DK	*DR*					81,4	
ES	*RTVE*	Approx. 75		Approx. 150			
FR	*FranceTV*				780		
PT	*RTP*	96	116	89	1.962		
IT	*RAI*					660	
CH	*SRG-SSR*				412		
SE	*SVT*			119		174	
SE	*UR*					22,3	

Other Options to Improve Accessibility. Aside from the accessibility measures already mentioned so far, there are some public service broadcasters that also work to find new and better tools that will allow anyone, regardless their functional diversity, to have access to broadcasters' contents. These broadcaster entities that have promoted an active search of new options until 2015 were: *Danmarks Radio* (*DR*), *Radiotelevisión Española* (*RTVE*), *Norsk Rikskringkasting* (*NRK*), *Radiotelevisione Italiana* (*RAI*), *Sveriges Radio* (*SR*), *Schweizerische Radio- und Fernsehgesellschaft* (*SRG-SSR*), Sveriges *Utbildningsradio* (*UR*) and *Yleisradio* (*YLE*).

One of the most followed alternatives has been the one of maintaining a steady contact with different functional diversity organizations in order to improve, through criticism and commentary, accessibility to contents. This possibility has been supported by some broadcasters, such as: *Danmarks Radio* (*DR*), *Schweizerische Radio- und Fernsehgesellschaft* (*SRG-SSR*) and Sveriges *Utbildningsradio* (*UR*).

In the case of *Radiotelevisión Española* (*RTVE)*, it has participated in different events about functional diversity: in 2013, it kept its involvement, through the Accessibility Unit, in the project called "Sistema Avanzado de Sincronización de Subtitulado para Emisiones en Directo" (SUBSYNC), in which the Centro Español de Subtitulado y Autodescripciones (CESyA) also participated. A year later, in 2014, *RTVE* co-organized the 7th edition of the conference Accesibilidad a los Medios Audiovisuales para Personas con Discapacidad (AMADIS), together with the Real Patronato de Discapacidad, University Carlos III and the CESyA.

The Norwegian case is also particular. In November 2014, *Norsk Rikskringkasting* (*NRK*) included, for the first time, a manager responsible for ensuring that people with functional diversity (especially visual or auditory) could enjoy this broadcaster's contents in any of its platforms. This post was assumed by Siri Antonsen. Moreover, in 2015, the Norwegian corporation counted on a council consisting of nine representatives of organizations of people with functional diversity to discuss and propose improvements which will make contents more accessible.

Another of the most supported proposals is the one relating to sound improvement, which suggests removing background noises, and increasing sound quality. The broadcasting entities that are taking measures about this issue are: *Danmarks Radio* (*DR*), *Schweizerische Radio- und Fernsehgesellschaft* (*SRG-SSR*), *Sveriges Utbildningsradio* (*UR*) and *Sveriges Radio* (*SR*), which also insists on a good pronunciation by its professionals. It is also important to highlight the case of *Radiotelevisione Italiana* (*RAI*) due to its creation of the project *Slow TV*, in 2015. This initiative makes possible to reduce video and sound's speed with the aim of allowing contents accessible for everyone. Controlling the reading speed is also one of the goals of *Sveriges Radio* (*SR*).

The promotion of using the simple standard of each territory's main language is also an objective for *Danmarks Radio* (*DR*), with Danish language, and for *Yleisradio* (*YLE*), with Finnish language.

Finally, *Sveriges Radio* (*SR*) has begun an experimental initiative about a languages resource bank focused on spreading options of the subtitled text and, in addition, on making better automatic subtitling by voice recognition.

4 Conclusions

Between 2013 and 2015, the period analysed in this research, public service broadcasters have focused their efforts, resources and programming on promoting diversity. Those actions with more support were, by order: cultural diversity (80%); functional diversity (76%); linguistic diversity (68%); and social diversity (64%), where minorities at risk of social exclusion or people experiencing poverty are included. Closely, the typologies supported in a 60% by the broadcasting entities are: age or generational diversity, ethnic diversity, and gender diversity. Professional diversity, sexual orientation diversity, and biological or environmental diversity are the ones which have less supporters.

In terms of functional diversity, all policies of broadcasters that are working on it agree on the same objective: the improvement of their contents' accessibility so that anyone can have access to their products in any of their platforms. At present, there are four main stepping stones: subtitling, sign language interpretations, audio descriptions, and the improvements of sound quality.

Subtitling programmes is the most frequent alternative. However, figures about annual subtitling hours varies widely from a broadcaster to another. Many of them only include subtitles in a small percentage of the programming, while others tend to increase it every year until approaching the whole broadcasts. This is the case of *Vlaamse Radio- en Televisieomroep*, which transmitted with subtitles 98,3% of the programming in 2015. Nevertheless, *Sveriges Utbildningsradio* is the one which occupies the first

place, as its programming was 100% subtitled in 2015. The main difference between these broadcasting entities and the rest is that both broadcasters defend automatic subtitling by voice recognition in live programmes, a practice mainly dismissed by other broadcasters so far.

Interpreting contents to sign language is also vitally important to improve accessibility of those who have limitations or lack of the sense of hearing. As happened in the previous measure, figures about the transmission of interpreted contents also varies widely from a European public service broadcaster to another. For instance, while *Danmarks Radio* interpreted a total of 776 h in 2015, *Sveriges Utbildningsradio* only broadcasted 28.7 h in sign language. However, *Norsk Rikskringkasting* stands out among the other broadcasters without any doubt, since it has an own cannel which exclusively transmits contents interpreted to sign language, *Tegnsprogskanal*, as well as it includes interpreted programming in other channels.

Another accessibility measure is audio descriptions, but hours transmitted using this resource also vary from a broadcaster to another. Finally, there are also other technical and organizational options that improve accessibility to contents. In terms of technical measures, some public service broadcasting entities are working on: reducing background noises, as *Schweizerischen Radio- und Fernsehgesellschaft;* improving sound quality, as *Sveriges Radio*; and introducing tools which allow users to reduce video and sound's speed, as *Radiotelevisione Italiana*. As regards organizational questions, broadcasters advocate for: maintaining conversations with functional diversity organizations in order to improve, through criticism and commentary, accessibility to contents, as *Radiotelevisión Española;* broadcasting contents using the standard of their language, as *Yleisradio;* developing specific departments dedicated to accessibility, as *Norsk Rikskringkasting*; and promoting the use of a clearer pronunciation by a professional staff, as *Sveriges Radio.*

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A Review of Mobile Journalism in Spain

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Abstract. Studies on communication in mobility have been taking importance as the access to contents has been consolidated among users in all the strata and social and cultural levels. In the last ten years, acceleration in the technological innovations in mobile telephony was produced. This has had its corollary in the corresponding interest in investigating its relationship with the diffusion of news contents and, in general terms, with social communication. This communication explains the impact of mobile telephony on journalism. We reveal the aspect of this device as a news medium and present the context of the vertiginous social expansion that digital mobile technologies have nowadays. Our objective is to disclose this new communicational phenomenon, where the media are usually making their incursions very slowly.

Keywords: Mobile journalism · Mobile apps · Cybermedia · Mobile devices · Mobility

1 Introduction

The last report of the International Telecommunication Union [1] points out that seven billion people (95% of the global population) live in areas in which a mobile broadband net exists. Spain is still in the European vanguard concerning telecommunication infrastructure, to the point that it occupies the first place in number of subscriptions of Internet access through fibre optic. This emerges from the last report of the Sociedad de la Información Telefónica [2]. Moreover, the worldwide penetration of mobile telephony is thought to have reached in 2015, 96.8 lines per 100 inhabitants, 0.7 percentage points more than in 2014. This penetration means that there are in the world more than 7.000 million lines of mobile telephony [2]. According to Comscore [3] the time spent browsing digital mobile media (51%) is, nowadays, relatively superior to the consumption of the same through desktop computers (42%). The tendency in the use of mobile devices (vertical screens) in relation to other type of screens shows that we are before a true turning point in the consumption of information. According to the report "Consumo móvil 2015" [4], which analyses the consumption tendencies of smartphones, instant messaging, 4G technology and mobile apps, the penetration rate of smartphones in Spain continues growing and places our country in a worldwide second position. The study has been carried out by Deloitte in Germany, Australia, Brazil, Canada, China, Spain, Finland, France, Holland, India, Italy, Japan, Mexico, Norway, Poland, United Kingdom, Russia, Singapore and Turkey.

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Of the total time devoted to media, mobile devices (smartphones and tablets) already compete for the preeminent position of television or PCs, with a daily average close to the 40% of the total – beyond two hours and a half each day both in the USA and in the European Union – [5].

Mobile apps are still an expanding sector in which the digital environment becomes our daily life. Reports made on the use of apps in Spain confirm that messaging applications continue one more year being the most downloaded and used by the Spanish. Regarding categories, the type of apps which has grown the least is that related to the gaming sector. Nonetheless, the personalization apps have been, with no doubt, the most used. This type of apps is used to block the home screen or to incorporate keyboards with emoticons. At the same time, news and magazines applications also went up in the last year [6]. These data confirm a new tendency to be informed which implies a displacement of television and computers in favour of smartphones, phablets and tablets.

2 New Mobile Media

Before this dynamic and changing context it is not strange that, in the last years, the scientific community developed great interest in the study of the irruption, acceptation and popularization of mobile telephony. Currently, the mobile media tend to be grouped within a large category of emergent digital technologies, usually called "new media". In order to understand the evolution and appearance of the "new media", we would need to go back to the reflections about the analysis of the social story of the media and the approach to the concept of "remediation" of which British historians like Asa Briggs and Peter Burke speak [7]. These authors warn that "the introduction of new media did not produce the abandonment of the older ones, but the coexistence and interaction with the newcomers (…) It is precise to consider the media as a system of constant change, in which different elements play more or less important roles". There is no doubt that the new media are born with their own particularities, which must be analysed and studied.

The story of the mobile media in Spain has been characterised by different stages of development. From 2000 to 2006 the media companies converged around the use of SMS and MMS to spread and communicate news and news alerts. During this period, scientific literature on mobile communication in our country was very residual. In general, the shortage of research production about mobile communication until the year 2005 contrasts with the quick and intense establishment of such technology [8].

In a second stage, between the years 2000 and 2005, there is a series of initiatives which study the phenomenon of mobile communication from multiple perspectives: sociocultural, evolutionary, descriptive, conceptual or focused on its integration in the Information Society [9]. The studies centred in the investigation of use are principally emphasised, whether about social interaction in general [10], about group interactions and coordination private life/work [11], about teenager users [12, 13] or about genre aspects [14].

It is from the year 2004 onwards when the perspective of cultural studies is consolidated, with works such as Haddon"s [15] who continues the research about

domestication of technologies initiated by Goggin [16] and Hoflich and Hartman¨s [17], developed in Australia and Germany respectively. This stage of scientific production has focused on the study of the mobile from a functional point of view, on its roles and on the effects of the new platforms in the communicative scenario [18].

2.1 Scientific Literature on Communication and Mobile Journalism in Spain: Pioneer Universities

2006 becomes the year of the dawn of research about mobile journalism in Spain. In this country, the existence of scientific production around this new discipline was inexistent until this year. So far, there were only works such as Castelló and Aviá's [19] about the implantation of MMS as the photographic reportage service in the Spanish press. Later, Aguado and Martínez [20] in the frame of the social impact of digital technologies, make a panoramic tour for its more relevant implications.

Regarding research and projects in Universities in Spain, several lines which start from the global concept of mobile communication in order to seek its development in different devices are developed.

It can be considered that Juan Miguel Aguado, Claudio Feijoo and Inmaculada Martínez, researchers in the University of Murcia, are the pioneers in Spain in the study of mobile telephones as incipient platforms for the distribution of contents [20] In their first works, these authors propose a panoramic tour through the most relevant implications of mobile technology in the communicative scenario, focusing on the technologic convergence, the diversification of services and the social transformations derived from its implantation.

The University of Murcia created the group eCOM (Research group in Social Communication, Culture and Technology) in 2006. With the launch of the project MOVILSOC (Social Impact of Mobile Communication: mediatisation, identity management and consumption rites) the mobile device is analysed for the first time in Spain as a new medium for communication. This project culminates with the publication of the first book that the group writes about this line of investigation and which is entitled "Sociedad móvil. Tecnología, identidad y cultura" [21]. It is a rapprochement to the state of the question of the research about mobile journalism carried out until that moment and also in the analysis of mobile devices as object and platform for cultural consumption.

Juan Miguel Aguado reflects, a couple of years later, on the profile of the new journalists [22]. From 2012, the interest falls on the prominence that mobile telephony has acquired in the convergent media context. The rapid spread of the use of mobile telephony causes modifications in the level of the interactions that the users establish with the technological medium, the ones that come from an individual, social, spatial and commercial level [23]. Precisely in his article *Mobile Media: Towards a Definition and Taxonomy of Contents and Applications* is where the area of study which continues to the present time is initiated. In this work, Scolari, Juan Miguel Aguado and Feijoo include a set of definitions and classifications of contents and applications with the intention of consolidating the construction of a solid mobile media theory [24].

These authors most relevant contribution consists of the creation of a positional model of classification of content mobile apps.

Aguado and Martínez publish in 2013 a book entitled *La comunicación móvil. Hacia un Nuevo ecosistema* in which the central role of the context of mobility in the clash between the digital industries and the traditional media is analysed, and where a tour through the lines of transformation of digital contents – from video and television to videogames, from journalism to music or comics- is proposed, consolidating mobile communication as a specific field in the development of media studies [25].

Their last publication *Emerging perspectives on the mobile content evolution* [26] seeks to understand the evolution of mobile content from the point of view of ICT and the media industry. It is a publication which delves into the interdisciplinary field of media studies covering thematic areas such as journalism, marketing and advertising, diffusion and management of information and media economy, among others.

In short, we can differentiate four clear phases within this research group:

1. FIRST PHASE (2006-08): the mobile as a sociologic phenomenon and its impact in a convergent scenario.
2. SECOND PHASE (2010-11): New professional profiles.
3. THIRD PHASE (2012): Taxonomy of apps and contents.
4. FOURTH PHASE (from 2012): Analysis of mobile content. The mobile between the digital industries and the traditional media.

From the year 2007, the GRID (Research Group in Digital Interactions) from the University of Vic, linked to the department of Digital Communication in the Faculty of Business and Communication, coordinated by Carlos Scolari at that moment (currently professor in the University Pompeu Fabra), incorporates the line of work about mobile communication to its production [27]. It is specified in a research realized for CAC [28] about communication and mobile devices in Cataluña: actors, contents and tendencies, from which specific investigations on transmedia narratives and mobility [29] and marketing and mobile advertising [28] emanate.

Among the researchers that have dealt with this area of study, Carlos Scolari, Héctor Navarro Guere, Hugo Pardo Kuklinski, Irene García and Jaume Soriano can be highlighted. In one of their first articles carried out about the actors and production of mobile contents in Cataluña, they already considered necessary to begin to speak about the mobile device as a new medium for communication. They declared that "it is necessary to assume that a new medium for communication has been integrated into the cultural industry, a medium with its own business dynamic, grammars, productive and consumption practices [28]. This research is especially relevant because its authors manage to articulate a series of categories of analysis which will serve as the starting point for the realization of further studies. Concretely, the following are established: native company/migrant company, adapted/non-adapted/specific and useful contents.

Navarro has been one of the researchers that has most focused on mobile communication, mainly from the point of view of consumption analysis in the new screens [30] and also of the grammar and the experiences of mobile journalism through the study of reference cases [31]. His last articles start from field studies about the use, the consumption and the preferences of media and content of digital communication by Catalonian

children, youngsters and adults. Although the principal focus, in a geographical level, from which more scientific bibliography about mobile communication is produced, has been pointed out, it is true that from other Spanish Universities, reflections on this novel field of study can also be highlighted. This is the case of Miguel Carvajal, from the University Miguel Hernández in Alicante, who studies the content analysis about the presence of the main editors of the Spanish press in mobiles and tablets [32].

Regarding Galician Universities, the group Interactive Culture and Communication from the University of A Coruña has departed from the global concept of interactivity to apply it specifically to communication in mobility, although this has not been the unique object of investigation in this field, since the scientific works have tackled audiovisual and journalistic contents in mobility. In this sense, it is precise to highlight the studies on the smartphone by Carmen Costa and José Juan Videla [33, 34]; the iOS environment [35] or radio apps for smartphones [36].

Among the last publications carried out by the group in A Coruña, the ones developed in collaboration with the group New Media from the University of Santiago de Compostela can be stressed. Among them, the article about the introduction of mobile devices in the publishing industry is particularly relevant. The authors Carmen Costa (A Coruña UDC), Ana Isabel Rodríguez Vázquez (Santiago de Compostela – USC) and Xosé López (Santiago de Compostela – USC) analyse the role of smartphones in the book industry [37]. The group from the USC has been researching on mobile journalism since 2012. Its lines of study are mainly focused on the analysis of the communication media in the new mobile screens. At first, their works were oriented towards the analysis of content in which the investigations about the news production in apps were given priority. They were studies which combined quantitative and qualitative methodologies and which tried to lay the foundations of an emergent scenario, not deeply investigated until that moment [38]. These works set a precedent of what nowadays is a maintained and consolidated branch of investigation in the group from the University of Santiago de Compostela. In the last years, those works focused on analyzing the outlook of printed media editor companies of cybermedia have gained relevance in relation to the strategy of products for mobiles [39] and also content analysis which draw a general map of the tendencies that, in a content, channel and conversation level, follow the main reference journals in the European scope [40]. The peak of mobile communication is provoking a redesign in the cybermedia conceived for the new platforms through models oriented towards interaction. The new digital culture, developed through the internet and mobile telephony, cherishes a more glocal and open net society. Citizens, in this hyper connected scenario, show behaviours in the field of communication use and consumption, which are different from those of the immediate past in the first years of the internet.

3 Conclusions

In a context dominated by mobility, changes which have to do with the space of news consumption appear, at the same time that new outlines which could easily readjust to the new communicative environment arise. These modern scenarios require brief, simple, clear, concise and able to be seen briefly contents. The logic of “always on”,

always online, alters the traditional ambits in which the technologies were used and new consumption contexts appear. Before this scenario of transformations, the scientific community in Spain has cared about the research of this new object of study.

All in all, we can identify four main Universities which have as their principal lines of investigation everything that has to do with communication and with mobile journalism in Spain: Murcia, Vic, A Coruña and Santiago de Compostela. Notwithstanding, the theoretical corpus of this object of study reaches multiple dimensions in our country from multiple topics: the study of the mobile as a sociological phenomenon, the new mobile professional profiles, analysis on the taxonomy of applications and mobile contents, transmedia narratives and mobility, or even marketing and mobile advertising.

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Uses and Trends of Social Networks by Public Service Media in Europe

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Abstract. The advent of social networks has transformed the ecosystem of communication by multiplying the possibilities of interaction between the media and the users. In this new digital context, the media must innovate and take advantage of the social networks. The objective of this research is to analyse the strategies of the main public televisions of Europe in the social environment. To do this, its presence and popularity in twelve social networks are studied. The result evidences a scarce use of the social networks, except in some groups of television like the British BBC or the German ZDF whose strategies are risky, innovative and successful. These strategies can serve as example on how to take advantage of the networks to reach the audience and improve public service media.

Keywords: Social networks · Public television · Social television · European Union · Innovation

1 Introduction

The new digital scenario has transformed the concept of television. Internet and the rise of social networks create a new logic of communication based on media convergence [1–3], which has enable the proliferation of channels, the emergence of new formats and possibilities of interactivity [4]. This convergence appears in the forms of distribution, content and audiences [5], giving rise to the transition from analogue TV to digital broadcasting. One of the main changes is the emergence of so-called social TV. The new television is based on the interactivity between media and user, breaking with the passive role of the analogue viewer.

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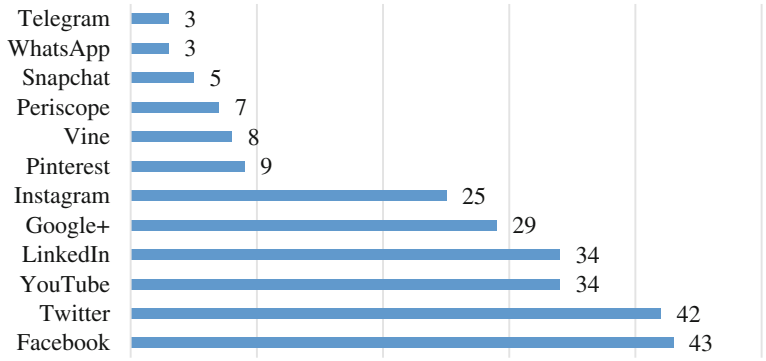

Fig. 1. Number of accounts in the social networks of public television in Europe. Source: prepared by the authors.

There is disparity of interpretations in the definition of social TV, but the main characteristic is the promotion of the active participation of the spectator [6–8]. On the one hand, the second screen applications are the result of the evolution of the first interactions of the mobile phone with television through SMS and are based on the evolution of technologies and changes in the consumption habits of the audience.

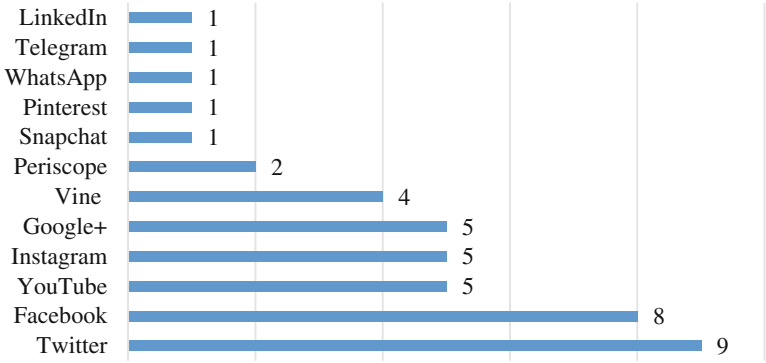

Fig. 2. Number of accounts of the BBC television group in each social network. Source: prepared by the authors.

The television set is no longer the only way to consume a television product and now mobile phones and other screens can be complementary tools to improve the television experience, inviting the viewer to take part [9].

Furthermore, the appearance of social networks has raised the possibilities of interactivity [10]. Its popularity has forced media to adapt to a space where the conversation is essential. Social networks emerge as a channel of communication between the television and its audience, facilitating a dialogue space that benefits both parties [11].

Table 1 Number of followers of the main public television channels in Europe. Source: prepared by the authors.

TV	Country	Facebook	Twitter	YouTube	Instagram
RTVE	Spain	552.428	339.537	168.942	16.798
ZDF	Germany	525.216	926.847	79.997	33.027
ARD DAS ERSTE	Germany	196.572	85.084	271.740	
ORF	Austria	628.77	22.520		4.172
VRT	Belgium	2.225	3.936	21.001	44.743
BNT	Bulgaria	74.609	11.779	7.938	
HRT	Croatia	40.734	18.166	4.282	
CyBC	Cyprus				
DR1	Denmark			4.489	
TV2	Denmark	397.305	28.481	21.295	30.679
RTVS	Slovaquia	29.680	5.951	5.210	
RTVSLO	Slovenia	10.952	52.986	269	517
ERR	Estonia	46.893	6.148	27.828	6.863
YLE	Finland	92.584	47.332	12.009	4.797
ARTE	France	1.686.213	821.286	83.801	86.096
FRANCETV	France	75.875	133.123	91.033	5.284
BBC	UK	1.991.556	1.158.658	3.336.170	164.513
CHANNEL 4	UK	622.053	807.828	233.177	38.448
ERT	Greece	176.359	58.839	17.280	
MTVA	Hungary	22.420		17.462	1.252
RTÉ	Irland	103.094	339.537	163.753	26.091
RAI	Italy	435.084	410.567	1.334.783	43.109
LTV	Latvia	5.176	8.974	1.965	2.985
LRT TELEVIZIJA	Lithuania	106.536	5.870	31.291	3.853
PBS	Malta	92.644	6.206	3278	
AT5	Netherlands	113.825	401.780	5.989	6.658
NPO	Netherlands	101.348	28.397	1.801	1.942
TVP	Poland	107.990	3.852	223.105	
RTP	Portugal	440.699	408.659	245.716	18.569
CT	Czech Rep.	97.368	165.615	8.903	10.679
TVR	Romania	87.795	3.163	64.623	1.601
SVT	Sweden	166.812	40.699	23.410	

According to the *VI Social Networks Study of IAB Spain 2015* [12], 82% of Internet users between 18–55 years old use social networks. The last publication of the *Televidente 2.0* study in 2015 [13] says that 71% of the spectators habitually uses the mobile or smartphone when they are watching TV and 15% of them comment on social networks the contents of television programs, series and films while they are watching. The same study says that WhatsApp, Facebook and Twitter are the most popular social media platforms used to comment on these television shows.

Social networks are becoming a tool for television, not only in the field of interactivity if not as instrument to know better the audience. For the first time, social networks and especially Twitter make it possible to know the opinion of viewers, which offers multiple possibilities in terms of marketing.

Social audience or audience generated by social networks (in Spain it is measured through Kantar Twitter TV Ratings from Kantar Media) is a valuable complement to the traditional audience measurement [14, 15]. However, it is important to highlight that it never replaces it. The social audience is not representative of all television viewers, but only of those registered on social networks [16]. As it is said in the book *Interactivity and Social Networks* (2015), innovations and their opportunities can be overvalued, but the key is to search for "an environment in which we can interpret the opinions expressed in social networks and take advantage of the opportunities they present, which are not few" [17]. Lara Tíscar [18] adds that "media have also learned that it is not enough to develop technology and wait for the results, but must go down to the sand and boost it". They must establish specific strategies and encourage participation.

Nevertheless, social networks have also created some uncertainty in the media ecosystem. Traditional media are concerned with the speed with which the digital and social scenario is transformed and the little control they have. At this point comes the debate on public media [19–21].

On the one hand, many experts argue that public television should be in social platforms and be pioneers in innovation. Its communication with the public, especially with the younger targets, should be improved. According to Mercedes Medina and Teresa Ojer [22], four key indicators of a public service can be set: service to the audience, diversity of the offer of programmes, technological innovation and social responsibility. They also say, based on Jakubowicz's [23] words, that public media "should hold the leadership in the analogue blackout, be on all content distribution platforms, attract the audience and develop interactive systems over the Internet to maintain and increase contact with the public".

On the other hand, the redefinition of public value is discussed. The media have had to move to a stage of connectivity, away from the conventional system and without guidelines or specific regulations for action. This raises doubts about the functionality to apply the current values of public service to social networks [24] and some experts opt for a reformulation of the model [25].

Despite the uncertainties of the digital landscape, the use of social networks is essential in any communication strategy, both in the private and public sectors. Proximity to users increases the visibility and impact of the media and, at the same time, allows to know firsthand the needs and opinions of viewers to develop a service more personalized and adapted to the demand.

2 Methodology

It has been used a quantitative methodology based on the observation of the accounts on different social networks of public television groups of the 28 countries that make up the European Union. It has analysed the more and less-used social networks and the

popularity of each account in each of the networks. To measure the popularity it has been taken into account the number of followers, data that appears on all social networks. Subsequently, the strategies employed by each public television in order to know which groups are betting on the social context and results that are reaping are compared. We have studied twelve social networks according to their current level of use: Twitter, Facebook, YouTube, Google+ , Instagram, Pinterest, Snapchat, Vine, Periscope, LinkedIn, WhatsApp and Instagram.

3 Analysis

Although the digital context is in constant change and the proliferation of social networks has increased considerably in recent years, the undisputed leaders for European public television are Facebook and Twitter (Fig. 1). Their profiles reach higher levels of followers and because of their specific characteristics they are also the most used by the broadcast networks. They are the most popular social platforms and they are basic in an online communication strategy.

However, there are several YouTube profiles in UK, Poland, Ireland and Italy with many followers. YouTube is the third most used social network, which agrees with the characteristics of the profiles of public corporations that publish their audiovisual content into the best known video platform and then use that content to spread it in the rest of social profiles through links.

In fourth place is LinkedIn, but the purpose of these profiles is to contact with other corporations and establishing networks of professional contacts. Google+ appears as the fifth most used social network, but most of the profiles identified are not active.

The proliferation of social networks and the continuous changes in the online stage oblige broadcasters to be constantly updated and adapted to new spaces. The closure of platforms that were a phenomenon such as the case of Vine or the sudden popularity of new spaces like Snapchat requires channels to take drastic decisions, like the abandon of old accounts. In most cases, Google+ account stays open but content has not been published for a long time. Instagram and Pinterest are the next more popular social networks, based on the publication of photographs.

Vine, Periscope and Snapchat have revolutionized the industry, but its use is still limited. For this reason, it is not surprising that they are in lower positions in the ranking. Only some innovative television channels that want to take advantage of the latest technologies have opted for these platforms.

In the journalistic field, Snapchat and Periscope are genuine revelations because they allow to tell stories in a different way. This has let them to grow as a tool not only for leisure but also informative.

In the last place we have WhatsApp and Telegram, two instant messaging platforms. Its use is not widespread because it is not known yet how to take advantage of these applications. Even if they open a way of direct contact between television and viewer, their use can be reduced precisely to that, just a contact number such as email or phone number. Although there have been several attempts to use WhatsApp as an information

medium where the user demands specific information and receives it instantly through the WhatsApp number, the perfect formula to make this a success has not yet been found.

3.1 Radiography of Social Media Strategies

In many cases the decisions of developing a certain social media strategy in one or several social networks are the same between public television groups. Not in vain they are corporations with common fines. By analysing the uses that each group and country give to social networks, we can extract a series of trends that help to understand the panorama of social television in Europe:

1. Public television groups in Spain (RTVE), UK (BBC), Germany (ZDF), Italy (RAI) and Ireland (RTÉ) base their social media strategy on being present on various social networks and with several different profiles. Except for WhatsApp and Telegram, they are present in all networks quantified in the sample. These televisions represent the most innovative group and with a greater commitment to experiment with new applications in the digital and social field. The British group BBC is present in all social networks (Fig. 2).
2. Public television groups in Bulgaria, Croatia, Slovakia, Austria and Belgium have almost no accounts on social networks. They follow a basic strategy that includes the presence on social networks like Facebook and Twitter, with an unified offer under one or few profiles that does not take risk. It only highlights the presence of the Belgian public group RTBF in Vine, but it is an unverified and inactive profile.
3. The social network accounts of public television stations in Romania and Sweden follow a similar structure. Both corporations are present in the same social networks. Although their strategy is simple, they have managed to have a considerable number of followers.
4. As for the other countries, their accounts remain on a medium term, without becoming glossy nor leaving the online space. They maintain their profiles active in several social networks obtaining a repercussion according to their activity. It is the case of Denmark, France, the Czech Republic, Finland, Estonia, Slovenia, Portugal, Poland, the Netherlands and Hungary.

3.2 New Ways of Doing Television: Snapchat, Periscope and Vine

The option to record something and publish it instantly on the Web is the origin of three social networks that have revolutionized the communication system: Vine, Periscope and Snapchat. Vine emerges in 2012 as an application that allows the user to create short videos and publish them on the platform itself or throughout other social networks. It begins to gain repercussion with the impulse of Twitter, who bought it shortly after its creation.

The value of this social network resides in the simplicity of the videos, since its short duration implies to be brief and concise. Although at first the social network got a good reception, the appearance of other similar platforms made announcing its final closure in 2016. Still, many public televisions in Europe gambled on this social network. In total,

thirteen groups have been identified with an account at Vine. Among them are the corporations of France, United Kingdom, Ireland, Spain, Italy or Germany.

In 2015 Periscope appears. Periscope goes a step further than Vine and is based on streaming videos. It allows to retransmit a live event through the mobile and the connection to Twitter in an easy and revolutionary way. This development has allowed the growth of innovative multimedia journalism projects and it has been used mainly in event retransmission. This is the case of RTVE that uses the application on certain occasions like the *Eurovision Song Contest 2016*. Apart from the festival coverage, RTVE developed a documentary project for Periscope called *Buscando a ABBA*. The program was presented by two reporters trying to meet ABBA members. Although the format has not had much impact, it is such a good evidence of the possibilities of Periscope as an information tool. In Europe, eight public television groups with official accounts in Periscope have been identified. United Kingdom, France, Germany and Italy continue to stand out for their social and innovative commitment.

Snapchat emerged in 2011 as an application to send content. Its peculiarity is the expiration of the files that disappear in a few seconds. It is currently one of the most downloaded applications worldwide. In 2016 the British channel BBC incorporated what has been called Snapchat Documentary or documentary of Snapchat. Through one of his programs, *Panorama*, a report was recorded entirely with Snapchat. The documentary called *Refugee crisis* is a sample of what can be done in television with this tool, not only to innovate but to approach the younger targets. It is a program recorded and broadcasted day by day recounting the migration journey of refugees from the Greek islands to Western Europe. This shows that Snapchat can be a perfect application for performing dynamic coverage with digital narratives and great graphic possibilities. In Europe, there are twelve public television groups with an account at Snapchat.

On the other hand, some television networks have tried to innovate with applications of instant messaging as a platform of news distribution. The popularity of apps like WhatsApp and Telegram has opened the door to a new way of reporting. However, it is still unknown how to take advantage of this tool, so there are few televisions that venture to use a WhatsApp number as a vehicle of direct contact with the public. The Belgian and British television channels (STV and Channel 4 Group) use this application as a personalized newsletter for each registered user. The user requests through a WhatsApp number the information he wants and receives almost immediately all the content demanded. It is remarkable the case of the autonomous television of Galicia (CRTVG), that also counts on a system of WhatsApp and Telegram denominated Gcontigo. It is the first public television in Spain to carry out a project like this.

3.3 Indicators of Popularity in Social Networks

One of the drawbacks of social networks is the difficulty to measure the effectiveness of a social media strategy. The main indicator in any social network is the number of followers or the number of users who follow a certain account. It represents the visibility of a profile and the beginning to make a strategy with impact.

The top 5 of European public television groups with more followers are the French group TV5 Monde, the German ZDF, the British BBC and Channel 4 and the Spanish

RTVE (Table 1). In the case of the Facebook account of TV5 Monde, they were registered about 2.306.523 followers in September 2016, being the highest figure of all corporate profiles of the sample.

The Spanish corporation RTVE rises with the profile with more followers in Twitter, showing off the popularity of this social network in the country.

The Belgian Public TV, VRT and the Cypriot CyBC do not exceed 4.000 followers on Twitter or Facebook. Both accounts are unverified and their low impact coincides with a poor social strategy in which no open profiles have been detected in other networks.

BBC, TV5 Monde, CyBC and VRT represent the face and cross of what can be done right or wrong in a social media strategy. While the first two show a great social activity in the networks claiming their brand and achieving greater visibility and impact, the last two have a basic presence and little impact.

There are also differences between public corporations of the same country, such as France Télévisions and TV5 Monde. Despite being both groups originating in France, they achieve different levels of social monitoring.

4 Conclusions

Social networks have become essential elements in corporate media strategies and even more so for televisions. The digital society requires participation and today, the easiest way to provide a space for interaction between the media and users are online platforms.

As a public service, television corporations in Europe have a responsibility to adapt to new circumstances and to be pioneers in innovation and new forms of communication. For this reason, efficient strategies are needed to position themselves as reference means. The analysis of the use of social networks by public televisions in Europe notes the supremacy of Facebook and Twitter as the main platforms of interaction between the media and its audience.

These networks have the largest communities of users and therefore it is crucial to be part of them to achieve greater impact. YouTube and Instagram are the next social networks with more popularity and they are based on publishing audiovisual content. The cases of Google+ and Vine are remarkable because of their scarce use. However, new social networks based on the recording and publishing of streaming videos are revolutionizing traditional information systems.

Nine public television groups in the European Union have an open profile in Snapchat. This type of social networks are becoming popular and are already part of the journalistic routines of media. Based on this, two types of social media strategies have been identified. The first is based on a complete presence of the channel or group in the most popular social networks to segment the content and offer the viewer the information they demand without any noise or spam.

On the other hand, it has been detected that in several countries the profiles of social networks are being restructured to improve them through the creation of a single profile that unifies all the digital activity. The most notable case is the British channel BBC. Their profiles have thousands of followers and they are already a media of reference in

the social context. Its activity in social networks goes a little closer to the first strategy exposed, as it has several profiles on several platforms. This strategy is based on a high rate of publications to keep interest and take risks and innovate to develop ideas such as the Snapchat Documentary.

However, there are groups with little elaborated strategies that only appear in the most known networks. Precisely because of this, they also do not achieve the necessary impact. They are completely opposite strategies that demonstrate the moment of transformations of the current media.

Finally, the media need to know the latest developments in the digital universe. This implies knowing the projects of other channels both nationally and locally. Projects like CRTVG's WhatsApp are an example for other TV's to know what can or cannot be done with a higher or lower budget.

In the coming years, the development of social television will become more visible in order to make user more participant. This value defines a modern society 2.0 in which social networks are crucial to understand the future of television. Nevertheless, today most of the experiments are still in their beta phase so we will have to wait to discover all the possibilities they offer.

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Television and Social Networks: An Analysis of the Influence of Live-Tweeting in the Social Audiences

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Abstract. Social networks have transformed the conception of the television audience. In order to adapt to a viewer increasingly active on the Internet, televisions conducted social media strategies to generate interactivity and attract users to their social profiles. One of them is based on the live-tweeting phenomenon, in which the conversation is encouraged through publications on Twitter during the broadcast of the programme. This research analyses the effectiveness of live-tweeting as a strategy for promoting user traffic on social networks and its impact in the social audience. According to a quantitative methodology, we have selected four Spanish prime time programmes broadcasted during the first half of September 2016. The aim is to study the network of interactions generated around the programme during its broadcast and the degree of influence of the official profiles in each case.

Keywords: Live-tweeting · Television · Social networks · Twitter · Social audiences

1 Introduction and Theoretical Framework

The network society [1] and the convergence [2] between the old and the new media have modified the traditional concept of television, opening a new scene marked by the hybridization of the media [3] in its confluence with Internet, the social networks and the mobile devices.

The exponential increase in the number of platforms and screens contributed to create a new paradigm in which the contents lose their temporal and spatial anchorage to be transferred to a digital universe [4]. In this context, the consumption of television converts into a personalized and individualized service to which users have access anytime, anywhere and on any device [5], and in which the dictatorship of clicks and likes [6], the cross and transmedia narratives and the permanent network connection [7] predominate.

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The classic lean-back experience is substituted by consumption guidelines that are closer to multitasking and multiscreen, in which the spectators combine the viewing of television with the simultaneous use of other devices –mobile phones, laptops or tablets– through which they surf the web, read emails, chat or check the social networks [8]. These second-screen experiences facilitate the interaction between connected users [9], able to create, share and spread contents in the online environment [10, 11]. The passive spectators are thereby transformed in active prosumers [2, 12, 13] that, when assuming the role of producers and consumers of content, get formed as protagonists of mediated narratives, getting integrated in the media ecosystem in a more complete way than if they acted only as mere receptors [14].

Television provides the context, but they are the channels like social networks the ones that act as a catalyst of the activity of an audience that is getting more compromised [9]. In fact, platforms like Twitter do not replace the traditional communication media, but they complement them, giving the users alternative routes through which they can get involved actively in the media sphere [15].

In this sense, the social networks work as an important backchannel through which the spectators canalize their activity [15], as well as the broadcasters integrate and interact with their audiences [16]. The users' viewing experience transforms inasmuch as practices like live-tweeting –"the real-time annotation and discussion of television shows on Twitter" [17] – get relevance. The action of tweeting about a television program while it is being consumed "gave participants a sense of connectedness with a broader audience", even though they are physically alone [17]. It is created, this way, a community of users in the distance that exchange judgment about the contents [18], transforming the act of watching television into a social activity whose aim is to give the spectator the sensation of being watching in company [19].

When initiating a dialogue, both in the horizontal –with other spectators– and the vertical sense [18], users experiment the sociability in the media [20], giving to it an additional value to the audiovisual consumption [21] and setting the basis for a new television, defined as social TV [22–24]. Conceptualized by authors such as Gallego [25], this emergent term names signifies "a set of technologies, services and practices that make evolve the traditional consumption of television through the interaction of the spectator with the televisual product, directly on the screen or through auxiliary devices". It is combined, this way, the irruption of the social platforms –that orientate the conversation about what happens in the televisual programming [26] – with the necessity of interacting that the audience has [27]. This is the model of the bidirectional and connected television, whose aim is to satisfy the new demands of the spectator regarding entertainment, communication, transaction and information.

2 Objectives and Methodology

With the purpose of analysing the efficacy of the called live-tweeting, in the present investigation the behaviour of the users that comment live a television programme through the Twitter social network is studied, in addition to the influence that the active management of the official formats' profiles has on them.

The methodology that has been selected is based on a quantitative type of descriptive analysis, divided in two phases of capture and processing of data. In the first place, it has been constructed the users' interaction network formed in Twitter, based on the main hashtag in each programme. Through the extraction of the comments, retweets and mentions carried away under the formats' hashtag, it can be visualised a network that indicates the users' behaviour, their interaction level and which profile or profiles have been the most influential. In this process, the use of the free software NodeXL for the capture of data was combined with the use of Gephi for their later analysis and visualization in form of graphs.

In a second phase, the activity developed in the programs' official profiles was observed during their broadcast. Counting the number of publications, invitations to participate, questions formulated to the spectator or the reference to other protagonist profiles (presenters, actors, talk show guests…) helps us to understand their influence level on the rest of the users.

The sample chosen for the investigation includes four television programs broadcasted in prime time during the first fortnight of September 2016, coinciding with the start of the traditional television season. We opted for selecting the formats that were in the first positions in Kantar Media's social audiences ranking, prioritising in the election those belonging to different genres to be able to analyse the use of live-tweeting from different perspectives. As it is shown in the following board, we chose *La Sexta Noche* from La Sexta (information), *Mar de Plástico* from Antena 3 (fiction), *Sálvame Deluxe* from Telecinco (entertainment) and *Gran Hermano*, a entertaining format also broadcasted by Telecinco which has been added later on for being a reality show –a microgenre that takes on value due to the high volume of audience that it achieves– (Table 1).

Table 1. Characteristics of the sample TV programs. Source: prepared by the authors.

Program	Channel	Genre	Day	Hour	Tweets	Impr.	Authors	Hashtag
La Sexta Noche	La Sexta	Information	10/9	21:20	32,9 K	3,74 M	8.86 K	#L6 N rivera
Mar de Plástico	Antena 3	Fiction	12/9	22:44	5.59 K	868.47 K	2.82 K	#MarDe Plastico
Sálvame Deluxe	Telecinco	Entertainment	9/9	21:58	17.08 K	2.49 M	4.50 K	#poli aramis
GH17	Telecinco	Entertainment	15/9	21:56	170.79 K	27.42 M	23.09 K	#Gala2 GH17

The analysis of these types of formats allows us to elucidate how users and official profiles of a program converge, with the purpose of drawing the basic patterns to encourage the spectators' participation through live-tweeting.

3 Results

3.1 The Interaction Networks in Twitter

The representation of the interactions network for the four cases has stated that a great volume of social audience does not imply a larger interactivity between users. When comparing the graphs generated for the program *La Sexta Noche* and for the reality *Gran Hermano*, the difference regarding the number of interactions produced is significant.

The second *Gran Hermano 17* gala –broadcasted on 15th September 2016– has generated, according to Kantar Media's data, almost 180.000 tweets, while the audience of *La Sexta Noche* –broadcasted on 10th September 2016– almost reached 33.000 tweets. A significant difference that contrasts the number of interactions achieved, standing up *La Sexta Noche* as the program that generates the most interactivity of the four analysed in the present study.

In this sense, the graph built from the users' interaction shows not only a great volume of participation (2.926 relations), but also the supremacy of the official profiles inside the network. As it can be observed in the graph –Fig. 1–, the profiles of @SextaNocheTV (program), @lasextaTV (television network), @albert_rivera (profile of the hashtag protagonist because of his interview on the program), @CiudadanosCs (the protagonist's political party account) and even @iñaki_lopez (presenter) are shown in a larger size, which means that they have interacted –as much in terms of publications as in responses– more than any other user. The network makes also clear the existence of a community of users around these official profiles that operates almost independently from the behaviour of the rest of the spectators, being visibly separated from the others.

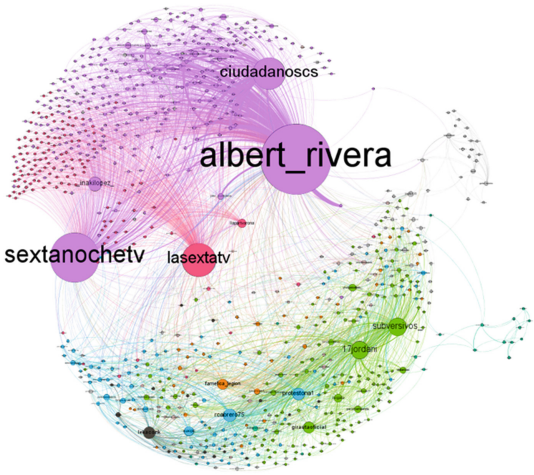

Fig. 1. #L6Nrivera interaction networks. Source: prepared by the authors.

However, the graph that represents *Gran Hermano 17*'s interactivity is substantially different (Fig. 2). At a glance, differentiated user communities can not be perceived and although the official program's profile (@ghoficial) stands up for the interactivity that

it causes, this does not happen in a such remarkable way as in the previous case. The presenter's account, Jorge Javier Vázquez (@jjaviervazquez), appears in a smaller size, but other 'anonymous' users like @manelvideoblogs stand up.

The same diagram is followed by the *Mar de Plástico* and *Sálvame Deluxe*'s networks (Fig. 3). The first is a fiction program that released its second season on 12th September 2016 and for which the official hashtag #MarDePlástico has been analysed. The second is a gossip show broadcasted on 9th September 2016 that launches several hashtags during its broadcast. In this case, the analysis focused in #poliaramis (about the polygraph test taken by fortune-teller Aramis Fuster), the first in the night and that got to become Trending Topic.

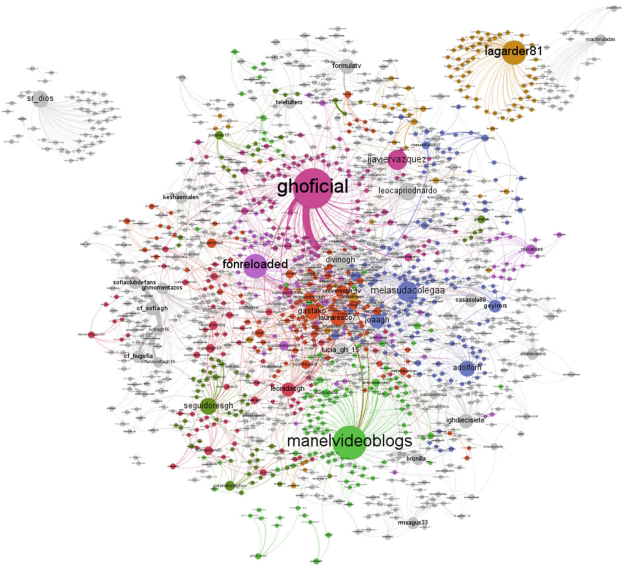

Fig. 2. #Gala2GH17 interaction networks. Source: prepared by the authors.

In *Mar de Plástico*'s case, the official account is the centre of the majority of interactions, although they also appear as influential profiles the ones of the television network (@antena3com) and the television series producer company (@grupoboomerang). The profiles of the actors Lisi Linder and Luis Fernández, that get to activate the participation besides the fact that their influence in the network is lower, also stand out. In this sense, the power of influence of the actors of a fiction series is a factor to take into account in the strategy carried out by the program and the television broadcast itself, since the fact that any of the main actors comments the episode through Twitter encourages the answer of their followers and other spectators.

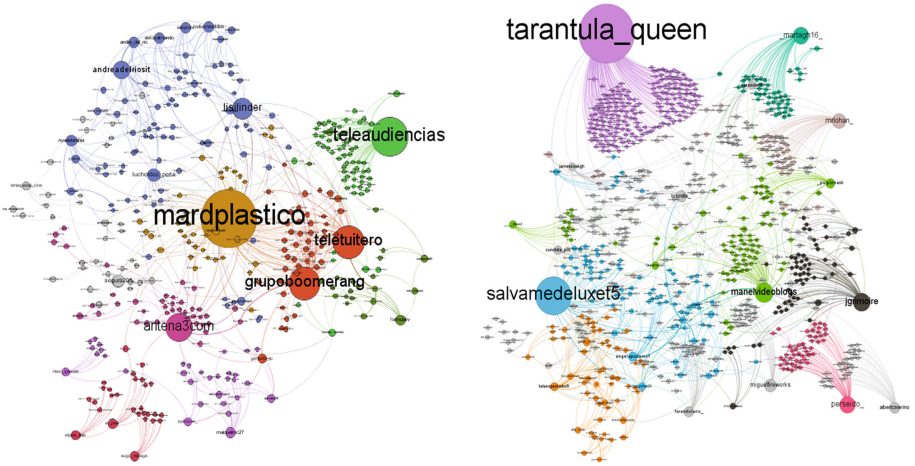

Fig. 3. #MarDePlastico and #poliaramis interaction networks. Source: prepared by the authors

In *Sálvame Deluxe*, the importance of an 'anonymous' user called @tarantula_queen stands out, being able to create a micro network of users around their tweets. The official profile of the program (@salvamedeluxet5), although with a smaller influence, also appears in this case. Similarly, the parody profile of Conchita Pérez (@conchita_poli), the responsible for the polygraph and regular of the program, and the user @manelvideoblogs, a youtuber that comments various television programs such as *Sálvame Deluxe* or *Gran Hermano*, also stand out.

3.2 The Official Profiles as Influencers: Their Impact in the Traffic Generation

With the aim of elucidate the role that the official accounts of the television programs have in the generation of traffic in Twitter, the profiles of each of the formats that form the sample have been selected, counting their activity in terms of number of tweets, retweets and mentions to other profiles and analysing the use of strategies destined to foment the interaction with the public (Table 2).

The official profile of *La Sexta Noche* is the one that had the most publications during the broadcast of the program. Thereby, with 321 tweets and 15 retweets, @lasextanocheTV registers a high rate of publications in which, besides, it mentions and makes reference to other related profiles: @_InakiLopez_ (presenter), @eduardoinda (talk show guest) or @pacomarhuenda (talk show guest), among others. In the total of these tweets the hashtag #L6Nrivera has been used 77 times and all the retweets were to profiles involved in the program. In this case, the strategy is based in the continuous publication of quotes of the interviewed and the talk show guests, as well as presentation, promotion or informative advances that offer data related with the topic spoken in the television set. It is about, in that case, a complete live-tweeting in which the profile comments live every prominent contribution in the program and allows the spectator to create a channel of access to participate and comment it (Fig. 4).

Table 2. Official profiles and protagonists of Twitter. Source: prepared by the authors.

Program	Channel	Official profiles	Protagonists profiles
La Sexta Noche	La Sexta	@SextaNocheTV	@lasextatv, @Albert_Rivera, @_iñakilopez_, @CiudadanosCs
Mar de Plástico	Antena 3	@mardplastico	@antena3com, @Atreseries, @GrupoBoomerang, @LuchoFdez_Perla
Sálvame Deluxe	Telecinco	@SalvameDeluxeT5	@telecincoes, @jjaviervazquez
GH17	Telecinco	@ghoficial	@telecincoes, @jjaviervazquez

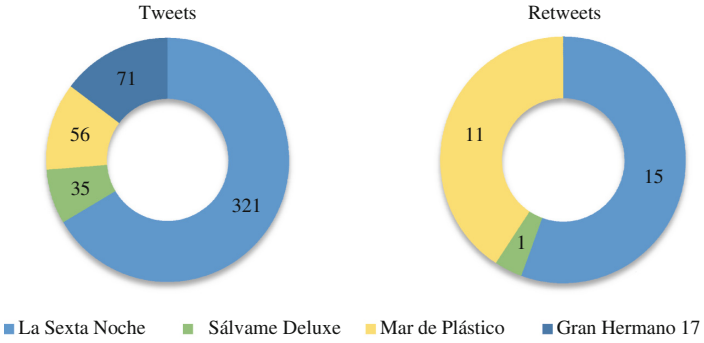

Fig. 4. Tweets and retweets of the official profiles. Source: prepared by the authors.

In the rest of the formats, the participation is smaller. The profile of *Gran Hermano 17* published 71 tweets during the broadcast of their second gala and made 0 retweets. The account of the fiction series *Mar de Plástico* registers 56 tweets and 11 retweets and the one of *Sálvame Deluxe*, 35 tweets and only 1 retweet. Nevertheless, in the four cases everything published in Twitter during the broadcast of the program has been retweeted or marked as favourite, which implies that the use of official profiles attracts more traffic around a television product and that the accounts with more activity –like *La Sexta Noche*'s one– encourage a higher level of interactivity amongst the users.

On the other side, the strategy followed by @SalvameDeluxeT5 stands out, in which they resort to the use of questions to foment the participation of the spectators. Although it is the profile that generates less interactivity, this type of publications appear amongst the most retweeted or marked as favourites.

The tendency is similar in the case of the fiction series *Mar de Plástico*, that makes use of questions in its tweets and, additionally, publishes extra content about the shooting of the episode, redirecting the spectator to the series' website and gaining traffic in the social network as well as in other platforms. In the same way, @mardeplastico is the only profile of the ones analysed that has responded to its users during the emission of

the episode, which favours the loyalty of a collective that, when sees that their comments are taken into consideration, feel motivated to keep participating.

4 Conclusions

In this research we have analysed the phenomenon of live-tweeting as a strategy to increase the conversation between spectators who watch a television programme as it airs. In this sense, the four programmes studied generate a certain degree of interactivity and their networks show how users take into account the activity on official profiles when they are tweeting and watching TV simultaneously.

Twitter, as a backchannel, provides an important platform through which broadcasters can establish contact with their viewers. Displaying hashtags on screen allows users to open a direct way of communication and encourages the spectators' participation through comments, which increases the traffic and visibility of the programme itself. This is the case of *La Sexta Noche*, around which it was built a community formed by official and protagonists profiles and participants who commented and retweeted their interventions.

The use of social media strategies based on launching questions, answering to users and posting extra content is one of the key points of the programmes analysed. In fact, tweets that follow these techniques appear among those that have more retweets or comments and those that have been marked as favorites more times.

Finally, it highlights the power that live-tweeting has in the field of social audiences. Although one of the conclusions of this study is that the social audience does not always coincide with the level of interaction, the use of live-tweeting gives visibility to the programmes –which allows it to reach new audiences– and create a shared experience between their protagonists (presenters, actors, talk show guests…) and their viewers. It breaks with the old television system based on passive and unidirectional messages and opens the way to a new type of active consumption where the value of the conversation is essential.

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Independence: The Cornerstone of Public Service Media Governance

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Abstract. Management and monitoring bodies of public service media (PSM) should reinforce and guarantee of independence of public audiovisual services. This paper aims at analyzing the governance bodies of the EU28 PSM, as well as checking whether they meet the criteria established by the EBU as regards transparency and independence. We used as research method the content analysis of the latest audiovisual acts in the European Union and the most recent reviews of their charters.

Keywords: Governance · Public service media · Regulation · European union

1 Introduction: Governance

Governance is a 20th century concept defined as the projection of the corporate government and governability with regard to stakeholders. Governance thus opposes to a non-hierarchical control model, characterized by a higher degree of cooperation and interaction [1].

Governance refers to as the intermediation tool between the independent players in connection with the media –stakeholders-, developing codes and ethical standards. Also, it represents a self-monitoring and accountability mechanism for strengthening PSM's legitimacy and reducing risks linked to their trust and reputation.

The concept of governance is essential to face the excessive politicization and governmentalization of PSM's management systems. It prevents PSM to be perceived as media managed by elites and political and union organizations. Governance can provide needed strategies based on transparency, interaction and interrelation between audience and media –social conversation-.

Governance is also important in a regulatory context. In 1994, the 4th European Ministerial Conference published the Resolution No.1 on media policy [2], according to which public broadcasting services are directly accountable to their audiences:

> "…public service broadcasters should regularly publish information on their activities and develop procedures for allowing viewers and listeners to comment on the way in which they carry out their missions."

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In 2012, the Council of Europe issued the Declaration and Recommendation of the Committee of Ministers on Public Service Media Governance [3]. It suggests that a well-functioning management system is an essential factor for facing the challenges of public service media and Member States.

Nonetheless, European policies on governance are failing. Among the causes that prevent public service media from achieving greater transparency are: the bureaucratic complexity; the poor perception of governance at all levels; and the overlapping of state interests [4]. Management should go beyond expenditure control, quality administration and HR attention. These elements are relevant but insufficient [5].

1.1 Governance and European Regulation

The EU Council of Ministers released in 1996 the Recommendation No. (96) 10 on the guarantee of the independence of public service broadcasting [6]. It establishes that public corporations have the obligation to operate with editorial independence and institutional autonomy, especially in areas such as: programming; content production and creation; recruitment; purchasing, selling, and using goods and services; managing and preparing budgets; negotiating; and the representation of these organizations in legal proceedings.

According to the same text, the respective PSM's board of directors should be the main responsible for the day-to-day activity of public organizations. Also, their members should be free from political or any other interferences. They are thus obliged to attend only the interests of the organization in the performance of their duties. This means that they could not –directly or indirectly- perform any function, receive payments, and to take advantage of communication companies and organizations that may lead to a clash of interests.

The Recommendation states that public broadcasting services may not,

> "receive any mandate or take instructions from any person or body whatsoever other than the bodies or individuals responsible for the supervision of the public service broadcasting organization in question, subject to exceptional cases provided for by law."

The independence of public service media has two key elements: independence of origin and performance. A certain body has independence of origin when its members are elected on the basis of their skills and without state interference. With regard to the second element, a body has independence in its performance when its activities can not be changed and paralyzed by any state power [7].

The European Parliament resolution of 21 May 2013 on the standard settings for media freedom across the EU [8], calls upon Member States and the European Union to make sure that there are legally binding procedures to elect media managers, supervisory boards, and monitoring bodies. And these mechanisms are based on transparency, expertise, professionalism, integrity and independence.

Also, the resolution requires consensus on the representation of politicians and social players, legal protection and continuity. That would prevent public broadcasting services from using partisan criteria, based on the will of political powers.

However, the concept of independence is quite uncertain when it comes to broadcasting [9], as governments have never relinquished their potential power, starting with frequency allocations and public funding.

Wolfgang Schulz, Kristina Irion and Peggy Valcke edited in 2013 the book *The Independence of the Media and its Regulatory Agencies* [10]. It explores the relationship between media governance and the independence of European regulatory authorities. The authors conclude that, depending on the social, economic, and legal context, the independence of the media may be flourished or dissolved.

The Council of Europe demands a clear separation between managing and supervising activities. Management boards are in charge of financial resources and the designation of high-level positions. Monitoring is exercised by supervisory bodies, usually regulated by the State and composed by broadcasting representatives and social groups, including unions, industry, sport, science, cultural organizations, the Church, and universities.

2 Method

The aim of this paper is to analyze the governing bodies of the EU28 public service media and to test whether they respect or not the value of independence set by the European Broadcasting Union. This allow us to assess whether or not the 28 corporations are meeting the standards as laid down in the EBU criteria.

The research method is the content analysis of the latest audiovisual legislation and reviews of charters, the documents governing the operation of these corporations for a 10-year period in most of the cases.

As regards management boards, a detailed list of their main features will be shown, paying special attention to selection processes, professional criteria and gender equality. Also, an analysis of supervisory boards will be carried out, particularly with regard to selection processes of governing bodies, pluralism, and the involvement of civil society.

3 Results

Governance refers to the framework of standards and practices that set out the rules on how an organization is managed: how is taking decisions, how stakeholders are listened, and how the organization is being accountable to those groups. When it comes to public broadcasting services, governance is linked to the agreements based on legislation and on governing bodies –executive and supervisors-. The modern view also includes the code of behavior with audiences, authorities, economic players and civil society.

The basic requirements of PSM governance in Europe consist in strengthening the democratic debate, guaranteeing the freedom of expression and pluralism, defending social cohesion and contributing to cultural diversity. A good governance should help to meet organizational and corporate objectives.

In Germany, the ZDF Charter (2015) notes that the Council of Television, composed by 70 members –men occupying two-thirds-, issues guidelines for programming and develops surveillance tasks based on the *Interstate Treaty*. Its main role is to approve

budgets, perform public value tests –*Drei-Stufen-Test*-, and participate in projects. This organism chooses its president every four years and among its members –secret ballot-. Also, it designates the DG every five years.

The Management Board, composed by 14 members (12 men and 2 women in 2016), is responsible for supervising the activity of the DG and appoint leading positions of each channel, the Chief Editor and the Executive Director. Also, the Board handles commercial activities via subsidiaries and launches proposals to modify statutes. The members of the Board are elected in the same way that the Council of Television. Decision are adopted by simple majority of all its members, and DG are allowed to attend meetings.

In March 2014, the German Constitutional Court established that the number of representatives of the State –including members of the government, PM and politicians- in the Management Board could not exceed a third of the total. The same resolution notes that the representation of civil society should be relevant and requires the public broadcaster to guarantee a minimum of transparency. Also, parliamentary representatives of the supervisory board are elected using a system of proportional voting.

The Management Board of the Austrian ORF is composed by 35 members, appointed as follows: six by Parliament; nine by governments and regions; nine by the Federal Government; six by the Audience Council; and five by the Works Council. All of them are required to have professional skills on management and media markets. This body is responsible for managing, appointing the DG for a 5-year-period, and approving medium and long-term plans, among others.

The Austrian Audience Council is in charge of safeguarding the rights and interests of society. It is composed by 31 representatives of chambers of commerce, agriculture, labor and trade unions, professional colleagues, the Catholic and Protestant churches, and the Academy of Sciences. The ORF's bylaws include an equity plan for guaranteeing woman representation, but detailed figures are not available.

The Management Board of the Belgian RTBF is composed by 16 members proposed by the Courts -11 men and five women-, who are responsible for guaranteeing compliance with laws, the public service mission, the management contract, and the financial stability of the company. The work of the board is complemented by the steering committee, composed by nine members, seven of them are men (2016).

The Board of the VRT has between 12 and 15 members –nine men and five women in 2016-, appointed every five years by the Government of Flanders according to the parliamentary representation. Members of the Supervisory Board are elected by qualified majority to guarantee the appointment of politically-independent people. Nonetheless, this protection is limited when government parties reach the required sum at Parliament.

The Executive Board of the Croatian HRT is comprised by five members –four men and one woman in 2016-, who are elected by Parliament, including the DG, for a five-year period. The DG is responsible for making decisions, designing strategies and ensuring compliance with regulation. Also, it appoints the Supervisory Board –five members, four of them are elected by Parliament and one of them by the workforce-.

In Denmark, the DR has a Management Board composed by 11 members –six men and five women in 2016-, elected for a four-year period. They are appointed by the Ministry of Culture (3), Parliament (6), and the workforce (2).

The Slovak RTVS has two management bodies: The Board of Directors and the DG, according to the statutes (2011). The Board has nine members –six men and three women in 2016- and proposes the candidates of the Supervisory Board, an internal body that depends on the public broadcaster.

In Slovenia, the governing bodies of the RTV are the Management Board and the Supervisory Board. The first one is composed by 29 members, who are in charge of managing and developing proposals of the DG in terms of programming, economy and strategy for a four-year period. The selection process is made as follows: a member is proposed by the Hungarian community, another one by the Italians, and other by the Slovenia Academy of Arts and Science; two people by the president of the Republic on the motion of religious communities; three members by the employees of the RTV; five of them by the National Assembly on the motion of political parties; and 16 members by audience, universities, associations and groups of arts, culture, journalism and science.

The Supervisory Board is an internal body of RTV, has 11 members and is responsible for monitoring and assessing economic transactions -amending budgets and setting prices-. The National Assembly elect five members, the government four, and the workforce two. The mandate covers a four-year period.

In Spain, RTVE has three governing bodies: The Management Board, the Advisory Council and the News Council. The Parliament, the audiovisual authority and the Court of Audit take care of the external monitoring.

The Management Board has nine high-skilled and experienced members –six men and three women in 2016-. These people are elected by the Spanish Parliament for a six-year and non-renewable period. The Congress also appoints the president of RTVE, the only member with full-time responsibility. In 2006, an enhanced majority of two-thirds was required for the appointment; however, since 2012 an absolute majority is allowed in the second round.

These bodies are presumed to have high-skills and expertise for the position, highly educated or recognized competence in management, direction, supervision or advice for at least five years. Also, they should have merits on communication. Among the incompatibilities, they could not have direct or indirect interests in audiovisual companies or media-related organizations.

The Advisory Council is the participatory board for society in RTVE. It has 15 members elected as follows: three people by the Economic and Social Council; two by the Council of Consumers and Users; one by the Ministry of Foreign Affairs; other by the Spanish Youth Council; one by the Woman Institute; one by bodies representing people with disabilities; one by the General Council of Migration; one by the Academy of TV Arts and Science; one by the Academy of Film Arts; one by the University Coordination Board; one by bodies representing advertisers; and one by national journalists' associations.

The Finnish YLE has two governing bodies: The Management Board and the Steering Committee. The first one is composed by 21 members -14 men and 7 women

in 2016- representing science, arts, education, business, economy and social groups, and the Finnish and Swedish languages. The Steering Committee has between five and eight members –five men and three women in 2016-, who are in charge of choosing the DG and members of Senior Management, as well as planning the budget.

As regards supervision, in Finland, the United Kingdom and Germany, it depends on the Management Board of the public broadcaster, without having an independent authority. Nonetheless, there are specialized bodies, as the legal supervisory body, the Audiovisual Regulatory Authority.

France Télévisions is managed by the Management Board, which is composed by 15 members for a term of office of five years. It is composed by the president, two members elected by the Commissions of Cultural Affairs of the National Assembly and the Senate; five representatives appointed by the government; five independent people designated by the Regulatory Council for Broadcasting; and two by staff of FT. The work of the Management Board is complemented with four general directorates and nine transversal directorates.

In 2007, FT became the first broadcaster to create a Foundation to support and collaborate with the Management Board in the supervision through multiannual action plans for five years. The Regulatory Council for Broadcasting (CSA, *Conseil Supérieur de l'Audiovisuel*) is an independent body created in 1989 with nine members: three of them are appointed by the President of the Government, three by the National Assembly and three by the Senate.

The Greek ERT has a Management Board composed by seven members: five are elected by the government and two by direct universal suffrage of the ERT's workforce. The mandate is for five years and is renewable only once. The Supervisory Board is external, independent and responsible for producing annual reports on ERT's performance.

According to the latest regulation (2010), the Management Board of the Hungarian MTV is elected by Parliament, with a two-third majority and a nine-year period. In 2013, the government proposed a bill, at the request of the EU, for the president of the National Authority of Communications to be elected directly by the President of the Republic, on the motion of the Prime Minister. The professional requirements are also tightened: from three to ten years of experience linked to the media market. The re-election of the president is forbidden.

The governance of RTE emanates from the Management Board, composed by 12 members –equal number of women and men in 2016-. Six of them are elected by the president of the government; four are proposed by the Ministry of Communications; one is the former DG; and the last one is a RTE employee. The corporation has an Audience Council composed by 15 members elected by the Management Board on the motion of representatives from various sectors. It is responsible for defending the public interest.

The Broadcasting Act of 2009 created the Irish Broadcasting Authority, an independent supervisory body of nine members, five of them elected by the government and four by a parliamentary committee.

The Management Board of the Italian RAI reduced in 2015 the number of members from nine to seven. Nonetheless, in June 2016 members are still nine –two women and seven men-. Four of them are elected by Parliament; two of them by the Council of

Ministers; and one by the RAI staff. Also, it provides for the creation of a chief executive, who will be responsible for approving contracts of up to 10 million euros and appoint the senior management.

The Italian public broadcaster does not have an external and independent supervisory body. However, there is parliamentary scrutiny via the Supervisory Commission of the RAI, which is composed by 20 deputies and 20 senators designated by the presidents of both chambers.

In Latvia, the public broadcaster is monitored by the National Council of Electronic Media, responsible for ensuring compliance with the normative. The organization is composed by five members –two women and three men in 2016- elected by Parliament on the motion of media-related, culture, science, and educational institutions. Members are required to held a university degree and have at least five years of academic and/or professional experience.

The Latvian TV and Radio Commission is the decision-making body of the LRT. It has 12 members –nine men and three women in 2016- for a six-year period. Four of them are elected by the president of the republic; four by the Parliament; one by the committees of education, science, culture and development of the information society; another one by the opposition; one by the artists' association; one by the journalists' union; and the last one by the Bishops' Conference.

Members of the Management Board should have higher education studies and at least five-year experience in audiovisual policies, production or dissemination of public information or academic texts. The term of office for members is limited to four years, and may be renewed once or even twice. The Chair shall be held by the oldest member.

The Management Board of the Dutch NPO has five members –three women and two men in 2016- and is in charge of the design of broadcasting formats, the coordination of programs, and the promotion of media cooperation. The Management Board of the Polish TVP has 15 members -10 men and five women in 2016-, appointed by the National Audiovisual Council. Ten members are elected on the motion of parliamentary groups and the remaining five are chosen by experts in culture and the media for a four-year period.

In Portugal, the General Assembly has the mission of electing and dismissed representatives of the Bureau of the Assembly and the Management Board. It also discusses on statutes, compensations and accounts. The Management Board has three members, appointed by the Independent General Council with immovable nature.

The public prosecutor is elected by the General Assembly and acts as a civil society watchdog, reviewing accounts and requesting an annual audit for public income. The governance is complemented by an Independent Council General. It has six members – four men and two women in 2016- elected by the government (six) and the opinion council every six years.

The 8th Royal Charter of the British BBC expired in December 2016. The new document (2017-2027) introduces structural changes. The internal government of the BBC will transform the governing body into a unified management in order for half of the executive to be appointed by the public broadcaster. Also, the BBC will no longer be autonomous, as the Ofcom extents its powers of investigation and application of sanctions.

The Board has now 14 members, and nine of them are elected by the BBC's appointments commission-. The government will protect the procedure for the election of the president and the remaining four, who will be representatives of Scotland, Wales, Northern Ireland and England. The Trust acts as a Management Board, a sovereign body concerning the implementation of the provisions of the Royal Charter or any other mandate. The body is in charge of safeguarding the public service and is composed by 12 members –seven men and five women in 2016- for a period not exceeding five years. They are appointed by the Queen on the motion of the government, including representatives of England, Scotland, Wales and Northern Ireland.

The Executive Board has the duty to launch BBC services and operating plans according to the priorities set by the Trust. This board is composed by 14 members – nine men and five women in 2016-, being eight of them non-executive. The Council delegates functions and decision-making processes to the corresponding commissions, individual members and the remaining staff. The president is designated by the Trust.

The British monitoring system is mixed and combines the work of internal bodies – the Trust-, in charge of ensure compliance with veracity and impartiality; and external control –the Ofcom-, which acts as competition regulator. The BBC has also Audience Councils –one by region-, which is responsible for assessing BBC's performance, recommending and commenting on decision-making processes, and identifying new audience trends.

The Management Board of the Czech CT has 15 members -14 men and one women in 2016- elected by the Congress of Deputies for a six-year period. In Sweden, the Management Board of the SVT has 10 members –six women and four men in 2016-, responsible for making decisions concerning the activity and programming of the broadcaster. There is also an independent and external body –the Broadcasting Commission-, which has the duty to supervise the SVT's performance and ensure compliance with the law.

4 Conclusion

Findings show that Management Boards of European public service media have between three and 35 members –Portugal and Austria, respectively-, which indicates that there are various interpretations on their function and role.

The Parliament is in charge of the election procedure in the German ZDF; the Belgian RTBF and VRT; the Cypriot CyBC; the Croatian HRT; the Spanish RTVE; the Finnish YLE; the French FT; the Dutch NPO; the Portuguese RTP; the English BBC; and the Swedish SVT. This model should be a guarantee of independence, as they are mechanisms to avoid control by majorities that may pervert pluralism.

In Austria, apart from the election by Parliament, there is also participation of the Federal Government, the Governments of Regions, the Audience Council and the Works Council. Bulgaria, Slovenia and Lithuania also rely on the university, the Church, and other social organism. In Denmark and Greece, apart from Parliament, the decisions are also taken by the workforce.

Public broadcasters from Bulgaria, Cyprus, Latvia, Malta and Romania do not provide information on their governing bodies in their corporate websites, which is a sign of lack of transparency to their stakeholders.

The Resolution of 21 May 2013 on the standards settings for media freedom across the EU notes that all Member States should seek consensus on the criteria to appoint PSM's management boards. This decision is in line with the principles of independence, integrity, experience, and professionalism.

In this regard, it urges Member States to establish guarantees to ensure independence of management and supervisory boards from political influences, parliamentary majorities and any other civil group.

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Youtube for Dialogic Relationship Building? Analysis of Content Management and Level of Participation of Spanish Best Reputed Companies Youtube Channels

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Abstract. Companies have incorporated new social media in their relations with the citizens. This article discusses the use of YouTube, the audiovisual message and the involvement of users in the channels of the best reputed companies in Spain according to Merco ranking (*Business Monitor of Corporate Reputation*). A total of 454 videos were analysed. The paper concludes that the use of YouTube is more promotional than informative, as well as unidirectional. The low interaction and participation of publics point to a lack of interest in the contents. For the moment, the conservative attitude is the main trend of business communication on YouTube.

Keywords: Business communication · YouTube · Social media · Audiovisual · Interactivity · Web 2.0

1 Introduction

Web 2.0 defines the new ways society, individuals and organizations use for communication. The companies are not immune to technological and social changes taking place around them and try to incorporate them, so, the new communication channels (social networks, social media, mobile devices, etc.) and the new dynamics of use (feedback on real time, sharing, customizing and creating contents, etc.) are added to their external communication strategy [1–5].

One of the social media that has more social impact is YouTube, the channel to share videos. In Spain 13.5 million people use YouTube per month, that is the 54.25% of the total Internet audience in the country. It is the fourth most visited website and the first one of entertainment (2015). Furthermore, according to the Interactive Advertising Bureau (2015), this is the best valued social network. YouTube (created in 2005 by Chad Hurley, Steve Chen and Jaweb Karim) lets you upload videos for free and without limit, and generate conversations among users through comments. It is one of the portals

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born under Web 2.0, as an UGC site (*User Generated Contents*). As it has been explained the birth and success of YouTube is part of the junction of three revolutions: the production of video, Web 2.0 and the cultural or viewing habits revolution [6].

The potential of the new tool, as search engine and content channel, is at the service of organizations, which, if they want to, have their own online social television. This allows them to provide their audiences with videos that can be discussed, can be shared, might be liked (or not), that is, they can establish a direct relationship with users.

Some of the reasons that lead companies to launch their channel on YouTube are: gratuity, huge storage capacity and the high popularity of the site, favouring a constant feedback [7].

This research studies how the best reputed companies in Spain (Merco) are using this new tool and evaluates the relational or unidirectional use of it [8].

2 Literature Review

As Jenkins explains, the power of storytelling is not only in the hands of large corporations, but grassroots media, that is, ordinary people media, which implies a better balance in the relationship between companies and audiences [9, 10]. "Customers want firms to listen, appropriately engage, and respond" [11]. However, the study of the use of social media at the service of business communication has taken place more in a theoretical than practical level [12].

One of the social media that is having more social impact is the video sharing channel YouTube. It is considered a participatory medium [13], a platform or video sharing service [14, 15], a means of production and distribution of content by the user [16], a social network [17] and a community of content [18]. In the classification proposed by Kaplan and Haenlein [12] YouTube would be a community of content with an intermediate level in the multimedia richness that allows (more than a blog, but less than a virtual world like *Second Life*) and also intermediate according to the exposure and personal projection.

According to Cheng et al. [15] YouTube exhibits many unique characteristics, especially in the range of distribution, the access model and the growth trend. These features introduce new challenges and opportunities to optimize the launch of services to share short videos.

The video may also contribute to give a human face to the firms and build the brand. "Videos enhance the public's impression of the organization's products or services, put a human face on the organization, and ultimately build the brand. The three V's of communication -verbal, vocal and visual- are brought together in the video form so that an audience is impacted on multiple communication fronts", explain Waters and Jones [19].

However, there is little research on the topics that media professionals should take to make the use of social media more effective or how to manage these issues [20, 21]. Also, there are few empirical studies on the use of YouTube from the point of view of Corporate Communication and, more specifically, Public Relations. Here the most relevant scientific literature is reviewed.

Bonsón, Bednárová and Escobar-Rodríguez [22] in a study on the use of YouTube by major companies in the Eurozone detect that 44% of the sample (composed of a total of 306 companies) have this social network, which is used mainly for marketing and brand promotion. They also show that the size of the company and the country of origin determine their activity on YouTube, while the number of subscribers, the activity and the company size are the major factors affecting the visibility of the channel.

In the study of Tapia and Caerlos [23], on the Ibex 35 companies, just over half (54%) use their YouTube channel, and given the business area there are more companies of the banking sector, followed by technology and telecommunication companies.

According to the business ranking of *Fortune*, around 37% would use it, that is, about four in ten [24].

Guzmán and Del Moral [25], on a sample of Latin American universities, find two trends in the use of the videos analysed: video publishing for promotion (therefore external communication) and video publishing to promote internal communication.

3 Methodology

YouTube's contribution to customer relations has been investigated empirically considering the purpose of the audiovisual speech, formats and the level of participation of the audiences. The research starts out with the systematization and analysis of a sample of videos of the best reputed Spanish companies (the first twenty, according to the index of business reputation, Merco 2013).

The sample of 454 videos was systematized according to a set of descriptive items both in formal (duration) and content level (purpose, format, participation, interaction). The research questions to be answered were:

R.Q. 1. What percentage do they use a channel on YouTube?
R.Q. 2. What is the relationship between the number of subscribers and the total views?
R.Q. 21. What is the relationship between the number of subscribers and the average views of the videos analysed?
R.Q. 3. What is the main purpose of the audiovisual speech?
R.Q. 4. What media formats do they create for the channel?
R.Q. 5. Do they manage to implement an interactive and relational paradigm with their audiences?

The factsheet was designed for the purpose of this investigation and was shaped by the following items:

(a) Identification items: Channel name, analysis date, video length.
(b) Video characterization items: audiovisual format [26], communicative aspect (distinguishing among the most important ones of corporate communication: external, intermediate or internal), purpose of the video (mainly: advertising, informative, corporate social responsibility, sponsorship, relationship building or other) and in the context of interaction, knowledge (views) and participation (comments and likes/dislikes) according to the methodology developed [27, 28].

4 Results

Below the results of the analysis in accordance with the items or subsections that formed the analysis tool.

4.1 Presence on YouTube

Among the 20 companies that are part of the sample, one had no corporate channel at the time of the study and three have no channel for Spain. Therefore, 80% (16 of 20) of the best reputed Spanish companies have incorporated YouTube to their catalogue of social media (R.Q.1).

Telefónica (one of the analysed companies of the sample) created the first channel on YouTube in 2005. Followed by BBVA, IESE and El Corte Inglés in 2006. The last company to activate its online channel was Repsol in 2014 (Table 1).

Table 1. Channel data. Personal compilation.

Channel	Creation	Subscribers	Channel views	Average views
Mercadona	16/05/2013	1.914	362.576	6.343
Santander	17/12/2012	633	792.578	93
Repsol	05/03/2014	No reported	114.176	104
Iberdrola	11/05/2011	921	447.299	1.871
Telefonica	1/11/2005	569	207.041	2.149
BBVA	08/07/2006	14.586	25.529.640	38.393
Seguros Mapfre	04/11/2007	844	7.899.145	6.433
Coca-Cola	13/10/2009	25.651	27.117.612	22.454
La Caixa	16/05/2008	7.144	28.880.289	7.976
Google	30/05/2007	21.892	22.576.917	6.162
Acciona	23/07/2008	1.700	1.029.603	429
Ikea	24/10/2009	20.263	24.568.139	3.424
Danone	14/10/2010	8.042	12.077.269	11.293
El Corte Inglés	29/07/2006	4.265	1.079.710	578
Indra	19/07/2010	950	142.091	190
IESE	28/03/2006	5.383	845.744	225

The companies that have achieved a greater number of subscribers –therefore permanent subscribers- are Coca-Cola Spain, Google Spain, Ikea Ibérica and BBVA. Consequently those are the ones that have more views of their videos, and here it should also be included the bank of Catalan origin, La Caixa. It is noteworthy that the date of creation of the channel on YouTube does not involve an increasing activity (more subscribers or views) (Table 2).

Table 2. Correlation table. Personal compilation.

		Subscribers	Views	Average
Subscribers	Pearson Correlation	1	,837[b]	,540[a]
	Sig. (2-tailed)		,000	,038
	N	15	15	15
Views	Pearson Correlation	,837[b]	1	,662[b]
	Sig. (2-tailed)	,000		,005
	N	15	16	16
Average	Pearson Correlation	,540[a]	,662[b]	1
	Sig. (2-tailed)	,038	,005	
	N	15	16	16

[b]. Correlation is significant at the 0.01 level (2-tailed).

[a]. Correlation is significant at the 0.05 level (2-tailed).

Subscribers and views are two variables that correlate positively. The Pearson correlation coefficient is high (0.837) and the significance level is appropriate (R.Q.2). Between the number of subscribers and the average views of the analysed videos there is a lower correlation, resulting from the limited sample (R.Q.2). The coefficient R2 shows that 70% of the viewing variance is explained by the variable channel subscribers (see Table 3).

Table 3. Model summary. Personal compilation.

Model	R	R Square	Adjusted R square	Change statistics				
				R Square change	F Change	df1	df2	Sig. F Change
1	,837a	,700	,677	,700	30,398	1	13	,000

Predictors: (Constant), Subscribers
Dependent Variable: Views

One of the keys to get more views is to have more usual channel followers, that is, it is important, first, the channel position, and then positioning the message.

4.2 Purpose of the Videos

A polarization of audiovisual messages is detected in two purposes: information and advertising. The informative purpose is built up if both objectives of *information about the organization and information about the programs and actions of Corporate Social Responsibility* are added. A total of 175 videos, 38.5% of the messages. The advertising purpose (100 videos) plus the product or service information (84 videos) can be grouped together under a promotional purpose, which would be 40.5% on the overall videos (R.Q.3).

The use of 2.0 channel to build relationships with users is a minority: only 13 videos, 2.86% of the sample is used for a relational purpose like promoting discussion or involving users in a campaign seeking their cooperation (Table 4).

Table 4. Purpose of the videos. Personal compilation.

Purpose	N	%
Relationship building	13	2,86%
Information organization	89	19,6%
Information product or service	84	18,5%
Advertising	100	22%
Sponsorship	24	5,28%
Corporate Social Responsibility	86	18,9%
Another	58	12,7%
Total	454	100%

4.3 Audiovisual Formats

Traditional advertising formats are the most used in this video sample. Spot and infomercial are the most common contents on YouTube channels, which is consistent with the promotional objective (R.Q.4).

It should be pointed out the use of branded content formats, mainly informative (rather than for entertainment), that is, audiovisual content produced by the brand that offers useful or interesting information to consumers. One example is the series of videos produced by Ikea with tips on how to use the space of the house or how to decorate or furnish a certain room or space.

Also, the Statements format, which personalizes the company in the directors or employees, giving it a human face, and with shorter videos than those of Interviews. Third, the Video news, like a journal providing information about the company news and the informative Microvideos, especially dedicated to provide information about products or services.

The most visible line of approach of Corporate Social Responsibility on YouTube is the one that has to do with socioeconomic matters. In a context of economic crisis with high unemployment rates in Spain, companies want to recover the confidence of citizens showing their solidarity and attempt to help improve the general welfare (Table 5).

For this study, the number of comments generated, as well as likes and dislikes facilitated by each video were used as indicators.

In terms of the number of comments, the trend shows no or very low participation. Comments are disabled by a significant percentage of the analyzed sample (79 videos of total), while more than half of the sample (263 videos) has had no comments. Videos with more than 50 reviews are rare (0.2%) (Table 6).

Table 5. Formats. Personal compilation.

Format	N	%
Spot	88	19,38%
Infomercial	81	17,84%
Video news	42	9,2%
Corporate video	8	1,76%
Microvideo	42	9,2%
Statements	45	9,9%
News coverage	7	1,54%
RSC	38	8,37%
Branded content	54	11,9%
Gross	2	0,4%
Interview	4	0,8%
Making of	9	1,98%
Another	34	7,48%
Total	454	100%

Table 6. Participation: Videos with comments. Personal compilation.

Number of comments	N	%
Comments off	79	17,4%
None	263	57,9%
1 to 50	111	24,4%
51 to 100	1	0,2%
Over 100	0	0%

If the access or knowledge (equivalent to views) is linked to comments, the participation rate is very low, 0.00011. This means that there is only one comment for every 10,000 video plays or views. Given that the average video play is 10085, there will be only half a comment for each video. It should be noted, however, the high percentage of videos with the comment option disabled, so that the user could not comment if he tried. If these were removed, the participation would increase to 0.00028. Consequently there would be a comment for every 4,000 views.

Concerning *Likes*, the participation rate is 0.00034, which means that there would be one *I like* for every 3,000 views. The participation rate for *dislike* is lower: 0.00021, one *dislike* for every 4,800 views (Table 7).

Regarding the most played contents, it should be pointed out the spot format linked to Corporate Social Responsibility actions focused on the socio-economic aspect, as the program of La Caixa to help youth at risk of social exclusion to get a job. Also BBVA programs to help entrepreneurs, small businesses or self-employed, start their business or hire other people.

In short, all the indicators analyzed -comments and affection (likes)- shows a low participation of the audience, which reveals, in general, little tuning with the contents (R.Q.5).

Table 7. Participation rate. Personal compilation.

Indicator	Rate	Necessary views
Comments	0,00011	10.000
Like	0,00034	3.000
Don't like	0,00021	4.800

5 Discussion and Conclusions

Like in political communication [29], a conservative communication style is the current trend of business communication on YouTube. The intended use of the channel is the promotional aspect (advertising and information of its products and services), followed by information. Therefore, there is a commitment to YouTube, especially as a channel for product promotion.

Companies use traditional and unidirectional formats such as the spot, the infomercial or statements, which do not promote participation. YouTube is best understood as a vehicle for communications produced by or for traditional media, especially television, and not so much as a new technology tool.

The informative branded content is one of the new commitments to add value to users. RSC videos related to socio-economic assistance programs are also a new trend, an attempt by the companies to become more responsive to the current context in Spain (high unemployment, job insecurity, etc.) and to the situation of the citizens. Users have been highly interested in them (more content views).

However, more innovative and striking formats as flash-mobs, lipdubs, event videos, teasers, videos of transmedia campaigns, etc. do not have a strong presence.

The participation of the audience regarding their message is very low. Those companies that get a larger number of subscribers are also more likely to have a greater number of content views. The key question is: how to attract subscribers?

The relationship with the audience arises in unidirectional terms. 17.4% of videos cannot be discussed. There are 10,000 views of a video for each comment. This confirms that the channel is used to broadcast (one-way message), rather than to seek dialogue and relationship (bidirectional message). According to the reformulation of the concept of audience [30], the latent diffused audiences have not yet received the message that makes them participate.

Markets are conversations [31]. It is necessary to rethink the audiovisual strategy to achieve greater harmony with the audience in terms of participation. Youtube is being employed like a channel of content, but its network potential is being ignored.

Future research will show whether, in the longer term, there is commitment to grab users' attention and take advantage of 2.0 options, a medium regarded as an exponent of participatory culture.

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Social Media Communication as a Corporate Positioning Strategy: The Galician Winemaking Sector in Spain

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Abstract. Like gastronomy, wine is one of the cultural and historical elements that comprise a region's heritage, reflecting its identity. Many destinations use this particular aspect to attract visitors and tourists in search of unique experiences related to the winemaking sector. This research addresses the case of Galicia, one of Spain's autonomous communities, renowned for the quality of its wine production that has earned it five designations of origin: Rías Baixas, Ribeiro, Ribeira Sacra, Valdeorras and Monterrei. This study aims to analyse the positioning of these Designations of Origin on the social medium Facebook. The research tool employed is of a qualitative nature, based on documentary analysis and consisting of the observation of the respective fanpages. The conclusions reveal the need for the further optimisation of the opportunities social media offer in terms of creating, boosting, improving and strengthening the future positioning of the designations of origin, the object of this study.

Keywords: Communication · Social media · Facebook · Winemaking sector · Galicia · Online positioning

1 Introduction

Changes in the field of social communication brought about by the impact of Information and Communication Technologies (ICTs) have led to the emergence of a new business scenario, related to the new consumer behaviour, globalisation, the Web 2.0 or the growing influence and role of social media.

Within this context, our research focuses on the winemaking sector, as wine is a cultural symbol that forms part of the identity of the places in which it is produced. Demand for this product, which also shares close ties with gastronomy, is growing considerably, as consumers are becoming increasingly interested in the opportunity to enjoy the experience of tasting fine wines or touring vineyards and wineries.

Spain boasts numerous autonomous communities that are renowned for producing top quality wines, and many of its regions have been awarded Designations of Origin.

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This is the case of Galicia, which with five such quality seals, comprises a suitable framework for this study.

The objective is therefore to highlight the crucial role played by social media communication for a number of major companies, products or brands operating in the Galician winemaking sector and based on their Designations of Origin. The analysis presented aims to determine their positioning on the social medium Facebook, chosen due to the fact that it has a greater general impact than any other medium and offers major potential for interaction.

2 From Traditional Communication to Social Media

For some time now the traditional media have been immersed in an extended and challenging series of strategic risks, due principally to the fierce competition between them and secondly as a result of the emergence of digital media that have incorporated new forms and models based on user or received cooperation and participation [1].

In the late 1990s, Buhalis [2] stated that companies that failed to establish a presence in the electronic marketplace would face serious short-term disadvantages, which would in turn lead to a considerable loss of market share.

This situation represented a new challenge for companies, as the general transformation of the media [3], coincided with the entry and expansion of the Internet.

The Web 2.0 revolutionised the online world, providing an open virtual platform built on architecture based on user participation [4]; in other words, it marked the start of a period in which the Internet began to be used for the purpose it had been intended, namely for sharing, collaborating, contributing, editing and above all connecting people with people [5].

Authors such as Álvarez, Benamou, Fernández and Solé [6], as well as Heerschap, Ortega, Priem, Offermans [7], Theodosiou and Katsikea [8] or Hudson and Thal [9], defend an evident transformation in all areas of the economy, attributable to the Internet and its ongoing evolution, and in which social media play an increasingly relevant role. In recent years, these media have undergone exponential growth, as companies have grasped the benefits they provide for promotion. They constitute an economic channel with a vast capacity for transmission and communication, capable of disseminating content, communicating and exchanging information [10].

Consequently, they have become a key platform for social change [11]. Gomis [12] defines them as media in a range of format that facilitate access to segments of users that can be classified in accordance with their interests, concerns, feelings and ideologies, etc.

According to the IAB study [13], Facebook (99%) and Twitter (79%) rank among the best-known social media. They are followed by Instagram (52%), LinkedIn (29%) and Tuenti, which has dropped 14 points in terms of popularity since 2015.

As for the usage ranking, 96% of those polled claim to use Facebook, ahead of WhatsApp (88%), YouTube (66%) and Twitter (52%). The difference between the rankings lies in the fact that in general the public continue to fail to identify platforms such as WhatsApp or YouTube as social media [13].

In the light of these changes to the virtual environment, companies are today aware of the crucial role social media play in business.

3 Galicia's Winemaking Sector and Designations of Origin

The improved quality of wine, the dissemination of the culture surrounding this product, together with its prestige and fashionable nature, are just a few of the aspects that have contributed to boosting the growing relevance of the winemaking sector [14].

Winemaking tend to be concentrated in rural areas, many of which are suffering the effects of depopulation, a loss of identity, unemployment and an ageing population. Wine routes have emerged as a means of socio-economic development, integrating existing tourism services and resources available in winemaking areas in order to create a sense of identity for the destination and thereby promote progress [14].

Initially, winemaking in Spain, one of the world's major wine producers, was concentrated in small and medium enterprises, many of which were also cooperatives and that had managed to generate sufficient wealth to partially stem migratory flows towards large towns and cities. Later, following the success of this sector, many wineries opted to rearrange their organisational structure, focusing on the production of wines of greater quality, a strategy that to date has generated substantial profits [15], to the extent that today Spain is considered one of the world's leading wine producers.

With just over 1 billion hectares of vineyards, in 2014 Spain is home to the largest wine production area in the European Union (EU) and the world. Although it was estimated that this figure would fall in 2015, wine production accounted for almost 30% of the total area of the EU (followed by France and Italy), and 13.4% of the world total [16]. As for world wine production (excluding grape must and juice), Spain ranked third with 36.6 million hectolitres, behind Italy and France [16].

Wine is made in a number of Spain's autonomous communities, particularly Castilla-La Mancha, Extremadura, Catalonia, Castilla-León, La Rioja, Comunidad Valenciana, Andalusia, Aragón and Galicia.

The case of Galicia is unusual in that it is home to five designations of origin.[1] The winemaking sector is of considerable importance for the Galician economy, with almost 10,000 hectares dedicated to production, more than 15,000 registered winegrowers and 450 registered wineries, generating a annual revenue of 153 million euros from the production of around 40 million bottles a year [16].

The Designations of Origin have a number of uses: to provide protection and defence against potential fraud in the products and their origin; and as a means of territorial development and quality-based differentiation [17]. Furthermore, they provide added value for the products they represent, as they protect the quality of food and agricultural products, which in turn impacts positively on rural development by guaranteeing producers improved access to the market and environmental protection [18].

Designations of Origin are also instruments for economic, social and environmental development. In economic terms, they contribute added value to the final product price;

[1] In some cases the term Designations of Origin is abbreviated to D.O.

socially they help to conserve traditional trades and employment, whilst environmentally playing a key role in land conservation [18].

In this sense, Galicia has a competitive advantage in the winemaking sector, as it holds the following Designations of Origin: Rías Baixas, Ribeiro, Ribeira Sacra, Valdeorras and Monterrei, two of which boast a long-standing tradition, as the D.O. Ribeira dates back to 1932 and Valdeorras to 1945 [19].

4 Methodology

This research is based on the case study method, defined by Serrano and Martínez [20] as a means of constructing knowledge through individual circumstances. It allows for the object of study to be examined within a real context using quantitative and/or qualitative sources simultaneously, although it is essentially a qualitative research tool [21].

The methodology applied here is of a qualitative nature, based on documentary analysis consisting of the observation of the following fanpages (Table 1):

Table 1. Fanpages included in the study

	Fanpages
D. O. Rías Baixas	https://www.facebook.com/DORiasBaixas
D.O. Ribeiro	https://www.facebook.com/DenominacionOrixeRibeiro/
D.O. Ribeira Sacra	https://www.facebook.com/pages/Ruta-do-Vi%C3%B1o-da-Ribeira-Sacra/180416552015111?sk=wall&filter=12
D.O. Valdeorras	https://www.facebook.com/pages/La-madre-del-vino/118554828167412?ref=hl
D.O. Monterrei	https://www.facebook.com/domonterrei

Fanpage Karma, http://www.fanpagekarma.com/ has been used for the analysis. This tool allows for the study and monitoring of social media such as Facebook, Twitter, YouTube, Google + e Instagram and has been previously used by authors including Rodríguez, Rodríguez, Viñán and Martínez [22] as well as Sánchez, Ludeña, Viñán and Martínez [10].

The study was carried out over a year, from 15.11.2015 to 15.11.2016. The items used for the analysis were Visibility, Interactivity and Profitability.

In terms of **Visibility**, the research was addressed from three perspectives: one the one hand, defined by Cavalganti and Sobejano [23] as "influence", namely the number of followers a brand has on the various social media. In addition to the recognition generated by the number of fans, Huertas, Setó and Míguez [24] posit that visibility can also be measured in each post, taking into consideration the number of 'Likes', comments and shares.

A further point for consideration is that the number of posts also impacts on the visibility of a page: the higher the number of posts published, the greater the chances of the information reaching more people.

As for **Interactivity,** Brodie, Ilic, Juric and Hollebeek [25] consider engagement as the interaction of experiences between consumers, the brands and other stakeholders.

Furthermore, it sheds light on a company's communication and interactivity with the users that comprise its virtual community. In calculating this variable, Cvijikj and Michahelles [26], Huertas, Setó and Míguez [24], Valerio, Herrera, Herrera and Rodríguez [27] apply the following formula:

$$Engagement = [\text{likes} + \text{comments} + \text{shared posts}/\text{No. fans}] \times 100$$

Finally, the question of measuring **Profitability** has always been surrounded by a certain degree of controversy. Cavalganti and Sobejano [23] have described a new Internet environment that emerged following the arrival of social media that has influenced corporate economic activity, with dynamics based on conversations and relations, which are difficult to calculate. For the purpose of this study, profitability will be analysed through two indicators: the advertising value of the Facebook page and profile performance.

5 Facebook Positioning of Galicia's Wine Designations of Origin

The results obtained regarding the Facebook positioning of Galicia's designations of origin are given below.

The information is presented in three sections, including the corresponding variables, as indicated here:

- Visibility: number of fans, number of posts, likes, comments, shares, post type, post content and timing.
- Interactivity: engagement, geographical analysis and brand response to fans.
- Profitability: advertising value of the Facebook page and profile performance.

Table 2 illustrates the data relating to **Visibility**.

Table 2. Visibility analysis from 15.11.2015 to 15.11.2016

	Fans	Total *Post*	*Likes* (*post*)	Comments (*post*)	Shares (*post*)
D. O. Rías Baixas	38,968	304	33,132	663	4,312
D.O. Ribeiro	11,043	305	11,063	459	4,804
D.O. Ribeira Sacra	3,021	119	4,770	68	1,004
D.O. Valdeorras	5,556	302	1,732	34	521
D.O. Monterrei	2,084	498	3,986	125	1,045

The results show that the D.O. Rías Baixas stands out in practically all the variables analysed (with the exception of the total number of posts and shares), thereby affording it a higher degree of representativity on Facebook than the other designations of origin. In this case, it is clear that the offline positioning of the D.O. Rías Baixas may impact on its online situation, as it is better-known or more popular among the general public.

The designations with the highest number of fans include the D.O. Ribeiro, with 11,043 fans, which ranks second to the D.O. Rías Baixas, which has 38,968. The D.O.

Ribeiro also obtains good results in the rest of the variables studied, unlike the remaining three, which obtain less representative values.

In this sense, the D.O. Ribeira Sacra, D.O. Valdeorras and D.O. Monterrei are positioned at the bottom of the Facebook relevance scale, obtaining fairly similar results for the parameters analysed. Interestingly, the D.O. Monterrei stands out for the high number of posts, exceeding the most representative Designation of Origin – Rías Baixas – which ranks top in terms of the number of 'Likes' and comments.

The content type of the fanpage posts varies in each case:

In the case of the D.O. Rías Baixas, the post content includes narratives and tales based on its wineries. This generates an interesting storyline which is commented on and shared by fans. Furthermore, the narratives are always accompanied by photographs depicting the place, thereby identifying the winery, its background and history. The posts are published in two languages: Spanish and, albeit with a lower frequency, English.

The D.O. Ribeiro applies a different type of content strategy, centred on showcasing wine tourism routes such as the *Rutas do Viño do Ribeiro* ('Ribeiro Wine Routes'), as well as featuring a video providing an insight into this designation and a number of posts providing details of a prize draw on this social medium. In this case, the information is published in Spanish and the Galician language.

The D.O. Ribeira Sacra generates content related to the area, including routes along the River Miño. Photographs feature considerably in the posts, which are published in the Galician language.

In the case of the D.O. Valdeorras, the presentation of promotion campaigns such as *Valdeorras: un saber facer único* ('Valdeorras, one-of-a-kind know-how') is a recurring theme in the posts published, in addition to a series of photographs related to the wineries and the designation of origin. This fanpage is also published exclusively in the Galician language.

The central theme of the posts published by D.O. Monterrei is related to the 11th edition of the Monterrei Wine Festival, as well as details of some of the principal performances and events included in the festival programme and a guide to the region's wines entitled *Guía de bodas e viños Monterrei*. The information is published in Galician, and, like the other designations analysed, features a large number of photographs.

Regarding the *timing,* it was observed that the posts were published at different times of the day, indicating that there is no pre-established pattern or programme for updating the channels.

The second item studied is **Interactivity**, in which engagement is considered a key variable. The results obtained are shown in Table 3.

Table 3. Fanpage interactivity analysis

	Engagement
D.O. Rías Baixas	97.79%
D.O. Ribeiro	147.84%
D.O. Ribeira Sacra	193%
D.O. Valdeorras	41.16%
D.O. Monterrei	247.40%

The interpretation of the engagement analysis varies from that of the data obtained previously. In this sense, although the Variability analysis indicates that the Rías Baixas and Ribeiro designations of origin scored highest in Facebook representativity in terms of fans, Likes, comments and shares, the results vary when considering the question of engagement.

The principal difference lies in the fans. In order to secure a high degree of engagement, followers must be active, commenting, sharing and indicating their liking for particular contents. If this does not occur, then the engagement rate falls.

Despite having the highest number of fans (38,968), the D.O. Rías Baixas fanpage has a relatively low degree of engagement (97.79%), compared with the majority of designations, with the exception of the D.O. Valdeorras. In contrast, the D.O. Monterrei, which scored low in terms of Visibility, registers a high degree of engagement.

In order to shed further light on the interactivity results, below is the breakdown of the geographical analysis, brand response to fans and the network of companies the brand shares fans with.

As was to be expected, the geographical analysis of the origin of the Facebook page fans reveals that in the case of the D.O. Rías Baixas, practically all the fans are from Spain (33,020), followed by countries such as Venezuela (1,294), Mexico (1,129), the USA (364) or Argentina (357).

This is also true in the case of the other designations of origin: the majority of fans are from Spain, followed by various nationalities form around the world.

Establishing where the fans are located will enable those persons responsible for managing and promoting the designations of origin to draw up more effective communication strategies in order to contact and interact with their Facebook communities, as well as designing successful online and offline advertising campaigns.

Regarding the variable 'Brand response to fans' the only data obtained corresponds to the D.O Ribeira Sacra and D.O Valdeorras, as the remaining designations do not feature any posts by fans during the period studied. In the case of the D.O. Ribeira Sacra fanpage activity is low, with just 2 posts commented by the designation. Particularly striking in this sense is that a total of 17 posts were simply ignored by the page. As for the D.O Valdeorras, the observation revealed that the page deleted a total of 9 posts during the period under study, although the reasons for this decision are unknown.

Turning to the question of **Profitability**, two general indicators were analysed: the advertising value of the Facebook pages and profile performance. The data obtained for these variables is shown in Table 4:

Table 4. Advertising value and performance of the Facebook pages

	Advertising value	Page performance
D. O. Rías Baixas	€19,684	2%
D.O. Ribeiro	€13,734	25%
D.O. Ribeira Sacra	€3,270	36%
D.O. Valdeorras	€2,386	4%
D.O. Monterrei	€5,700	38%

Advertising value allows for the calculation of the expenditure that would have been required in other advertising channels in order to reach the same number of people as the Facebook page. This figure is directly related to the number of fans. Rías Baixas scores highest in terms of its advertising value, which stands at 19,684 euros, followed by the D. O. Ribeiro, with an advertising value of 13,734 euros.

The page performance variable enables us to determine the situation of the Facebook community. The data presented in Table 4 show that the designations are underperforming in this sense. None have managed take advantage of the opportunities this channel offers, particularly the Rías Baixas and Valdeorras designations, which score 2% and 4% respectively. These percentages reveal that their fanpages have the potential to take far greater advantage of their respective online communities.

6 Conclusions

Consumer centricity is an essential factor for any business today, highlighting the importance of connecting with customers and consumers in order to build up long-lasting relations that will secure their loyalty. In particular, organisations deploy tools that enable them to contact and learn more about their customers in order to achieve greater interaction that will in turn generate major reciprocal value. In this sense, social media are positioned as the perfect platforms from which to connect with users in a direct and personalised manner.

The results of this study allow us to conclude that in general terms and considering the number of fans, Likes, comments and shares, Galicia's wine designations of origin are well positioned online. However, the D.O. Rías Baixas and Ribeiro obtained the most positive results, possibly attributable to their positive offline image, contributing added value to their online channel representativity.

The importance of fanpage content and post type is also relevant: in order to guarantee maximum visibility, they must be both interesting and appealing to fans. In this sense, creating narratives for the virtual community is of major importance, as they produce content that appeals to both social media users and consumers of the various designations of origin. In these types of posts, photographs are the most frequently used resource, although all the designations of origin would be well-advised to introduce new and more varied formats. As for the timing, all the designations should post their contents at those times of day when their fans are most active.

Regarding interactivity, it has been observed that the fanpages with the largest number of followers do not necessarily score highest in terms of their engagement rate, a question that should be analysed and redressed. The analysis of the origin and number of persons that make up the respective online communities reveals that users show major interest in the designations of origin. Particularly worthy of note is that fact that although the highest group of fans are Spanish, there is also a considerable group of followers from various parts of the world.

In terms of fanpage profitability, the trend is similar to interactivity: those designations with the highest number of fans are precisely those that are failing to take full

advantage of the social medium Facebook as an information and promotion channel, and are therefore missing out on major opportunities.

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Higher Education and Facebook: Faculties Versus Academic Libraries. A Case Study

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Abstract. Although the importance of Facebook has been demonstrated in education, very little research provides concrete evidence on its use as a means of communication. This research is one of the very few, if any, to go into faculties and their libraries and try to analyze the use of Facebook *and to determine which faculties or libraries are putting the opportunities* offered by Facebook to optimum use in order to communicate with their audiences for promotional purposes. The findings indicate that Facebook plays an important role in communication between universities libraries and their audience in order to achieve greater efficiency, brand image and reputation, but in the case of the three faculties analyzed our study revealed significant shortcomings in comparison to their libraries. The results reveal a professionalization of the use of Facebook tools by libraries universities, creating new opportunities, while faculties fail to achieve this level.

Keywords: Higher education · Facebook · Faculties · Academic libraries

1 Introduction

The globalization of the world has produced a series of changes where knowledge has become a crucial element for companies. These changes are creating a new generation of knowledge that enables the development of competences required by companies to survive in a competitive context [1]. In this sense, the value of a business is directly related to intangible assets rather than physical assets, namely company image, customer loyalty, employee satisfaction, innovation, organizational culture, staff with appropriate skills, etc. [2].

There is increasing consensus among social sciences disciplines about the importance of the social capital concept. They have suggested that the present and future of business survival lies in networks of relationships among individual and organizations rather than traditional modes of competition [3]. This is particularly important in a knowledge-intensive sector such as high technology industries or universities. Research into networks is increasingly focused on understanding how the social context in which firms are embedded influences their behavior in terms of knowledge exchange, as can be seen from the extensive research available [4]. We adopt a network approach based on the relevance of three faculties web sites in Facebook and their libraries

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(University College of Technical Architecture, Polytechnic University College and Faculty of Computer Science), as a form of social status or reputation.

The study aims to analyze the positioning of these faculties and libraries on the social medium Facebook and observe any differences in their management, despite their shared audience, highlighting the importance of determining the preferences of their own student community are.

The paper is organized as follows: Sect. 2 gives a review of relevant literature on the importance of Facebook and its use as a communication tool; Sect. 3 describes the methodology employed; and Sect. 4 reports the research findings.

2 Theoretical Framework

Research community has established that users of information prefer other colleagues, friends or family members as their preferred source of information [5]. This new form of information has led to the setting up of webs of relationships to access information from one another [6]. These new relationship formats are called "social media", that is, forms of electronic communication such as websites and applications dedicated to forums, micro blogging, social networking, social bookmarking and wikis. On these platforms, users can communicate with friends, share their experiences, watch news, adding instant messages with real-time web chat and share videos and, videos etc. The characteristics of social media and especially social networking sites have the capacity to impact profoundly on all aspects of educational marketing and can influence the ability of higher education institutions to guarantee freedom of access to knowledge, the ability to generate, absorb and apply new knowledge as well as to enhance the transfer of knowledge between University as a whole and its stakeholders [7]. Universities are already beginning to use social media for recruitment process, to engage students and build a network of graduates with a shared affinity for the institution, to smooth the transition from student to alumni by helping the two groups connect and collaborate, to offer their own online job databases, etc. [8].

In recent years, burgeoning research activity has focused on the role of Facebook in higher education. This research covers a range of topics (see review by Wilson, Gosling and Graham, 2012) [9], from the use of Facebook as an effective way to provide tools to support the teaching-learning process; to the use of social media by higher education institutions to market themselves to students and stakeholders (see review by Nyangau and Niamboue, 2012) [10].

In the specific case of university libraries, Facebook can be an effective means of discovering what library user wants and needs, as it is a vehicle for the libraries to market events, resources and/or deliver services, as well as a vehicle for the creation of library branding [11, 12]. Articles about Facebook in the context of academic libraries began to appear in 2007. Since then, research activity has steadily increased and has been adapted to changes in the new media environment. A review of the existing literature shows that topics range from the most relevant Facebook uses and the best practices for academic libraries to how libraries and librarians have employed a variety of strategies to market their Facebook pages to students and their perceived-use study [12].

Despite the benefits that scientific literature has revealed regarding the importance of Facebook for the academic community, the reality is not that positive and many authors have voiced their concerns regarding the scant use of Facebook in an university environment [13]. Several studies offer additional insight into this problem [14]. For these authors it is critical for each faculty and academic library to establish the preferences of their own student community [15] and how they must manage their own image through social networking sites, taking into account the specific features of their target audience [14]. Despite the extensive literature on Facebook and its potential uses for higher education communities, only a very few studies have reflected the reality of the situation of different university faculties and their differences with faculty libraries.

Understanding and examining the factors that may influence the use of Facebook in each faculty or each faculty library is crucial for the academic community. However, researchers pay relatively little theoretical and empirical attention to the analysis of the most visited content or undergraduates' degree of engagement. Our research is based on the assumption that the effects of social media (Facebook in our specific case) within each faculty or academic library must be studied and understood as they are important for these institutions as they are for the world of business. The purpose of this research is to fill into the gap by attempting to provide recommendations for the improvement of their marketing policies and strategies.

3 Methodology

This study investigates the nature and degree of Facebook usage by 21 faculties and libraries of University of A Coruña (UDC) in Spain (Table 1).

For the purpose of obtaining the sample of this research, an analysis was made of the websites of all the schools, faculties and libraries that belong to the University of A Coruña (UDC). A final selection was then made of those centres whose school or faculty and library both have a Facebook page and also meet the following criteria:

(a) The fanpage must be official and global (those faculties or libraries with local rather than global fanpages were ruled out).
(b) The fanpage must be more than a year old (in order to ensure a relatively consolidated follower base).
(c) The fanpage must not have been inactive for more than 6 months within the period of observation (2016).

However, of the 21 faculties, on the Faculty of Computer Science and the School of Architecture, both situated on A Coruña city campus and the Polytechnic School in Ferrol have Facebook pages for both their schools or faculties and their respective libraries. The decision was therefore taken to limit the scope of the study to the following fanpages: (Table 2)

Table 1. UDC centres

UDC centres	
Coruña	Ferrol
Faculty of Communication Studies	Faculty of Humanities
Faculty of Computer Science	Faculty of Nursing and Podiatry
Faculty of Economics and Business	Faculty of Work Science
Faculty of Educational Studies	Polytechnic University School
Faculty of Health Sciences	Polytechnic School of
Faculty of Law	Industrial Design
Faculty of Philology	
Faculty of Science	
Faculty of Sociology	
Faculty of Sport Sciences and Physical Education	
School of Architecture	
School of Maritime and Naval Machines	
School of Civil Engineering	
University College of Physiotherapy	
University College of Technical Architecture	

Source: Own elaboration

Table 2. Scope of the fanpage study

Schools & Faculties	Faculty fanpages	Libraries	Library fanpages
School of Architecture	https://www.facebook.com/etsac.udc/	School of Architecture Library	http://www.udc.gal/biblioteca.etsa https://www.facebook.com/Biblioteca-da-Escola-T%C3%A9cnica-Superior-de-Arquitectura-UDC-156480721081896/?ref=bookmarks
Polytechnic University School (Ferrol campus)	https://www.facebook.com/Escuela-Universitaria-Polit%C3%A9cnica-Ferrol-134306619929512/	Polytechnic University School Library (Ferrol Campus)	http://bibliotecaeup.cdf.udc.es/index.php/es/ https://www.facebook.com/beupferrol/
Faculty of Computer Science	https://www.facebook.com/FIC.UDC/	Faculty of Computer Science Library	https://www.facebook.com/BiblioInformaticaUDC

Source: Own elaboration

The research was carried out during the period between 01.09.2105 and 11.12.2016. Our research design relates to a descriptive focus based on case studies that have allowed for the analysis of the phenomenon under study within its real context and the simultaneous use of quantitative and/or qualitative sources of evidence. Furthermore, the methodology applied here is of a qualitative nature, based on documentary analysis consisting of the observation of the various fanpages.

Fanpage Karma, http://www.fanpagekarma.com/ has been used for the analysis. This tool allows for the study and monitoring of social media such as Facebook, Twitter, YouTube, Google+ e Instagram and has been previously used by authors including Sánchez, Ludeña, Viñán and Martínez Rodríguez [16], as well as Rodríguez, Rodríguez, Viñán and Martínez [17] as it adapts to the objectives laid out. The parameters used for the fanpage analysis were Visibility, Interactivity and Profitability, based on the following items:

- **Visibility**: number of fans, number of posts and the total number of reactions ('Likes', comments, shares (Love, Wow, Haha, Sorry, Anger); post type and hashtags.
- **Interactivity**: engagement and brand response to fans.
- **Profitability**: fanpage advertising value of the Facebook page and profile performance.

4 Findings

In the case of the **Visibility** parameter, the items selected for analysis were those that enabled us to determine how to achieve a greater presence on Facebook. In this sense, most researches consider that the **number of fans** is a key factor in determining the degree of visibility as it provides a direct insight into site influence [18] and therefore the interest it generates. However, this criterion cannot be considered as the most important as it does not necessarily follow that a higher number of fans will guarantee the objectives will be met; indeed, ineffective interaction will reduce this item to a mere quantitative value.

Other equally relevant indicators are the **number of posts** and the **reactions provoked** by each among fans. The higher the number of posts published, the greater the possibility that the messages will reach a larger number of people [19].

Finally, the **post type or format and** the use of **hashtags** also influence visibility, as the appropriateness and quality of their content will boost their virality and therefore enhance brand awareness, securing a higher degree of loyalty and generating increased business.

Consequently, and in relation to our analysis, the number of fans, the posts and the 'Likes', comments and shares obtained indicate that the faculty libraries are better positioned on Facebook than the faculties themselves (See Table 3).

A more detailed study of the data reveals that there is little difference between the various schools and faculties and their respective library fanpages in terms of the number of fans. However, considerable differences were observed between the School of Architecture, with 1,600 and 1,200 fans registered on its faculty and library fanpages respectively, and the other pages, which, with the exception of the Faculty of Computer Science

Table 3. School and faculty and school and faculty library visibility between 01.08.2015 and 11.12.2016

Schools & faculties	Fans	Total Post	Total reactions, comments, shares	Likes (post)	Comments (post)	Shares (post)	Love	Wow	Haha	Sorry	Anger
School of Architecture	1600	25	164	129	3	22	10	0	0	0	0
Polytechnic University School (Ferrol Campus)	537	3	10	10	0	0	0	0	0	0	0
Faculty of Computer Science	1000	6	41	28	1	12	0	0	0	0	0
Faculty libraries											
School of Architecture	**1200**	**521**	**4545**	3500	74	828	92	5	7	35	4
Polytechnic University School (Ferrol Campus)	**341**	**557**	**572**	437	8	124	2	0	1	0	0
Faculty of Computer Science	**304**	**1500**	**2030**	1700	24	275	16	2	11	2	0

Source: Own elaboration based on *Fanpage Karma*

page, all have less than a thousand followers. In contrast, in terms of the number of posts and the reactions they provoked, it is clear that the library pages are far more visible than those of the faculties themselves.

Indeed, the comparison of the School of Architecture page and that of its library reveal major differences between the total number of posts – 25 (0.06 per day – 0.42 per week) and 521 (1.42 per day – 9.9 per week) respectively, and particularly the total number of reactions, comments and shares obtained. The library page registered 4,545 interactions from its 1,200 fans (3,500 Likes; 74 comments; 828 shares; 92 Love; 5 Wow; 7 Haha; 35 Sorry and 4 Anger); compared with a mere 164 reactions (129 Likes; 3 comments; 22 shares and 10 Loves) from the 1,600 fans of the School page. This indicates that the library generates considerable visibility and virality thanks to the various reactions, which in turn allows for better positioning and greater success over the other pages analysed. Likewise, as the reactions are related to the post type that generates them, we can observe that in the most successful case, that of the library fanpage, the types of posts that generate most reactions are the links (385), images (119) and videos (10). It must also be noted that in no case are hashtags used to boost visibility. This is because they fail to provide users with the option of viewing other publications on the same topic, thereby reducing their effectiveness [20].

In the case of the Polytechnic University School on the Ferrol campus, the comparative analysis of the school and library fanpages produces no significant results in terms of the number of followers (537 and 341 respectively), particularly when compared with

the other pages analysed. This situation would appear to limit their possibilities of enhancing their degree of visibility. There is a clear difference between the number of posts, as the faculty fanpage published just 3 during the period under study, generating 10 reactions (Likes for 2 photographs and a link), whilst the library published 557 posts, generating a total of 572 reactions (437 Likes; 8 comments; 124 shares; 2 Love and 1 Wow), allowing for greater visibility and interactivity with its audience. This success is attributable to the variety of post formats employed, which includes photographs (93), videos (7) and links (443), which in turn generates greater engagement. Both pages use a limited number of hashtags, which also contributes to greater visibility.

Finally, the comparative analysis of the fanpages of the Faculty of Computer Science and its library shows that although the library has a far lower number of followers - 304 compared to 1,000 in the case of the faculty fanpage, the number of posts, 1,500 against just 6 and the reactions, which total 2,030 (1,700 Likes; 24 comments; 275 shares; 16 Love; 2 Wow; 11 Haha and 2 Sorry), compared with just 41 in the case of the faculty page (28 Likes; 1 comment and 12 shares), is far higher, proving that success does not always reside in a large number of fans but also depends on the ability to attract the interest of fans and interact appropriately with them, as well as using a variety of post formats. In the case of this item, our analysis reveals that the library fanpage deploys a wider variety of formats, including images (205), videos (8) and links (463). As for the use of hashtags, the results provided by the monitoring tool indicate that in both cases they are used more frequently than on the fanpages of the other faculties, schools and libraries, thereby generating a greater degree of visibility.

The degree of **Interactivity** also depends on the content published on the fanpages. This variable is determined by questions such as engagement and brand response to fans.

Engagement, a term that refers to users' commitment or loyalty to a brand, measures the reactions of fans and other network members to the posts and also sheds light on the company's degree of communication and interaction with the members of its virtual community [21]. In order to calculate this degree of commitment the PTAT (People Talking About This) or number of interactions (Likes, Comments & Shares) produced during a specific period is divided between the total number of fans and multiplied by one hundred. The resulting percentage is the engagement rate [19].

Table 4 shows that in general terms, and in line with the trend observed in the case of visibility, the engagement rate of the fanpages of the faculty and school libraries analysed is far higher than those of the faculties and schools, even though the number of fans is lower. Cvijikj and Michahelles [22] claim that the degree of engagement is due to a number of factors, including the post formats, publication timing and length. These may have a negative or positive impact, which will depend to a large extent on the way the schools, faculties and libraries manage the information they publish.

The analysis of the school and library fanpages for the School of Architecture reveal that the engagement level of the former cannot be considered to be low, if we take into consideration the Likalyzer tool criteria, which puts the minimum engagement rate for effective interactivity at 7%. However, in the case of the library fanpage, the engagement rate stands at 375%, showing that even though the number of fans is small, success is possible thanks to the nature and content of the posts, thereby generating greater engagement, provided that they are tailored to the followers' interests. In the case of the

Table 4. Fanpage interactivity analysis

Schools & Faculties	Engagement	Faculty libraries	Engagement
School of Architecture	10.25%	School of Architecture	**375%**
Polytechnic University School (Ferrol Campus)	1.86%	Polytechnic University School (Ferrol Campus)	**167%**
Faculty of Computer Science	4.1%	Faculty of Computer Science	**657.89%**

Source: Own elaboration based on *Fanpage Karma*

Polytechnic University School in Ferrol, the comparative result is also favourable for the library page (167%), as the school engagement rate is just 1.86%, attributable to the very low number of posts and the scant interest shown by its followers (10 reactions). Finally, the Faculty of Computer Science experiences slight fluctuations in the trend observed, as the difference between the faculty and library fanpages is considerable in terms of the engagement rate. The faculty page, with a thousand followers but only a very small number of posts (6), only generates 41 reactions, an engagement rate of just 4.1%. In contrast, the faculty library fanpage obtained the highest engagement rate of all those analysed (657.89%), reflecting the success of its posts, which are capable of generating interaction and visibility.

The other item that enables us to analyse interactivity, **brand response to fans**, enables us to gauge company feedback. In all the cases analysed, but particularly the library fanpages, fans receive a response in the form of comments, suggestions and even questions that help to establish a dialogue and therefore boost interactivity. However, the FanPage Karma tool reveals that the School of Architecture library page should use more the 'Sorry' option when responding to fans, whilst the Faculty of Computer Science library fanpage should use the 'Wow' option more in its responses.

The final item analysed was **Profitability.** In this case two general indicators were used: the Advertising Value of the fanpages and the Performance of each profile. Table 5 shows the results obtained for these variables:

Table 5. The advertising value and performance of the Facebook pages

Schools & Faculties	Advertising value	Page performance	School & Faculty libraries	Advertising value	Page performance
School of Architecture	€1700	5%	School of Architecture	€**2,500**	**7%**
Polytechnic University School (Ferrol Campus)	€129	4%	Polytechnic University School (Ferrol Campus)	€**350**	**5%**
Faculty of Computer Science	€389	4%	Faculty of Computer Science	€**983**	**12%**

Source: Own elaboration based on *Fanpage Karma*

Advertising value allows for the calculation of the expenditure that would have been required in other advertising channels in order to reach the same number of people as a fanpage [12], and is therefore directly related to the number fans. In our study, the school and faculty libraries once again obtained the highest scores, as they registered the highest number of interactions and greatest visibility.

The **page performance** variable enables us to determine the situation of the Facebook community [12]. The data in the Table 5 indicate that all the fanpages analysed are underperforming, particularly in the case of the libraries, confirming that in Higher Education, although social media form an integral part of the daily activity of both students and faculty, in the professional sphere universities are failing to invest sufficient resources in the, as they do not consider them to be efficient promotional tools.

5 Conclusions

The globalization of the world has produced a series of worldwide changes where knowledge becomes a crucial element in the company. This new context has implications for Higher Education communities which are continuously growing and expanding. The characteristics of social media and especially Facebook may have a profound effect on all aspects of educational marketing and can influence the ability of higher education institutions to guarantee freedom of access, as well as generate, absorb and apply new knowledge.

Despite the extensive literature on Facebook and its potential uses for Higher Education communities, there is limited study, if any, which reflects the reality of the situation of different university faculties and their differences with the situation of their faculty libraries. Understanding and examining the factors that may influence the use of Facebook in each faculty and its library is crucial. In this sense, this study has attempted to fill this cap by analysing the position of several schools and faculties and their libraries on the social medium Facebook based on their visibility, interactivity and profitability.

The results show that regardless of the item analysed, the school and faculty libraries are more effective at managing Facebook as a positioning tool before their target market. This indicates that the library community managers are far more active and seek greater interactivity with users, which in turn secures greater visibility. In the particular case of the schools and faculties, the trend would appear to lean further towards voluntarism than knowledge when addressing the potential opportunities Facebook offers.

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Educational and Serious Games

Realistic Boccia Game Simulator Adapted for People with Disabilities or Motor Disorders: Architecture and Preliminary Usability Study

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Abstract. Over the last decades, Serious Games have gained increased importance, mainly due to the evolution and expansion of video games and its application in multiple areas. Integration in the world of sport is one of the solutions that individuals with disabilities or motor disorders develop to feel more socially integrated, more independent and confident with themselves. Boccia is a Paralympic sport that is increasingly getting more attention around the world. This has contributed for the objectives of this project since it attracts these patients a lot more easily and including it in the Serious Games category enables them to develop and rehabilitate their cognitive capabilities. It will allow the users being dynamic, holding their attention and motivating them instead of the traditional cognitive rehabilitation processes that quickly become repetitive and discouraging. This paper describes a realistic Boccia game simulator adapted for people with disabilities or motor disorders still on development that aims to integrate a set of features that include real physics, multimodal user interface and social features (diversion, rehabilitation, competition and improvement). These features can be used to enhance the interest of non-practitioners of the sport and to improve the training conditions of Boccia athletes. Results observed in an experiment with real Boccia game components indicate that the simulator offers great similarity to the reality with the maximum difference between the measures obtained in both being 10 cm.

Keywords: Boccia · Simulator · Realistic · Serious games · Games · Rehabilitation · Game engine · Multimodal interface · Health informatics

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1 Introduction

This document shows a first approach to the subject of an ongoing work, in which the primary goals of the project are defined as well as the work done so far. It is also presented the subject contextualization and motivation that led to the choice of developing this project.

Over the last decades, the quality of life has increased, causing the increase of life expectancy and therefore, the increased number of people with a disability or impairment, especially in terms of mobility [1]. This problem causes the level of autonomy of these people to be very small. Due to technological advances in the fields of artificial intelligence, robotics simulation and graphic and physical computations, it is possible to develop simulators capable of enabling advances to help solve this increasingly recurring problem. The importance and concern for such problems has been increasing over the years, and one of the major focus points is the integration into society [2].

One of the solutions developed for these individuals to feel more independent, more autonomous and more confident with themselves, both socially and vocational level, it is the integration in the world of sport. The Boccia is a Paralympic sport that has generated a lot of attention around the national level due to the great results achieved by the Portuguese federation [3], which led to the aspiration of developing a simulator of the sport. This tool was thought so that athletes can make their practice more independently and without the help of a coach.

The main motivation of this work comes directly from the problem described above, and is an effort to help close the gap between people with lack of mobility and people without mobility problems. As the athlete does not have sufficient autonomy to move the launch pad of the ball without help or even put the ball in the top of the ramp, he is extremely dependent on their coach. Through the simulator, is expected to greatly increase the athlete's autonomy to control the ramp, since it will be a robot that will move based on the athlete's orders, taking into account their limitations.

These aspects allow the removal of the athlete's coach during training, thus reducing costs involved in these (as the dislocations to the training camps or the constant presence of the coach), allowing the training from home and possibly enhance the performance of athletes in competitions. Because it is a simulator, it also allows the attractiveness of other users who are not athletes of this sport, encouraging social integration. Another reason is the fact that this is an innovative project with great social impact, which can be upheld by Boccia associations to benefit the training of their athletes.

In a previous study was made a literature revision on Serious Games [2, 4], Game Engines [5, 6] and User Interfaces [7] that was used to decide which ones had the best features allowing a successful achievement of this work's main objective. The goal is the development of a simulated game of Boccia adapted for people with disabilities or motor disorders using a realistic virtual environment with the physics accessories as similar as possible with the real ones (created with the help of the resources provided by the game engine chosen).

The game should be aimed at the entertainment of casual users (developing their social interactions and interest in the Paralympic sport) and to allow the training of the athletes from the comfort of their home without the need of a coach to provide constant

help they need. It should also favour the athlete's training to achieve better results. It will allow the participation of at least two players and these players will be able to control the launching pad of the ball (through the virtual joystick or by using the multimodal interface (MMI)) in the most appropriate way to their limitations.

The rest of the paper is structured as follows. Section 2 presents the importance of Serious Games and some of the main features of the Game Engine and the User Interface chosen that were essential to the development of the simulator to be the most realistic and adaptive as possible. It also presents some of the existing game simulators and their main characteristics making the comparison possible between those simulators and the one under development. Following, Sect. 3 describes the final aim that the simulator should achieve as well as its features and the work developed so far. Section 4 describes the experiment used to compare the simulator with a real Boccia game and Sect. 5 presents the results of user testing using the experiment described in the previous section. Section 6 presents the major conclusions and some directions for future work.

2 Problem Characterization and Proposed Solution

Serious Games are games that do not have entertainment as their main purpose. They are more of a mental contest, played with a computer in accordance with specific rules with the main objective of further improve the knowledge, skills and aspects related with education, healthcare, defence, training and other pedagogic components (although they are not necessarily deprived of entertainment, enjoyment or fun) [8].

This term is becoming a lot more popular since video games are getting increasing audiences with an expanding age range, they can be of any genre, use any game technology and be developed for any platform. As they can have many applications, the main focus of the current research is the rehabilitation area for patients with impairments and disabilities. That happens because it has been shown that the patients function can be improved with intensive training, however, the problem is that the lack of the patient interest in performing repetitive tasks significantly increases over time [2].

Since the traditional treatment approaches include exercises often considered repetitive and boring for patients, using computer games to improve physical and cognitive rehabilitation can offer the potential for a significant therapeutic benefit (even in the management of pain since it distracts the patient's attention) [4].

One of the main technologies used in the rehabilitation of cognitive and motor deficits is the application of Virtual Reality (VR), since the VR based-methods can offer the patients really immersive experiences that are engaging and rewarding for them [2, 4].

Based on the literature review made until now, below are presented some of the existing game simulators that represent virtual environments of the game Boccia and their main characteristics:

- *"Virtual Boccia"* – Puts the user in the perspective of the ball thrower and by using the Wiimote, he can control the ramp inclination and throw the ball using arm movements, although the ramp is not visible. Was developed to prove that the simulated

practice of this sport can influence its real practice. It has no cost and is available to install in any personal computer [9];

- *"Boccia o simulador"* – A project developed in "Universidade Técnica de Lisboa", in Portugal, and it is a very basic version with unintuitive graphics and without proper interfaces for its users (since it only allows its control by mouse, keyboard or joystick) [10];
- *"BocciaSim"* – A project developed by two high-school students and is a very basic simulator that can only be controlled by the mouse and keyboard. This simulator was to be updated but the project was left in a final version without much characteristics that highlight it. It is in 2D and has no advantages or even possibilities to be played by patients with physical disabilities [11].

As can be seen that there are not many Boccia game simulators, and the ones that exist cannot adapt to the various users with different physical and psychological conditions.

That is the reason why it is so important to implement a user interface that can aid the simulator to adapt automatically to the various disabilities. Thus allowing a bigger range of people to play the game and even help the practitioners practice without having to dislocate to the training fields and without the constant help of the trainer.

The idea for this project appeared from a previous work of a Master's Degree that had the objective of developing and implementing a virtual representation of some adapted sports [12]. The major purpose were *Motorized Wheelchair Football* and *Boccia* involving adapted electronic devices. For this purpose, it was integrated a MMI capable of controlling the games components, providing flexibility and adaptability. When the project described above was finished it focused more on the *Motorized Wheelchair Football*. Were created various variants of the game such as: a game that had the objective of driving a ball from an initial point to an ending point through a map with multiple walls where the user had to go around them; a game where the user had to bring the ball into the goal various times along the map until reaching the ending objective; a game where the objective was the placement of multiple objects with different shapes in the holes with the right shapes; and, by last, was created the football game itself, that had two players against each other and they had to put the ball into the goal of the opposing player [12].

As can be seen with the work described above, the *Boccia* scenario was not developed so much. Therefore it was only created an arena with an objective square in the floor where the player had to drive the designed ramp to it and aim the balls against the three existing objective targets. Since its main goal is not much related to the Boccia sport itself, it served only as a base to what was needed to be developed in the project of this dissertation [12].

With what was said above in mind, the ongoing work aims to develop a realistic Boccia simulator, so that the practitioners that carry the various physical and psychological conditions, can practice this sport in a more autonomous way.

The simulator will consist on the representation of the field, the rules and ball throwing platform (Intelligent Robotic Ramp (IRR)). The ramp will be a robot that will move according to the user's orders, positioning as the user wants (both position and inclination parameters). The main focus will be on the user's ability to manage as

independently as possible the launch pad. The system must be provided with a MMI, which allows the user to create his most appropriate usage profile.

After all the research made for the proposed project it was defined that it was needed at least a game simulator, a robotic simulator and a user interface. Using all the comparisons made between the available solutions, it was relatively easy to reach a decision on which ones to use and learn more about their capabilities and how to use them. The fact that some of them have already been used in a similar project targeted for people with CP (made by another student about simulated serious games using multimodal interaction) [12], helped with this decisions.

Speaking first of the game engines they are applications that allow graphic processing in real time that through the abstraction of physical and graphic concepts facilitates the creation of virtual games. Its objective is to remove from the user the responsibilities of understanding the low level architecture, such as the mathematical and physic formulas that are responsible for the visualization and collision detection of the objects in the virtual space [5]. The best one for this work was definitely the "Unreal Engine" (UE4). It is ideal to represent realistic environments and objects due to the high graphics and physics accuracy, realistic collision detection, which is very important for this project. The sub-editors that it provides allows a realistic object creation and personalization [6].

As it was needed the development of the IRR for the Boccia simulator, was needed a robotic simulator (a development platform that represents the robotic behaviour in a virtual environment allowing the representation of real robots in simulated environments). Also allows a detailed analyses of the behaviour that the robot must have bearing in mind his ultimate goal. This kind of simulators are a very important part in this project because they allow the creation of applications for robots without actually having a real robot [5].

The best choices were the USARSim and the V-REP. The main feature of USARSim is that it uses the UE4 so there is no need to worry about the adaptation between the robotic simulator and the game engine while still having high accuracy representing simulated robots [13]. Comparatively, the V-REP has the capability of a really realistic robot simulation, probably better than the USARSim, and a great development environment with much more functions. The V-REP has to import and convert the data to be used by the UE4, despite of having a low complexity on that level [14]. So, based on the study made, the V-REP was chosen because it had a low complexity and it was more realistic, which is the main goal of the project.

Regarding the user interface, it supports the interaction between a human and a computer, because it allows the users to control the machine in an appropriate manner to their physical and psychological limitations. The main feature of these Interfaces is the adaptability, which can improve the interfaces capability to interact with a user based on the experience with that user. Using that experience data and some tests it is possible to adapt the interface according to the limitations of its user, optimizing the communication Man-Machine [7].

As a user interface, it was chosen a MMI because it allows multiple input methods what grants the possibility to make the interface adapt automatically to the users easily and to create specific and customizable profiles for each. This feature is really important to the project since the main target users are people with physical and psychological

conditions. The fact that an application can adapt to its users so a vast group of conditions can be covered allows most people to practice the sport without problems. It also removes the necessity of moving to the training field in the case of official athletes or even prevent users from getting frustrated in the case of casual players [15]. Of all MMIs, the one already developed for the project *IntellWheels* (one of the main projects associated with this one), will probably be the chosen one because it was carefully thought and it adapts perfectly to this work [16]. The project quoted above consists in an intelligent wheelchair simulation and visualization platform that can be adapted to any commercial wheelchair and thus assist any person with special mobility needs [17–29].

Finally, all these choices were decided by thinking in the main characteristic of the game, which is to create the most realistic Boccia Simulator possible. To make that achievable, was provided access to a real Boccia ramp so that physical measurements could be made, both of the several balls available as the different trajectories attainable by the many positions of the ramp, since the ramp can have multiple angles vertically and horizontally.

3 Realistic Boccia Simulator: A Simulator of Serious Games for Athlete Training and Casual Users Inclusion

A Simulator adapted for use by the Boccia athletes to train and by casual users for recreation or to enhance their interest in the sport has been developed. In this section is described the development process of this solution.

The first step in the development of the simulator consisted in defining features to be included in the environment created so that it could be as realistic as possible. It was decided that the simulator should contain rehabilitative features (capable of stimulating at least one cognitive function), as well as some proposed features in this research as a way to improve the motivation of patients within the rehabilitation process (use of natural interaction interfaces and social features as competition). The implementation of rehabilitation characteristics is a complex task. Not only because it depends on the limitations of each patient but because its design must be made effective by a multidisciplinary team composed by professionals from various fields (such as physicians, psychologists and therapists, among others). In this work, it was decided to integrate a MMI, used in a previous project, to allow the simulator to adapt to each user and to his limitations. This is made by creating a profile for each player that indicates the more adequate way of interaction with the simulator [30, 31]. The available choices are keyboard, joystick, head movements, voice recognition, facial expressions or hand movement. After that, the step to be taken was the creation of a realistic Boccia field (Fig. 1) so that the users could feel like they were in a real field instead of just a basic floor with the markings on the ground. So the markings were made in the floor of the field using the real measurements, which are a field (with $12{,}5 \times 5$ m) with play boxes (that are $2{,}5 \times 1$ m) from where the players have to throw the ball from [3]. Posteriorly, it was made an approximate representation of a sports hall and was added standings, doors, windows, spotlights to recreate the lighting, benches for the player's teams, a scoreboard, a clock and even two referee models. All this was made with one of the

main objectives in mind which was to develop the simulator as real as possible when compared to a real game of Boccia including its tools and components.

Fig. 1. On the image to the left is a representation of the environment of the Boccia field developed and on the image to the right is the Boccia ramp created for the simulator.

The following objective to accomplish was the development of a realistic Boccia ramp where first was created a mobile robot using the robotic simulator chosen (V-REP). This allowed the ramp to be moved around and to change its inclination realistically. So that the ramp could be as realistic as possible, all the measures of a real Boccia ramp, provided by the Portuguese Association of Cerebral Palsy (APPC), were taken (which were 95 × 12 × 80 cm with an inclination angle of 45 degrees). Then, using the mesh editor MAYA 2016, was created the ramp with those measures and added to the robotic model with a mechanic arm serving as connector. When the development of the IRR was done (Fig. 1) it was programmed its forward and backward movement in the robot as well as its rotation. These allowed the ramp to be moved inside the play boxes and to aim the balls with precision to where the user wants them to go. For the ramp itself, it was added the change of its inclination from 40 (lowest height) to 50 (highest height) degrees by rotating the ramp and changing the length of the mechanic arm. The ramp was coded to not allow any kind of movement after the active ball is thrown until the next ball becomes active. Regarding the Boccia balls, they were also added with their real specifications measured from balls provided in conjunction with the ramp, where their weight was 250 g and their diameter was 8,6 cm [3]. As there are many types of balls relatively to their toughness, it was decided to include three different types: soft, medium and hard. Was developed a function so that could be controlled its acceleration and friction allowing an easy creation of balls with different toughnesses (was designed taking in consideration the results obtained from the comparison tests explained in the next section). Was also added the possibility of changing the spawn position of the ball in the ramp where the user can chose between three different positions: Top, 3/4 and Middle. These were the positions used in the comparison tests so that when the simulator is used it will produce results really approximate to reality. Finally, were allowed two different viewpoints of the field with: a camera behind the IRR (that allows aiming the balls) and another one on the ceiling (that allows the user a view of the whole field from above for strategic purposes). Besides those two points of view, when the ball is launched the camera changes to a chasing-camera attached to said ball.

Notice that the UE4 allows the use of a Blueprint-based coding which means that no hard-code was referenced since it was not applied. This blueprint-based coding recurs to graphic blocks which are equivalent to hard-code functions. These blocks can either be very simple functions or complex algorithms [6]. The settings of the project were changed in order to equalize a centimetre to an Unreal Unit (UU).

4 Comparison Testing

The tests described here were designed primarily to assess a preliminary usability and the reality of the simulator, to see if the IRR developed and the physics of the balls created were approximately equal to the real ones provided. The comparison tests counted on a total sample of 270 throws using the real balls and ramp, and one throw for each position of the ball and inclination of the IRR in the simulator. It was required these throws in the simulator because it uses a mathematic model to simulate its physics so the results are always the same using the same specifications. The first test performed was in a real environment using the real Boccia equipment. It was taken in consideration the characteristics of the floor of a Boccia field during the test and so these were made in a floor with the same characteristics. The test field had a length of 10 m where was used a measure tape that allowed us to register the distance travelled by the balls in each situation. There were three different types of Boccia balls used in the tests where were used two balls of each type (with slight different specifications and insignificant to the value of the tests) and each type had a different toughness: soft, medium and hard balls. Regarding the ramp, were used three different inclinations: 40º, 45º and 50º and three different positions of the ball along the ramp as well: top, 3/4 and mid ramp. For each combination of the possibilities described above were made 10 throws, registered the results disregarding the lateral deviations as they cannot be reproduced in the simulator. Then was calculated its mean (Table 1) and standard deviation so it could be compared to the single result of the simulator (Table 2). After that, were made the simulator tests where was made one throw for each situation as well. This allowed the refinement of the values used for the physics of the balls so that the results could be as close as the real ones.

Table 1. Mean of the obtained results in the real environment tests in metres.

	Soft balls			Medium balls			Hard balls		
	40º	45º	50º	40º	45º	50º	40º	45º	50º
Top ramp	3,072	3,732	4,058	5,784	6,598	7,529	6,136	7,059	8,021
¾ Ramp	2,388	2,509	3,025	4,509	5,216	6,194	4,917	5,702	7,122
Mid ramp	1,716	1,839	2,315	3,652	4,467	4,863	3,909	5,002	6,180

Table 2. Obtained results in the simulated environment tests in metres with a measurement error of 10 cm.

	Soft balls			Medium balls			Hard balls		
	40º	45º	50º	40º	45º	50º	40º	45º	50º
Top ramp	3,1	3,8	4,1	5,7	6,6	7,5	6,2	7,1	8
¾ Ramp	2,4	2,6	3,1	4,5	5,3	6,2	4,9	5,7	7,1
Mid ramp	1,7	1,9	2,4	3,6	4,5	4,8	4	5	6,1

5 Results and Discussion

The results of the real environment tests were registered taking in consideration an inclination error of 2°, a measurement error of 5 mm and a standard deviation of 0.46 m. As can be seen in the tables below (Tables 1 and 2), the results wanted have been easily achieved since the game engine used allows a really easy change of parameters and customization of the physics related to the balls. These results were obtained using a methodology based on an iterative method of successive approximations. It follows the gradient, in order to minimize the absolute sum of errors between the distances in the simulator and the mean of the distances obtained from the tests. The acceleration and the friction of the balls were changed based on the real distances travelled measures acquired until the desired results were achieved. In the simulated environment, the maximum absolute error of the measures taken was defined at 10 cm. It happens because the values of the parameters chosen for the balls to get the right distance in a certain inclination had small deviations from the pretended distances for the other two inclinations. Possibly, this error can be shortened by choosing some different values for the parameters where, instead of only having an error in the two inclinations referred above, this error will be distributed equally for all three inclinations. The executed tests had a major importance to the development of the simulator, since they allowed the recreation of realistic balls. The ball's distances travelled and the collision characteristics were one of the focuses for implementing the simulator in the Boccia athlete's scene.

6 Conclusions

It is being developed a Boccia simulator with the objective of being realistic and integrate in the Serious Games category with its social features and user interaction via MMI. The usability and approximation to reality were evaluated based on the tests performed. The usability was considered to be the capability of the simulator to represent the reality with a high reliability as it is needed to accomplish the objectives of this work, resulting in a positive assessment which means the simulator is complying with the main objective (realism). For future work is intended to finish adding the rules of Boccia to the simulator including the player's turns as well as the score interface. Finally, if possible, integrate the MMI for the user profiling which is very important feature regarding the adaptation context because it allows its users to interact with the simulator using the most adapted way for each (such as keyboard, joystick, head movements, voice recognition, facial

expressions or hand movement). Is also aimed to validate the simulator on a population with limitations (either physical or cognitive) which can be preferentially composed by casual users that never played Boccia before and by federated athletes. This validation can be effectively performed via quiz considering all the related features such as its reality, usability, adaptation, attraction and its social/cognitive rehabilitation capacities.

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Emerging Trends and Challenges in Business Process Management

Toward an Approach to Improve Business Process Models Reuse Based on LinkedIn Social Network

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Abstract. Business process (BP) modeling is an important stage in Business Process Management (BPM) lifecycle. However, modeling BP from scratch is fallible task, complex, time-consuming and error prone task. One of the promising solutions to these issues is the reuse of BP models. BP reusability during the BP modeling stage can be very useful since it reduces time and errors modeling, simplify users' modeling tasks, improve the quality of process models and enhance modeler's efficiency. The main objective of this paper is to propose a Social BPM approach based on the user social profile to perform the reuse of BP models. We identify the need of exploring user profile to reuse BP models. The LinkedIn social network is used to extract the users' business interests. These user business interests are then used to recommend the appropriate BP model.

Keywords: Business process model reuse · Professional social network · User business profile · Business process modeling · LinkedIn · Recommender system

1 Introduction

Business Process Management (BPM) objective is to make efficient, flexible and competitive business. BPM consists of different phases, such as analysis, design, modeling, implementation, and evaluation. The reuse of BP models by different business actors (e.g. analysts, modelers, managers, and process developers) is highly recommended to reduce modeling time and errors, increases model quality and flexibility [3, 12]. A BP models repository is therefore necessary to store and manage process models that have been made available by companies for future reuse [14]. A BP model repository provides a central location for collecting and sharing process knowledge [9]. Several solutions have been proposed to build such repositories, such as SAP [15], IBM-BPEL [16], and the MIT Process Handbook [17]. However these repositories suffer from several limitations that affect their abilities to reuse the BP models [9]. Indeed, recent works [9, 17–20], show that the existing repositories do not adequately support reuse of process models. So, it is difficult for business actors to find the relevant process models in BP models repositories and to share process knowledge [21]. The lack of an efficient models retrieval system

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[17, 18], the different process repositories classifications and the heterogeneity of repositories structure and modeling languages affect the abilities of these repositories to reuse BP models. To overcome the aforementioned limitations, we propose an approach that aims at allowing users (e.g. modelers, analysts, managers, process developers, and IT experts) to find the appropriate BP models according to their business profiles. Indeed, one of the BP model repository requirements to increase process model reuse is the navigating, searching, and querying support facilities for users [19]. Recently social BPM are proposed to improving BPs by encouraging a more collaborative and transparent approach to process improvement [7]. These approaches combine social software with BPM in order to optimize and improve the efficiency of traditional BPM. Professional social networking sites (e.g. LinkedIn) are an example of such social software. In this paper, we provide a social BPM approach to improve BP models reuse. Our approach aim to provide users with the model they want or need according to their profiles and without requiring them to search for it explicitly. To reuse BP models we explore the user profile on professional network LinkedIn. We identify user business interests in order to recommend adequate BP models. The idea of exploring users profile from the social software is not new. Recent works show the benefits of exploring users profile data on the Web [8]. According to Lops et al. in [1], the proliferation of social networks generates a massive volume of data useful to learn user interests. User interests based on professional profiles extracted from LinkedIn allow recommending scientific articles to researchers. In the same line, Ye et al. [13] argue that social influence between friends and personal preferences of users can be captured quantitatively; the authors propose a generative model, called social influenced selection, to model the decision making of item selection.

The remainder of this paper is organized as follows: Sect. 2 presents the related works. Section 3 gives an overview of our Framework. In Sect. 4 shows how to provide user with adequate BP model. Section 5 presents a comparative study between our approach and the related approaches proposed in BP models reuse. Finally, Sect. 6 concludes and outlines our future research directions.

2 Related Works

Several works related to the BP models reuse have been proposed in literature. This section reviews the most referenced ones. We carried out the literature review along three main contributions in BP models reuse as follows:

- **The modification of BP repositories structure**

Yan et al. in [17] have proposed a framework for BP model repositories to better design a new BP models. A BP model repository is structured according to a specific conceptual model of process. This specific conceptual model consists of reference architecture and a list of functions that such repositories can provide. Derguech in [5] has proposed a framework for BP models reuse for managing configurable process models. It defines a data structure that captures the different process variants at the business goal level which enable BP modelers to define the most suitable process variant that suits their requirements.

- **An architecture for a business process model repository**

Elias M. In [9] has proposed an architecture of a process models repository for process model reuse. The architecture provides the basis for developing a repository system that will increase the probability of process model reuse. In this research, Elias M. has proposed an open and language-independent process model repository with an efficient retrieval system to support the reuse of process models.

La Rosa et al. [16] suggest an advanced process model repository called APROMORE. The architecture for the process model repository consists of three layers: an enterprise layer, an intermediary layer and a basic layer. Contrary to La Rosa et al. architecture in [16], Elias in [9] introduces an interoperability layer that implements a process information mediator to enable exchange and sharing of process models between repositories. Yan et al. [18] proposes reference architecture for a BP model repository. Compared with concrete architectures reference architectures are defined on a high level of abstraction. The proposed repository architecture is designed to meet the attributes of all stakeholders. Wohed et al. in [21] has proposed universal process repository architecture which is independent of process modeling languages, comprises a large number of existing repositories, and it is open for change and growth by any user. The architecture presents an adequate organization and navigation structures with mechanisms, for analysis and comparison of process models in the repository.

- **New process description language for storing business processes**

Shahzad et al. in [4], proposed a generic data model for storing and sharing process models between different modeling languages that only captures fundamental elements of a process. The generic data model is capable to store fundamental elements of a process model in a format that is independent of any process modeling language. In addition, the author proposed an automated method of extracting process model which facilitate storing and retrieving process models to users.

However, cited approaches have not yet provided effective solutions that consider what the user want and their intentions during the modeling phase and more particularly during its BP models reuse. None of these solutions have taken into consideration user's modeling interests during BP modeling phase. Indeed, Erol in [2] shows that integration of stakeholders in the lifecycle of BP can provide new opportunities for more efficient and flexible design of BPs. The comparative study of the social BPM approaches by Khider et al. in [11] shows that the user participation criteria is not taken into account in design phase of BP life cycle. Our goal is to propose an approach that enables user to design new BP models according to its business profile.

3 The Framework Overview

In this section, we introduce an overview of our framework, to support the reuse of BP models. Figure 1 presents the conceptual architecture of our approach, including its main components. Then we show how we explore the user profile data extracted from LinkedIn social network in reuse of BP models. Business actors in our approach are business

users who access to BP model repository such as BP model designers, process developers, and a process designer, with not much experience in BP modeling.

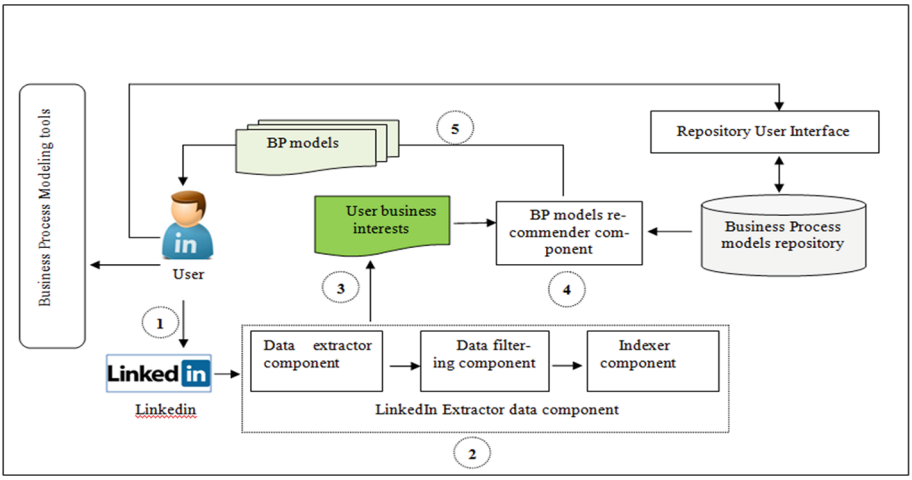

Fig. 1. The conceptual architecture of our framework

The main components of our approach are:

- **LinkedIn data extractor component** builds the business profile of user and includes:
- **Data extractor component**: extract all data available from LinkedIn user account using the LinkedIn APIs for extracting user personal data. The API LinkedIn People Search could help developers to access information about user. This is an API about personal information of user.
- **Data filtering component** filters the data provided by *data extractor component* to keep the necessary data to build users business profile, i.e. user interests.
- **Indexer component** performs a language processing to transform the data provided by the *Data filtering component* into a set of keywords. Each keyword presents a business profile data of user.

Let consider a User U_x. The indexer component provides for U_x a set of business profile labeled BPr_x.

$$BPr_x = \{attribute_1, attribute_2, \ldots\ldots\ldots\ldots., attribute_n\} \quad (1)$$

Where n denotes the number of user attribute, x the user identifier and profession, company, position, experience, specialties attributes are example of business profile attributes of user.

- **BP models recommender component** recommends to a user the appropriate BP model according to his business profile. (See Sect. 5 that explain how to recommend to user the adequate BP model)

- **BP models repository**: contains a set of BP models. The BP models in repository are classified by category and presented by vector

$$\text{Mrep} = \left(C_0, \ldots, Cn\right) \tag{2}$$

where **Mrep is a mod**el repository.

$$C_k = (\text{model}_1, \text{model}_2, \ldots, \text{model}_m) \tag{3}$$

C_k is the category identifier and k = 0…n.

Example of repository categories: *Product Development and Introduction, Sales*, *Marketing, Production*, *Logistics, Financials*, *IT Platform, after sales* and *services.*

Table 1 shows an example of business process model description for category 'sales' in SAP repository:

Table 1. Example of models description in repository

Process model	Model description
Model_1	Collect sales price of stock transfers
Model_2	Analyze sales performance
Model_3	Analyze sales statistics
Model_4	Analyzing advertising sales orders

Model_description: is the descriptive information of BP models in repository. For models description example see Table 1 above. The filtering component transforms the Model_description into a set of keywords (see Fig. 2).

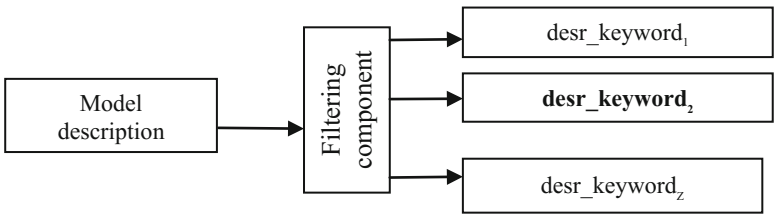

Fig. 2. The model description transformation

For each $\textbf{model}_\textbf{m}$ we describe **Model_description** as **vector** in an z-dimensional: Model_description = $\{\text{desr\_keyword}_{1,\ldots,}\text{desr\_keyword}_z\}$.

Each $\textbf{Model}_\textbf{m}$ is represented as a vector in an n-dimensional space, where each dimension corresponds to a keyword in the description of the model:

$$\begin{aligned}\text{Model description} &= \sum \text{desr\_keyword}_i \text{ and } i = 1 \ldots z \\ &= \{\text{desr\_keyword}_1, \ldots, \text{desr\_keyword}_z\}\end{aligned}$$

Example: the description of $model_3$ (view Table 1) is: Mobile self service for Travel expenses. This description will be presented as a vector of the following keyword {mobile, service, travel, expenses}.

- **BP modeling tools:** Business process modeling tools provide business users with the ability to model their business processes, implement and execute those models.
- **The repository user interface (RUI):** a useful graphical user interface manages BP models in repository. This interface allows users to search, upload, download and share BP models.

This section describes the steps mentioned in the Fig. 1 to find the appropriate BP model by the user.

1. User can access to the interface of our Framework via his LinkedIn account –or directly retrieve the adequate BP model from repository or create new models using the available tools,
2. The extractor data component gets his profile data,
3. The data filtering component builds the user business interests,
4. The recommendation component uses the user business profile as an input then searches the adequate BP models from the repository,
5. When the BP models are founded, the user chooses the appropriate model and uses it to design new model using the BP Modeling tools,
6. Then the user can integrate his final model into the repository.

3.1 Case Study

In this section we present a case study to describe the results obtained in two situations: first when the user uses the recommender system on our Framework and the second one when the user uses directly the repository to find a BP models, in this case we use SAP repository for simulation.

Our user named '*Sara Brown*' a BP expert that has the following business profile (as is defined in LinkedIn):

Sara Brown:

Business Process Expert Manufacturing in Lanxess Elastomers BV	
Lieu Région de Richmond, Virginie, États-Unis	
Secteur Technologies et services de l'information	
Current company	Business Process Expert Manufacturing
Previous company	Project Assistance in Profero Solutions, in IBM.US
Training	Strayer University, Delaware State University

Situation 1: When the user 'Sara Brown' use our Framework, the recommender system generate the followings BP models (as described in Table 2)

Table 2. The BP models recommended to user 'Sara Brown' according to his business profile

Process model	Model description
$Model_1$	Advance procurement (Project manufacturing)
$Model_2$	Billing for project manufacturing (A&D)
$Model_3$	Accounting for project manufacturing (A&D)
$Model_4$	Contract manufacturing procurement process
$Model_5$	Integration of manufacturing execution systems
$Model_6$	Planning for project manufacturing with manual
$Model_7$	Project setup (A&D)

Situation 2: when the user 'Sara Brown' uses directly the repository (in this case SAP repository) he will browse all categories available on SAP (sales, marketing, production, logistics, financial…) or else directly enter its search request in the search area.

4 How to Provide the Adequate Business Process Model to User?

In this section we show how to provide user with adequate BP model. To find the model adequate to the user business interests we have defined two methods: content-based techniques recommendations and tags-based techniques recommendations.

4.1 Content-Based Techniques Recommendations

To make recommendations by matching a user's business interests or user business profile attributes (presented as vector BPr_x) with the BP models description in repository (presented as vector.

The following algorithm describes how to match user business profile with BP models description:

Algorithm 1. Matching user business profile with BP models description

```
User Ux;
Ck ={model1, model2,…,modelm} //category Ck
BPrx= {attribute1,.,attributen};
Model_description={desr_keyword1,…,desr_keywordz}
// Ux has the business profile BPrx
1   Begin
2   (for i=1 to n) {If attributei match to category Ck then
3   (For each model modelj in category Ck)
4   ((for k=1 to z) for each desr_keywordk in Model description)
5   {if attributei match to desr_keywordj then
6          recommend model modelj to Ux;}}
7   END;
```

4.2 Tags-Based Techniques Recommendations

Social tagging for business process models has been suggested by various authors such as Laue in [6] and Prilla [10]. Tagging models in repository by assigning a words or short phrases that describe the content of the model. We add tags describing the models to help users searching a model in repository.

4.2.1 Recommending Models Based on Models Tag

If a user uses our framework for the first time, in this case we calculate the similarity between models tags and a users business profile attributes (presented as victor BPr_x).

Algorithm 2. Similarity between models tags and a users business profile attributes

```
User Ux;
Ck ={model1, model2,……,modelm}
// For each model modeli we have m tags modeli= {tag1,….,tagn}
BPrx= {attribute1,…,attributet};//Business profile of user Ux
1  Begin
2   (for i=1 to m){ // Browse all models in repository
3  (for j=1 to n)
4  // Browse all tags for the model i
5  {  (for k=1 to t)
6  If Attributek match to tag j then recommend modeli to Ux;}
7  }END;
```

4.2.2 Recommending Models Based on History of Users

If the user has already used our framework, we keep the history of the models he used. We also give the possibility to the user to add a tags to the model used, and in this way all the models of the repository will be tagged. We keep the history of the models he used, so in this way we will associate to a user business profile the tags of the models that he used. To recommend these models to a user who has the same business profile.

Algorithm 3. Recommending models based on history of users

```
Begin
Ux, Uy : business users;
Tags Ty={tag1,……,tagn};  //Ty tag used by the user Uy.
1  BPrx= {attribute1,..,attributen};//Ux has BPr profilex
2  BPry= {attribute1, ….,attributen};
3  If (user BPrx matching BPry) then
4  {Recommend all models which have the Tags Ty to User Uy; }
End;
```

For calculate the similarity between two business profiles, for simplicity, we consider a user profile to be a set of unstructured keywords. In our case user profiles only consist of user item values from ‘business interests’. The easiest way is to use a string matching approach to compute individual item similarity. Items on two profiles are said to be similar if their values are identical and dissimilar otherwise.

5 Comparative study

In this section, we compare our approach with the related approaches proposed in BP models reuse and cited in Sect. 2. We focus on the following five criteria: (1) New architecture, (2) New language, (3) New repository structure, (4) Recommendation system and (5) User business interests.

The first three criteria are the contributions made in the BP models reuse (see Sect. 2 related works) while the last two criteria deals with the availability of a recommendation system and user business interests. Hereafter, a brief description of these last two criteria's:

- **Availability of a recommendation system**: the existing BP models repositories are massive. Query such a large number of models efficiently is challenging and a recommendation system would be very helpful to the designers.
- **User business interests:** Is to take into account the business intentions of user. A business interest means the business, activities and skills that interest the user.

As illustrated in Table 3, our approach does not require modifying the structure of the BP models repositories as in [5, 17] and does not require the definition of a new process models description language like in [4, 9]. In our approach we don't need to design a new architecture of process model repositories as in [9, 16, 18, 21]. Contrary to [4, 5, 9, 16–18, 21] approaches. Our solution can be applied to existing repositories (e.g., MIT, SAP, and IBM) without any modifications, neither in the format of models nor in the structure of repositories, seen that is based on the business profile of the user extracted from the professional social network LinkedIn.

Table 3. Comparative study of our approach with the related works in BP models reuse

	New architecture	User business interests	New language	Recommendation system	New repository structure
Yan [17]	No	No	No	No	Yes
Derguech [5]	No	No	No	No	Yes
Our approach	No	Yes	No	Yes	No
Yan [18], Wohed [21]	Yes	No	No	No	No
Shahzad [4]	No	No	Yes	No	No
Elias M. [9]	Yes	No	Yes	No	No
La Rosa et al. [16]	Yes	No	No	No	No

6 Conclusion

Many challenges affect existing BP models repositories from supporting reuse of BP models like the difficulties to locate and retrieve relevant process models. To overcome these challenges, we have proposed an approach to BP modeling through reuse of

existing BP models for supporting business users (e.g., modelers, managers, developers, analysts) based on their business profile. The users business profile and interests are captured from online LinkedIn social network. We have also designed a recommender system to recommend the suitable BP models according to the user's business profile. Our approach allows business users' to search, download, modify and upload a BP models and design new ones; the new BP models are stored in the BP model repository for reuse. Our solution can be applied to existing repositories, such as MIT, without any modifications neither in the format of models nor in the structure of repositories seen that is based on the business profile of the user extracted from the online social network LinkedIn. As future work, we plan to apply our approach in real world BP model reuse case study.

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Social Media World Sensors

Are You a Compatible User?
Compatibility of a Microblog User with a News Article

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Abstract. A novel concept of compatibility between a news article and an online microblog user is introduced, and a framework embodying the concept is proposed. The framework currently proposes to match two factors – user's interest and user's sentiment as reflected in the user's microblog texts – to determine the compatibility. Using Twitter as an example, the framework is instantiated using the RAKE algorithm for topic keyword (for interest) matching and the VADER model-based sentiment scoring algorithm for sentiment matching. Gold standard tests show that considering both interest match and sentiment match improves the accuracy of compatibility decision significantly and that filtering topic keywords based on co-occurrence semantics helps to disambiguate the user's sentiment match, hence the compatibility decision.

Keywords: Online news media · Online social media · User compatibility · User interest match · User sentiment match

1 Introduction

News media went online from the inception of online social media, and now they are one of the major driving forces behind the interplay among content providers, consumers, and commentators, involving millions of users in complex real-time social dynamics. Online social media is a domain where a large number of users interact, share, and disseminate information freely, and there has been an increasing interest in identifying users who appear to be expressing opinions compatible with online media news. Users found as such can be targets of marketing in sales, candidates of polls in politics, or potential donors in fund raising, to mention a few.

In this regard, a larger goal of our work is to efficiently and accurately find users that are most compatible with a certain news article. The specific work presented in this paper focuses on one issue critical to achieving the objective, that is, profiling whether a given user (who is an online news reader) is compatible with a news article posted in online social media. We have chosen Twitter as the online social media because of its ability to disseminate information rapidly across extensive user base and also because of the challenges stemming from its being *micro*blogging (i.e., no more than 140 characters).

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The notion of compatibility between news and users has no established definition yet, and so we mean to start the discussion and propose an initial set of factors for judging the compatibility between a news article and a Twitter user. In this paper, we focus on user's interest and user's sentiment as the two key baseline factors. These two require analyzing microblogs to see how well they match with the interest and sentiment reflected in a news article, and are founded upon bodies of work in the respective areas of topic mining (e.g. [3,7,24]) and sentiment analysis (e.g., [13,16]). Thus, the protocol we currently use for the compatibility is a two-step approach – perform the *user interest matching* first and then the *user sentiment matching* next.

One lesson learned during the work was due to the sparsity problem, which is inherent in tweets because of their limit on the length and is worsened by the recently emerging flimsy tweeting behavior of users. That is, tweet users do not write much in their messages – many times they simply retweet other tweets or include links to other media materials (e.g., longer text, images, audio, video), without adding substantial contents of their own. This phenomenon – well known in the community (e.g., [15]) – drove us to be inclusive in identifying a user's tweets that are relevant to (hence match) the topic of a news article and judging if the relevant tweets of the user show the same sentiment as the news article. In addition, we leveraged the bootstrapping technique (i.e., bundling up multiple tweet texts together into a longer text) as used in other work (e.g., [5,18,23]) to overcome the same problems of tweets.

Another lesson learned is that, while using multiple topic keywords helps with determining the user's interest match, it brings ambiguities in the subsequent sentiment analysis. The reason is that the selected keywords have no bearing on the sentiment of the user's tweets, and, therefore, often lead to opposite sentiments, thus cancelling each other in determining the polarity (i.e., positive or negative) of the user's sentiment. Our finding in this regard is that taking advantage of the keywords' co-occurrence semantics to filter out some of the keywords helps to resolve this problem greatly.

Evaluations were done with regard to the two factors (i.e., user interest and user sentiment). A real tweet dataset, collected from Tweet User API was used for experiments. Ground truth was constructed with news articles and Tweet users selected manually based on their contents' relevance and sentiments. Algorithms that consider either of the two factors separately were used as the baselines. The gold standard test using the ground truth showed that the average f-score achieved by our algorithm (with keyword filtering) was higher than those achieved by the interest-match-only algorithm and the sentiment-match-only algorithm by 2.07 and 2.93 times, respectively. The test also showed that filtering out keywords that have weak co-occurrence relationships improved the f-score 1.43 times.

We claim the merit of this paper in being the first to introduce the notion of compatibility between a news article and online social media users, which finds a lot of real world applications. Additionally, this paper introduces a framework and presents an implementation by leveraging proven state of the art algorithms, which not only demonstrates the feasibility of assessing the compatibility but also provides a baseline for further research on this topic.

The remainder of the paper is organized as follows. Section 2 discusses related work. Section 3 describes the proposed method for judging if a user is compatible with a news article. Section 4 presents the experiments and results. Section 5 concludes the paper with a summary and an outline of further work.

2 Related Work

To the best of our knowledge, there is no prior work done by others to consider both the interest and the sentiment of a user in light of those reflected in a new article.

Some research focused on user's interest as reflected from their tweets – to determine the user's interests themselves [10,14] or to classify users based on their interests [1,2,11]. Kapanipathi et al. [10] determined the topic of user's interests by generating a Wikipedia "hierarchy" and determining the topic from the user's tweets from the hierarchy. Michelson and Macskassy [14] built a "topic profile" from multiple users and identified the topic of interest for a given user from it. They also used Wikipedia to disambiguate the concepts mentioned in tweets. Alvarez-Melis and Saveski [1] proposed a new "pooling technique" by which tweets exchanged between users are grouped based on topic modeling. Lim and Datta [12] picked a user that had more than 10,000 followers and classified the followers to categorize their interests into 15 topics using the Wikipedia hierarchy. Campbell et al. [2] proposed a method to classify users based on both tweet content and contextual information (e.g., retweets, mentions, co-occurrences).

Some research focused on sentiment to classify users based on the sentiment reflected in their tweets [6,21]. Gutierrez and Poblete [6] clustered users based on their sentiment polarity trace to generate individual profiles for different concepts, and studied the characteristics of the clusters. Tan et el. [21] proposed to take advantage of social relationships (e.g., followship, homophily, approval) between users to improve the sentiment-based user classification.

Some research used both interest and sentiment in their work [4,17]. Chen and Mirisaee's work [4] on topic-based sentiment analysis has something common with ours in that they built topic-dependent models – one driven by a target keyword and one driven by a group of topic-related tweet terms – and used them in sentiment analysis. Their work, however, is not concerning users at all. Pennacchiotti and Popescu [17] developed a generic model for user classification with a larger scope based on a comprehensive set of key features such as user's attributes (e.g., name, location), user's tweet behavior (e.g., frequencies of different types of tweets), user's tweet contents (e.g., keywords, hashtags, topic word, sentiment words), and user's interactions with other users (e.g., retweet, reply, friend).

3 News-User Compatibility

3.1 User's Compatibility

Figure 1 shows the framework for determining the compatibility between a news article and a Twitter user.

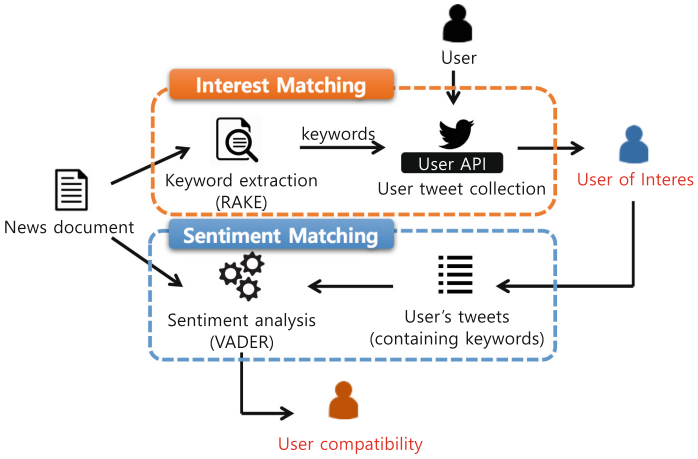

Fig. 1. News-user compatibility framework.

As explained in Sect. 1, determining a user's compatibility with a news article is currently based on two factors – user's interest match and user's sentiment match. The former is achieved through a simple form of topic mining based on keyword extraction, and the latter is achieved through a rule-based sentiment analysis. Both approaches have been chosen empirically after trying some alternative approaches. Given the two inputs, we first check whether the user matches the news in his/her interest as reflected in his/her tweet texts, and then check if the user matches the news in the sentiment analysis result as well. Both matches should be confirmed before we determine that the user is compatible with the news. Let us discuss each step in the remainder of this section.

3.2 User's Interest Match

The decision on whether a user's interest matches the topic in a news article is made according to the following definition.

Definition 1 (Interest Match). *Given an article A and a user U, we say U's interest matches A's topic if and only if any of recent tweet texts posted by U contains any of the topic keywords extracted from A.*

In this definition, the cutoff for recency is application-dependent, and all tweets posted by the user within the past recent period are considered for topic keyword match. We use a Boolean keyword match in this work.

As mentioned in Sect. 1, our definition of interest match is deliberately inclusive by making the match condition existential, and this strategy is necessary in order to overcome the well-known sparsity problem of tweet texts and flimsy tweeting behavior of users. According to Twitter statistics by Sysomos [20], at least 20% of tweets are retweets, and, in our observation, at least 40% of tweet

This tweet contains many hashtags that are irrelevant to the topic of the message and there is very little meaningful text content.

Fig. 2. Tweet sparsity caused by hashtags.

messages contain links. As a result, there is not enough meaningful text in a lot of individual tweet messages. Hashtags, which often are not real words, make the problem worse, as illustrated in Fig. 2.

One key issue in this user interest matching is *keyword extraction* from the input article. We first looked into a model-based approach. A topic model was generated by Hierarchical Dirichlet Process (HDP) [22], which is used popularly in topic mining and, given a news article, the topic model was looked up to find matching topic keywords. The performance, however, was inadequate in both speed and accuracy. The reason was that HDP is a classifier, which needs a collection of documents for training and testing and, therefore, it is highly likely that common words irrelevant to the topic are selected from the model. Indeed, when we analyzed a collection of New York Times articles to find topic keywords, HDP extracted words that did not represent the topic of the article.

Thus, we used a simpler approach that does not need a model. The *Rapid Automatic Keyword Extraction (RAKE)* algorithm by Rose et al. [19] was chosen for that purpose. RAKE analyzes a text by considering not only the frequency of each term but also its position and component (e.g., subject, predicate, object) in a sentence. This approach enables the algorithm to extract more meaningful keywords than a simple term frequency analysis can. In addition, the performance is better than using classifiers like HDP because it uses only a single document. RAKE first splits the input text into sentences and then extracts candidate keywords by removing stop words and phrase delimiters. Second, RAKE computes pairwise co-occurrences of the candidate keywords and calculates their scores as the sum of the scores of the words in the keyword. Third, RAKE merges some of the keywords separated in the first step if they have been separated by interior stop words that should be in the same phrase. Finally, from the resulting set of keywords, RAKE returns the keywords ranking one third top scores. In our implementation, we instruct RAKE to return at least three keywords and take the top three from the keywords returned.

3.3 User's Sentiment Match

The decision on whether user's sentiment reflected in his/her tweets matches the sentiment reflected in the new article is made according to the following definition.

Definition 2 (Sentiment Match). *Given a set K of topic keywords extracted from an article A, and a user U with matching interest (according to Definition 1), we say U's sentiment matches A's sentiment if and only if the results of sentiment analysis on U and A are the same, i.e. either both positive or both negative.*

In this definition, sentiment analysis is performed on selected texts, specifically, on only the sentences from an article A that contain *any* of the topic keywords in K, and on only the tweets texts from a user U's tweets that contain *any* of the topic keywords in K. The reason for excluding sentences/tweets that do not contain any of keywords in K is, evidently, that they have adverse effects on the sentiment scores, and the reason for including sentence/tweets that contain any – not all – of the keywords in K is, as in the interest match, to overcome the sparsity problem, especially for tweet texts.

We used a sentiment scoring algorithm [8], which is based on the *Valence Aware Dictionary for sEntiment Reasoning (VADER)* model developed and validated by Hutto and Gilbert [9]. The VADER model is a sentiment lexicon constructed using a combination of qualitative and quantitative methods. More specifically, it is a set of pairs of a lexical feature (i.e., word) and a score, from various resources such as sentiment word banks (e.g., LIWC, ANEW, GI), microblogs, and sentiment-related acronyms. This lexicon is especially accustomed to microblog texts and enables us to achieve impressive results in analyzing the sentiment of tweets.

Given the VADER model, the sentiment scoring algorithm [8] first calculates the triple (i.e., positive, negative, neutral) sentiment matching scores between each word in the input text document and any element in the lexicon whose feature matches the word and accumulates the scores over the words in the input text document. Then, it returns a sentiment score calculated as follows.

$$\text{Sentiment\_score} = \frac{\text{sum}_{\text{pos}} + \text{sum}_{\text{neg}} + \text{sum}_{\text{neu}}}{\text{sum}_{\text{pos}} + |\text{sum}_{\text{neg}}| + \text{sum}_{\text{neu}}} \tag{1}$$

where sum_{pos}, sum_{neg}, and sum_{neu} are the accumulated triple sentiment-matching scores. This is a compound score indicating the overall sentiment of the entire document.

To convert the compound sentiment score to a binary sentiment polarity (i.e., either positive or negative), we introduce a threshold, δ_{neu}, and then assign the polarity to either positive or negative only if the magnitude of the score exceeds the threshold and to neutral otherwise.

As the final step, the sentiment polarities of the news document and the user (with matching interest) are compared and they are determined to be compatible

if and only if both have the same polarity. In other words, they are determined to be incompatible in case their sentiment polarities are opposite or at least one has no polarity (i.e., neutral).

Given this sentiment match framework, we have tried two approaches to selecting the keywords that are input to the VADER model-based sentiment scoring algorithm [9]. One is to use the *RAKE-provided keywords* as they are, and one is to process them to identify fewer keywords that are likely to belong to tweets that have the same sentiment polarity. The underlying observation is that two or more keywords co-occurring in news article headlines tend to find *consistent* user's sentiment polarity as a result of the sentiment match according to Definition 2. We thus say that the latter approach uses *co-occurrence-based* keywords. Specifically, we consider different subsets of the three keywords returned from the interest match step and bootstrap New York Times headlines that contain any co-occurring keywords in the different subsets, and then select one or more keywords that occur frequently enough (i.e., term frequency above 80%). In case no such keyword is found, then we use the RAKE-provided keywords.

4 Evaluation

The main objective of the evaluation is to measure the accuracy of our algorithm in determining the compatibility. For this purpose, we conducted gold standard tests using ground truth articles and users. In this section, we compare the accuracies with those obtained when considering only one of the two factors – interest-match-only and sentiment-match-only – in order to validate that we need both. While doing so, we also compare between the two approaches to selecting inputs to the VADER model-based sentiment scoring algorithm (see Sect. 3.3). Additionally, we provide some examples of output from our algorithm.

All experiments were performed on a Red Hat 4.4.7-1 Linux server with Intel Xeon CPU E5-2667 v2 @3.30 GHz and 2 GB RAM. Our algorithms were implemented in Python 3.5.2 programming language.

4.1 Experiment Setup

Ground Truth. Table 1 describes the ground truth. We chose three seed topics abortion, immigration, and Brexit, as they have been the subjects of recent controversy on news media. For each topic, three news articles showing negative-sentiment and three articles showing positive-sentiment were collected from the Internet. News articles whose sentiment scores in absolute value are higher than 0.8 have been selected to assure definite polarity so that the compatibility will be determined by the sentiment scores on the side of the *users* of matching interest.

Additionally, for each topic, we assigned ten users such that five of them are compatible with the positive-sentiment news article and five of them are compatible with the negative-sentiment news article; the compatibility was manually vetted independently of our algorithm. In order to find the users, for each topic, first users whose tweets contain the topic keyword were identified through the

Table 1. Ground truth for compatibility accuracy evaluation.

Seed topic	Sentiment	Article	Compatible users
abortion	negative	US News Instant Answer Youthvoices	LGBT4LifeIRL, DidiJeremie, MichaelKellyIC, ColleenBarry1, misfeet
	positive	Shenvi Salon Media Group NY times	rtraister, HuffPostWomen, ihiccupalot, DonnaHowardTX, KathySchiffer
immigration	negative	Debate opinions Business insider Debate opinions	mkolken, MigrantVoiceUK, reformny, prioritydate, MaddieAndMichi
	positive	American progress The HuffingtonPost Debate opinions	SachaWoolLegal, K_Sreeharsha, jpsimmigrate, DetentionForum, RepGutierrez
Brexit	negative	Netivist The Guardian NY times	eyejosh, Hogmeisster, NYtitanic1999, Australiaunwra6, judithmknott
	positive	The Huffington Post International Business Times Al Jazeera Media Network	moboboandyking, JakubKrupa, massimousai, CarolHope01, bevilwooding

URL's of the articles are available at https://github.com/paper-data/user_compatible/blob/master/User_Compatible.pdf

Twitter Advanced Search engine and, then, for each user identified, the user's tweets in the past three months were retrieved through the Twitter User API.

Thus, for each topic, there are exactly five compatible users and 25 incompatible users – specifically, five users have matching interest but non-matching sentiment and 20 users have non-matching interest. These 30 users make a ground truth of an adequate size given the trending nature of tweets reflecting transient interests and sentiments, and they reflect the actual number of users whose tweet messages do not show the sparsity or flimsiness problem mentioned earlier.

As mentioned in Sect. 3.2, the RAKE algorithm returns at least three keywords in the one-third top scores and we selected the top three keywords from them. When we did it for each news article in the ground truth, the keywords selected for all news articles altogether covered all of the three topics used in the ground truth.

Parameter. The threshold parameter δ_{neu}, used in sentiment determination (Sect. 3.3), is the minimum sentiment score required to assign a polarity to the sentiment score. Its value was set to 0.4 for our algorithm with the co-occurrence-based keyword selection and 0.6 for our algorithm without it and to 0.4 for the sentiment-only algorithm. (Note that the interest-match-only algorithm does not need this parameter.) These values were determined as a result of manually tuning the algorithm outputs against the ground truth.

Table 2. Compatibility accuracy evaluation results.

Seed topic	Sentiment	Interest match only			Sentiment match only			both-RAKE			both-fltered		
		Preci	Rec	F-Scr	Preci	Rec	F-Scr	Preci	Rec	F-Scr	Preci	Rec	F-Scr
abortion	negative	0.22	1.00	0.36	0.27	0.33	0.27	0.60	0.43	0.50	1.00	1.00	1.00
		0.31	1.00	0.48				0.40	0.80	0.53	1.00	1.00	1.00
		0.29	1.00	0.45				0.60	0.60	0.60	1.00	1.00	1.00
	positive	0.21	1.00	0.34	0.32	1.00	0.48	0.24	0.83	0.37	1.00	0.83	0.91
		0.21	1.00	0.34				0.29	0.83	0.43	1.00	0.83	0.91
		0.35	1.00	0.52				0.60	1.00	0.75	1.00	0.83	0.91
immigration	negative	0.26	1.00	0.42	0.12	0.20	0.15	0.83	1.00	0.91	0.71	1.00	0.83
		0.25	1.00	0.40				0.57	0.80	0.67	0.50	0.80	0.62
		0.17	1.00	0.29				0.36	0.80	0.50	0.50	1.00	0.67
	positive	0.25	1.00	0.40	0.11	0.40	0.17	0.50	0.67	0.86	0.71	0.62	0.82
		0.29	1.00	0.45				0.44	0.80	0.57	0.56	1.00	0.71
		0.21	1.00	0.34				0.50	1.00	0.67	0.71	1.00	0.83
Brexit	negative	0.33	1.00	0.50	0.35	0.60	0.44	0.83	1.00	0.91	0.71	1.00	0.83
		0.33	1.00	0.50				0.71	1.00	0.83	0.71	1.00	0.83
		0.23	1.00	0.37				0.63	1.00	0.77	0.71	1.00	0.83
	positive	0.29	1.00	0.45	0.14	0.67	0.21	0.50	1.00	0.67	0.71	1.00	0.83
		0.23	1.00	0.37				0.38	1.00	0.56	0.71	1.00	0.83
		0.22	1.00	0.36				0.56	1.00	0.71	0.71	1.00	0.83
Arithmetic average		0.26	1.00	0.41	0.22	0.53	0.29	0.53	0.86	0.66	0.78	0.94	0.85

In the interest-match-only column, each accuracy number is with regard to the compatibility between the news article in the same row of the ground truth table (see Table 1) and the ten users assigned to the article's topic. The sentiment-match-only algorithm is not relevant to the topic, and therefore each accuracy number reflects only the five users' tweet sentiment. Thus, in the sentiment-match-only column, each accuracy number is with regard to the five users in the same topic & sentiment row of the ground truth table. Our compatibility algorithms (i.e., both-RAKE, both-filtered) consider both interest match and sentiment match. Each accuracy number is with regard to the compatibility between a news article and the five users assigned to the article's topic & sentiment in the same row of the ground truth table.

4.2 Experiment Results

Compatibility Accuracies. Table 2 shows accuracies resulting from four algorithms: interest-match-only, sentiment-match-only, both matches with RAKE keywords without filtering (called "both-RAKE"), and both matches with filtered keywords (called "both-filtered"). Our algorithm with keyword filtering outperforms the interest-match-only by 2.07 times in f-score (resulting from 3.00 times in precision and 0.94 times in recall), and outperforms the sentiment-match-only by 2.93 times in f-score (resulting from 3.55 times in precision and 1.77 times in recall). Table 2 also shows that filtering the keywords from RAKE in our algorithm improves the f-score by 1.29 times over using the RAKE keywords as they are.

We see that the precision increases from interest-match-only or sentiment-match-only to both-RAKE and further increases to both-filtered, which is consistent with the way f-score increases across these algorithms. For recall, interest-match-only shows 1.0 for all news articles. This is from that every compatible user matches in the interest as one of the required conditions. In both-RAKE and both-filtered, however, the recall is lower than 1.0 because some of the keywords for a user may have different sentiment polarities. Evidently, both-filtered achieves higher recall than both-RAKE because there are fewer such keywords as a result of the filtering.

Fig. 3. Compatibility example cases.

Compatibility Example Cases. Figure 3 shows example cases of news-user compatibility determination. The text of a news article is shown on the left side and an exemplary tweet posted by each of the three tweet users LGBT4Life, Donna Howard, and Larry Hawk are shown on the right side. (We are showing only one exemplary tweet per user due to space limit.) Two topic keywords "murder" and "abortion" extracted from the news article are shown in the gray box `A` and are highlighted in the news article and the tweets. The sentiment scores are shown in red color – labeled `B` for the news article and `C-1` and `C-2` for tweet messages.

The news article's sentiment is negative. First, the user LGBT4Life's tweet contains a matching topic keyword "abortion", so this user matches the news in the interest, and this user's sentiment is negative, which matches the news article's sentiment. Therefore, this user is compatible with the news article. Second, the user Donna Howard's tweet also contains a matching topic keyword "abortion", hence matches in the interest, but this user's sentiment is positive, which is opposite to the news article's sentiment. Therefore, this user is incompatible with the news article. Third, the user Larry Hawk's tweet does contain either topic keyword, and hence this user's interest does not match the news article's topic. Therefore, this user is incompatible with the news article. Our algorithm made correct compatibility decisions in all three cases.

5 Conclusion

The notion of news-user compatibility introduced in this paper enables user profiling, which has many practical applications. The proposed framework combines interest match and sentiment match as two steps for compatibility determination, and each step can be instantiated using different algorithms. In this paper, we used the RAKE algorithm for interest match, to extract topic keywords from the news article for use in matching against the tweets written by the user. Then, we used the VADER model-based sentiment analysis algorithm for sentiment match, to determine the user's sentiment reflected in the user's tweets containing the keywords, where the keywords from RAKE are filtered based on their co-occurrence frequencies in news headlines. Gold standard test results

show that considering both interest match and sentiment match and avoiding sentiment ambiguities through co-occurrence-based keyword filtering are instrumental in achieving an average 85% f-score over all ground truth cases.

One further work is to take more factors than interest and sentiment, such as the user's language, geolocation, timeline, and hashtags, into the framework for more accurate compatibility matching. Currently in the plan is the next phase framework, which aims to find users that are compatible with a given news article. Since there is a huge number of users in online social media, iterative processing is needed in order to first find tweets based on semantic and sentimental "cues" and then find users who posted those tweets and then find additional tweets posted by those users, etc. while progressively refining the compatibility scores of the users found thus far.

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Designing and Managing a Real-Time Collaborative Learning Paths by a Multi-agents Platform

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Abstract. In this paper, we present a new architecture of learning path generation and managing the learner's progression in multi-users context. By "multi-users context", we hint at real time collaboration between different learners in a hyper-dynamic world; moreover, the architecture allows us to take into account the preceding learners' appreciations about pedagogical resources and learning path during the new learning path generation. The generation implies two steps: (i) building a graph of learning objects according to their prerequisites and according to the learner progression in her/his learning path, (ii) the recommendation of pedagogical resources associated to each graph node. Different criteria are proposed to select the relevant pedagogical resources in the scope of the learner's profile, learner's communities, and the appreciations of other learners about the available pedagogical resources. These criteria are used to maximize a fitness function for the pedagogical resources. The progression of the learner in her/his learning path and the communities are managed by the multi-agent system based on JADE to ensure the smooth organization of the training session.

Keywords: Learning path generation · Recommendation of pedagogical resources · Multi-users context · Web-based learning environment

1 Introduction

With the advent of new Web technologies, learning a language, a job, a skill, etc., becomes possible at any time and in any place. However, the learning phase itself must take into account the learner profile at the time of her/his request. The topic central to the issue of Web-based learning is adapting learning paths to the learner, in order to get a more relevant apprenticeship. The goal is to build dynamic and individualized learning paths. In fact, firstly the pedagogical resources should be adapted to each student need, according to their profile such as their level of knowledge and preferences; and, secondly, the learner must not have the feeling of doing repetitive activities, or always see the same kind of content. To allow the learner adaptation, many solutions have been proposed [1,2]. These solutions are generally based on learning model approaches. There are

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three approaches to model a learning process: (i) oriented activities approaches [3] where the learning process is represented by a graph in which the activities are identified and decomposed, (ii) oriented resources approaches [4–6] where the path construction returns to select, assemble and present contents, and (iii) oriented objectives approaches [7] where the learning process is seen as a process of satisfaction of pedagogical objectives. These approaches use a set of algorithms and techniques from Artificial Intelligence and Web Semantics such as ant colony optimization [3,4,8,9], Bayesian networks [7], ontologies [10], etc.

The aforementioned research has led to the development of several adaptive learning systems. These systems are intended either for a single learner or a group of learners. We propose, in addition to two learning situations mentioned above (*i.e.* learning in single mode or in group mode), a new situation called individual learning with ad hoc meeting points between peers of the same level. Thus, in one learning session, the learner can alternate between "individual mode"/"collaborative mode" according to her/his preferences, her/his progress and the progress of other learners in the course, but also according to the availability of pedagogical resources of the learning environment. Besides the adaptation problems, this situation shows new issues such as synchronization between peers (in a hyper-dynamic world) on the activities taking place in multi-users, and critical cases that may arise during the lack of the same learners level, in addition of the lack of multi-users pedagogical resources and heterogeneity of learners profiles.

2 Model of Knowledge System

2.1 Knowledge Network

Our knowledge network consists of two ontologies designed training about manual trades for *Learning Café* project (FUI-15). The first one, named User-Profile Ontology (UPO), designs the different users who learn, evaluate, collaborate, guide, etc. in *Learning Café* platform. Each user is described in terms of specific personal information such as *firstname*, *lastname*, *email*, *gender*, *curricula*, etc. The second kind of information concerns the user preferences and contributions in the platform in terms of collaboration and activities, and the auto-evaluation made when users registered to *Learning Café* by different properties such as *level* (beginner, junior, senior, etc.). Finally, several relationships memorize the different dynamic learning path followed by learners, and their opinions about the made pathways. Figure 1 presents a partial view of UPO and focuses on the learner information and her/his relationships with the different classes such as *Training*, *LearningObect*, *PedagogicalResource*, etc. UPO is also the cornerstone of social network.

In the same manner, the second ontology, named Training Ontology (TO), represents the different known trades, and the associated trainings created by users.

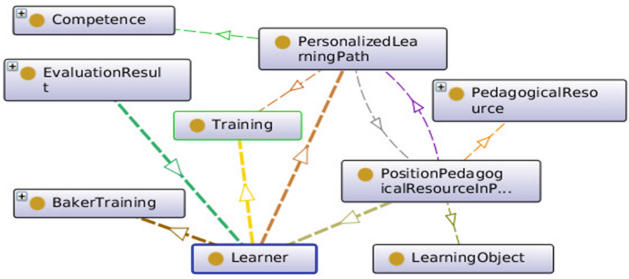

Fig. 1. Partial model of user-profile ontology (UPO)

2.2 Using Knowledge Network

The two ontologies (UPO and TO) are accessible through a revision engine for managing ontologies, and a services interface for consulting data. The revision engine allows new concepts, new properties, new axioms, etc., to be added to the ontologies, whilst ensuring the ontology consistency. The interfaces of data consultation offer a set of data operations services such as research of individuals (instances of a class or of a set of related classes).

Moreover, reasoning on these ontologies makes it possible the detection of emerging learning communities according to trades or/and skills based on UPO. For example, the reasoner brings together people interested by *Baker* trade and proposes them to collaborate about this topic. This community varies over time by adding or removing people. This is notably because an user can express they like or unlike collaborate with other.

3 A New Architecture for Building and Piloting Training Paths in Multi-users Context

To answer the issues announced in the introduction, we propose a building system and piloting personalized training paths (Fig. 2).

This new architecture is based on a hybrid learning approach, and manages two situations, i.e. individual learning and collaborative learning. In the first situation, the system can dynamically generate training path adapted to each learner. The architectural components involved in this situation are the "**Receiver**", the "**Graph Generation Engine (GGE)**", the "**Recommendation Engine (RE)**" and ontologies. In the second mode of learning (i.e. collaborative learning), the system allows building training path for a group of learners. In addition to the above components, the system uses the third multi-agents architecture for managing synchronization between learners and management of critical cases that can be created in a collaborative learning session. The agents involved are the "**Agents Manager (AM)**", "**Recommendations Agents (RA)**" and "**Critical Case Management Agents (CCMA)**".

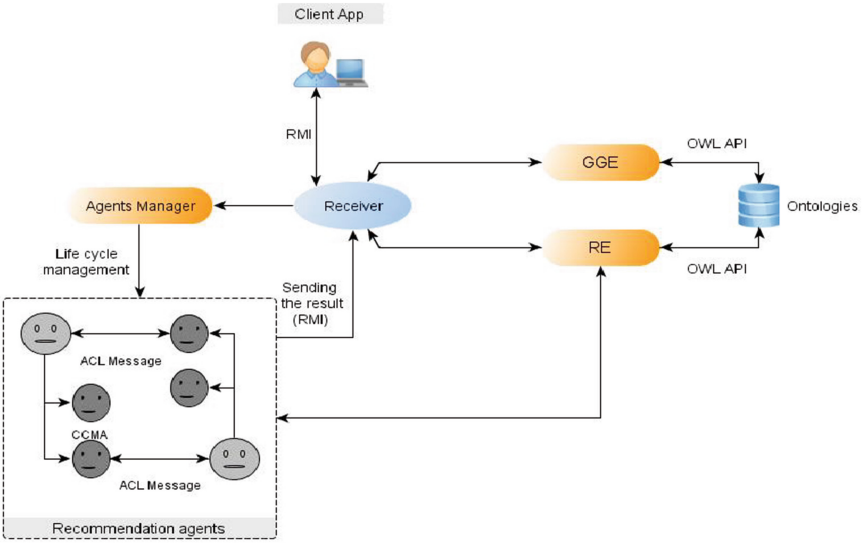

Fig. 2. Multi-agents architecture of the building system and paths piloting

Building a path involves two steps: (i) the generation of a learning object graph based on each learner's profile, and depending on the training or competence chosen by the learner. This first step is the same for both learning situations; (ii) deriving a pedagogical resources recommendation guideline for each node of the graph, for a single learner (videos, text documents, etc.) or for a group of learners in case of a collaborative learning situation (e.g. mini multi-users games, etc.). In the same learning session, the architecture allows learners to switch between individual learning and collaborative learning based on their preferences and depending on availability in terms of pedagogical resources known in the training ontology.

The following sections describe the role of each component of the architecture.

3.1 The "Receiver" Component

The **Receiver** ensures the appropriate functioning of the system. All other components are to its service and its responsibility. It is responsible for assigning different requests that it receives to components involved in the path construction and piloting process. The **Receiver** manages both individual learning and multi-users situations. In the first case, it communicates only with the **GGE** component to build the graph and to select the appropriate pedagogical resources. In the second case, after building the graph by using the **GGE** and after checking the existence of multi-users pedagogical resources to that node via the **RE**, the **Receiver** starts a communication with the multi-agents of the system to synchronize learners and piloting the collaborative learning session.

3.2 The "Graph Generation Engine (GGE)" Component

The **GGE** builds dynamically the graph of Learning Objects (LOs) based on a training (resp. competence) and the learner profile. It involves to transforming an initial list of LOs into a hierarchical graph of several levels. This hierarchical organization takes into account the progress of the learner in her/his path, and what she/he has already acquired in terms of LOs, and prerequisites links between different LOs (i.e. other LOs must be acquired first). In fact, the LOs of the initial list that have no prerequisites represent the leaves of the graph (level 0), the nodes that have as a prerequisite from level 0 nodes are level 1, and so on.

LOs of the same level are independent. Then, the student is free to start with any LOs of the same level. Moreover, validating a LO by the learner involves updating the graph by the **GGE**.

Indeed, the **GGE** dynamically updates the graph depending on the progress of the learner in her/his career. Therefore, the LOs of a higher level can go down to a lower level if the learner has validated the preceding LOs of the lower level.

Three LOs acquisition evaluation strategies are planned: (i) self-evaluation where the learner is invited to examine herself/himself if she/he has acquired or not LOs, (ii) peer review where the learner is evaluated by other learners in the community, (iii) evaluation by quizzes.

3.3 The "Recommendation Engine (RE)" Component

For each LO (a node of the graph), the **"Recommendation Engine" (RE)** selects the most appropriate pedagogical resources for a learner profile or for a group of learners. The choice of a resource is made according to several criteria. These criteria are related to the learner, community or pedagogical resources. The criteria are:

- **Preferences Criteria (f_p):** mainly comprise learner preferences in terms of preferred languages, preferred resource formats; but also the duration of the learning session.
- **Evaluation criteria (f_e):** about appreciations community regarding of various pedagogical resources offered by the **RE** during learning sessions. Those criteria are understanding, appreciation, recommendation and efficiency.
- **Criteria for the pedagogical resource (f_r):** include the language of resource, format, level of difficulty and duration.

The **RE** objective is to minimize the following fitness function:

$$f = f_p \times [f_r + f_e] \tag{1}$$

where

$$f_p = \prod_{i=1}^{l} w_i \times C_i, f_r = \sum_{i=1}^{m} w_i \times C_i, f_e = \sum_{i=1}^{n} w_i \times C_i,$$

w_i are weights representing the importance of C_i criteria, and l, m and n represent the numbers criteria.

We offer three possibilities to calculate the weight: (i) the weights are set by a pedagogical team, (ii) the weights are determined by the system after a learning step involving a minimum number of learners, or (iii) the weight are calculated dynamically and change from a node to another depending on the prioritization criteria during a learning session. C_i value depends on each criterion according to a specific formulas.

3.4 The Multi-agents System for Learning in Collaborative Mode

In the multi-users context, in addition to the adaptation issue, it exists the synchronization issue between learners to build, in real-time, homogeneous working groups. This synchronization must consider several constraints: (i) the learner waiting time to collaborate on a LO shall not exceed a maximum duration of her/his choice, (ii)the members of a group must have at least one language in common, (iii) the recommendation of educational resources must take into consideration the preferences of all members of the group.

To answer to these different constraints, we proposed a multi-agents system to manage learning in a collaborative mode. The components of this system are:

The **"Agent manager (AM)"** manages the life-cycles of recommendation agents. Thus, for each learning object selected, if it has not already done, the component creates a recommendation agent. The agent created will be destroyed by **AM** when there is no learning on its queue.

The **"Recommendation Agents"** manages synchronization between learners and ensures the smooth running of the paths avoiding critical cases that can be created during the learning session. Thus, each "Recommendation Agent" manages a queue of learners in a learning object. The main tasks of such agents are:

- the management of the queue on the LO. Then, the agent adds newcomers to its queue and delete each served learner;
- creating collaborative homogeneous groups on the basis of different learner profiles;
- for each created group, the agent uses the **RE** to calculate a recommendation of pedagogical resources based on the LO in question and the group profile. The group profile is the intersection of the profiles of its members;
- detection of critical cases. A learner is in critical case after the expiration of the waiting time chosen without the agent finds him a group to collaborate. Such cases can occur because of the absence of learners on the learning object, or because of the heterogeneity of the learners' profiles. To fix this situation, the agent in question creates a "son" agent, **"Critical Case Management Agent(CCMA)"**, whose task will be to find a solution to the problem.

The **"CCMA"** manages critical cases. To find a solution to a critical case, the **CCMA** contact agents of the same level, in other words, agents managing

learning objects at the same level on the graph. The goal is to obtain information on each queue of those agents and offer the learner to go to "work" the learning object where there is no more learners waiting, or, in the opposite case, proposes her/him to work individually. The **CCMA** is destroyed at the end of its task.

4 Experimentation

We have implemented a first prototype of our proposed architecture. This prototype has a web interface that allows to the learner to interact with the learning environment. In this interface, the learner could exploit the different services, such as the generation/visualization of the learning graph, the visualization of the different pedagogical resources recommended by the system, and the evaluation of each resource. In a multi-users context, and in this paper, we have tested our system with a console version. The aim is to connect many learners in real time in a set of LOs by using a set of terminals of a same machine.

We tested the system on a training called "Development", about the basis on JAVA language. The training is a set of LOs and their prerequisites. For each LO, we associated a set of pedagogical resources. Figure 3 represents the graph of the training "Development".

The following section will give in details an overview of our system, and the results of the couple of learning situations.

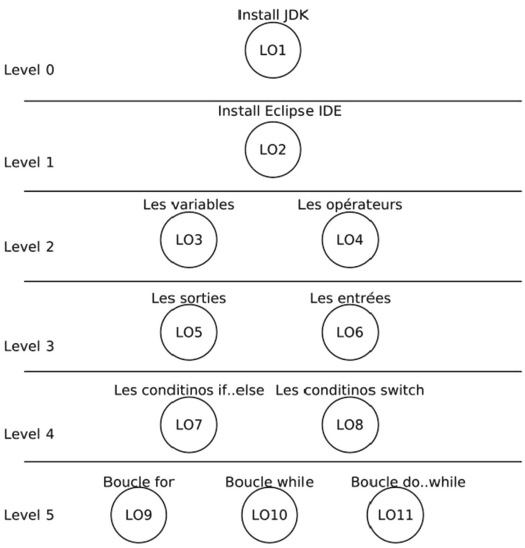

Fig. 3. Example of graph for the training "Development"

4.1 Graph Generation

For each training session of learner, the graph is generated regarding the progress of learners in the training. Indeed, irrespective of the learner, the system builds a graph composed of all LOs not yet acquired by the learner. Figure 4, shows an example of a learner graph created by our system.

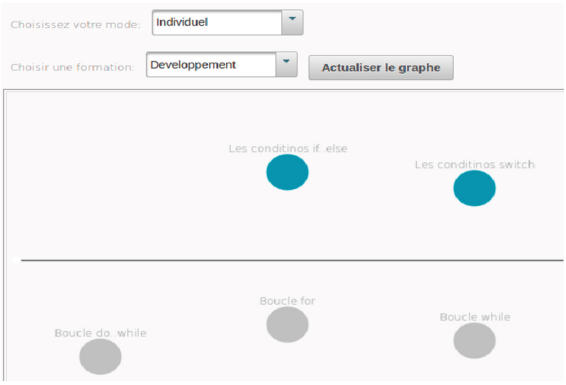

Fig. 4. Example of graph of a learner for the training "Development"

The dark nodes (in the top) represent LOs that are accessible for the learner. There is no constraint on the order on these LOs, the learner is free to choose the starting LO. The gray nodes are LOs that belong to highest levels at which the learner have not yet access. Indeed, the set of nodes of this level have the prerequisite LO7 (about "if ... else conditions") in the precedent level, the learner should validate this LO to have the access to the next level.

4.2 Recommendation of Pedagogical Resources in Individual Mode

In individual mode, the engine processes a list of pedagogical resources tailored to the preferences of the learner. The list of pedagogical resources is ranked depending on the value of the fitness function described previously. Thus, the pedagogical resource whose value of the largest fitness function is put in the header of the list.

The recommended list to the learner displays different information on each of the pedagogical resources. The learner can navigate in the list to select a resource. Before closing the resource, the system prompts the learner to self-assess and advises on this pedagogical resource. After that, our system redirects the learner on its graph which will be automatically updated.

4.3 Recommendation of Pedagogical Resources in Collaborative Mode

In the collaborative learning mode, the course generation engine calculates the pedagogical resources for groups of learners. In the current version of the prototype, the engine manages groups of two learners. For all the learners connected in real time on a same LO, the system built a pair of profiles. If a learner is in a critical case previously mentioned, the engine runs the learner in question to the LO of the same level for which there are more waiting learners or, where appropriate, proposes her/him to work individually.

Example. We connected four learners "user1", "user2" and "user3" on LO9 (about "Boucle for"), and "user4" on LO11 (i.e. "Boucle do..while"). The RE process ran. The following messages shows the proposed recommendation:

```
##########---Receiver listening ----##########
New connection => user1 on the LO : Boucle For
New connection => user2 on the LO : Boucle For
Creating a Binome => (user1, user2)
New connection => user3 on the LO : Boucle For
New connection => user4 on the LO : Boucle Do..while
user3@test.com is in CRITICAL CASE on the LO => Boucle For
BEST PROPOSITION for user3@test.com is Boucle Do..while
```

The learner "user3" is in a critical case on LO9 after the expiration of the waiting time (of 10 sec). Consequently, the system proposed to this learner to do LO11 where "user4" is waiting for.

For each learner of the pair, the system send the necessary pedagogical resources and avatar with which the learner is supposed to work.

5 Conclusions

In this paper, we proposed a new architecture for building and piloting path in a multi-users context. This architecture integrates four main components, the **Receiver** for the management of exchanges between the various components of the architecture, the **Graph Generation Engine** for graph generation of LOs for training (resp. competence), the **Recommendation Engine** to calculate recommendations of pedagogical resources in both learning contexts (i.e. learning in individual mode and collaborative mode) and finally third parties multi-agents to manage collaborative learning path.

The LOs's graph generated by the **Graph Generation Engine** takes into account the relationships between prerequisites and different LOs of a training (resp. competence and the progress of the learner who demanded a training (resp. competence). The different criteria hold for a recommendation of pedagogical resources are very varied to take into account not only the learner profile but also the opinions of other users.

Our proposed architecture allows learners to dynamically build their personalized paths all within the constraints imposed by the designers of training. Then, on one graph level, the learner is free to choose the LO to work; but,

she/he has not the opportunity to work a LO without validating its predecessors. Moreover, from a list of recommended pedagogical resources for LO, the learner can view one or more resources as one wishes. Therefore, each learner will have a personalized learning path according to their choice in terms of LOs and pedagogical resources.

Our future works will mainly concern the optimization of the learning path generation to foster the real-time collaboration and get an efficient scalability. We think to use meta-heuristics such as Variable Neighborhood Search. A comparison of different meta-heuristics will be done in the context of *Learning Café* to obtain a better recommendation system of learning path.

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Information Systems and Technologies Adoption

Determinants of Facebook Adoption and Use Within the Workspace in Catholic University of Central Africa

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Abstract. Given new and innovative services brought about by Information and communication technologies (ICTs) including social media, they have become vital tools and channels for both individual users and organizations. Thanks to social media, people and institutions are being given the possibility to automate and improve the performance of their activities, to take advantage of rapid electronic diffusion processes to guarantee a better information sharing between users, inter alia. This study focuses on the Facebook social media network and attempts to identify and analyze the factors that influence the usage of this tool in the Cameroonian professional environment. To test our proposed model, data were collected from 142 social media users from Cameroonian universities. Findings have shown that the perception of connectivity and the attitude toward using Facebook have significant influence on the intention to use Facebook at the workplace.

Keywords: Social media · Perceived connectivity · Use and adoption

1 Introduction

Since their introduction in the early 2000s, social media (e.g., Twitter, Facebook) have steadily progressed to become today the most used media [1], sharing the limelight with and even overcoming traditional media platforms. First developed to facilitate communication in a network of friends using images, videos, and sharing everyday experiences, social media are increasingly gaining ground in all domains including professional activities [2]. For example, they provide companies with the means to acquire and retain new customers [3], improve communication with its partners [4], facilitate sharing of knowledge between companies, improve the process of merchandising and purchasing through the Internet [5]. Culnan et al. [6] believe that the use of social networks creates value for internal communication with customers or suppliers.

This paper will specifically examine the use that is made of Facebook in professional environments in a Cameroon, a developing economy with limited access to Internet, the

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connection being of low bandwidth and costly while there are great opportunities through mobile phones and strong growth of cheap Smartphones. To achieve our research objective, the study uses the innovation and adoption of IT theories (IDT) [7] and the Technology of Acceptance Model (TAM) developed by Davis [8].

2 Research Model and Hypotheses

The proposed research model is based on the combination of TAM and IDT to which we added other variables to assess feedback related to the use of Facebook.

Perceived Feedback Received (PFR). Facebook is used by many people because of the perception they have of this social network. Like other social media platforms, Facebook has increasingly become a privileged social media network for information interchange within specific groups. In terms of affordance, this platform enables its users to post photos, videos and make comments on the publications made. But, at the same time, the visuals posted can be modified images, especially selfies and memes, with a variable standard of expression and amenity. In return, the users can receive the comments of other users on their publications (texts, photos and videos) in the form of comments and 'likes'. The quality of these comments will greatly determine the intention to use this social media platform. Therefore, we suggest the following hypotheses:

H1: PFR has a significant positive effect on the intention to use Facebook within workplace environments.

H2: PFR has a significant positive effect on PFS within workplace environments.

Perceived Feedback Sent (PFS). Unlike the perceived feedback comments made by Facebook users to other users are generally related to the postings being made. Comments made are in response to the postings of relatives, friends, colleagues and other virtual and non-virtual acquaintances, who all form one's Facebook 'Friends'. The quality of these comments depends tremendously on the quality of other Facebook members' comments and therefore can influence the intention to use the said social media. So, we can propose this hypothesis:

H3: PFS has a significant positive effect on the intention to use Facebook within workplace environments.

Perceived Usefulness (PU). Is defined as the degree to which a person believes that using Facebook would enhance his or her job performance [8]. Several recent studies have examined the correlation between perceived usefulness and the attitude and behavioral intention, when evaluating consumer acceptance of an innovative product [9]. Based on prior research, the following hypotheses were proposed:

H4: PU has a significant positive effect on the intention to use Facebook within workplace environments.

H5: PU has a significant positive effect on PFR within workplace environments.

H6: PU has a significant positive effect on PFS within workplace environments.

H7: PU has a significant positive effect on PEoU within workplace environments.

Compatibility (COMP). Is defined as the degree to which an innovation is perceived as consistent with existing values, norms, social practices and user past experiences [10]. Agarwal & Prasad [11] argue that the relationship between individual's prior compatible experiences and the new information technology acceptance is positive [12]. Based on prior research, the following hypotheses are proposed:

H8: COMP has a significant positive effect on the intention to use Facebook within workplace environments.

H9: COMP has a significant positive effect on PU within workplace environments.

Attitude Towards Using Facebook (ATU). The attitude toward an innovation is a critical variable in the innovation adoption decision [10]. Thus, the attitude toward a specific information technology is conceptualized as a potential user's assessment of the desirability of using that technology and predicts an individual's use of technology according to TAM. Hence the following hypothesis:

H10: ATU has a significant positive effect on the intention to use Facebook within workplace environments.

Perceived Ease of Use (PEoU). TAM suggests that PEoU has a positive effect on the behavioral intention of a potential adopter of an IT technology. Moreover, Luo *et al.* [13] reported that the PEoU has a positive impact on PE, PU and the intention to use instant messaging in the enterprise. Therefore, the following hypotheses are proposed:

H11: PEoU has a significant positive effect on the intention to use Facebook within workplace environments.

H12: PEoU has a significant positive effect on PU within workplace environments.

H13: PEoU has a significant positive effect on ATU within workplace environments.

H14: PEoU has a significant positive effect on PE within workplace environments.

Perceived Connectivity (PC). Luo *et al.* [13] found that PC is an important determinant of IT adoption, especially for interactive technologies such as Internet, enterprise instant messaging and social media. Therefore, we formulate the following hypotheses:

H15: PC has a significant influence on the intention to use Facebook within workplace environments.

H16: PC has a significant positive effect on ATU within workplace environments.

H17: PC has a significant positive effect on PEoU within workplace environments.

Perceived Enjoyment (PE) and Perceived Playfulness (PP). Davis [8], when studying the role of intrinsic motivation, introduced the constructs of 'perceived enjoyment' and 'perceived playfulness'. They are considered factors influencing user acceptance of technology [14]. Prior studies have found strong evidence of relationships between PP and PE and the behavioural intention to adopt and use ITs. For example, Luo *et al.* [13], in their study of IM acceptance, found that perceived enjoyment had a strong positive relationship with the adoption intention. Therefore, we suggest the following hypotheses:

H18: PE has a significant positive effect on the intention to use Facebook within workplace environments.

H19: PE has a significant positive effect on PP within workplace environments.

H20: PP has a significant positive effect on the intention to use Facebook within workplace environments.

3 Methodology

In this study, we used a quantitative approach. This approach is based on instruments or quantitative research techniques for data collection. It results in figures that make descriptive analyzes, tables and graphs, statistical analysis of research links between the variables or factors, correlation analysis and association [15]. This approach allowed us to gather clear and observable data to test the assumptions of our theoretical model. This study was conducted in November 2014 in Cameroon.

We used a questionnaire to collect data. All items in our questionnaire were assessed on a Likert scale with seven levels [16]. Our target consisted of 142 people who use Facebook in the workplace, particularly within the Catholic University of Central Africa in Yaoundé. A delay of one week was given to the participants to fill out questionnaires. At the end of the week, we received 142 questionnaires and all were usable. The investigation began on November 15 and ended on December 18, 2014; so it lasted 34 days. For the analysis and processing of collected data, we used mainly two programs: SPSS (version 22) was used for data encoding and implementing the descriptive statistics of our sample, while the SmartPLS software (version 3) allowed us to assess the adequacy of the theoretical model and to verify its hypotheses (Fig. 1).

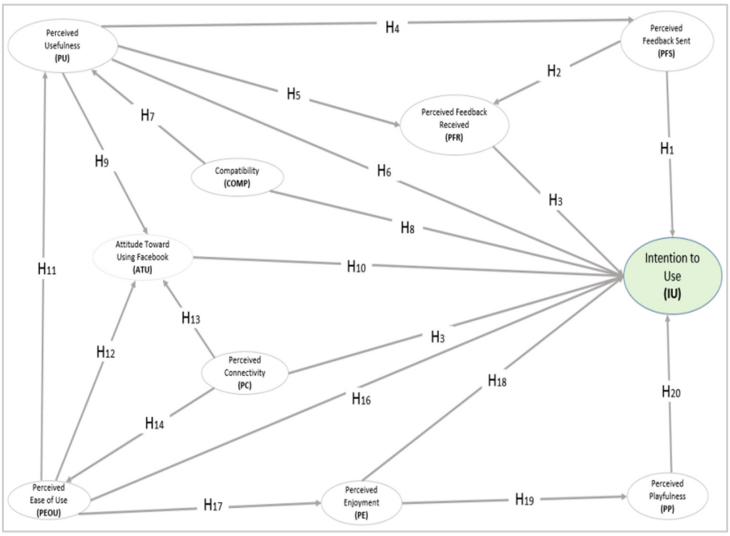

Fig. 1. Research model

4 Results and Discussions

According to the demographic profile of our 142 respondents, 56.3% are men and 43.7% women. Approximately 83.8% of respondents have a bachelor's degree and 12.7% have master's degree. Most of the respondents live in the city (83.1%), and a small percentage live in rural areas (3.5%). A total of 35.9% of respondents have more than 10 years' experience in the use of the computer, against only 0.7% for those with little experience in using computer. Respondents who are students and non-teaching staff account for 65.5%. In terms of Internet use, 45.1% of respondents use the Internet several times a day.

Table 1 presents the number of items, mean, standard deviations (SD), Cronbach's alpha, composite reliability (CR) and average variance extracted (AVE) of each construct of the overall model. All reported values (Cronbach's alpha, CR, AVE) in the table meet the acceptable threshold values – respectively, 0.7; 0.7; 0.5 [17] – and thus justify the use of all our constructs. Table 2 presents the results of hypothesis testing of the specific research model. For a probability p less than 0.05 and a Student statistic below the 1.96 threshold, a hypothesis is accepted [18].

Table 1. Numbers of items, Mean, SD, Cronbach's alpha, CR and AVE

Latent variable	Numbers of items	Mean	SD	Cronbach's alpha	CR	AVE
ATU	4	5.195	1.085	0.796	0.867	0.622
COMP	3	4.076	1.347	0.772	0.868	0.687
IU	4	4.915	1.344	0.774	0.856	0.598
PC	4	5.527	0.972	0.718	0.825	0.544
PEoU	3	5.916	1.001	0.728	0.844	0.644
PE	3	5.226	1.25	0.883	0.927	0.810
PFR	4	5.377	1.169	0.873	0.914	0.726
PRS	4	4.89	1.305	0.838	0.893	0.679
PP	2	5.16	1.238	0.794	0.906	0.828
PU	5	3.146	1.315	0.796	0.876	0.610

There are strong relationships between the following: ATU and IU; PC and IU; PFR and PFS; PFU and PFS; PFU and PFR; PFU and ATU; PC and ATU; PC and PEoU; PEoU and PE; and finally PE and PP. Our results clearly indicate that only two constructs (ATU and PC) have a positive influence on the intention to use the technology.

ATU and PC have a positive influence on IU, and this confirms the hypotheses H10 ($T = 2.268$, $p = 0.024$) and H11 ($T = 2.078$, $p = 0.038$). However, PFR, PFS, PU, COMP, PEoU, PE and PP on the intention to use Facebook (IU) do not have any significant effect. Therefore, the hypotheses H1 ($T = 0.123$, $p = 0.902$), H3 ($T = 1.208$, $p = 0.228$), H4 ($T = 1.102$, $p = 0.271$), H8 ($T = 1.373$, $p = 0.170$), H11 ($T = 0.438$, $p = 0.662$), H18 ($T = 0.251$, $p = 0.802$) and H20 ($T = 1.587$, $p = 0.113$) are rejected. PU and PC have a positive influence on ATU, which enables us to confirm the hypotheses H7 ($T = 4.096$, $p = 0.000$) and H16 ($T = 2.044$, $p = 0.042$). The effect of PEoU on ATU is no significant, which leads to the rejection of hypothesis H13 ($T = 1.705$, $p = 0.089$). Also, PC has a positive influence on PEoU, thereby confirming the veracity of hypothesis

Table 2. Results of the structural model

Hypothesis		Path coefficient	T (observed value)	P-Value	Conclusion
H1	PFR - > IU	0.012	0.123	0.902	Rejected
H2	PFR - > PFS	0.525	7.185	0.000	Accepted
H3	PFS - > IU	0.133	1.208	0.228	Rejected
H4	PU - > IU	0.087	1.102	0.271	Rejected
H5	PU - > PFR	0.199	2.349	0.019	Accepted
H6	PU - > PFS	0.230	3.775	0.000	Accepted
H7	PU - > ATU	0.341	4.096	0.000	Accepted
H8	COMP - > IU	0.127	1.373	0.170	Rejected
H9	COMP - > PU	0.531	8.991	0.000	Accepted
H10	ATU - > IU	0.236	2.268	0.024	Accepted
H11	PEoU - > IU	0.040	0.438	0.662	Rejected
H12	PEoU - > PU	–0.018	0.175	0.861	Rejected
H13	PEoU - > ATU	0.145	1.705	0.089	Rejected
H14	PEoU - > PE	0.245	2.515	0.012	Accepted
H15	PC - > IU	0.191	2.078	0.038	Accepted
H16	PC - > ATU	0.245	2.044	0.042	Accepted
H17	PC - > PEoU	0.344	2.725	0.007	Accepted
H18	PE - > IU	0.025	0.251	0.802	Rejected
H19	PE - > PP	0.635	8.655	0.000	Accepted
H20	PP - > IU	0.186	1.587	0.113	Rejected

H17 ($T = 2.725$, $p = 0.007$). It is also the case with PEoU producing a positive influence on PE and therefore confirming the formulation of hypothesis H14 ($T = 2.515$, $p = 0.012$). However, the effect of PEoU on PU is no significant, and thus hypothesis H12 ($T = 0.175$, $p = 0.861$) is rejected. PU has a positive influence on PFS and PFR, and this confirms the hypotheses H6 ($T = 3.775$, $p = 0.000$) and H5 ($T = 2.349$, $p = 0.019$). However, the effect of COMP on PU is significant, so hypothesis H9 ($T = 8.991$, $p = 0.000$) is accepted. PFR has a positive influence on PFS, thereby confirming hypothesis H2 ($T = 7.185$, $p = 0.000$). Finally, PE has a positive influence on PP; we can confirm hypothesis H19 ($T = 8.655$, $p = 0.000$).

5 Conclusion, Implications and Future Research

This paper explained factors that influence the use of social networking in the workplace. The social media platform selected as Facebook and the specific professional environment was the premises of the Catholic University of Central Africa, in Yaoundé, Cameroon. To achieve this goal, a literature review on models and theories of acceptance and diffusion of technology was conducted and a theoretical model developed. Findings have shown that the intention to use Facebook is strongly influenced by the perception of connectivity associated with the attitude toward using it. Regarding our empirical model, PEoU was not confirmed ($p = 0.089$), and it appeared that PU, COMP, PFR,

PFS, PE, PP, and PEoU did not influence significantly the intention of using Facebook. Finally, the intention of using this social media platform was proved to be influenced, in order of importance, by the ATU and PC. This research work indicates a strong relation between the following: PFR and PFS; PU and PFR; PU and PFS; PU and ATU; PC and ATU; PC and PEoU; COMP and PU; PEoU and PE; and PE and PP.

Theoretically, this study presents a model justifying the use of Facebook in a specific workplace: the Catholic University of Central Africa. This model may be used for further studies, while developing a framework for factors likely to facilitate the integration and constant use of Facebook, together with other platforms to be compared with, in Cameroonian universities. In terms of information sharing, a comparative study of available social media (Facebook, Twitter, WeChat, WhatsApp, Imo, Instagram, etc.) may well be carried out in the academic milieu in Cameroon.

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Definition of Information Systems Security Policies

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Abstract. Information systems security (ISS) is crucial in all and each one of the services provided by organizations. Among security measures, policies assume a central role in literature. A lot has been said about this issue over the last years, however, the analysis of some studies conducted by different authors show that this ISS measure has not yet been institutionalized in most companies. By approaching aspects intrinsically related to ISS policies, this paper aims to contribute suggestions of some actions which might be taken to formulate and implement an ISS policy. Methodologically, the study involved interviewing the officials in charge of information systems in 21 Small and Medium Sized Enterprises (SMEs) in Portugal. The results are discussed in the light of literature and future works are identified with the aim of enabling the implementation of ISS.

Keywords: Information security · Definition of security policies · Information systems security policies

1 Introduction

Information is considered to be the most critical asset in the business world and the management of the risks associated with information must become a pattern practice within the companies [1]. Therefore, the adoption of an Information Systems Security (ISS) policy for the protection of such an asset makes total sense.

Organizations handle increasingly larger amounts of information in technological supports, which makes continuously stricter and broader security controls indispensable. The technological process may work as a catalyst for threats but is not alone enough to ensure the effective security of information.

Just as if not more important than reaching the appropriate levels of information security within each organization is being able to maintain them. Having software and hardware which contributes to the security of information is not enough. Organizations must also have a security policy and a good security management so as to firmly anchor the efforts to protect the assets of the information system [2].

In order to better understand the concept of ISS policy, it is convenient to distinguish it from concepts such as norms, directives and procedures. Table 1 shows the differences between these concepts.

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Table 1. Concepts of policy, norm, directive and procedure.

Policies – Documents which guide or regulate the actions of people or systems within the ISS domain [3].
Norms – Documents which specifically refer to the implementation technologies, methods and procedures as well as other details, with an applicability timeframe inferior to that of policies due to their higher technical nature [4].
Directives – Descriptions of specific activities and tasks.
Procedures – Descriptions of "who" executes the specific tasks as well as of "how" to execute them.

The ISS policy is a document which must contain the security recommendations, rules, responsibilities and practices to be adopted by the company so as to reach a desirable pattern of protection of the information systems. Since the security policy has to be formulated according to the company where it is going to be implemented, its drafting is a complex task which complies with a series of features and components. Regardless of the amount of literature available about this issue, the formulation of the policy represents a difficult task for the company. Therefore, its definition reveals to be paramount.

This context represents the framework of this work, in which, after this introduction, we proceed to the review of literature regarding the value and protection of information. Consecutively in Sect. 3, we focus on the risk analysis and in Sect. 4, we approach the research strategy. Finally, we present the conclusions in the light of the results obtained from the research, we identify the limitations of this study and propose future works.

2 The Value and Protection of Information

Information represents an asset which as any other important asset to business, has a value to the organization and consequently needs to be appropriately protected. Nowadays, information may be seen as a base product similar to electricity, without which many companies cannot operate [5].

The use of information pervades all aspects of the business. Most organizations need their information systems to survive and prosper. Therefore, they must act seriously to protect information [6].

As a concept, information security was developed as much in width as in depth and since it became a responsibility of the company itself, it needs the involvement of a strong management system that may determine the way to achieve the goals efficiently and coherently [7]. Information security is defined by the norm [2] as the set of procedures aiming the protection of information against several types of threats so as to ensure the continuity of business, minimize the risks and maximize the investments return as well as business opportunities.

Understanding that information is priceless to a certain organization and that the reasons to protect it are plausible, the set of procedures mentioned above must be put into practice. This set of procedures consists of nothing more than the formulation and implementation of an ISS policy in the organization.

Literature suggests a consensus as far as the importance of an ISS policy is concerned, and it is viewed by several authors as the foundation of the security effort. This observation can be confirmed by the following statements:

"… the security policy is the foundation sustaining the whole security" [8].
"… it is the cornerstone of the efficiency of information security" [9].
"… it is a crucial milestone to guide workers' behavior for the management and protection of information" [10].

Since information has currently become an essential factor for starting and maintaining a business, it needs to be protected. An efficient ISS policy represents the main basis for information security within an organization.

Information security involves technology, processes and people. The technical measures such as passwords, biometric data or firewalls are not alone sufficient to mitigate the threats to information. A combination of measures is needed in order to secure and protect information systems against potential risks or threats [11].

3 Risk Analysis

It is almost impossible to approach the issue of information security without coming across the term "Risk Analysis" or "Risk Management". Both terms are tightly related to the process of information security management, namely when it comes to organizations and institutions. They represent determining factors to the choice of security measures and controls to be implemented, varying according to the needs and goals of each organization regarding the maintenance of its information confidentiality, integrity and availability.

Similarly to what happens with information security and risk analysis, it is difficult to talk about risk analysis without bumping into some concepts related to this issue:

Vulnerability – Term usually used to define the fragility of an asset which can be explored by one or more threats [12]
Threat – A circumstance or event whose observation or occurrence translates into a set of negative impacts on a system or resource presenting one or more vulnerabilities likely to be explored by the given threat.
Impact – This concept concerns the result caused by the occurrence of a certain security event on one or more resources which normally results in direct or indirect harmful consequences to the given resources.
Risk – Potential associated with the exploration of one or more vulnerabilities of a resource (or a set of resources) by one or more threats, with a negative impact on the affected resources and consequently on the activity and business of the organization.

Risk Analysis is the name given to the process of collecting and identifying critical resources, determining the existing vulnerabilities and threats as well as their impact and probability of occurrence, and the subsequent calculation of the level of risk associated with each one of the resources.

As observed in Fig. 1, the risk analysis is conducted bearing in mind the exploration of a certain vulnerability by a threat (there is the intention, opportunity and capacity to

be a threat) which may cause a more or less negative impact on the organization and can consequently be more or less harmful.

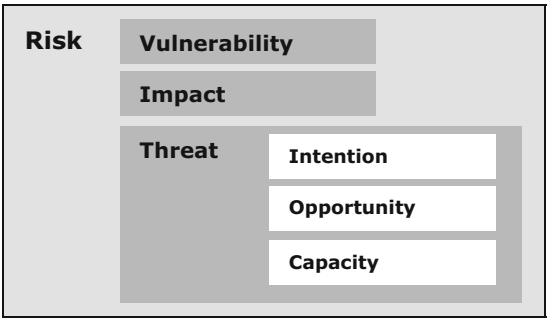

Fig. 1. Risk analysis

The risk analysis must be part of a permanent process of information security risk management capable of identifying new vulnerabilities and threats.

Such a risk analysis of the information system security is carried out in four stages [13]:

1. Risks identification – The identification of risks is achieved by acknowledging the risk context surrounding the organization. Several models can be used for this contextualization, among which we highlight the SWOT analysis (strengths, weaknesses, opportunities and threats). After this contextualization starts the identification of the elements necessary to the risk analysis: the threats, the vulnerabilities and the goods which might be in danger.
2. Risk and impact analysis – After identifying the threats, the next stage consists of characterizing risks by quantifying or qualifying the probability that those threats have of causing damage. An analysis of the impact on business must also be conducted by analyzing the critical activities for the survival of the company in case of disaster. This analysis may also be used for the creation of a business continuity plan against disasters.
3. Controls identification – The next step following the risk and impact analysis should be the identification and selection of the mechanisms allowing the reduction of the effect of the threat or damage. This identification of controls necessarily requires the definition of a structure for the information system security which must be based on a global strategy, so that the different interventions may be consistent with a global strategy, thus contributing to a higher maturity of the information system security.
4. Controls analysis – After identifying the controls, it is necessary to analyze them. The selection of the measure which will be applied results from this analysis and from the consequent reference of risk and impact. Among the several applicable measures, ISS policies are often used to protect the organizations' information systems from possible risks which may hinder their action.

One of the main priorities of the company in managing information is risk minimization, for which the organization must have a written information security policy [12]. Such a policy provides the formal guideline and intention of management regarding the protection of information in the company. It represents the structure for the definition of goals and norms to be implemented in order to mitigate risks to information [14].

4 Research Strategy

A field study was carried out through face-to-face semi-structured interviews with the officials in charge of the information systems in the Small and Medium Sized Enterprises (SMEs).

Considering the fact that this work addresses SMEs, it is essential to define this latter concept. The status of SME is defined in the Decree-Law n. 272/2007 of November 6, according to the companies' number of permanent workers, which must be under 250; the turnover, which must be under or equal to 50 million Euros; and an annual balance-sheet total which must be under or equal to 43 million Euros.

In Table 2, we present the number of workers and their representativeness within Portuguese business.

Table 2. Number of workers and percentage in 2012 in Portugal.

Type of enterprise	No. of workers	Percentage
Micro	1–9	94.6
Small	10–49	4.7
Medium sized	50–249	0.7
SME = 1+2+3	1–249	99.8

As shown in the table above, SMEs in Portugal represent 99.8% of business. Their representativeness is extremely high, which makes them deserve more attention in many respects.

In total, 21 SMEs workers were interviewed, evenly distributed among the three types, that is 7 Micro, 7 Small and 7 Medium sized companies.

As far as the process is concerned, the field study was developed through the following steps:

1. Elaborating the interview guides.
2. Elaborating the codebook.
3. Elaborating coding instructions.
4. Doing the interviews.
5. Transcribing the interviews.
6. Codifying the interviews.
7. Analyzing results.

These seven steps enabled us to carry out point 5 of this research work, in which we analyze a set of critical success factors to the implementation of an ISS policy in SMEs.

We also present a synthesis of the critical success factors to be borne in mind in each stage of the adoption process so that the whole procedure can be better understood.

5 Critical Success Factors

The development of an ISS policy is a critical activity. The credibility of the whole information security program of the organization depends on a well-drafted security policy [15].

The stages of the application process of an ISS policy in an organization (Formulation, Implementation and Adoption) are crucial to the correct adoption of a policy. However, other factors deserve all our attention as they are considered critical to the success of the ISS policy implementation.

The formulation of the policy is an indispensable element when managing information security within a company.

The policy document does not need to be very detailed, but it neither is a declaration of interests. The most important for it to be effective is to increase the awareness, understanding and commitment of all the parts involved.

The success of a policy strongly depends on its users' adoption and compliance. It is important to establish individual responsibilities for example, by clarifying who has access to a certain part of the system. For that, people must know, assume and comply with the security policy, norms and procedures in force, thus being committed to observing professional secrecy and the confidentiality of the data used in their work. They must also be committed to communicating possible security occurrences or problems they might detect with urgency and according to the established procedures.

Another aspect which is considered as a critical success factor to the good implementation is the definition of penalties for users who do not comply with the policy.

The support of the organizations' managers in the elaboration and implementation of the policies is also a critical factor essential to the success of an ISS policy. Only the involvement of all collaborators and especially the involvement of managers and heads of department will enable the achievement of a good elaboration and implementation of the policy.

ISS policies are often considered as a "live document" as they are never completed. Policies must be reviewed and if needed, updated periodically.

A policy will be of little use if it is not updated. Organizations are increasingly more dynamic and consequently, changes in structure and operating procedures occur at a fast pace. Therefore, it is necessary to adapt the policy to those new realities.

The timespan used for the review of a security policy varies from company to company. However, one thing is known, the review must be conducted whenever new facts are identified which are not accounted for in the existing version of the policy and may have an impact on security.

The policy communication and dissemination among all those who must acknowledge and observe it have also been considered paramount for the success of policies. We can easily accept that all users must know about the security policy. Although the ways to disseminate it may vary (internal memorandum, providing the policy in the

organization's Intranet or other mechanisms), it is necessary to ensure that all have been informed of the content of the policy.

It is claimed that the security process starts immediately at the stage of recruitment. Organizations should attach the ISS policy to their workers or collaborators' working contracts.

Integrating policies along with the organization's goals, processes and culture is paramount to the success of the policy implementation. ISS policies must be a constructive and protective vehicle and never a mechanism which might hinder the development of the organization's activity. For that, before formulating a policy, the goals of the company as well as its organizational processes and culture must be taken into account.

The feasibility of the policies (as far as implementation and compliance are concerned) represents another essential factor. An ISS policy will be of little or no use if its feasibility reveals to be impossible.

It is necessary to raise the awareness of the people involved towards the fact that technology is not the only element to consider. Without an ISS policy or without mechanisms of response to occurrences or business continuity plans, technologies will not be effective in the protection of information within the organization.

Another aspect to bear in mind respects the awareness of users and leaders regarding security issues. Since the human factor is pointed out as the responsible one for most security occurrences, peoples' awareness is crucial so as to allow the organizational ISS policy to produce the desired result.

As expected in all processes involving change, there is a natural resistance from people. In the particular case of information security, there is another detail which is the "misinformation on the issue". People do not easily understand, at least not initially, the real motive and need for so many controls, processes and evidences. It is not rare to see some quite varied reactions when implementing some action targeting the promotion of security.

The support of the organization board is paramount for the information security policy to be effective, thus starting any action in this direction without such support is foolhardy, to say the least.

The executive board or the people in charge of the organization must be responsible for promoting and supporting the establishment of security measures which may ensure the integrity, availability and confidentiality of their computer assets with the purpose of avoiding their possible alteration, destruction, theft, copy, forgery or any other existing threats, whether unintentional or not.

There is consensus in literature regarding the fact that the biggest threat to information security lies on careless workers who do not comply with what is established in the organizations' information security policies and procedures. Therefore, workers must not only be aware of the content of the policies but must also comply with the organization's information security policies and procedures [16].

The security policy must only be put into practice after users have been informed of its content, after they have been trained and after they have signed a declaration of commitment.

Furthermore, the provision of regular training on information security to collaborators is not only essential but it is what will actually ensure a successful application of the guidelines contained in the information security policy.

An effective and somewhat easy way to raise workers' awareness towards information security issues is to provide policies which are understandable to all the workers of the organization and which are easily available at any given time [17].

We consider these aspects to be critical success factors to the institutionalization of a security policy. For a clearer display, Tables 3, 4 and 5 present a synthesis of the critical success factors to be taken into account in each stage of the policy adoption process, according to the 21 interviews conducted in the SMEs.

Table 3. Critical success factors during formulation.

Formulation
- Risk assessment
- Defining goals for security
- Existence of political willingness
- The document must be well-drafted
- The document must not be long
- Approval of the executive board

Table 4. Critical success factors during implementation.

Implementation
- Defining the way for the document to reach users
- All users must be familiar with the document
- Explaining to users the advantages of having a policy
- Establishing responsibilities for both users and those in charge of implementing the policy
- Defining penalties
- Engagement and commitment in the implementation

Table 5. Critical success factors during adoption.

Adoption
- Monitoring compliance with the policy
- Capacity to penalize users
- Investing in users' training
- Reviewing the policy periodically
- Updating the policy
- Solving possible conflicts and difficulties in applying the security parameters

Above all, it is important to highlight that the new reality we live in as far as new information and communication technology is concerned demands higher levels of attention regarding ISS. The use of information pervades all aspects of a business

as well as of our lives. Most organizations need an information system in order to survive and thrive. Therefore, they need to be very strict in the protection of their information assets.

The institutionalization of ISS policies must become a reality within organizations, regardless of their size or of their area of business. However, due to their high number, SMEs deserve even more attention.

6 Conclusions

This study identified a set of factors which condition the adoption of ISS policies in Portuguese SMEs. Besides this contribution, this paper brought forward guidelines which are believed to enhance the institutionalization of ISS policies in SMEs in Portugal.

The ISS policy must be the guideline to be followed by a company in order to keep their most valuable information safe, whether it is essential information for the daily decision-making of the company or previously filed information.

Keeping in mind the activity of the company and whatever is required by such activity, it is convenient to formulate a policy that is clear and concise, without any rules which might not be obeyed when the policy is implemented due to the specific characteristics of the company.

Besides the implementation of an ISS policy, we also recommend its monitoring. Having an excellent security policy is not enough if it is not being adopted by the users of the system. The same happens to updating, since no matter how good the ISS policy is, it will never be an asset for the company's information security if it is not updated.

One of the limitations of this research work is related to the circumscription of the study to 21 SMEs. Although we believe that enough data was collected for the purpose of this work, we understand that a study conducted in more companies could result in a richer and more grounded set of data.

Among future works which might be undertaken, we highlight a recommendation in the form of a proposal containing the elements that an ISS policy might comprise. The aim of such a work would be to try to invert the incipient numbers of policies currently existent in companies by using the proposal as a potential model to follow.

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Simulated Environments in Architecture Education. Improving the Student Motivation

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Abstract. The increasing graphic quality and ease of use of the current generation of videogame technology compels educators to rethink how architecture students learn. This paper presents the results of an educational experience with architecture students that explored the suitability of virtual environments as an educational tool. Students explored the simulated environment of an architectural proposal and filled a survey asking whether the experience had made them reason about some fundamental qualities of space. The results revealed that the virtual environment was capable of making students reflect on the functional, formal or material qualities of architectural spaces, suggesting a new education avenue using gamification or serious games strategies.

Keywords: Architecture · Education · Gamification · Unreal engine · Virtual environments

1 Introduction

In the field of architecture, the suitability of the designs (buildings or urban environments) must be assessed before they are built, in a process that can span years. Representation technologies are used throughout the architectural design process to bring ideas into reality, allowing communication between designers, clients, contractors and collaborators [1]. Architecture students must learn to be proficient in these representation technologies throughout their studies, and must reach the point where drawing and representation blend together, and drawing becomes thinking [2]. Therefore, it is paramount that students become skillful in multiple representation technologies, and that they are capable of incorporating the latest technologies into their design process in order to better communicate their proposals, and to facilitate the critical reasoning on the spaces they conceive.

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The project presented in this article consists of an investigation at the intersection between computer sciences, the education of future architects and multimedia engineers, and the urban policies in future cities [3, 4]. One of the most innovative aspects is the incorporation of game strategies in a virtual and collaborative urban environment, aimed at improving the initial proposal. This approach incorporates the architecture students into the project in an active way, clearly enhancing their spatial and urban competences.

2 Literature Review

2.1 Games and Architectural Representation

Games are created by designers/teams of developers, and are consumed by players [5]. They are purchased, used, and eventually cast away like most other consumable goods [6]. The difference between games and other entertainment products (such as books, music, movies and plays) is that their consumption is relatively unpredictable. The string of events that occur during gameplay and the outcome of those events are unknown at the time the product is finished [7].

The gamification in classes helps to improve the connection between the material and the student. It offers the opportunity to reflect on a topic in depth and allows positive changes in behavior [8]. In this approach, learning through gaming is achieved by aligning the game mechanics with Bloom's taxonomy of learning [9], allowing learning to be classified into three domains [10]:

- Cognitive, which is taught in traditional education and implies understanding and synthesis of knowledge.
- Affective (involving emotions), which reflects the attitude toward a situation.
- Psychomotor (the physical), which is activated by requiring a union of mental and physical activity.

To encourage the use of games in learning beyond simulations and puzzles, it is essential to develop a better understanding of the tasks, activities, skills and operations that different game types can offer, and examine how these might correspond to the desired learning outcomes [11].

Using game engines for representation is beginning to gain traction in the architectural field, which until recently had been a stronghold of 3D rendering, generally producing static images and occasionally videos (as a succession of 3D renderings with scripted camera movements). With the game industry improvements in real-time hardware-assisted 3D rendering, the quality provided by game engines is quickly approaching the levels of realism of traditional offline rendering engines, while providing additional features, at a fraction of the cost.

Furthermore, real-time rendering offers one benefit that no other technology can provide: immersion, which allows the user to freely navigate the environment and interact with some of its elements (e.g. doors, lighting, avatars); this sense of presence can be enhanced when using positional audio cues and/or virtual reality (VR) head-mounted displays.

2.2 Videogames in Education

Historically, in civil and building engineering education, visualization and understanding of 3D space was typically accomplished via the classical view (physical models and drawings), in front of 3D models and using virtual specifications. This approach is changing due to a generational change and the continuous improvement and development of technology. The new systems based on VR/AR (Virtual and Augmented Reality), Geo-Referencing, and learning gamification will gradually reduce the control imposed on the designed tasks and scheduled presentations.

The current generations of students are "digital natives" [12], and Information and Communication Technologies (ICTs) are an integral part of their life. Smartphone and computer use among Spanish digital natives is very high, as well as digital communications, with over 95% of Spaniards under 35 using the Internet for personal reasons [13]. Digital natives enjoy playing videogames, and as a result spend less time consuming other audiovisual content [14]. Although players have different preferences [15], the use of game mechanics in non-game situations, or "gamification" [16] can be a powerful educational tool [17], stimulating motivation [18] through engaging elements of game-playing, although some authors [19] attribute the observed benefits not to game mechanics themselves, but to framing.

Gamification should not be confused with "serious games" [20], which use simulations [21] to provide a realistic context for training purposes. While gamification and serious games apply to game-playing in general, they are both frequently discussed in the context of videogames or videogame technology.

3 The Project: ArchGAME4CITY

The project and initial case study presented are framed within a university environment. The main hypothesis is based on demonstrating that the implementation of virtual gamification strategies in the urban design field generate an improvement in the student's spatial comprehension and motivation, not only for the contents, but also for the use of virtual technology.

This paper discusses an educational experience developed in an elective course in the Barcelona School of Architecture, introducing new technologies to architecture students: photo scanning, augmented reality (AR) on mobile devices, 3D printing and real-time rendering using videogame technology. In this course, the use of the game development platform Unreal Engine 4 (UE4) was introduced for the first time, being selected because of its cost (free for architectural visualization), graphics quality and ease of use of its node-based scripting.

The authors wanted to explore the suitability of videogame technology in architectural education, following their experiences using AR in formal education in the architecture degree [22], and on informal learning in public participation processes [23]. This course introduced different emerging technologies in the field of architecture representation. The section about real-time rendering discussed in this paper was distributed into 9 sessions following the sections about photo scanning and augmented reality, and before the section on 3D printing.

The surveys were conducted electronically using Google Forms, which allowed the students to fill them easily using any internet-connected device with a web browser at any time, an important advantage because their studies did not leave them much free time to devote to responding anonymous non-compulsory surveys. The pre-course survey was filled by 6 participants (23%) and the post-course survey by 10 (38%) and their responses were automatically collected into a Google Drive spreadsheet for later analysis. The surveys were visually divided into blocks of related questions according to their theme (questions specific to architecture, the development of the course, the example demo, motivation after the course, participant profile and satisfaction with the Unreal Engine platform). Each block had between 2 and 5 questions.

The pre-course survey questions focused on the example executable used in the first session of the course, and the post-course survey on the development of the course. Both surveys were in Spanish language. The majority of the responses used a Likert scale [24], either diverging between two opposite poles (positive, neutral and negative), or ordered sequentially. The possible responses were presented in a grid, with the shared scale ordered from low (left) to high (right) on the vertical columns and each aspect of the question in a different row. The order of the rows was automatically randomized in each survey to eliminate response order biases.

4 Results

The demo students played during the introductory class focused on visual aspects related to architecture visualization instead of gameplay: there were no competitive elements or any possibility to be harmed; the avatar walked instead of running, and materials and lighting were realistic instead of stylized. The virtual environment recreated a lot besides the building where they studied (Fig. 1).

Fig. 1. Picture of the actual building next to the barcelona school of architecture (left) and virtual environment with the renovation proposal (right).

The objectives of this demo were twofold:

- Showcase the features of the game engine applied to realistic architectural visualization, in order to encourage students to learn to use the tool after seeing its advantages.
- Explore the possibilities of using virtual environments as an educational tool in architectural education to reason about the qualities of architectural spaces.

Students were asked about the perceived usefulness of 9 different architectural representation techniques, ranging from the more traditional to the most widely used in their studies (Fig. 2).

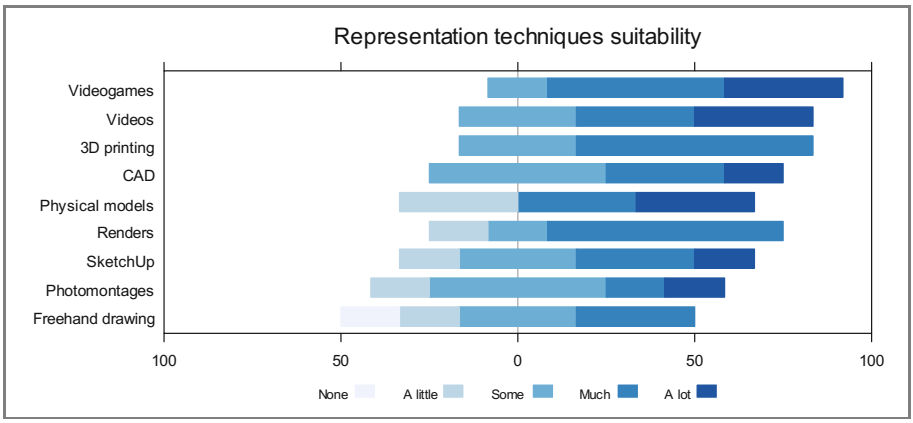

Fig. 2. Perceived usefulness of different representation techniques used in architecture.

To explore the suitability of virtual environments as educational tools to promote critical reasoning among architecture students, the participants were asked whether their experience navigating the simulation had made them reflect on several fundamental qualities of architectural design.

The results showed that, in most of the key aspects they were asked about, the interactive first person virtual experience of the environment had a positive influence on their appreciation of the qualities of the simulated space (Fig. 3 Capacity of virtual environments to promote critical reasoning on fundamental architectural education aspects).

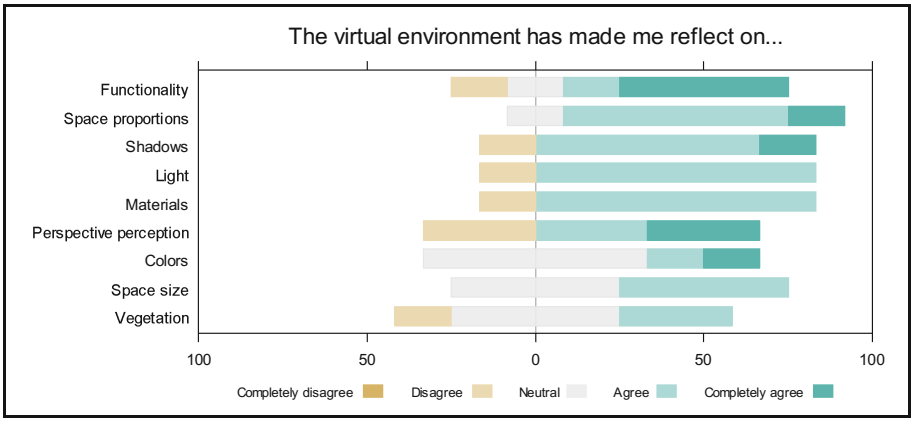

Fig. 3. Capacity of virtual environments to promote critical reasoning on fundamental architectural education aspects.

However, a small number of participants did not report any advantage in some of the aspects (brown segments in the graph), a fact that will be researched in further investigations.

In the post-course survey, two questions were designed to indirectly measure student motivation at the end of the course, asking their interest in developing their newly acquired skills and to apply them professionally (Fig. 4 Interest in further developing skills acquired in the course, specific skills (above) and professionally (below)).

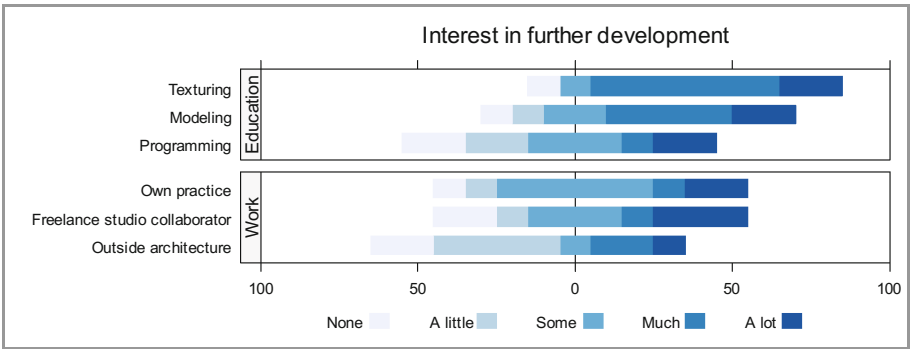

Fig. 4. Interest in further developing skills acquired in the course.

When asked about their interest in continuing their education on basic skills introduced in the course (Fig. 4), they manifested very high interest in developing texturing and modeling, while their interest in programming was more lukewarm, with only about half of them being highly interested. Their response was in line with the results of the questions about what aspects should emphasized in the next edition of the course, where texturing and modeling were highly rated, while interactivity and programming were not. Apparently, while the participants clearly manifested a high interest in the creative aspects of the technology, in the more technical skills appeared to two profiles: one very interested in the programming side of the technology and another one not interested at all.

5 Discussion and Conclusions

The main objective of the course was to introduce architecture students to videogame engines as an emerging technology in the field of architectural visualization, taking advantage of the availability of affordable (zero or low-cost) solutions that offer very high quality results and –considering their complexity–, relatively friendly user interfaces.

The surveys showed that the students were very interested in the technology before taking the course, and remained interested when they finished, a remarkable fact considering that the course was demanding in its difficulty and required a considerable time dedication. This motivation can be explained from a practical point of view because videogame technology has the potential to replace the current non-real-time rendering solutions with a cheaper alternative, providing immediate feedback when placing 3D

elements, defining materials or lighting the scene, while offering extra features like the capacity of navigating and interacting with the virtual environment, and other features like VR which will soon be supported on mobile platforms.

In addition to validating videogame technology as a representation technique, a secondary objective of the experience was to explore the suitability of virtual environments as a tool to promote critical thinking in architecture students.

The survey conducted after exploring the virtual environment showed promising results, supporting the hypothesis that virtual environments are capable of making students reflect about the functional, formal or material qualities of architectural spaces. These findings open a new avenue of educational research using serious games, where students could virtually experience different cultural and historical contexts, or be placed in a specific space, but with different roles (e.g. wheelchair-using person, child) or situations (e.g. crowded spaces, day/night cycle, weather and seasonal changes). These virtual environments should complement, and not replace, other means architectural education, such as traveling or open discussion of ideas. Furthermore, tracking the behavior in these virtual environments could be a valuable architectural research tool to conduct controlled experiments.

Tracking individual persons in public spaces is challenging; although it is possible to accurately track their movement using RFID or other technologies [25], it is technically difficult, and it raises privacy concerns when gathering data in public spaces. In areas such as economics, synthetic experiments are performed to model real situations, even though in some cases participants do not understand the rules fully [26].

The next phase of the development will include the capacity of tracking (with their consent) the users' behavior in virtual space (position and gaze along time), which will allow the application to be used as a research tool [27] to conduct controlled experiments. Also, we will implement a mixed method approach to improve the assessment methodology. This model is based on a pragmatic paradigm that contemplates the possibility of combining quantitative and qualitative methods to achieve complementary results [28]. The quantitative approach will be based on ISO 9241-11, previously used in other educational cases [4, 29], which provides usability assessment guidelines of efficiency and user satisfaction. The qualitative approach will be post-visit interviews with a representative sample of the students involved in the project, who will share their experience with the appliance of this new technology into the visit. For this final stage, Bipolar Laddering Assessment (BLA) will be used, a technique also previously validated in other educational experiments [30].

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Next Generation Access Networks: Infrastructure Sharing

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Abstract. The migration to Next Generation Access Networks (NGAN) has raised a range of issues related to building wiring and infrastructure sharing. The deployment strategies for operators and entrants are completely different. European Commission argues that infrastructure-based competition is the best and fastest way for broadband development. The arguments are that infrastructure based competition provides efficiency incentives to operators, reduces prices, increase penetration, stimulates innovation, etc. However, civil costs represent up to 80% of the total roll-out cost of NGA. The study deployed shows several broadband access infrastructure sharing solutions.

Keywords: NGA infrastructure · Broadband access networks · Infrastructure sharing

1 Introduction

The Europe 2020 strategy focus the sustainable and social inclusive economic growth. The Digital Agenda for Europe proposes fast Broadband coverage: at least 30 Mbps for 100% of EU citizens (by 2020) and 50% of EU households with subscriptions above 100 Mbps (by 2020). To achieve this objectives, the strategy is the roll out of Next Generation Access (NGA) networks (e.g. Fiber to the home FTTH networks).

European commission new directive focus on facilitate NGN roll-out by reducing deployment cost. Civil Works and Physical infrastructure, deployment of high-speed broadband networks, and by any provider of public communications networks leads to the reduction of costs by 20 to 30% and exploit synergies with utilities (energy, water, transport) [1, 2].

In this context, it is important "obliged" all the entities to give access to its own (or managed) infrastructure suitable for accommodating European Competition Network (ECNs) (Fig. 1).

The access network is usually the most expensive component in terms of capital investment (specifically passive infrastructure) and OA&M costs. Of the several costs, civil engineering costs are greatest when it is necessary to run a new fiber or copper connection to the cabinet, building, or home. Moreover, access to existing infrastructure, such as the ducts of the incumbent or other market players or sewage pipes, is critically

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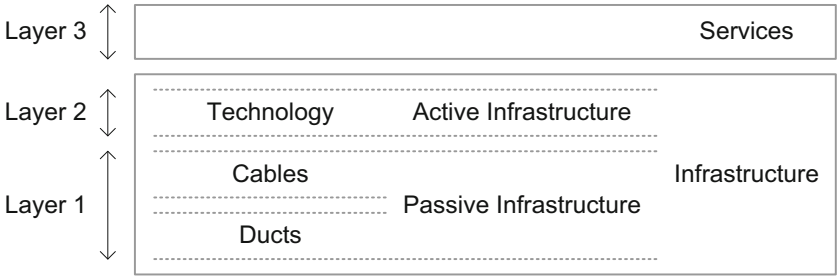

Fig. 1. Network layers [3].

important to avoid digging. For [3], a local loop network can be divided into three main layers or segments: a service layer and two infrastructure layers (see next figure). Layer 1 includes passive infrastructures, such ducts and cables, and requires the greatest investment. Layer 2 consists of active infrastructures, such as the technical installations at the end of the fibers that send, receive, and manage the optical signals. Layer 3 includes several services that consumers buy from telecommunication operators.

Andersen Management International [4] defends that an effective and sustainable infrastructure competition is superior to service competition, as it allows for head-to-head competition between operators and requires a minimal need for regulatory intervention with competitors not being reliant on the incumbent infrastructure. So, operators, especially new entrants, will have a choice as to whether they should invest in their own infrastructure (i.e. build) in order to provide services to end-users, or to seek access (buy) from an existing provider (normally the incumbent).

1.1 Infrastructure Sharing

The civil work required to deploy Next Generation Access (NGA) infrastructure is a significant part of the business case of any NGA deployment (ducts are not easily replicable), and some estimates put it as high as 80% of the overall cost [1, 5–7]. The broadband deployment cost reduction's directive (Directive 2014/61/CE) has four main pillars: Access to infrastructure, coordination of civil works, streamlining permit granting, and in-building infrastructure.

One of the solutions is provide access to exiting ducts, poles, antennas, etc. (see Fig. 2), that may lower barriers to entry and therefore support competition. However, to duct access became a viable option in the access network, it may need to be complemented by extra civil work to increase infrastructure capacity, the use of dark fiber (where available) or the use of conduits of alternative infrastructure providers.

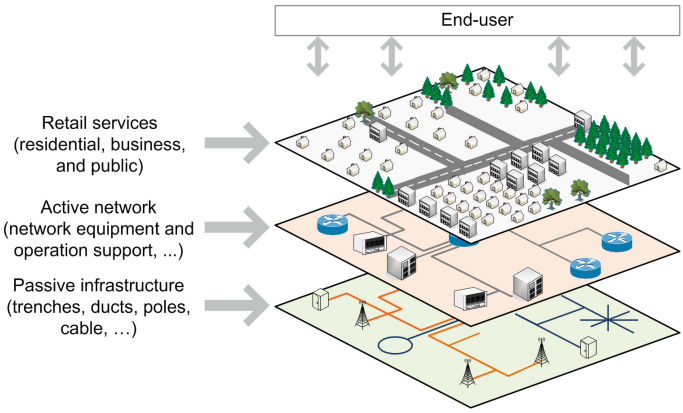

Fig. 2. Infrastructure sharing layers [7, 8].

1.1.1 Fixed Infrastructure Sharing

Overall, migration to fiber-based NGAN greatly complicates pro-competitive regulation due to both physical characteristics of the new (fiber-based) networks and the economic characteristics of the costs of deployment and, in turn, of business plans.

With regard to the key challenges of the migration to NGA for future competition and regulatory policy, it is reasonable to utilize a functional perspective and differentiate between the (1) passive infrastructure of trenches, ducts, and dark fiber, (2) active infrastructure, including lit fiber, and (3) actual service provision of retail services (see Fig. 2).

A priori business models that differ in the level of integration of these functions are possible. The challenge for competition and for competition policy will be to implement suitable forms of "open" access. The important issues related to competition for FTTC/VDSL and FTTB/H solutions are described in Table 1.

Table 1. Regulated wholesale services for VDSL and FTTH solutions [9].

FTTC/VDSL solution	FTTB/H solutions
• Unbundling of the sub-loop (network part between the street cabinet and the end user's home), • Access to or joint utilization of the cabinet, collocation at the cabinet, • Access to civil engineering infrastructure (e.g. "ducts"), • Access to the fiber access infrastructure between the newly established Metro Core Locations and the cabinets.	• Access to existing ducts - loop access to civil engineering infrastructure, • Joint establishment of trenches, ducts etc., • Access to the unbundled (dark) fiber loop, • Joint utilization of optical switching facilities (e.g. ODF), • Access to different colors in the case of WDM • Access to/joint utilization of in-house cabling.

[10] argued that service-level competition could exist over a shared FTTP network infrastructure. He added that sharing was possible at different levels and that the sharing of dark fiber required attention to the fiber layout (see Table 2).

Table 2. Sharing network infrastructure [10].

Layer	Shared infrastructure
0	Conduit and collocation facilities.
1 (Physical layer unbundling)	Dark fiber leasing, or perhaps, Optical Layer unbundling (CWDM or DWDM in PONs)
2 (Data link layer unbundling)	Dark fiber and link-layer electronics at each end. For example, Ethernet-based VLAN, or ATM-based PVCs.
3 (Network layer unbundling)	Basic network service provided. For example, IP Layer 3 service over cable using policy-based routing to multiple ISPs.

In layer 0, the owner of the trench/duct, can rent this part of the infrastructure to other operators, and receives an agreed fee from their use. The owner can (or not) also provide broadband services directly to subscribers. In layer 1, the owner (for example, incumbent operator) install for example optical dark fiber and the new operators rent the infrastructure (is required light the optical fiber). It is the customer's responsibility to install active optical equipment to light the fiber and maintain the network services [11]. To share layer 2, the infrastructure owner needs to light the optical fiber (requires active equipment), and customers are able to buy wavelengths. The service layer (layer 3) provides the capacity of network services provision (i.e., VPN, Internet, etc.).

In fixed solutions, infrastructure sharing can reduce costs because the duct is one of the most expensive components in the deployment of an NGAN. Results of studies and deployments suggest that civil infrastructure represents a large proportion of the costs of fixed access deployment. Further, they indicate that duct access or duct sharing can reduce or eliminate this capital cost and barrier to entry and may enable sustainable infrastructure-based competition in NGA [12, 13]. In the nonexistence of fiber unbundling, shared access to infrastructure ("duct access") presents a potential alternative passive remedy and provides the freedom for new entrants/competitors to innovate in their network whilst avoiding the high civil costs associated with new build. The survey performed by [5], show that overall, significant unoccupied space in the duct infrastructure was found (the overall average space in the duct-ends was 35%). Also, the results show that 51% of all duct-ends surveyed have at least 42% of unoccupied space, and that the distribution of the unoccupied space varies according to the cities/towns and sections of the network considered (more space is unoccupied in sections near the metro node, and less space is unoccupied in sections near the street cabinet).

In Portugal, the reference offer for access to ducts and associated infrastructure (known as duct access reference offer - ORAC) became, in February 2010, a regulatory obligation imposed on that operator following the finding of significant market power in the market for physical network infrastructure access. In 2008 and 2009 the government adopted measures to promote investment in NGA, focusing on access to horizontal and vertical infrastructures. The obligation of providing access to optic fiber has not yet been set out in detail. In October 2010, ICP-ANACOM (regulator) approved amendments to ORAC, in particular regarding information about duct occupation in competitive areas, conditions for accessing poles and conditions for compensation [14, 15]. Table 3 presents the duct access pricing in various countries.

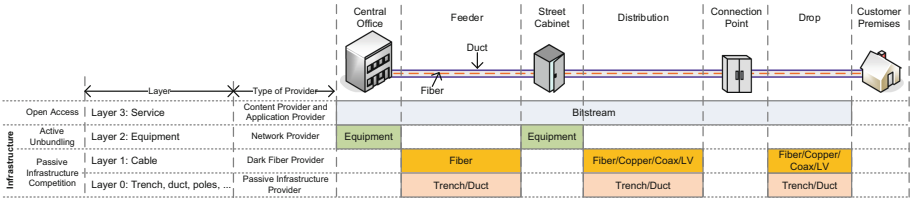

Fig. 3. Infrastructure sharing options (fixed solution).

Table 3. Duct access pricing [12].

Country	Pricing
Portugal	€7.50 - €10.60/month/km/cm2 Monthly charge for occupying sub-conduit (30 mm or 42 mm): Lisbon/Porto: €10.60/month/km/cm2 and Other municipalities: €8.30/month/km/cm2 Monthly charge for occupying a main conduit: Lisbon/Porto: €9.80/month/km/cm2 and Other municipalities: €7.50/month/km/cm2 Occupancy fees for associated infrastructure: Entry point in a footway box/manhole: €1.80/month Joint in a footway box/manhole: €3.90/month Spare cable in a footway box/manhole: €2.70/month
France	The pricing is calculated in relation to the amount of duct area that is occupied by the cable. The effective area is calculated by multiplying the cross-sectional area of the cable by 1.6. The draft price for duct access is €1.20/m/cm2.
USA	Duct: $0.50-$5.00/m/year and Pole: $5-20/year
Canada	Duct: CAN$27.00/30 m/year and Pole: CAN$9.60/year
Australia	AU$6.95/m/year

Under EC telecommunications rules, national regulators assessing an operator to have SMP in markets such as LLU (or access to the local loop) and wholesale broadband access (or bitstream access) must impose appropriate ex ante regulatory obligations [16]. LLU and wholesale broadband access allows alternative operators to enter the retail market and to offer broadband services to consumers. However, if in a particular market no operator has SMP, the regulator must define the regulatory remedies that should be imposed in order to address potential order to address potential anticompetitive behavior, prevent abuse of SMP and/or promote competition.

Several OECD countries are applying geographically disaggregated regulation. In 2007, Ofcom (United Kingdom regulator) was the first regulator in the EU to define sub-national geographic markets for wholesale broadband access and found that the incumbent did not have SMP in one of the defined local markets. Ofcom define sub-national markets and a relaxation of ex ante regulation in the most competitive areas of these markets (densely populated Central and East London Area). [17] identify four sub-national geographically segmented markets: Hull, local exchanges where Kingston Communications is the only operator (0.7% of UK premises); Market 1, local exchange

areas where only British Telecom is present (16.4% of UK premises); Market 2 - local exchange areas with 2 or 3 wholesale providers and forecasts for 4 or more, but where the exchange serves less than 10,000 premises (13.7% of U.K. premises); and Market 3 - local exchange areas with 4 or more wholesale providers and forecasts for 4 or more, but where the exchange serves more than 10 000 premises (69.2% of UK premises). For example, in Market 3, the regulator considers that there is effective competition to protect consumer interests and that regulatory obligations should be withdrawn from this market (after a transition period of one year).

In Australia, the regulatory authority (ACCC) argues that it is important that the LLU is a declared service available on a regulated basis, and for which the ACCC has signaled cost-based prices on a geographically de-averaged basis - Australia has different ULL prices for different regions with distinct pricing areas [18–20]. The Australian incumbent operator (Telstra) also defends that in several urban areas there is significant and increasing competition in access infrastructure that these areas should not be subject to ex ante regulation [21].

The Canadian NRA (CRTC) defends that facility is considered vital if it satisfies all three of the following conditions: (1) The facility is required by competitors as an input for provision of telecommunications services in a relevant downstream market; (2) The facility is controlled by a firm that possesses upstream market power such that withdrawing mandated access to the facility would likely result in a substantial lessening or prevention of competition in the relevant downstream market; and (3) It is not practical or feasible for competitors to duplicate the functionality of the facility. When services don't satisfy all three conditions or fit within the other regulatory categories should not be subject to ex ante regulation. Generally, CRTC apply wholesale regulation on the national basis and retail regulation is segmented geographically.

The study of [13] show that duct access can work relatively easily for new build, and can also work for brownfield NGA projects with case examples identified in Italy (Telecom Italia Socrate duct offering), Australia (Telstra duct offering) and in Japan (NTT obligatory and general passive infrastructure offering). The study also demonstrate that duct access is more likely to be successful for NGN and NGA where the final duct section is not required to be shared (e.g. FTTC). [22] defends the sharing of passive infrastructures (ducts, trenching,…) will be an important key.

1.1.2 Mobile Infrastructure Sharing

As the main driver to share networks is reducing network costs, that represents one-third of total expenditure, network sharing between the mobile operators in the European countries has grown in importance. For example, in UK operators have announced their intention to share some elements of their access networks [17]. The most common shared options used in mobile solutions are mast (also known as pylon or tower) sharing and co-location. Figure 3 presents the infrastructure sharing options (Fig. 4).

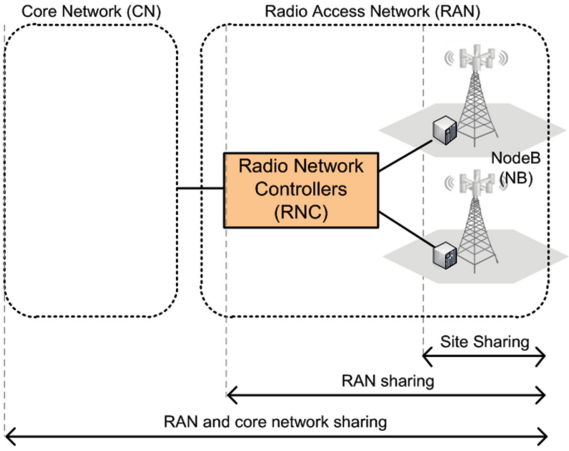

Fig. 4. Infrastructure sharing options (mobile solution).

Infrastructure sharing between multiple operators can be implemented in several ways [23]: (1) Physical infrastructure (e.g., masts and antenna systems) has been shared frequently in second-generation systems; and (2) Sharing the complete RAN and part of the core network has recently been implemented in some countries during the introduction of 3G networks (Table 4).

Table 4. Sharing network infrastructure (mobile solutions) [13, 23, 24].

Layer	Component	Description
Physical infrastructure	NodeB and co-location	Masts and antenna systems
RAN connectivity sharing	Site sharing	Only non-intelligent equipment at base station sites are shared. For example masts and power supplies, possibly also antenna systems.
	BS sharing	The BSs (and "below") are shared, but operators have their own radio network controllers and core networks.
	RAN sharing	The whole RAN is shared, but core networks are still operator specific.

2 Conclusions

In Portugal, the regulator (ANACOM) concluded in January 2009 the analysis of broadband markets, which includes the analysis of the market for wholesale (physical) network infrastructure access (including shared or fully unbundled access) at a fixed location and wholesale broadband access market [14, 25]. One of the key developments was the imposition of a cost-oriented, open and nondiscriminatory access obligation to ducts, poles and other installations of public utilities (such as highways, railways, ports,

airports, water, transport, gas and electricity), which are suitable for electronic communications networks.

Innovations in the regulatory framework are required to extend the reach of efficient platform competition. Duct sharing is an innovation that can reduce barriers to new infrastructure investment by opening bottlenecks at the lower level of the value chain. Several studies [3, 9, 13, 23, 26, 27] found that the most efficient manner of entry for a supposed fixed line network operator involves the use of existing ducts and trenches. As the cost of constructing new trenches is high, it is a good option for network operators to enter into the market by renting space in the existing ducts and/or trenches. [27] argued that new entrant operators can use trenches and ducts from the incumbent infrastructure for a price, rather than building or upgrading their infrastructure.

It is fundamental that incumbent operators provide access to the civil works infrastructure, including its ducts, and give wholesale broadband access (bitstream) to the local loop, regardless of whether it is copper-based or fiber-based. However, at the same time, alternative operators should be able to compete on the basis of the wholesale broadband input while they progressively rollout their own NGA infrastructure. In some areas, especially those with higher density, alternative operators have introduced their own infrastructure. As a result, broadband competition has developed, which should result in more innovation and better prices for consumers.

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Reaching Consensus on the Adoption of Discount and Outlet E-Commerce Platforms Through a Delphi Study

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Abstract. Discount and Outlet E-commerce Platforms (DOEP) are technologies with more and more influence in people's lives, and the literature on this subject is still somewhat scarce in relation to the proportion these platforms have today, in the context of e-commerce. In this study, the research team aims to characterize the variables that have the greatest relative importance in DOEP adoption, with the use of 25 experts related to IT and e-commerce in general. For this, a succinct literature analysis is done, in order to aggregate all the constructs that may influence the adoption of this technology. The contribution is distributed in the form of practical and theoretical implications, as well as future lines of action for possible investigations.

Keywords: e-commerce · Discount and outlet platforms · IT adoption · Delphi method

1 Introduction

Over the past decade e-commerce has evolved from a marginal and sporadic mechanism of trade involving a small number of IT enthusiasts into an economy-wide phenomenon [1]. Currently the e-commerce has been growing rapidly. Development of internet and expansion of infrastructure and technology are key drivers to exponentially increase of e-commerce value inevitably [2].

Due to an increasing saturation in their home market, the retailers have become involved in a market battle, from which the discount format emerges as one of the few formats that manages to consistently grow [3]. With this thought in mind, a new concept of e-commerce platform emerged. As we call, the Discount and Outlet E-commerce Platforms (DOEP), are platforms whose one of the great objectives is to provide competitive prices to consumers, comparing with traditional e-commerce platforms.

Focused on this concept, and based on the fact that these platforms will thus add more and more consumers and have an increasing impact on their lives, the research

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team inherent to the present study, believes that it is necessary to characterize the variables that have the greatest relative importance in DOEP adoption at individual level, since there are not enough studies that support business initiatives carried out on the basis of such platforms.

The present paper is divided into five sections, starting with an introduction section where a very brief approach to the paper's main topic is made. A second section presents the readers with a detailed perspective on the theoretical background inherent to both the relevance of topic e-commerce and DOEP already present in the literature. In third section, a comprehensive description and characterization of the proposed Delphi method is made. A fourth section was developed in order to address the results obtained in the previous section, thus generating theoretical and practical considerations. The paper finalizes with a fifth section containing some conclusions on the performed work, and on the expected future work.

2 Theoretical Framework

The existence of various e-commerce conceptualizations in the literature has led to a wide interpretation and practical application of this concept. Hence, the majority of existing conceptualizations are more concerned with directing their attention to particular research scope or uses carried out by their authors [4]. In the present study scope we adopted the conceptual view of e-commerce term defended by Ueasangkomsate [2], according to which e-commerce is "the process of buying, selling or exchanging products, services and information, through a computer network, including the internet". This as the most adequate definition that was adopted, because it is focused, linear, quite comprehensive and widely accepted by the scientific community.

DOEP platforms, which in most cases aggregate several different brands, aim to provide users with very attractive prices and purchase advantages, especially when compared to traditional e-commerce platforms. This has helped the growing DOEP's evolution, given that for the majority of customers, a small discount is enough to encourage the purchase [5].

Despite the inexistence of relevant scientific literature focused on the topic under study, it is possible to observe that the business model supported by the DOEP has been evolving besides the initial reference to the product price discounts [6]. Apart of whether actual reductions may lead to increased demand for the product, both the economy and market research suggest that the way the discount is presented and all the marketing that surrounds it, can influence consumers' perception of savings, that affect their intention to buy [7].

With this thought in mind, it is clear that the DOEPs have launched their efforts to improve their products value, by offering higher quality and branded items in the social context [8]. It should also be noted that this increase in quality doesn't imply an increase in prices, since this attribute is the basic requirement for DOEP inflows. Such requirement becomes irrelevant since it is perceived by the consumer, otherwise it will be considered extremely relevant and dangerous [9].

3 Delphi Method Applied to DOEP

In the late 1940s, Rand Corporation began developing the Delphi method, through its investigations into the processes of gathering and analyzing opinions submitted by scientific experts [10]. Currently, it is considered a unique way of developing forecast decision where no data exists, and it is an iterative and consensual approach to requesting an opinion and judgment, by a group, on a particular theme [11]. Although some aspects of Delphi evolve, its main features remain: participant anonymity, iteration, controlled feedback, and statistical aggregation of the group response [12].

Considering the literature review, and based on relatively recent studies, it was possible to conclude that in recent years the Delphi method has been widely used in the ICT area of research [13]. In our study and based on what has already been described, we established a Delphi study, with the objective of gathering, together with several specialists in the field of IST, e-commerce and online platforms, the opinion regarding the relative importance that a predefined set of variables might have to DOEP adoption at individual level.

3.1 Design and Implementation of the Delphi Study

The Delphi process consists in collecting consensual opinions from experts on a given topic of research. The way to achieve this consensus is through successive questionnaires rounds, where the experts express their opinion individually [14] (Fig. 1).

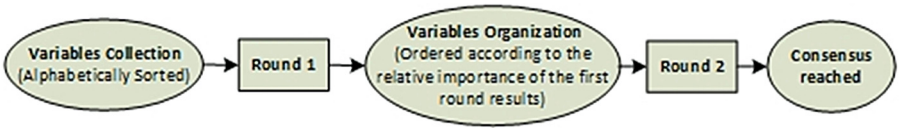

Fig. 1. Example of a two-round Delphi study workflow.

For the present research, the Delphi study first round consisted of presenting to the experts all the variables collected earlier (in the literature review stage) arranged in alphabetical order and ask them to classify the referred items according to its relative importance to DOEP adoption. Despite the various interpretations that importance may have, in the context of our investigation, relative importance has to do with the effect that any variable has on a particular action or occurrence [15].

In order to classify relative importance a 7-point Likert scale [16] was used, where the first level is assigned the classification of "Not important" and at the seventh level the classification of "Very important".

As a distribution method, a questionnaire management web platform was used, with the link to be shared via e-mail with the experts, thus ensuring the response anonymity. At the end of each round it was necessary to analyze the obtained results in order to assess if the study had reached consensus (and consequently ended) or if it was necessary to advance for another round. If a new round is required, the average rating of each variable will be used as the following round variables sorting criteria.

3.1.1 Consensus Criterion

The consensus criterion definition is fundamental in a Delphi study developing process, because it is here that the logic of obtaining knowledge is based on a common opinion. Consensus approval is a complex procedure, which must take into account the variables nature and the measurement scale used [17]. Therefore, in the data analysis, decision rules must be established in order to gather and organize the Delphi information [18]. Drawing on existing literature [19] we assumed that 80% barrier is the minimum level that should be accepted in a study of this scope.

3.1.2 Expert Group Characterization

One of the researchers' major concerns, when conducting a Delphi study is the definition of the specialists group that try to reach consensus on the research topic [20]. For the purpose of the present study, several perspectives on the "specialist" concept have been analyzed, being the one presented by Martins [21] the one aligned with our own perspectives. The referred authors claim that a specialist is someone who has great knowledge about a specific subject, in their research field.

With this concept in mind, it was then necessary to define the elements that would make up the expert's panel. Although there is no truly optimal size for the number of elements to be used in a Delphi study, according to Goluchowicz and Blind [22] groups of 13 elements already have the ability to present a response confidence level of about 0.8, and this value is not significantly extrapolated in studies with 30 or more experts.

One concern that was inseparable from the very beginning of choice panel was the elements link to areas such as ICT and IS. In Fig. 2 it is possible to visualize the specialists distribution by their expertise area and academic degree.

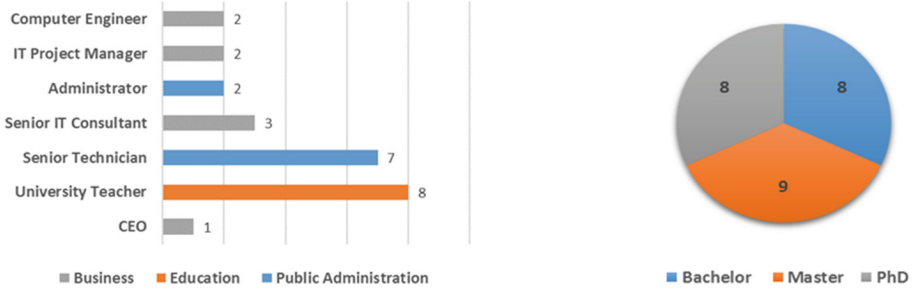

Fig. 2. Specialization areas and academic qualifications of the specialist's panel.

3.1.3 Achieved Results

For this study validation to be considered empirically relevant, the research group decided to analyze the data obtained through the use of parametric methods (average) and non-parametric methods (Kendal concordance coefficient and Spearman correlation coefficient) [23, 24]. In this section the achieved results will be presented, and a data detailed description of each individual round will be made.

3.1.3.1 Round 1 Description

After the initial round, the variables analyzed in this study were sorted according to the consensual average relative importance obtained by the experts' opinions, in regard to the relative importance of adopting DOEP, at the consumer's level. In Table 1 it is possible verify that the order at the end of the first round is very different from the one used to start the process, since this was obtained in alphabetical order. At the same time, some relevant statistical data can be verified, as the relative importance average value presented individually for each variable, and higher this value, the more impact the variable has on ongoing research.

Table 1. Data after the first round

Variables	Initial position	Round 1 position	Average
Structural assurances	11	1	6.00
Initial trust	8	2	5.96
Price	17	3	5.96
Firm reputation	19	4	5.96
Individual characteristics	2	5	5.84
Effort expectancy	10	6	5.76
Performance expectancy	9	7	5.72
Task technology fit	1	8	5.64
Task characteristics	3	9	5.64
Complexity	6	10	5.64
Facilitating conditions	7	11	5.64
Perceived technology security	15	12	5.60
Compatibility	5	13	5.58
Technology characteristics	4	14	5.48
Habit	12	15	5.44
Relative advantage	20	16	5.40
Personal propensity to trust	18	17	5.36
Observability	14	18	4.96
Social influence	13	19	4.92
Hedonic motivations	16	20	4.56

Although the statistical values analysis presented in Table 1, is important to reach the perception of answers direction to each one of the variables in question, isn't possible with these data clearly perceive the consensus degree between the two rounds. For this, the research team used the Kendall correlation coefficient and Spearman correlation coefficient, with SPSS tool. The results can be visualized in Fig. 3.

	Variables	Initial Position	1ª Round
Correlation matrix (Spearman):	Initial Position	1	0.3
	1ª Round	0.3	1
	Variables	**Initial Position**	**1ª Round**
Correlation matrix (Kendall):	Initial Position	1	0.2
	1ª Round	0.2	1

Fig. 3. Round 1 statistical analysis results.

Assuming the calculation differences of the two statistical methods referred to, both the result of the Spearman correlation coefficient (0.271) and the Kendall coefficient of agreement (0.179), returned correlation values lower than 0.3, which indicates a very low index between the variables initial ordering and the ordering resulting from the first round. From the interpretation of these values, is possible to deduce that the minimum reference (>80%) was not reached as a goal for consensus level among the specialists. Based on this indicator, it was necessary to move towards a questionnaire round with the objective of achieving a more meaningful consensus level.

Table 2. Data after the second round

Variables	Round 1 position	Round 2 position	Average
Structural assurances	1	1	6.37
Initial trust	2	2	6.04
Firm reputation	4	3	6.04
Perceived technology security	12	4	6.04
Price	3	5	5.58
Effort expectancy	6	6	5.58
Performance expectancy	7	7	5.58
Task technology fit	8	8	5.45
Complexity	10	9	5.45
Habit	15	10	5.29
Task characteristics	9	11	5.25
Compatibility	13	12	5.25
Individual characteristics	5	13	5.20
Technology characteristics	14	14	5.16
Facilitating conditions	11	15	5.12
Relative advantage	16	16	4.95
Personal propensity to trust	17	17	4.87
Social influence	19	18	4.79
Observability	18	19	4.54
Hedonic motivations	20	20	4.29

3.1.3.2 Round 2 Description

Following the process carried out in the previous round, for this round, the average scores of the relative importance to the variables under study were again calculated, and it is possible to reach a new ordering, which can be visualized in Table 2. In this table, it is also possible verify the average and the standard deviation obtained through the results as happened with the previous round, the assumption that the larger relative importance average of the presented by a variable, the greater its impact on the research concerned.

As was the case in the previous round, after a more direct observation of the responses obtained in the present round, the research team carried out a more robust statistical analysis with the aim of reaching consensus degree in the responses between the rounds. The analysis methodology was again based on the use of the Kendall correlation coefficient and the Spearman correlation coefficient. The results of this statistical analysis can be seen detailed in Fig. 4.

	Variables	1ª Round	2ª Round
Correlation matrix (Spearman):	1ª Round	1	0.9
	2ª Round	0.9	1
	Variables	**1ª Round**	**2ª Round**
Correlation matrix (Kendall):	1ª Round	1	0.8
	2ª Round	0.8	1

Fig. 4. Round 2 statistical analysis results.

As can be seen in Fig. 4, the Kendall correlation coefficient has a value of about 0.8. Regarding the Spearman correlation coefficient, it is evident that the correlation is higher than 0.8. Thus, the analysis allows us to verify the existence of consensus between the experts' answers, which according to the definition of the Delphi method itself, is sufficient criterion for the study's end, and it is possible at this moment to infer considerations about the results obtained in the next chapter of this article.

4 Discussion

Previous research on DOEP has not fully understood the various factors that might impact the adopt these platforms. To contribute to address this research gap, this study used a set of variables, gathered through a literature review to information systems and technologies adoption models, who might have an impact to the characterization of DOEP adoption process and, through a Delphi study, reached a consensual acknowledgement on what might be the most important ones to the referred platforms adoption process

4.1 Theoretical Implications

This study makes several important theoretical contributions. First, to the best of our knowledge this is an early attempt toward a holistic and integrative approach to explain

DOEP adoption. The strength of this research lies in combining the behavioral, technological and environmental determinants from various established adoption models, with literature that supports its use in e-commerce. This is evidenced by the high explanatory power of our literature review. The variables presented in this study were collected from several known adoptions models and cover a wide range of assumptions that in our view do not leave out any options that may have validity in the investigation that is carried out.

Developing an integrative research list of variables and evaluating it using a specialists group with inherent capabilities is an important step towards addressing the paucity of research in the comprehensive assessment of the social, organizational, and environmental perspectives of DOEP adoption. Our study not only addresses this important research gap but also serves to improve the awareness of the direct and indirect effects of the constructs that influence the adoption of DOEP.

Through this research, it was also possible to perceive that there isn't really an IST adoption model that can fully integrate all the factors that explain the adoption of DOEP by consumers. The study also emphasizes an often-neglected dimension, yet very relevant and profound, the trust dimension. It was very interesting to note that the variables top-3 with the highest relative importance, in our expert's opinion group, is linked to trust, all of which are incorporated in the Initial Trust Model. It is thus understood that consumer confidence is an intrinsic characteristic of the individual, which can in no way be excluded from the adoption studies.

Hence, we believe researchers initiating future studies on e-commerce platforms adoption will find this study beneficial.

4.2 Practical Implications

This research serves important practical implications to decision makers, IT departments, and marketing departments involved in the implementation and deployment of DOEP or other e-commerce platforms.

The study showed that trust and security has a very significant importance in the adoption of DOEP. Variables such as Structural Assurances, Initial Trust, Firm Reputation, Perceived Technology Security are intrinsically linked to trust, and being the services provided by these highly customizable technologies, consumers are mainly concerned with their confidentiality and security. Focused on this idea, companies and managers of these platforms should focus on establishing a relationship of trust with the customer from the beginning. Marketing campaigns have to emphasize the security policies and safeguards that are in place to prevent financial and information loss [25].

The variable that had the greatest impact was Structural Assurances, this variable is especially important where the parties concerned are involved in financial transitions via electronic channels [26]. As the technology in question is based precisely on this assumption and the essential objective of DOEP is loyalty to the service by consumers, through our study, we see the absolute necessity of providing the necessary infrastructure, both organizational and technical, in order to guarantee a perfect consumer experience. Data security, privacy and confidence guarantees, is something that companies must take into account when deciding to implement these technologies.

Although the discounts are an essential feature of these platforms, the price variable was not considered the most important factor behind the adoption process. With this in mind, companies should continue to bet as much as they can in reducing prices, since this is the characteristic that differentiates these from the other platforms.

The validation of variables such as the effort expectancy and the performance expectancy in DOEP adopting indicates that these platforms should be designed in such a way that the consumer spends the least possible effort and is able to perform the task in a simple and robust way, efficiently and conveniently, enabling users manage their tasks properly. These platforms can improve their products based on users' suggestions to better meet users' performance expectations. In addition, platforms need to run marketing campaigns to enhance users' knowledge about skills in using it.

One of the constructs that achieved a considerable RI score from our group of experts was the Task Technology Fit variable. Therefore, we consider that if users obtain services that aren't appropriate to their needs they become services of low utility, which doesn't favour technology adoption. Platforms should tailor all of their functionality to tasks that consumers perform, concentrating all efforts on developing useful solutions.

The notion of complexity associated with DOEP is, according to our study, a factor with impact on the platforms adoption. This construct, often associated with the change perception, which is known to cause discomfort and frustration, is closely linked to a lack of knowledge about some technology. The results of this research provide information for companies that make informed decisions about the DOEP adoption. In evaluating this relatively recent technology, our study emphasizes the importance of evaluating not only the organization innovation characteristics but also the environmental and individual context of its consumers.

5 Conclusions

Recognizing the DOEP potential on the e-commerce area, this study designed a comprehensive set of variables that examines a consumer's intention to adopt this technology in their day-to-day. The variables were validated by an experts group, using the Delphi method. Specifically, the variables were collected revisiting the literature in technology adoption models.

Consequently, this study occupies a unique position within the literature, regarding the DOEP adoption, since this area still shows an initial state of investigation. As these platforms present a very current and increasingly important status, the results reflected here can be seen as encouraging steps needed to fully understand the adoption of this technology, providing a solid foundation for practitioners, with valuable insights for the development and Implementation of these platforms.

The research shows that in assessing the adoption of new technologies such as DOEP, a scientific approach that takes into consideration the technology, organization, and environment contexts of the organization along with the innovation characteristics is more holistic and meaningful in provideng valuable insights to practitioners and researchers.

6 Future Work

Due to the still early stage of the study, the research team opted for this article to validate a set of constructs that characterize relative importance, according to the opinion of a panel of experts. Only with the initial realization of an investigation for this purpose could the research team advance to more concrete studies and with a broader scope of analysis, since there are already true validated by people with area credibility and contributions. Based on what has been achieved here, a solid basis of variables is consolidated in future projects, from which one can move in other directions.

Thus, the next step will be to construct an adoption model that characterizes the consumer's intention to adopt DOEP. This model will have to be validated using a more global and comprehensive sample that accurately defines all the factors that influence the adoption of this technology.

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An Initial Proposal for a Web 2.0 Information System that Supports a 360º Customer Loyalty Assurance Process in Private Healthcare Organizations

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Abstract. This study translates how the potential exists for ICT and Web 2.0 to promote and improve the quality and efficiency of the supply of health services. The segmented and personalized access to individual clinical records is considered in the context of basic support information which simultaneously facilitates an initial screening by a health professional, to all those who fit in a universe of clients and patients of Private Healthcare Organizations - PHO. The context is of excellent customized health care which builds trusting relationships with the target market. The project does however recognize barriers to this change namely by making the health system more transparent clinicians who hitherto have gone mainly unquestioned and unnoticed will subsequently possibly be subject to more scrutiny and possible judicial action in case of mal practice. Nonetheless, with this work we aim to present an initial position relative to the need for the existence of information systems which support the process of creation of customer loyalty in private organizations delivering health care services.

Keywords: Web 2.0 · Information system · Healthcare · Customer loyalty · Private healthcare organizations

1 Introduction

The Organization for Cooperative Economic Development, in a study done on information and communication technology in the health sector, states that if implemented efficiently, information and communication technology may facilitate and promote an improvement in the quality of health services delivered, as well as increasing the security in patient attendance while diminishing the costs due to the elimination of health care considered unnecessary [1, 2]. On the other hand, the health sector is challenged constantly by new surgical techniques, new medicine and therapy and surgical procedures, which are more modern, and require investment, updating and training with

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regards to professionals in the sector, it still further having to be ensured that medical processes are followed in conformity [3].

Health is a business of organized information, based on trustworthy data, and dependent on professional knowledge [4, 5]. The difficulty in the obtaining of resources, allied to the aging of the population and tendency for chronic diseases to prevail, challenges health organizations to above all optimize their current resources. So, resource management must be considered, as well as quality and efficiency, the quality of information and the integration of information systems. Gradually the importance of technology in this sector will lead to important advances. Hospitals, in turn, face very significant pressure to control costs, improve the quality of their service to the customer, avoiding wastage and, at the same time, adapting to new business models and developing health service in general focused on the patient/customer. In view of these pressures, hospitals seek to focus on business processes which are considered to be more important, using information and communication technology to promote agility [6, 7]. The adoption and use of information and communication technology in health care has been gaining relevance over time and this growth results from the fact that its use brings with it a compromise for improving the quality of health assistance while at the same time increasing the security of patients [8].

With this work we aim to present an initial position relative to the need for the existence of information systems which support the process of creation of customer loyalty in private organizations delivering health care services.

2 Web 2.0, Social Media and Health Data

2.1 Background

Currently, worldwide, organizations exist that want to move forward to the digitalizing of their businesses. In reality, for some of the executives of these organizations, the issue is essentially about technology. For others, digital is new way to get connected with current and potential customers. And still yet for others, digital represents an entirely new way to promote and make business happen. None of these definitions is necessarily correct. Albeit, the different perspectives are oftentimes responsible for tripping-up leadership teams, due to the fact that they may reflect some lack of alignment and strategic vision about where the company needs to go in this domain. This often results in fragmented initiatives or mistaken efforts which lead to the loss of opportunities, slow performance, or even false starts. Adopting and integrating the digital era requires being open and re-examining all of the ways of doing business while simultaneously analysing the whole value chain of the firm. For some organizations, this option may represent the opening of new frontiers making possible the development of entirely new businesses in adjacent categories; for others, we may be talking of the identification of new business niches in the context of their own sector [9, 10].

On the other hand, we also witness that consumers are confronted with more opportunities and more information about products and services and very quickly and increasingly more informally, with the referred-to information coming from diverse sources which can be trustworthy or not, depending on each case [11]. Whether we are discussing

a good buyer of luxury products or a controlled and demanding consumer, both currently spend much more time doing research and analysing before arriving at the decision phase. In the social media environment, we today live with an immense amount of denominations, such as for example "social bookmarks", "hashtags", and "tag clouds", which not only represent new words, but also emerging concepts and which are different from everything that was accepted as normal for organizations and users of Web technologies [12, 13].

We are thus naturally living in a digital era which is ever more dynamic. However, for many it is a question of being a confusing jungle and whose structure is everything but clear. Social networks and technologies transformed the way we communicate, and effectively modified society and the promotion of health, altering messages in the context of communication of one to many, from many to one, but also from many to many, at the same time that they reach all in real time [14]. Observing this theme from a health perspective, there are several international reports which reveal data about the behaviour of users of social networks (Facebook and Twitter currently have more than 1.5 billion users who share information on a daily basis), their diseases as well as about their attitudes concerning health, the perception and quality of health services and their information needs about health [15].

Even if this phenomenon is increasingly becoming something massive, the majority of user health data of the so-called social media users are stored, analysed, and oftentimes passed on to third parties, without the consent of users/patients. It is still curious that when in a hospital context these same patients present various fears relative to the use of their data by the same organizations which are giving them health care services, mainly fearing a violation of their privacy and indicating a significant discredit of the effective need to have data for medical and scientific research purposes [16]. On the other hand, some more recent studies indicate that, in specific circumstances, a substantial number of users exists who would consent to sharing data from their social networks with researchers and specialists. These indicators thus suggest that social networks can represent a promising path in the exploration of how patients conceptualize and communicate their specific health problems. Up until now little is known about the individual and social acceptability for the sharing of data on social networks for individual purposes of public health or for medical research and even for the building of a "Digital Health Data Bank" (DNA Banking) [17].

As with all communication pathways, social networks have advantages and problems, allowing for new voices to emerge in the social sphere, so that individuals may have such a significant presence on social networks, much as with big brands, researchers and rulers of nations. The openness of this double communication as compared to newspapers and articles gives the opportunity to connect and interact as if we were in a conference where we may directly question the researcher and the scientist.

Information may easily become available in multiple languages and adjusted to the characteristics of the group and in a low-cost format, in which case this becomes very important due to the speed of distribution, reaction and commentary which can contribute positively to the search process through interdisciplinarity. On the other hand, however, it may contribute negatively due to a loss of control, due to its democratic

nature, being able to rapidly distribute information meaning also that incorrect knowledge may be produced and shared.

Some health professionals already use social networks in order to evaluate public opinion, population studies, and the dissemination of information about health. Still, in recent studies it is possible to verify that only a small minority is currently interested in this professional space. Social networks are seen by most as being more useful in the sharing of information than in obtaining it [18]. The capacity for social networking through social networks provokes alterations in society and events associated to the Arab Spring were evidence of this, demonstrating very well how ideas can spread virally by and amongst the population without the need for personal contact and using social networks as a primary vehicle for transmitting messages.

A recent evaluation about the use of social networks by local health departments using mainly one-way communication from departments to the public shows that dialogue and involvement/commitment are growing [19].

Looking at the phenomenon of social networks from the perspective of the life cycle of a product (introduction, growth, maturity, and decline) we may infer that these are in a growth phase, so on their path to maturity we will still see much change and innovation for us to live through and experience. However, the health sector and in particular PHO should maintain special attention aimed at the opportunities that these platforms present in the context of developing one's business, naturally involving one's network of customers (current and potential).

The democratic nature which social networks present must be taken advantage of and used to its potential as concerns structural characteristics which create a new vision of digital or virtual democracy. On the other hand, it is essential that all types of security mechanisms and solutions, as well as rules for interaction and relations in this new world, be promoted, which will take on the form of traffic signage, much due to the necessity to serve the purpose of harmonizing this immense relational platform. In the context of the evolution of Web 2.0 in the core of PHO much ground needs still to be covered and the evidence of the advantages and benefits of social networks may above all bring a useful sharing of information – useful to the customer/patient, with all of the rigour and ethical and deontological criteria which needs to be in place, such as these elements help define the frontier in the process of health communication.

2.2 Perspectives on the Use of Web 2.0 in Healthcare

So as to make possible an analysis of the most varied perspectives about the utilization of technology systems associated to Web 2.0 in the health sector, we did a scientific literature review related to the theme as well as a systematization of its contributions.

In agreement with Cimino, Patel and Kushniruk [20], clinical information is generally fragmented along the treatment process in the various locations where it occurs, creating obstacles from a clinical/therapeutic point of view, from a research perspective, as well as concerning the public health impact. Electronic medical records and the Internet made possible a technical infrastructure in which clinical data is longitudinally registered which can be integrated in the various locations of treatment. According to the authors, even if the integration of information and communication technologies

(mainly of a Web nature) with the activities and processes tied to the providing of health care is more essential as time goes by, a set of variables is necessary relative to this integration concerning: comprehensibility; accessibility; interoperability; confidentiality; accountability and flexibility.

The existing literature also presents examples of usage of information systems for the management of patient medical records and in this way making information accessible in several locations, to a number of professionals and to the patient him- or herself. In agreement with Barrows and Clayton [21], the technical challenges related to the implementation of an information system to manage medical records, despite being technically challenging, and having stimulated the enthusiasm of patients, the same does not occur with, in general, the doctors, as the typical implementation of these systems is assumed as being generic and inadequate to the specific reality of each clinician or health care providing unit. In sum, the clinicians present themselves as being generally concerned with disinformation and confusion relative to the results of an information system such as this. However, this same study reveals that Pandora's Box was previously opened by laboratories which give online access to patients so that they may consult their analyses results. The same authors assumed also that a set of questions exists to be taken into account for the implementation of an information system to manage medical records: (1) Will the patients be able to utilize the platforms?; (2) Will the patients be able understand and interpret their results?; (3) Will this usage affect the doctor-patient relationship; (4) Will the architectural support of the platforms support the rapid integration of the applications?; and (5) Will an adequate but not excessive security be provided?

When we discuss the access of data by patients, security appears as a primary discussion theme due to confidentiality reasons [21, 22]. The patients to whom access is given to their electronic clinical records via the Web use them for ever longer periods and feel that this type of access may increase their understanding of their health and improving also how they communicate with health care professionals. These advantages suggest the potential of these platforms of reaping benefits from the exchange of information between doctor and patient, resulting in a better overall communication and negotiation process.

In agreement with Kellermann and Jones [23], more informatization in health care has been useful in the increase of guideline adherence, the reinforcement of vigilance of pathologies and the diminishing of medication errors. The question of privacy regarding information acquired in the treatment process is necessary for many relevant reasons – economic, psychological and social which could damage the patients when it is not protected. With well-defined precautions or restrictions digital clinical records and their subsequent sharing may include very considerable levels of security. The authors indicate that various trade-offs exist between accessibility and security of electronic medical records as compared to paper records. The goal of privacy of information raises issues of control of access (authentication and authorization of who uses the information) and the application of cryptographic protocols to transmit and store clinical data. The goal of making data available, raises questions concerning the trustworthiness of the platform, control of access and backup mechanisms used.

3 Research Opportunities

After the above analysis of the existing literature about the adoption of technology and information systems associated to management and electronic medical records, it was possible to verify that even if the advantages were recognized as concerns their integration with health care services, these systems are still not interconnected with the existing infrastructure. The information systems associated to the health sector only now are starting to develop some interoperability, even if this characteristic may represent a problem as even when two organizations acquire the same I.T. Health System, the degree of local customization is so extensive that the systems cannot communicate between themselves without interface costs. This leads to the progress of interoperability being so accentuated that it leads to speculation and the opposition of the sales people as concerns operability [24].

Are the modern technology and information systems in the health sector largely adopted? The answer continues to be no [23, 25, 26].

There is a big difference between the small hospitals in the provinces and the non-school hospitals and the school-hospital units in the big urban centres [27]. The experience with the diffusion of technological information in other industries demonstrates that the value of this content increases in direct proportion to the number of people who use them, which is the network effect which also occurred in the past with the telephone and which recently was reaffirmed by the rapid proliferation of social media applications.

Today people can quickly access and manage their online information about their personal financial situation, however this is not possible with the majority of electronic health records. To achieve a true and competitive health market the locus of control of electronic health information must change to the patient instead of staying in the hands of an individual owner. The use of technological information systems should facilitate the work of clinicians using similar interfaces. For example, automotive manufacturers offer a large variety of brands and models, but there is an important control in so far as the customer is able to drive any vehicle without instructions [28]. The I.T. Health

Fig. 1. PHO integrated services model for delivering a 360º customer service.

Systems cannot be different as regards the ease of use of this information technology [29].

The implementation of health information systems will be a significant benefit, reducing the barriers between doctors and patients (Fig. 1). Thus, a total interoperability, centred on the patient and ease of use of this type of system are critical requisites, but insufficient to ensure its potential [17, 20].

4 Proposed Methodology

Naturally the exact definition of the methodological considerations is a fundamental issue in the development of any research project. We do know, however, that when the definition mentioned above is done according to high quality parameters and scientific rigour, the execution of the activities which the researcher addresses occurs in line with the best practices developed in the knowledge area [30, 31].

As a way to focus on the research opportunities previously identified a methodological approach was defined in phases and aiming at specific objectives, which should be truly attainable and measurable. As such, and as concerns this present project, we foresee the use of a mixed research methodology [32, 33], which is seen to be the most appropriate as it will allow for the solving of two main problems: a rigorous audit of the necessary requisites to fulfil the proposed customization objectives, for the PHO as well as for customers/patients/health care consumers, with the necessary identification of the implicit needs in this process.

In practical terms, the research project will start with a qualitative approach, represented by a study using the Delphi Method. The research team will try and identify the more relevant list of characteristics and factors not only for the information systems which support the loyalty process of customers in private health care organizations as a technological solution, but also regarding adoption and incorporation across the board in the functioning of organizations. Following this, a number of interviews will be performed with members of boards of directors and with technical, business, and functional management teams of Portuguese PHO so as to validate not only the results of the previous Delphi, but also to ensure a contribution by those who are really interested in a final solution, such as the one sought for here.

After this, and via a set of approaches supported by the Design-Science methodology, the components will be identified and characterized which should constitute an architecture of a Web 2.0 information system which allows for, in a 360º perspective, a loyalty promoting process in private health care service enterprises.

5 Expected Research Contributions

The organizational culture of hospital structures, in particular PHO, should integrate relationship marketing policies which dilute the frontiers between offices, services and departments. The patient, customer or consumer is very sensitive, due to his or her state of illness, but due also to the surrounding environment, and thus easily is aware of dysfunctional systems and actors who do not communicate effectively. The concept of

health service consumer brings a relatively recent opportunity to the market, considering also here that the PHO have a head start with regards to the installed public offering, due in effect to the consolidated investment in preventive medicine.

The better 360º customer loyalty and customization program performance of the PHO, is aligned with the subsequent improvement in the gains of the management and business processes of these sectoral health organizations [34, 35]. A strong increase in the customer positioning in the value chain of these structures of health care providers is witnessed.

From the perspective of the patient, customer, and consumer of health care, the recognition of advantages and benefits of Web 2.0 in the improvement of quality of life, improvement of health and life safety will directly link to the freedom of movement and the comfort of knowing that one's most precious gift is safe and well-informed – online, 24 h a day and 365 days a year.

As the health sector increasingly comes under attack, for on the one hand spending a tremendous amount of resources in developed but aging economies, while on the other hand customers, and in particular the millennial generation, become more technologically adept and efficient, information technology needs to bring a break-through in the quality of the health service offered. Indeed, we argue that it has to do so, it is only a question of time – and the sooner the better, for all of the stakeholders involved. What needs to be in place is a decentralized system where the end consumer has considerable power over decisions concerning what is, ultimately, his or her health care situation, regarding life itself. We do understand, however, that there are barriers to change. Clinicians do not like being evaluated and a more transparent system will make this possible, as they will come under additional scrutiny. At a time when lawyers in certain developed nations (e.g., the USA and UK) actively seek to win insurance claims for their clients, for clinical mal practice, we do understand the serious issues involved with making clinical information more accessible, but still see that it is worthwhile – given the greater good of providing for a better health care system, in which more lives are saved and better quality of life ensues.

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Technologies in the Workplace – Use and Impact on Workers

Experiencing the Impact of Facebook on Work Relations

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Abstract. The use of social network web based such as Facebook and LinkedIn continues increasing. This poses challenges and opportunities to workers and organizations. This research aims understanding how workers manage Facebook invitations from co-workers and supervisors and the impact of the way how workers manage being connected with other members of their organization through this technology, namely if they start to manage personal information and adopt specific strategies and how this impacts work relationships.

Keywords: Facebook · Social networks · Personal information management · Work relationships

1 Introduction

The acceptance of companies concerning the use of technology has been increasing. In the 90s some researchers believed that organizations would find that using e-mail would reduce productivity and eventually would be removed [1]. Ten years later, similar arguments were used related with instant messaging - it was considered that it would be a way for employees to spend time and should be avoided by organizations. Currently email is a critical tool and many organizations, including managers and executives, use instant messaging [2].

The increasing use of social networking on the Internet rises the sharing of personal information and details that are easily accessible by organizations. In recruitment processes, for example, we can see the usefulness that information shared by users can have for organizations. This information, so valued by recruitment managers, allows drawing conclusions or inferences about the personality characteristics of candidates that may not be obtained by traditional methods [3]. A study conducted in Canada and the U.S. showed that 44% of recruiters would seek information from their candidates on Facebook [4]. And many users report that Facebook is a good tool to find out more about people they know recently [5].

Facebook is an online community that allows users to create and complete a profile with photos and a variety of specific personal information. This personal information is voluntarily provided by the user and usually contains information such as place of residence, marital status, political choices, interests, favorite books / movies / music and a "about me" section that may contain personal information [2, 6]. Since its inception in 2004, Facebook has been reinventing itself and creating ways to get users to filter the information they share with other members of the community. However, investigations

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show that benefits coming from using Facebook tend to compensate for perceived privacy risks [5, 7]. The most common privacy protection strategy - restricting profile visibility - is a weak mechanism. It is a quick option rather than a form of privacy protection. Specific concerns about privacy in social networks include unintentional exposure of personal information, reputation deteriorated through rumors, unsolicited contact and provocation or harassment, use of personal information by others, and piracy or identity theft, according to Boyd and Ellison (2008 cit in [5]).

Despite the benefits of approaching the professional and personal fields of employees, as reflected in the use of Facebook, there are some tensions in this overlap. People like to share information about their mood, and photos of their holidays, parties, and activities with friends despite the risks and problems associated with such large-scale sharing. The ability to build affinity and close professional relationships can diminish if personal life is hidden from co-workers [2]. Apart the tools developed by social network managers to categorize our network of contacts and filter the shared information, those actions can condition and undermine the establishment of relationships. On the other hand people want to share information with their colleagues, trusting that it won't be shared inadvertently with the public [2].

In a study by Skeels and colleagues [2] on the implications of social networking in the workplace, one participant pointed that he responded to an invitation from his boss to join his social network in a humorous way: "you can be in my group of friends on Facebook provided that nothing I say will be on my annual performance review". The participant added that he hesitates when he wants to share information about his workday on Facebook when it is being bad.

The question of using Facebook is when "people judge through the information and interests that have been posted. This becomes apparent when the line between social and professional becomes tenuous" [2, p. 6]. People from personal and professional contexts will be able to access the shared information and draw different interpretations, which may have negative consequences if interpreted in the wrong context.

As the boundaries between personal and professional contexts decrease, some strategies arise and begin to be employed by workers. Vitak and colleagues [8] revealed that workers apply different strategies, such as keeping coworkers out of their networks or restrict access to just a few trusted ones; creating multiple Facebook accounts, effectively segregating off professional contacts from the rest of their network; or even, in a conscious way, avoid sharing any content that might negatively impact their job or their relationship with coworkers.

1.1 Research Purpose

This research aims to explore in depth how Facebook is managed by workers and influences professional and personal spheres in work environment. Besides the pressure that workers may feel if invited to a co-worker's or supervisor's Facebook friends group, the study will explore how they felt when they received the invitation.

1.2 Research Questions

First Question. How do workers experience invitation to join the Facebook network of friends of colleagues and superiors?

In some organizations employees who create favorable impressions are more likely to be seen as having positive behaviors. In fact, previous studies suggest that when employees are viewed favorably, their superiors tend to focus on these aspects and reminisce about positive behaviors. However, when employees are viewed negatively, superiors also tend to remember employee behavior that is less positive [9].

Second Question. How do workers manage their impressions on supervisors and co-workers by sharing their information on Facebook?

Facebook takes a leading role in increasing understanding and intimacy [2, 10]. Finding common interests and experiences, sharing successes, frustrations, and states of humor allow you to build a sense of closeness. Keeping in touch at a simple level, according to Thompson [10, p. 3] "every little update - every small piece of social information - which is insignificant in itself, or even mundane", keeps the knowledge about personal and professional information of a large number of links, preserving the relations with a brief contact [2, 8].

Third Question. How does the perception of co-workers and supervisors about their colleagues change when they are confronted with personal information on Facebook?

The notion of personality, expressed through online contexts, now begins to become extremely relevant to interpersonal perception. Gosling and colleagues [7] suggested that digital social networks are indeed important and valid means of communicating the personality of individuals. It is important to clarify if this perception is also present in the organizational environment and if the employees make use of the information they have on social networks, namely Facebook.

2 Method

The study adopts a qualitative methodology with a phenomenological perspective since it wishes to access the experiences of workers regarding the use of Facebook on the workplace.

2.1 Participants

Data will be gathered from 20 workers, so theoretical saturation is reached [11, 12]. Participants will be from different teams in Human Resources departments of Portuguese companies from diverse sectors, by purposive sampling [11]. The choice of this group of participants was based on the importance that Human Resources take on companies, in a strategic view and also regarding the influence they can reach in the relationship between co-workers and managers [13]. Criteria for participant inclusion are: not leading a team, working with at least one coworker and a supervisor; having a Facebook profile; and being an active social network user.

2.2 Data Collection Strategy

The data will be collected using individual semi-structured interviews, organized according to the study's research questions.

In order to develop the semi-structured interview script, a first non-structured will be conducted with a member from the selected population (Human Resources professionals). This interview will identify the themes that need to be considered in the semi-structured interviews. This first non-structured interview will also provide the research with clues to the research's design itself [14]. The goal is to build a structured interview script that will guarantee obtaining consistent descriptions on the research theme, answering to the research's questions.

2.3 Procedures

Participants will be contacted by email, where information regarding the study's purpose, the interview's objective and ethical aspects will be presented.

The interviews will be conducted according to the participant's convenience. At the beginning of each interview, there will be a briefing where participants may clarify any doubts regarding the study. The interviews will be audio recorded with the participant's approval of and the interviewer will take notes during the interaction. Participants will be asked to sign an informed consent.

2.4 Data Analysis Technique

The data from interviews will be fully transcribed and returned to participants, in order to be validated. Next, content analysis technique [15] will be used to analyze the data with the support of NVivo (QSR), which will enable dealing with the technical and conceptual challenges that these types of data tend to poses to researchers [16].

The analysis will be conducted according to the model of responsive interview [14]. This model considers that interview transcripts should be prepared: the concepts, themes and events that will guide the analysis and support codding the interviews' data, in order to group what participants said about each concept, theme or event. The aim is to respond to the study's research questions by comparing the concepts and themes that emerged from the different interviews. Below the analysis process is described in more detail.

The analysis will comprise several steps, which sometimes overlap. The first of these phases is the recognition of the categories of analysis: concepts (words that represent an important idea for the purpose of the research); themes (statements and summary explanations, which may present relations between concepts); and events. After that, the interviews will be examined to clarify the meaning of specific concepts and to synthesize the different versions of those concepts, in order to organize the overall understanding of the narrative. Following this process of clarification and elaboration of categories, the interview is coded.

Given the current state of the literature on the study's subject, the system of categories will be inductive. Hence, categories will emerge during a careful reading of the interviews transcripts and interview notes, considering the study's objectives [17].

Specifically regarding the analyses, the text will be divided into units of data: blocks of information that will be analyzed together, and whose size may vary - from a sentence to a simple definition, to several paragraphs for the story of a coherent whole [14]. This means that the theme will be adopted as codding unit [15].

After codding the interviews systematically, occurs the meaning extraction from the data: it begins by clarifying and summarizing concepts and themes, grouping the information around the categories or groups of interviewees. As the items are grouped together, patterns and links between the themes are sought and a descriptive narrative of events is formed, which considers the different views analyzed. Finally, implications are sought for the results and the circumstances under which they can be applied [14].

3 Expected Results and Discussion

Given this is a qualitative research, at this point we are unable to strict delimit our expected results. Nonetheless, and considering our research questions, we expect to understand how workers manage Facebook invitations from colleagues and supervisors. We also expect to understand the emotional and behavioral impact regarding sharing information when having coworkers and supervisors as Facebook friends. We will search for implications from our results and the circumstances under which they can be applied [14].

We believe employees feel compelled to accept coworkers and supervisors from their workplace on their Facebook friends group. They should experience stress and pressure to construct their online self according to the image they want to build. Workers must be aware about the impact of the information they share on social networks, and so they will filter what they post on Facebook or develop strategies in order to avoid exposure which may be detrimental do their professional life. One of these strategies may be using Facebook tools to restrict information shared with coworkers and supervisors.

The perception and image that co-workers and supervisors construct regarding a worker may change when they become connected by Facebook profiles. That perception could change in a positive or negative perspective, since individuals develop feelings that make them become more engaged with each other or make them move away.

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Gamification in the Workplace: A Systematic Literature Review

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Abstract. Gamification has increasingly been applied to various life domains and environments, including work and the workplace. Accordingly, research on gamification has grown considerably in the past years. This study presents a systematic review of the theoretical and empirical literature produced in the past 11 years about the application of gamification to the work domain. We analyze the available literature about why gamification is important in work and human resources management, how it can be guided, and which are the examples of gamification in this domain. The systematic review was based on 35 articles, including theoretical papers, empirical (quantitative, qualitative, and mixed-methods) studies, case studies, and other types of papers (presentation of new resources for gamification). Findings are summarized in terms of the sample, country of the study, study type, main results, and gamification and work dimensions associated. The results show that research on the applications of gamification in the workplace is scarce and mostly exploratory. Most studies were conducted using quantitative methods, but with small samples and simple research designs. Although the literature suggests evidence for the usefulness and appropriateness of gamification in the workplace, there are significant limitations in the research, translating a gap between HR practitioners' concerns and academic developments in this field.

Keywords: Gamification · Work · Systematic review

1 Introduction

Whereas work and play were traditionally seen as separate, mutually dependent but exclusive spheres, and emblematic of the relationships between seriousness and playfulness, recent years have witnessed a strong phenomenon of hybridization, both in the rhetorics and in the practices of these spheres [1]. A lively debate on the increasingly blurred boundaries between work and play in a post-industrial information society (e.g., [2, 3]). has weaved together the two clashing discourses of what have been described as two opposite but mutually dependent developments of the "gameful world": "the ludification of culture" and "the cultivation of ludus". On the one hand, "practices and

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attitudes, patterns and tropes, materials and tools, languages and concepts from (digital) games and play increasingly pervade all arenas of life", whereas on the other, "artists and businesses, scholars and technologists, institutions and subcultures in turn attempt to harness and shape games and play for their own purposes" [3].

The increased merging of work and play, both as a phenomenon that is currently restructuring our societies and everyday lives in general and as a process encountered in the sphere of work in particular, give rise to new conceptions on the work-play relationship, and the implementation of gamification in the world of labour. Indeed, growing claims are being made that organizational issues are possible to be solved through games (e.g., [4, 5]): the burgeoning technological progress has been accompanied by a correspondingly expansion of game design, such that it is now capable of being utilized for organizational purposes, contributing to the trend of gamification and gamified workplaces as an innovative, strategic and effective solution to addressing contemporary problems in organizations.

In the literature, gamification has been described as the implementation of game dynamics – ludic elements or qualities – into traditionally non game-based settings, products or services, in order to improve user engagement and afford gameful experiences with non-game initiatives [3, 6, 7]). In a narrower understanding, gamified workplaces can be defined "as organizations that use gamification to transform some of their work processes into a game-like experience for the employees by applying selected principles of game design and game interaction" [5]. A gamified workplace intends to increase positive results at organizational and individual level, developing healthy organizations, with higher levels of performance associated with higher levels of individual engagement and well-being.

By changing work itself using a gameful paradigm, the argument is made that gamification is a promising strategy for promoting personal and organizational wellbeing. Although a deeper understanding of how gamification can be best used in the workplace for positive change, benefits of gamification in the workplace are pointed at increasing satisfaction, increasing positive affect at work, improving performance, encouraging work, bolstering training and recruiting [8, 9]. Three main features of the game concept, each leading to complex outcomes in the workplace, have been pointed out [10], to emphasize the benefits of gamified workplaces: *(i)* games are considered a model of engagement which, by providing a set of activities that set the player aside from the repetitiveness of the daily routine, promises to make typically boring tasks fun and merges rule based practices and significance, *(ii)* games are models of fairness, transparency and justice, both in assigning tasks and duties and in evaluating users, and *(iii)* games are taken as examples of efficient activities, leading players to search for the best possible outcome and self-improvement.

Indeed, regardless of what the reason, numerous examples of successful enterprise gamification exist [11]. Also, several possible uses of gamification in organizations are suggested, related to the improvement of work performance, work attitude, social relations, and on-boarding and training processes [12], which could be able to make the employees' experience of performing tedious and repetitive tasks more enjoyable, rise their engagement, improve their attitude towards work, and, consequently, increase their productivity and wellbeing in the workplace. In this study, we aim to review the

theoretical and empirical literature produced in the past years about the application of gamification to the work domain. The main goal of this systematic literature review is to synthesize the available literature on how the application of gamification to work is theoretically justified and can be guided, while providing evidence to clarify its benefits for human resources management.

2 Method

A review protocol has been made in which the search strategy, article selection, data extraction and data synthesis were taken into account. The Preferred Reporting Items for Systematic Reviews (PRISMA statement) has been used as a formal systematic review guideline.

2.1 Search Strategy, Data Sources and Procedure

This review is limited to articles written in English and published in the last 11 years (January 2005 to October 2016). We searched Web of Science (WoS) and Scopus databases for articles theoretically or empirically describing the applications of gamification to the work domain. In our search, we combined the terms "gamification" AND "work" as keywords for the topic (WoS), and title and abstract (Scopus). Selection of the reviews was conducted in three rounds. In the first round, we included conference papers, articles, book chapters and conference reviews. The first round of analysis consisted of the title and abstract screening, in which four reviewers screened part of the retrieved records. Each of the four reviewers (ATF, AMA, SF, and IM) screened a quarter of the records independently. Records were screened based on adequacy towards the research question. We eliminated studies that were systematic reviews and repeated entries were then identified and excluded. In the second round, a single reviewer read and integrated all results in a single document (ATF). In the third round, four reviewers (ATF, AMA, SF, and IM) analyzed quarters of the selected articles independently and the search was refined. We limited our search to articles and conference papers, excluding book chapters due to a probable higher theoretical load, which was not the main focus of this study. Repeated entries were then identified and excluded. Articles were retrieved for full examination, in order to decide for inclusion in our study. Studies that were not fully available were eliminated. We then read the studies and evaluated fit for the review's goal. At this step, we eliminated studies that presented data on the application of gamification to educational contexts and instructional processes, and that weren't related with our research question. We also eliminated articles that were not written in English. Results were compiled and two reviewers (ATF and AMA) conducted a final review considering the need for a full integration of criterion. During the process of selection, disagreements were resolved by obtaining consensus during several meetings with all reviewers.

2.2 Data Coding

After retrieving and identifying the articles that met the inclusion and exclusion criteria for this literature review, we listed the studies by year of publication and by alphabetical order of the first author's name. The articles were then coded with a number. The data table was constructed, organizing data in terms of country, sample, type of article, and main findings. The type of article was coded according to the types of papers identified by APA (2010) standards: empirical studies, literature reviews, theoretical articles, methodological articles, case studies, and other types of articles. In this case, descriptions of mobile applications or specific game resources were coded as "other types of articles".

2.3 Organization of Themes in Gamification in the Workplace Research

The content analysis of the articles was based on strategies and procedures developed by Bardin [13]. After reading each article, key sentences and general ideas were identified and translated into standardized statements (coding), which were then grouped into more abstract categories (classification), and grouped into more abstract themes (interpretation). This procedure allowed classifying each article according to its main theme(s).

3 Results

The search based on the inclusion criteria yielded a total of 586 articles. After the application of exclusion criteria (Fig. 1), we narrowed this number to a total of 35 relevant articles for the present systematic review of the literature.

Although we were looking for studies published since 2005, the oldest study we identified as fitting our research question was published in 2011 [15], indicating that gamification at work is a fairly recent research topic. The located studies included a total of 17 independent samples, ranging from 8 [16] to 3486 participants [17]. Samples tended to include a very low number of participants, except for some quantitative studies that used more robust samples (e.g., [18–21]). Gamification at work seems to be a topic that is receiving attention internationally, since the retrieved studies came from many countries from North and South-America, Europe, Asia, and Australia. Research teams from Germany [22–27] were the ones who contributed most for the topic. Most of the studies were empirical, using quantitative designs (e.g., [18–21, 25], but theoretical papers were also very frequent (e.g., [5, 28–31]). In addition, most studies were published as conference papers and only a few were published as journal articles.

The content analysis of each article lead to the identification of a structure of themes in gamification in the workplace research. The main identified theoretical dimensions were the following:

A. The Human Resource Management System associated to gamification processes: selection, talent management and selection, performance, training, practice-based innovation practices, competitive and cooperative teamwork, implementation

processes, collaborative work, knowledge management, and internal communication [16, 17, 19, 21, 27, 32–38].

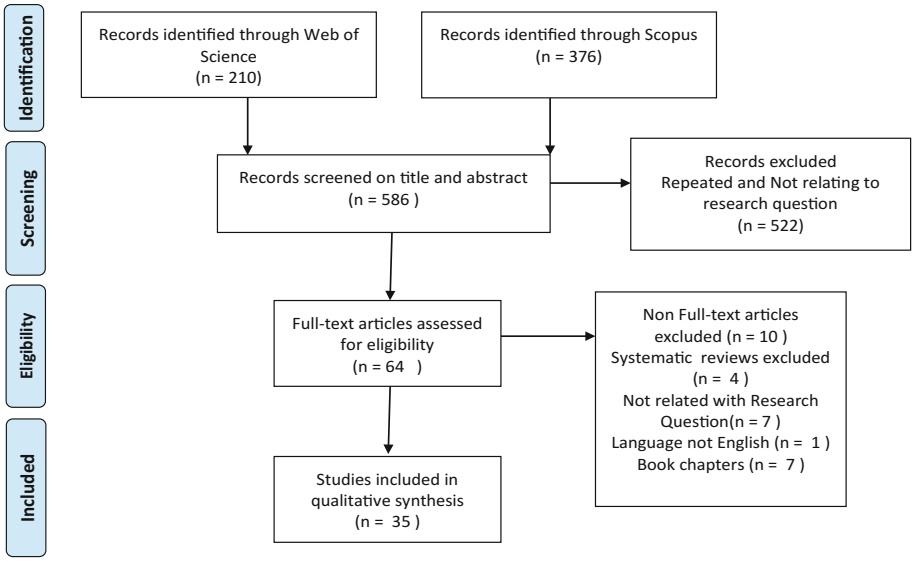

Fig. 1. Reporting items for the systematic review. Adapted [14]

B. Psychological positive dimensions associated to gamification: motivation, well-being, performance or productivity, enjoyment, engagement, emotions, stress and distress, and creativity [18, 20, 24, 26, 33, 39–42].
C. Organizational results associated with processes of gamification: productivity, team performance, and team productivity [15, 22, 23, 25, 43–45].
D. Critical approach to gamification at work [1, 5, 28–31, 46, 47].

The most common categories found in the selected studies for this review were Motivation, Training, Engagement, and Selection (by this order).

The empirical study of the application of gamification to the workplace found that gamification seems to yield high levels of motivation and engagement, [18, 26, 42] learning [21], and of performance and effectiveness in organizational implementation processes [18, 22–24]. In addition, gamification also seems to positively contribute to collaborative work and team performance [35, 38], enjoyment and well-being [20]. However, while increasing speed in performance, gamification can also lead to the production of more errors [24]. It is noteworthy to highlight that most of these studies were conducted with small samples or did not adopt pre/post-test experimental designs with control groups, therefore presenting problems for generalizability and validity of the findings.

The theoretical papers were mostly concerned with the exploration of a framework to justify the application of gamification to the work domain [10, 30, 43, 45] describing involved learning and motivation processes [27–29, 31, 45, 47]. Some theoretical papers

were also focused on the presentation of tools and guidelines for such an application [5, 27, 30, 45, 46]. Finally, we analyzed some studies that presented new apps or other online resources for gamification [34, 37, 39, 40].

4 Discussion and Conclusion

The present study aimed at collecting, organizing, and analyzing research about the application of gamification to the workplace and work domain. We retrieved very few empirical studies, some theoretical papers and brief descriptions of tools for gamification. Most literature produced in this domain is of a fairly exploratory nature, aiming to justify the utility of gamification for HR management, describing examples of experiences in this topic, or presenting guidelines for the application of gamification. Empirical studies were supported mainly on small samples and are not able to guarantee that the findings in terms of learning, engagement or efficacy are related to gamification, because the effect of exogenous variables was not controlled for or because the research design did not include comparisons with control groups or pre and post-test analysis, as well as follow-up results. Some of the studies produced have tentatively advanced in these concerns (e.g., [23, 24, 35]) but these are not the majority. Future studies should include meta-analysis, investigating the links from gamification to organizational and individual results, such as performance and wellbeing.

Our results present scarce findings regarding gamification at the workplace, suggesting that academia is having difficulties in developing integrated research, based on robust methods regarding this topic. However, industries have worked seriously on gamification and no relevant reference to this was found in our results.

The gap between science and practice is broad and relevant, which is not a new finding in academia. Considering previous literature, we selected one example to observe the gap in the translation between science and practice in the work context. Such an example was presented by Rynes, Giluk and Brown [48], who studied editorial board members' and Human Resources vice president, directors and managers' considerations about the most fundamental issues from Human Resources Research, considering what should be studied and published. Their most relevant result is that there is a very significant failure of translation in academic research to the most important practitioner media information. Science is producing relevant results and media practitioner most relevant players do not emphasize it, neither publish it. These results have impact on evidence-based [49], defined as decision making at managerial level based on critical appraisal and best available evidence that integrates scientific information on a pursue for higher levels of efficiency on applied areas [50, 51]. Considering this specific need, it is relevant for organizational psychology science to understand the industry needs, and what is relevant for them on the present moment. In 2014 leading scholars in UK were associated, as a first exercise to evaluate the impact of research outside of academic world. Their work group is named REF (Research Excellence Framework) and it was the first exercise to assess the impact of research outside of academia. Although results are broad, we can observe that industry does not follow thoroughly academic research [52].

Regarding gamification, and considering organizational psychology impact on evidence based research, industries have been leading more research than academia. In companies' websites, such as Mckinsey, Unilever, Newton, L'Oreal, Deutsche Bank, Microsoft, just to state a few, we can find that gamification is being broadly used. Organizational psychology academia has not been interested in developing new and innovative measures leaving human resource practitioners with measures with low levels of validity [46]. Considering the gap between HR practitioners and science, associated with the increase of non-academic development of new digital tools for the workplace, the study of gamification at work should focus on the development of valid and precise measures and evidence-based tested tools that companies can use to recruit and train employees. These tools, without scientific validity are worthless and can produce fake results, with a high impact on organizations development and sustainability. Due to the limitations that this literature review found, there is indeed a very high potential for applied research about gamification and work.

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Using Online Recruitment: Implicit Theories and Candidates' Profile

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Abstract. A growing number of organizations use new technologies in Human Resource processes. Online recruitment tools allow receiving job applications, a quick triage and feedback to candidates. This exploratory research aims describing perceptions regarding this tool, using interviews with organizational informants and an online survey with potential job candidates. Results from the survey show that 46% of participants already used online recruitment, most being female (71%). More than 43% of these candidates said to have taken them less than a week to get feedback from the recruiting organization. Qualitative data suggests a dominant positive appraisal of this type of recruitment (53%). It's considered a fast method and able to reach a wide audience. However, it is considered impersonal and there are some doubts regarding the control over the process and the veracity of the job ads. Organizations' should consider the advantages and disadvantages associated to this type of recruitment, in order to optimize the process.

Keywords: Online recruitment · Job candidates · Content analysis · Implicit theories

1 Introduction

Growing globalization and the use of new technologies have led to changes in the job market. It is in this changing context where new technologies have a rapid development that online recruitment arises. Online recruitment is a relative new process. It is internet based and uses tools that allow for job applications' online reception, feedback and triage [1].

Recruitment is the process of attracting a pool of candidates to a particular position. It is followed by the Selection phase. Together they comprise the Recruitment and Selection process (R&S), which is one of the most traditional areas of Organizational Psychology intervention and research.

Online Recruitment is conducted through the internet, via email or any other type of advanced communication system [2]. Its main goal is to capture the attention of those who may have the adequate profile for the job advertised. Online recruitment is much more than placing job opportunities available on the internet, it involves the use of a number of technological tools, such as the screening of candidates' resumes. It is also

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related to the need to maintain an up-to-date and efficient database that helps human resources professionals in the search for specific characteristics in candidates profiles [3]. It implies publishing job opportunities online, having an online fill-in form available for applicants and a computerized database available to store the curricula received. It may also imply using specialized selection tests, providing online feedback, and online procedures that allow eliminating candidates who do not fit the required profile. This last action already concerns the Selection phase of the R&S process.

Online recruitment happens through different platforms. Organizations may use their organizational website to inform candidates about job opportunities and they often have a permanent system for receiving applications from those interested in working at the organization, even if the organization is not hiring at the moment. In fact, organizational websites are frequently the main channel of communication between organizations and job seekers [4]. There are also several job search websites, which are dedicated to presenting job opportunities and receiving applications. These websites present a variety of job offers to which candidates may apply, submitting their resume and all the information that may be requested by the organization recruiting. They are specialized in the process of supply and demand of job offers, presenting several services aimed at jobseekers and employers.

According to literature [5] reactions of candidates to the information on the job ad are influenced by the perceived efficiency and ease of use, which refers to whether or not the candidate considers the job ad easy to understand and apply to, sending his application. The candidates' reaction is also influenced by the amount of information provided by the organization regarding the job position. Also to consider are perceptions of fairness in the process. This has to do with candidates perceiving to have equal opportunities, specifically when Online Recruitment includes stages of the Selection phase. At last, we must also consider the image that the organization portraits of herself in the internet and in the job ad itself. This may impact the satisfaction of a potential candidate, influencing his decision to apply to the job offer.

1.1 Advantages of Using Online Recruitment

Literature associates this form of recruitment with cost reduction and higher efficiency [6]. This is easy to understand given that placing ads on the internet is often cost free, while publishing a job ad in a newspaper, for example, has a cost, sometimes high. Online recruitment also allows for a considerable reduction in the amount of paper work and the possibility of quickly providing feedback to candidates [6]. Candidates' curricula (CV) can be stored and organized in digital databases, which allow selecting the ones that are most relevant to a specific job position. This makes the work of human resources' professionals easier. It should also be noted that some organizations have systems that provide an automatic feedback to the candidate, thus improving not only the recruitment process, but also the organization's image that is communicated to the candidate.

One of the advantages often mentioned of online recruitment, when compared to traditional recruitment, is the ability to overcome geographical limits, making it possible to reach distinct populations. This means it reaches many people in a matter of seconds, no matter where they are. Online recruitment also enables candidates to contact with

more job opportunities and accessing a greater flow of information [5]. The candidate can access the job ad at any time or place [6], having access to information regarding the organization that is recruiting with just a click. According to Alves [6] online recruitment is a safe procedure.

1.2 Disadvantages of Using Online Recruitment

Disadvantages of online recruitment should also be considered. One of them is the potential high number of applications that this type of processes often originates. Also, using the Internet in recruitment processes may not be as simple as it may seem. If the organization is not technologically prepared with systems that organize the data into a database, the organization may receive more curricula than desired, which can result in a waste of resources [7].

The use of online recruitment also requires a previous careful analysis of the population that the organization wishes to target, since many people still don't use internet or are familiar with this resource [8]. According to Alves [8] when online recruitment processes include selection procedures this stage of the R&S process becomes impersonal, and the contact between the employer and the candidate may be inexistent. This contact is guaranteed in traditional recruitment processes.

Our literature review informs that online recruitment remains an unknown research topic, namely regarding the characteristics of online recruitment candidates. This research aims describing existing theories regarding this Human Resource process and the profile of effective and potential candidates that use online job search process.

2 Method

An exploratory descriptive and interpretative study was conducted, having two research questions.

Research Question 1. What is the profile of candidates who use online recruitment?

Research Question 2. What are the perceptions of organizational actors and potential and effective users of online recruitment?

2.1 Participants

For Research Question (RQ) 1 and 2 we gathered data from 74 participants using a convenience snowball sample. These participants had a Median age of 28 years ($DP = 9.24$), 68% were female and 32% were male. For Research Question 2 we also gathered data from three organizational actors: two RH professionals (Median organizational tenure = one year), and an owner of an organization, also using a convenience sample. All participants are Portuguese.

2.2 Data Collection and Procedures

Data was collected using an online survey and an interview. The online survey presented four items that assessed the use of online recruitment: three close ended questions (RQ1; e.g., *Have you ever applied to an online job ad?*), the last was open ended (RQ2; *what is your opinion about online recruitment*?). The last three items on the survey asked sociodemographic data (RQ1; e.g., age). The interview (RQ2) was structured and adapted from Gomes [9].

2.3 Data Analysis

Qualitative data was subjected to qualitative thematic content analysis, according to Bardin (2009) and with the support of NVivo11 (QSR). Content analysis was used to identify participants' implicit theories regarding Online Recruitment. Quantitative data was subject to descriptive statistics using SPSS19 (IBM).

3 Results and Discussion

3.1 The Profile of Online Recruitment Candidates

Thirty four of our participants (46%) already used online Recruitment. Hence, we consider these participants as online recruitment candidates. Fifty percent of these candidates belong to the age group of 20–25 years and more than 79% hold a high degree level of education. Table 1 presents these participants' characteristics.

Table 1. Characterization of online recruitment candidates (n = 34).

	n	%	M	DP
Received feedback				
Yes	21	61,76		
No	13	38,24		
Time to feedback				
<1 week	9	42,86		
1 to 4 weeks	7	33,33		
>1 month	5	23,81		
Gender				
Female	24	70,59		
Male	10	29,41		
Age			25,95	4
Education				
PhD	1	2,94		
Master degree	3	8,82		
Bachelor degree	23	67,65		
High school	7	20,59		

Data shows that nine candidates received feedback regarding the job application in less than one week, seven had to wait one to four weeks, and for five participants it took more than one month to get feedback. This suggests that organizations that use online recruitment not always have an online system with an automatic mechanism of feedback to candidates, thus not making use of one of the advantages that is associated with this form of recruitment, specifically, its potential to contribute for a positive organizational image among the candidates, through a fast feedback.

The data suggests that the person who uses online recruitment tends to be young and holds a bachelor's or higher degree. Participants' mean age also suggests that he may be looking for his first job position. This result may reflect the fact that people who belong to this generation (generation Y) are more technological informed and competent (they are also called the generation internet), thus being more able to use this type of resource.

3.2 Perceptions Regarding Online Recruitment

Data regarding perceptions on Online Recruitment was coded at two levels: the type of appraisal underlying participants' discourse on Online Recruitment (OR) (e.g., positive or negative); and the reasoning presented by the participant.

Analyses show that 36 participants made a positive appraisal on OR; 19 made a negative one; 7 did not present a position; 1 made a neutral appraisal and 11 had a two-way appraisal, that is, they made a positive and negative appraisal simultaneously. Table 2 presents excerpts that illustrate the different type of appraisals found in the data.

Table 2. Excerpts illustrating participants appraisal on online recruitment (N = 74).

Type of appraisal	Excerpt
Positive	«*An effective way to address as many people as possible, at lower costs*» (P1)
Negative	«*Its veracity is always very uncertain*» (P5)
No position	«*For now I have no opinion*» (P19)
Neutral	«*It is normal, it reflects the daily evolution*» (P33)
Two-way	«*Interesting and essential given the new technologies. (…) However personally delivering the CV can also be beneficial*» (P27)

Note: P refers to participant.

Participants presented several perceptions regarding Online Recruitment, organized in eight implicit theories.

Online Recruitment is a facilitator of access (n = 18). We identified in the data the perception that Online Recruitment facilitates the access of job candidates to job opportunities («*One has easy access to the needs of the working world*», P16) and that this is a way for candidates to have a quicker access to the organization. We also identified the perception that this type of process facilitates the organization having access to job candidates («*organizations can reach more people and have more candidates to fill a*

*vacanc*y», P36). So the advantage is considered twofold - for the candidates and for the organizations.

Online Recruitment is fast and practical (n = 15). According to this representation Online Recruitment makes the application process quicker and practical for candidates («*it is convenient*», P16). One participant also referred himself to the fact that this process allows one to avoid what he considers to be the expenditure of time with an initial interview. Regardless of whether a first interview may be dismissed or not from an R&S process, this verbalization reveals that this participant conceptualizes Online Recruitment as a process that encompasses selection procedures.

There is a specific relational dimension to Online Recruitment (n = 14). Participants refer to the impersonal nature of R&S process globally («*It may be too technological (…) we lose the human part of the process»*), in the recruitment phase («*I registered in several websites (…) they never gave me feedback (…) after filling in they do not call or email you. This is awful (…) They mix technology with people management, but they have to pay more attention to people, we are not machines!*», P27), and also in the selection phase («*There will not be a physical application but an application like that of so many others, it will not be possible for me to stand out*» P32).

We can also see that when participants associate impersonal to Online Recruitment they tend to be thinking on the job interview, which is already part of the selection phase («*It's weird doing a Skype interview*», P8). Once again we see that despite the process being named Online Recruitment, it includes more than the procedures associated with this specific phase. This suggests that maybe we should be talking about Online R&S instead of Online Recruitment. Curious enough, the impersonal dimension of the process may also hold a positive side. In the words of one participant «*the physical aspect is unfortunately taking an increasing importance in our society, and it will be devalued through such recruitment*» (P31). Once again we see selection procedures being included on Online Recruitment. And we see that the impersonal dimension of this process may avoid the influence of the evaluator or recruiter's beliefs regarding the candidate physical appearance.

Fears regarding the safety of Online Recruitment (n = 13). Another implicit theory present in the data has to do with the veracity of the process. Specifically, participants sometimes doubt the veracity of the job offers («*provided that the organizations involved are identified and legally authorized*», P18), if the process is controlled by some entity and what use is made of the information that the candidates make available online («*it remains dangerous to share very important information on the internet regarding the candidate, which has to be well used by the organization*», P36).

Online Recruitment is cheaper (n = 6). This implicit theory states that participants consider that online recruitment is a cheaper process for organizations but also for candidates. While it is true that organizations can make their ads available on the organization's site or on a free job website, it is also true that those who are looking for a job no longer have to buy newspapers to access to job ads opportunities that in the past were necessarily published there. It also enables candidates saving money on the

documentation sent to organizations («*you reduce costs since you can present everything in curriculum and other documents in digital format*», P63).

Online Recruitment is effective (n = 5). This process is considered to be effective. Unfortunately, participants who hold this implicit theory didn't developed their perception in depth, but one participant said something that can help us understand what it might mean here to be effective: «*It is easier to filter and organize; it is less likely to lose the CV sent by the job applicant*» (P27). It is interesting to note that we had already mentioned [6] the ability of information systems used in Online Recruitment to organize applications into databases which allow for filtering candidates with specific profiles.

Its functioning needs to be enhanced (n = 3). Some participants consider that Online Recruitment still does not work in its full potential. Two participants consider this in general; the third considers specifically Portugal «*Online recruitment is a very important tool in today's world, but here in Portugal it is still much underutilized*» (P69).

Online Recruitment is an asset (n = 2). This last implicit theory was not explained or developed by the participants, but it seemed important to differentiate it from the rest. It signals that the process is useful and brings value. However, it is not clear in what terms this happens.

Participants' implicit theories reflect some of the characteristics that the scarce literature that exists on the subject associates to online recruitment, namely being a quick and cheaper process. However, it's interesting to note that there is the representation (i.e., theory) that it is impersonal. If the possibility to reach a great number of individuals can be something positive, it can also make it difficult to stand out, as seen in the discourse of participant P32, presented above. These results suggest that organizations must become aware of the existing implicit theories about recruitment, so they may minimize flaws in the process and optimize it and thus find the best talent.

Regarding the theories specific to the manager (the owner of an organization), he considers traditional recruitment as more personal, which is coherent with the theory identified in the data from survey participants. Interestingly, this organizational actor considers that the fact of having costs associated with posting a job ad on a newspaper (and the longer the job ad, the higher its price) turns the ad objective, only presenting the necessary information. Nonetheless, he is aware of the restrictions regarding the number of people one may reach when using traditional recruitment strategies; and that the possibility of reaching a wider public in a faster way is indeed an advantage. Nonetheless, he believes that traditional recruitment should not be put aside, since many candidates still use traditional channels when searching for job opportunities.

Finally, we have the HR professionals' perspective. According to them online processes are carried out within a week. Both refer to several online job platforms, namely platforms managed by colleges, which are contacted by the companies searching for candidates, in order to post job ads at their online platforms. This way the organizations are able to reach their target in a much more strategic way. They too consider online recruitment to be a cheaper and quicker strategy to conduct recruitment and it seems they consider it "the future"; that is, that companies will increasingly use online tools.

It will be interesting to see the development on the use of Online Recruitment and how Human Resource professionals and academics think and research on the topic. One also needs to understand the potential changes that may occur regarding the profile of online candidates. As *millennials* workers conquer the job market, one will probably witness an increase in this way of finding and managing talent.

4 Discussion

The rapid technological evolution of our days and the increase in the level of people who hold a high technological literacy suggest it would be important to conduct again this research in a near future, so we may see if the Online Recruitment candidate's profile evolves as well as the implicit theories that we have identified.

This research has some limitations that must be addressed. We used a convenience sample in order to answer to both our research questions. Future research should use a representative sample. Also, data should be gathered regarding the organization's sector to which candidates apply. It is probable that the use of Online Recruitment continues to increase considerably in the private sector when compared to the public sector, where the level of bureaucracy imposes a slower pace of change, making it more difficult to adopt online procedures in R&S processes. One can speculate that the use of Online Recruitment may continue to increase in private sector, but that this tendency will not be observed in the Public Sector. It would also be interesting to research this topic considering the dimension of the organization (e.g., SME, large organizations).

Future research will make it possible to understand if there are changes regarding the time to get feedback from organizations and the type of feedback that is present (more or less personalized). Research should also look at the specific phases that are included in Online Recruitment. As our results show, participants refer to procedures included in the Recruitment stage; others refer to procedures included in the next stage of R&S, which is Selection. Hence, we should try to understand the profiles of the use of Online Recruitment. This means – do organizations tend to use it to do Recruitment and sometimes Selection; or do organizations increasingly use this process not only to recruit but also to select, hence taking advantage of the functionalities of online information systems. However this may happen at the expense of important dimensions, as our participants refer, specifically, relational aspects of the process.

Considering the use of technologies and the importance of R&S process this research suggests the need to continue focusing this topic.

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Healthcare Information Systems: Interoperability, Security and Efficiency

An Ontology for Mapping Cerebral Death

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Abstract. Brain death is one of the most serious diagnoses that can be diagnosed in a patient. The possibility to detect it before its happening is one of the possible steps for the prevention of this event. The x-rays – Computed Tomography scans, are a very important test for the detection of this diagnosis. This paper proposes the use of an ontology on the registration of x-rays made to patients. This work was performed through the data provided by the Centro Hospitalar do Porto - Hospital de Santo António. The ontology was used based on an analysis made to the data and with the use of a dictionary developed in the same analysis. Finally, we added to the ontology the types of patients with brain death that were discovered in a previous work that used the dictionary that is present in this ontology.

Keywords: Ontologies · X-rays · Brain death · Text mining · Natural language processing · Predictive medicine

1 Introduction

Every day, health agencies write large numbers of clinical notes that contain information about the condition of the patients. An example of clinical notes are x-rays – Computed Tomography scans. These x-rays are very important for the detection of brain death in patients. Having said this, it is essential to create a system that automatically analyzes those x-rays in order to detect in advance if the patient will be brain-dead or not. This paper focuses on the development of an ontology focused on the x-rays Computed Tomography with the objective of organizing all the data that the doctors insert in the same ones and the identification of types of patients who have brain death after the realization of the x-ray. The ontology will also contain the types of patients who have brain death. This analysis was performed on x-rays reports on patients who died after performing the x-ray. This analysis was done with Text Mining tools. The greatest advantage of the development of this ontology is the ability to help to predict brain death before it occurs. The data used in this paper is the result of an earlier project that defined the eight types of patients that had brain death [1]. The possibility of detecting brain death in these patients is the ability to provide such patients with an alternative treatment to prevent brain death or any clinically undesirable event occurring in the patient.

This paper is divided into 5 points. In the introduction a contextualization of the theme is carried out and what is the objective of this paper. In Sect. 2, is made a point

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of the state of the art, where clinical notes and ontologies will be discussed. In Sect. 3 the ontology creation process, the components of the ontology, and the steps and decisions taken when developing the ontology are explained in detail. Section 4 discusses the work done and the objectives achieved. In this section we talk about the relevance and the effort invested in this project as well as the contribution that this will have in the scientific community as well as in a real context. Finally, Sect. 5 talks about the future work that can be done on this topic, such as an extension of the ontology created in this project.

2 Background

2.1 Health Records

An electronic medical record is computerized in a health care organization, such as a hospital, office, health center, etc. This tends to be part of an isolated system of health information system that allows the storage, collection and manipulation of medical data to reduce medical error [2]. The electronic health records contain the patient's history of illness, as well as their demographics, current health problems, usual medication, vital signs, immunizations, laboratory data, and x-ray reports. Health records automate and create patient timelines. A medical report may be created by each medical service the patient enjoys, such as radiology, laboratory, pharmacy or as a result of an administrative action. There are also medical systems that allow the capture of vital signs, nursing notes, and doctor's orders [2].

X-rays are a type of clinical notes. The x-ray used in this project are a type of clinical records that provide the information of the x-ray performed to the patient. In this work, the data collected was stored in x-ray reports.

2.2 Ontologies

Brank *et al.* [3] state that one can note that the focus of modern information systems is moving from "data processing" to "concept processing", which means that the basic processing unit is less and less an atomic piece of data and is increasingly becoming a semantic concept that carries an interpretation and exists in a context with other concepts. An ontology is usually used as a framework for capturing knowledge about a given area, providing the relevant concepts and relationships between them.

The textual analysis of data plays an important role in the construction and use of ontologies, especially with the increasing popularity of semiautomatic construction of ontologies. There are different methods of knowledge discovery that have been adopted for the problem of semi-utopian ontology construction [3], including semi-supervised and supervised visualization. One of the reasons for a level-based approach is that when Machine Learning techniques are used to construct an ontology, the envied techniques in construction are substantially different for the different levels [3]. The individual levels were defined differently by different authors [4–9], but these different definitions tend to be quite similar and generally involve the following levels: • Lexical, vocabulary,

or data layer; • Hierarchy or taxonomy; • Other semantic relationships; • Level of context; • Syntactic Level; • Structure, architecture, design.

2.3 Related Work

About the work related to the work of this project there are some projects that fall into the area where this project is carried out. Oliveira *et al.* [10], created an ontology that focused on the management of complaints made in healthcare entities. For this, a collection of the most important terms existents in the claims was organized and organized by each type of class existing in the ontology. Silva *et al.* [1], carried out a study in which he aimed to obtain information on the x-ray Computed Tomography performed on the patients who died after the x-ray In addition, a dictionary of medical terms was developed that obtained the medical terms used in these x-rays. This project was able to obtain patterns of information about patients who had brain death and these standards as well as the developed dictionary were applied in the ontology created in this study. MuthamilSelvan and Balamurugan have created a framework that can build ontologies for applications in the healthcare area [11]. The authors based on Graph Derivation Representation for the construction of the ontologies, and made several tests to evaluate the ontologies developed.

3 Creation of the Ontology

3.1 Problem Contextualization

Computed tomography x-rays are housed in the health care providers' computer system, and these are written under some form of free text making it difficult to group analysis of various clinical notes. The x-rays Computed Tomography are essential for the discovery of brain death in patients, and a rapid analysis of various x-rays may yield identifications of types of patients who have had this diagnosis. Silva *et al.* [1], as previously mentioned, carried out a study where eight types of patterns of patients who had brain death were obtained and in addition a dictionary with medical terms about these same patients was developed.

3.2 Development of the Ontology

The developed ontology obtains all the knowledge obtained by the work of Silva *et al.* [1], namely the dictionary and the types of patients who had brain death.

The data as previously mentioned contain terms used in the patients x-ray reports. These terms are incorporated in a dictionary created for the purpose, which was used to perform the interpretation of these same clinical notes. The data of the dictionary was incorporated into the ontology. After introducing all the terms in the dictionary, the eight groups that differentiated patients who had brain death were developed. These groups contain the terms included in the ontology, and this ensures the relationship between the terms of the dictionary and the types of patients identified. This ontology was constructed

with the use of the software Protégé. The Protégé is a software developed by the Stanford Center for Biomedical Informatics Research and is a resource for the construction of ontologies and knowledge bases mainly in the healthcare area.

This ontology, as can be seen in Fig. 1, took an approach to its "top-down" hierarchy, which allows in the future the addition of different types of clinical notes. The HealthRecords class is the main class of clinical notes, that is, the classes that fall within this are different types of clinical notes. One of these classes is RadiologyReports, this class is the class that stores the x-ray reports. This class is divided into several types of subclasses being one of those classes the CT_Cranioencephalic, that refers to the Computed Tomography scans. This class has two subclasses, the description class, and the Brain Death Diagnostic class. The description class contains all the data in the dictionary, that is, the relevant data on the diagnosis of x-rays to patients, and the Brain_Death_Diagnosis class has eight types of patients who had brain death. These types were discovered using the terms in the description class, that is, the two classes are directly related. The eight types of patients that had brain death are as follows:

- Diagnosis_1 (Hypodensity, Bilateral, Substance, Lacunar, Cerebellar, Left, Infarction, Crown, Island, Parietal, Ventricle, Old, Lenticulostriate-Capsular, Radiata, Subcortical, Lenticular)
- Diagnosis_2 (Pneumatized, Jaw, NasalSeptum, Bruising, Epicranial, Septum, Hypocellularized, Nasal, Thickening, Convexity, Periorbitary, Fontopolar, Mastoid, Mucous, Moderate, Ears, Average, Right)
- Diagnosis_3 (SoftTissue, Inflammation, Total, Hyperdense, Obliteration, Chronic, SphenoidSinus, Chamber, Losses, Collapse, Infectious, Reduction)
- Diagnosis_4 (Territory, Perforating, Basilar, Transependimary, Location, WithoutChanges, Ipsilateral, Branches, Artery, Brain, Area, Transudation, Tetraventricular)
- Diagnosis_5 (Craniectomy, Hyperostosis, Focal, Arm, Prior, Gray, Fronto-Basal, External, Nucleus, Recent, GrayNucleus, Caudate)
- Diagnosis_6 (Calcification, Component, Sphenofrontal, Sequel, Patent, Base, Pale, Pericerebral, Gap, Thickness, MagnumHole, Blood, Hemorrhagic, Capsular, Permeable, Air, Tomodensitometria, Evidence, Segments, Less, Cistern, Space, Hemosinus, Punctate, Possibly, Arteriosclerotic, Tonsil, Dilation, Default, Patents, Negative, CerebrallTent, Parenchyma, Correspondence, SylvanValley, Transependimary, Densitometric, Bleeding, Subarachnoid, Lesion, Protuberance, Cavernous, Losses, Leukomalacia, Extra-Axial, Central, Occipital, Hemotympanum, Collection, Density, Hematic, Interpeduncular, Horns, Perinasal, CerebellarTonsil, Changes, Tumor, Sero-Hematic, Suspicion, Occupy, Inflows, Craniotomy, Fractures, Inflow)
- Diagnosis_7 (Deviation, Ovoid, Exam, Structures, Uncus, Parietal, Hyperdense)
- Diagnosis_8 (Encephalic, Mesial, Atrophy, Temporal, Lobar, Predominance, Nervous, TemporalRight, Volume, Hinged, Increase, TemporalLobes, Hemotympanum).

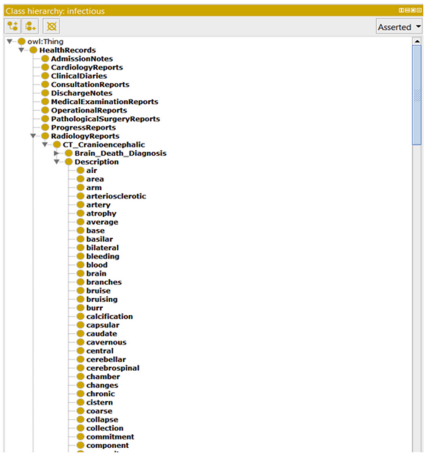

Fig. 1. Hierarchy of classes of the Ontology

The Fig. 2 shows the hierarchical form of this ontology, and the correlation existing between the subclasses description and the diagnosis of brain death.

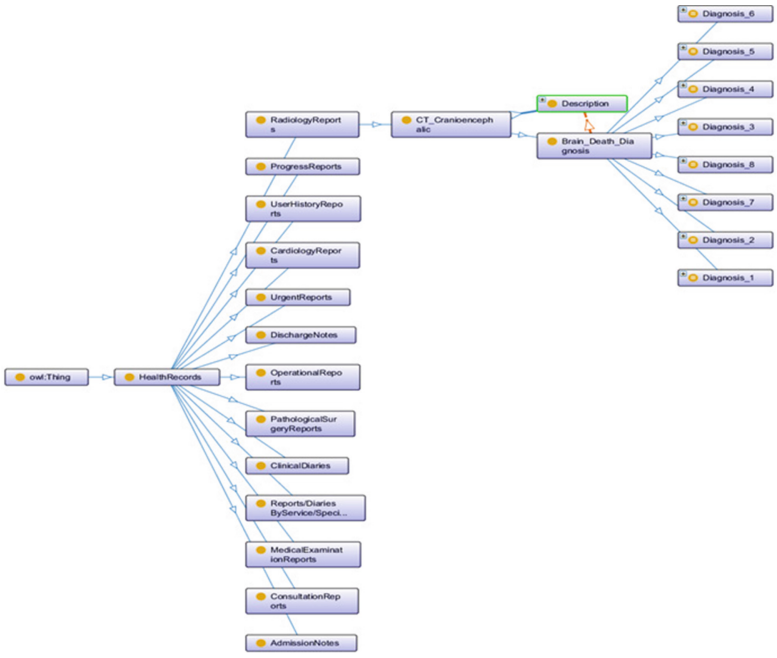

Fig. 2. Diagram of the Ontology

4 Discussion

This ontology was developed on events that take place in a real environment, namely in a hospital. This ontology followed the hierarchy of types of clinical notes and subdivided them into their more specific strands. With the development of this ontology, a better organization was obtained on the types of clinical notes existing in health institutions, since the diagram of this ontology allows to observe clearly its different types of clinical notes. In addition, the data belonging to each type of clinical note can then make connections to the type of clinical diagnosis, if a standardization study of information of these clinical notes is made. Finally, this ontology has as its main objective the implementation in a real environment. This implementation could be performed because it used real data from real environments and was hierarchized in order to be adopted by health institutions. In comparison, MuthamilSelvan and Balamurugan have created a framework that can build ontologies for applications in the healthcare area [11]. This method differs from the ontology developed in this paper because it is performed automatically. This ontology was developed in a manual way, because the dataset used in the conception of the ontology was relatively small, and this way the authors make sure that the data contained in the ontology does not contain any errors or unnecessary information.

5 Conclusion and Future Work

The ontology developed in this study is an ontology applied to x-ray Computed Tomography with the purpose of making an immediate identification of the type of diagnosis made to the patients, whether or not the brain death. This ontology complemented the previous work, and makes it easier to organize information represented in these clinical notes. One of the greatest advantages of this study is the possibility of adding content on other types of clinical notes in this ontology, since its structure allows the expansion of the ontology, which can bring different types of knowledge to the same ontology as well as complete different types of clinical notes. Thus, it can be stated that this ontology can be used in real environments, but in a phased manner, where it could be inserted as it is, adapted to the Centro Hospitalar do Porto – Hospital de Santo António. Then, later to evaluate its impact on the organization with analyzes carried out by the people working in these organizations as well as by the scientific community.

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A Case Base View of Heart Failure Predisposition Risk

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Abstract. Heart failure stands for an abnormality in cardiac structure or function which results in the incapability of the heart to deliver oxygen at an ideal rate. This is a worldwide problem of public health, characterized by high mortality, frequent hospitalization and reduced quality of life. Thus, this work will focus on the development of a decision support system to assess heart failure predisposing risk. The framework is built on top of a Logic Programming approach to Knowledge Representation and Reasoning, complemented with a Case Based approach to computing. The proposed solution is unique in itself, once it caters for the explicit treatment of incomplete, unknown, or even self-contradictory information, either in terms of a qualitative or quantitative setting. Furthermore, clustering methods based on similarity analysis among cases were used to distinguish and aggregate collections of historical data or knowledge in order to reduce the search space, therefore enhancing the cases retrieval and the overall computational process. The proposed model classifies properly the patients exhibiting accuracy and sensitivity higher than 90%.

Keywords: Heart failure · Logic programming · Case-Based reasoning · Knowledge representation and reasoning · Decision support systems

1 Introduction

Heart failure (HF) may be defined as an abnormality of cardiac structure or function, resulting in a reduced cardiac output and/or elevated intracardiac pressures at rest or during stress [1, 2]. The aetiology of HF is most commonly that of an ischaemic event, primarily affecting the left ventricle [2]. HF is a worldwide problem of public health, characterized by high morbidity and mortality [3]. HF is the most common cause of

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hospitalization, with high coasts to the healthcare system, with a higher prevalence in patients over 70 years old [2, 4–6].

HF is an inherited or acquired clinical syndrome characterized by typical symptoms (e.g., breathlessness or dyspnoea, palpitations or fatigue) that may be accompanied by elevated jugular venous pressure, pulmonary or valvular hypertension or muscle fibrillation and peripheral oedema, caused by a structural and/or functional cardiac abnormality of left ventricle [1, 4]. Diagnostic testing will usually include an ElectroCardioGram (ECG), chest X-ray and transthoracic echocardiography. The ECG is sensitive but very non-specific, while the echocardiogram is the determinant test in the diagnosis of heart failure [1, 2, 5].

The definition of HF restricts patients with asymptomatic structural or functional cardiac abnormalities, such as systolic or diastolic left ventricular dysfunction, which are precursors of HF [1, 7]. Symptoms and sings may be particularly difficult to identify and interpret in obese individuals, in the elderly and in patients with chronic lung disease [1, 4]. Additionally, patients with non-cardiovascular pathologies such as (e.g. anaemia, renal, pulmonary or hepatic disease) may have symptoms similar to those of HF and each symptom may intensify the manifestation of this pathology [1, 3]. Thyroid dysfunction is present in 5% to 10% of the population with HF [8].

For a correct diagnosis of HF it is mandatory evaluate some plasma biomarkers, namely B-type Natriuretic Peptide (BNP) and its N-Terminal fragment (NT-proBNP). Plasma concentrations of NT-proBNP are elevated in patients with left ventricular dysfunction (systolic or diastolic) and are frequently used to aid in the diagnosis of clinical HF [9]. However, these concentrations increase with increasing age. A low value (i.e., < 300 pg/ml) means low propensity for HF independently of age. Conversely, a high value, (i.e., > 450 pg/ml for ages under 50 years old, > 900 pg/ml for age ranging between 50–75 years old and > 1.800 pg/ml for age higher than 75 years old) stands a high propensity for heart failure [9]. Others plasma biomarkers may be useful for the diagnosis of related clinical manifestation, e.g., Troponin, Hemoglobin, Thyroid-Stimulating Hormone (TSH), Urea, Creatinine, Glomerular Filtration Rate (GFR), just to name a few [1, 3, 10].

Solving problems related to the early detection of HF requires a proactive strategy able to take into account all these factors, where the available data can be incomplete, self-contradictory and even unknown. In order to overcome these difficulties, the present work reports on the founding of a not common approach to *Knowledge Representation and Reasoning* [11], complemented with a *Case Based* (*CB*) attitude to computing [12, 13]. *CB* provides the ability to solve new problems by reusing knowledge acquired from past experiences [12, 13], i.e., *CB* is used especially when similar cases have similar terms and solutions, even when they have different backgrounds [14]. Its use may be found in many different arenas, namely in *Online Dispute Resolution* [14] or *Medicine* [15, 16].

This paper involves six sections. In the former one a brief introduction to the problem is made. Then the proposed approach to Knowledge Representation and a *CB* view to computing are introduced. In the fourth and fifth sections it is assumed a case study and presented an answer to the problem. Finally, in the last section the most relevant conclusions are described and possible directions for future work are outlined.

2 Knowledge Representation and Reasoning

Many approaches to Knowledge Representation and Reasoning have been proposed using the *Logic Programming* (*LP*) epitome, namely in the area of *Model Theory* [17, 18] and *Proof Theory* [11, 19]. In the present work the *Proof Theoretical* approach in terms of an extension to the *LP* language is followed. An *Extended Logic Program* is a finite set of clauses, given in the form:

$$
\begin{aligned}
&\{\\
&\quad \neg p \leftarrow not\ p, not\ exception_p\\
&\quad p \leftarrow p_1, \cdots, p_n, not\ q_1, \cdots, not\ q_m\\
&\quad ?\,(p_1, \cdots, p_n, not\ q_1, \cdots, not\ q_m)\ \ (n, m \geq 0)\\
&\quad exception_{p_1}\\
&\quad \ldots\\
&\quad exception_{p_j}\ \ (0 \leq j \leq k)\ \ \ being\ k\ an\ integer\ number\\
&\}:: scoring_{value}
\end{aligned}
$$

where the first clause stand for predicate's closure, "," denotes "*logical and*", while "*?*" is a domain atom denoting falsity, the p_i, q_j, and p are classical ground literals, i.e., either positive atoms or atoms preceded by the classical negation sign ¬ [11]. Indeed, ¬ stands for a strong declaration that speaks for itself, and *not* denotes *negation-by-failure*, or in other words, a flop in proving a given statement, once it was not declared explicitly. Under this formalism, every program is associated with a set of abducibles [17, 18], given here in the form of exceptions to the extensions of the predicates that make the program, i.e., clauses of the form:

$$exception_{p1}, \ldots, exception_{pj}\ (0 \leq j \leq k),\ being\ k\ an\ integer\ number$$

that stand for data, information or knowledge that cannot be ruled out. On the other hand, clauses of the type:

$$?\big(p_1, \ldots, p_n,\ not\ q_1, \ldots, not\ q_m\big)(n,\ m \geq 0)$$

also named *invariants*, allows one to set the context under which the universe of discourse has to be understood. The term $scoring_{value}$ stands for the relative weight of the extension of a specific predicate with respect to the extensions of peers ones that make the inclusive or global program.

2.1 Quantitative Knowledge

Aiming to set one's approach to knowledge representation, two metrics will be set, namely the *Quality-of-Information* (*QoI*) and the *Degree-of-Confidence* (*DoC*). The *QoI* of a logic program should be understood as a mathematical function that will return a truth-value ranging between 0 and 1, once it is fed with the extension of a given predicate, i.e., $QoI_i = 1$ when the information is *known* (*positive*) or *false* (*negative*) and $QoI_i = 0$ if the information is *unknown,* where the "*i*" denotes the term or clause "*i*" in a predicate's extension. For situations where the extensions of the predicates that make the program also include *abducible* sets, its terms (or clauses) present a $QoI_i \in]0, 1[$ [20].

The DoC, in turn, stands for one's confidence that the argument values or attributes of the terms that make the extension of a given predicate, having into consideration their domains, are in a given interval [21]. The DoC is figured using $DoC = \sqrt{1 - \Delta l^2}$, where Δl stands for the argument interval length, which was set to the interval [0, 1], since the ranges of attributes values for a given predicate and respective domains were normalized using $\left(Y - Y_{min}\right) / \left(Y_{max} - Y_{min}\right)$
where the Y_s stand for themselves [21].

Thus, the universe of discourse is engendered according to the information presented in the extensions of such predicates, according to productions of the type:

$$predicate_i - \bigcup_{1 \leq j \leq m} clause_j(((Ax_1,\ Bx_1)(QoIx_1, DoCx_1)), \ldots \\ \ldots, ((A_{xn}, B_{xn})(QoI_{xn}, DoC_{xn}))) :: QoI_j :: DoC_j$$

where $\cup$, m and n stand, respectively, for *set union*, the *cardinality* of the extension of $predicate_i$ and the number of attributes of each clause [21]. The subscripts of *QoIs* and *DoCs*, x_1, …, x_n, stand for the attributes values ranges.

2.2 Qualitative Knowledge

In present study both qualitative and quantitative data/information/knowledge are present. Aiming at the quantification of the qualitative part and in order to make easy the understanding of the process, it will be presented in a graphical form. Taking as an example a set of *n* issues regarding a particular subject (where there are *k* possible choices (e.g., *absence*, *low*, …, *high* and *very high*), let us itemized an unitary area circle split into *n* slices (Fig. 1). The marks in the axis correspond to each of the possible options. If the answer to issue 1 is *high* the area correspondent is $\pi \times \left(\sqrt{\frac{k-1}{k \times \pi}}\right)^2 \Big/ \text{n}$, i.e., $(k-1)/(k \times n)$ (Fig. 1(a)). Assuming that in the issue 2 are chosen the alternatives *high* and *very high*, the correspondent area ranges between $\left[\pi \times \left(\sqrt{\frac{k-1}{k \times \pi}}\right)^2 \Big/ n,\ \pi \times \left(\sqrt{\frac{k}{k \times \pi}}\right)^2 \Big/ n\right]$, i.e., $\left[(k-1)/(k \times n),\ k/(k \times n)\right]$ (Fig. 1(b)). Finally, in issue *n* if no alternative is ticked, all the hypotheses should be

considered and the area varies in the interval $\left[0,\ \pi \times \left(\sqrt{\frac{k}{k \times \pi}}\right)^2 \Big/ n\right]$, i.e., $[0,\ k/k \times n]$ (Fig. 1(c)). The total area is the sum of the partial ones, i.e., $[(2 \times k - 2)/(k \times n),\ (3 \times k - 1)/(k \times n)]$ (Fig. 1(d)). In some situations similar responses to different issues have opposing impact in the subject in consideration. For example the assessment of healthy lifestyle includes issues like physical exercise practices and smoking status. The response *high* to the former issue has a positive contribution for healthy lifestyle, while the same response to smoking status has a negative one. Thus, the contribution of the items with negative impact on the subject in analysis is set as $k/k \times n$ minus the correspondent area, i.e., $(k/(k \times n) - (k-1)/(k \times n)) = 1/(k \times n)$ for issue 1, $[0,\ 1/(k \times n)]$ for issue 2 and $[0,\ k/(k \times n)]$ for issue 3 [20].

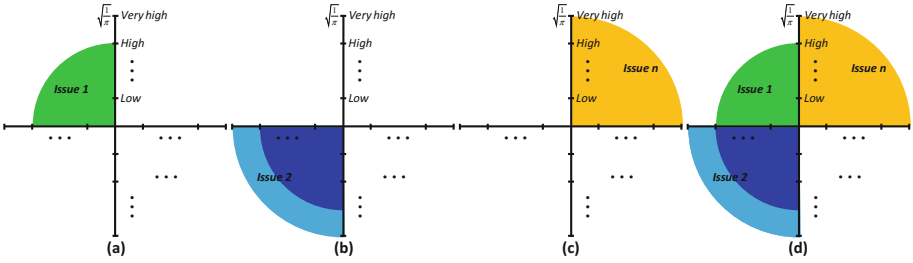


Fig. 1. A view of the qualitative data/information/knowledge processing.

3 A Case Based Methodology for Problem Solving

The *CB* methodology for problem solving stands for an act of finding and justifying a solution to a given problem based on the consideration of similar past ones, by reprocessing and/or adapting their data/knowledge [12, 13]. In *CB* the *cases* are stored in a *Case Base*, and those cases that are similar (or close) to a new one are used in the problem solving process. The typical *CB* cycle presents the mechanism that should be followed, where the former stage entails an initial description of the problem. The new case is defined and it is used to retrieve one or more cases from the *Case Base*.

Despite promising results, the current *CB* systems are neither complete nor adaptable enough for all domains. In some cases, the user cannot choose the similarity(ies) method(s) and is required to follow the system defined one(s), even if they do not meet their needs. Moreover, in real problems, the access to all necessary information is not always possible, since existent *CB* systems have limitations related to the capability of dealing, explicitly, with unknown, incomplete, and even self-contradictory information. To make a change, Neves *et al.* [16, 22] induced a different *CB* cycle (Fig. 2). It takes into consideration the case's *QoI* and *DoC* metrics. It also contemplates a cases optimization process present in the *Case Base*, whenever they do not comply with the terms under which a given problem has to be addressed (e.g., the expected *DoC* on a prediction

was not attained) [16, 22]. The optimization process can use *Artificial Neural Networks*, *Particle Swarm Optimization* or *Genetic Algorithms* generating a set of new cases which must be in conformity with the invariant:

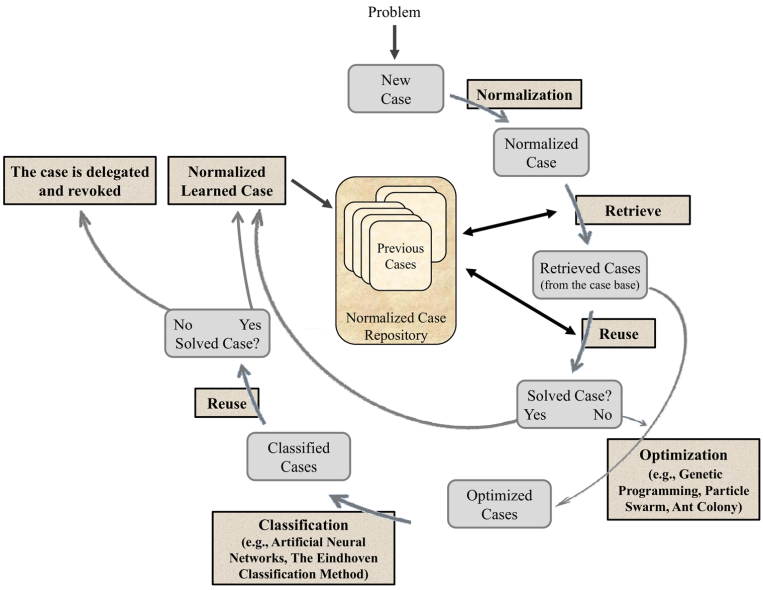


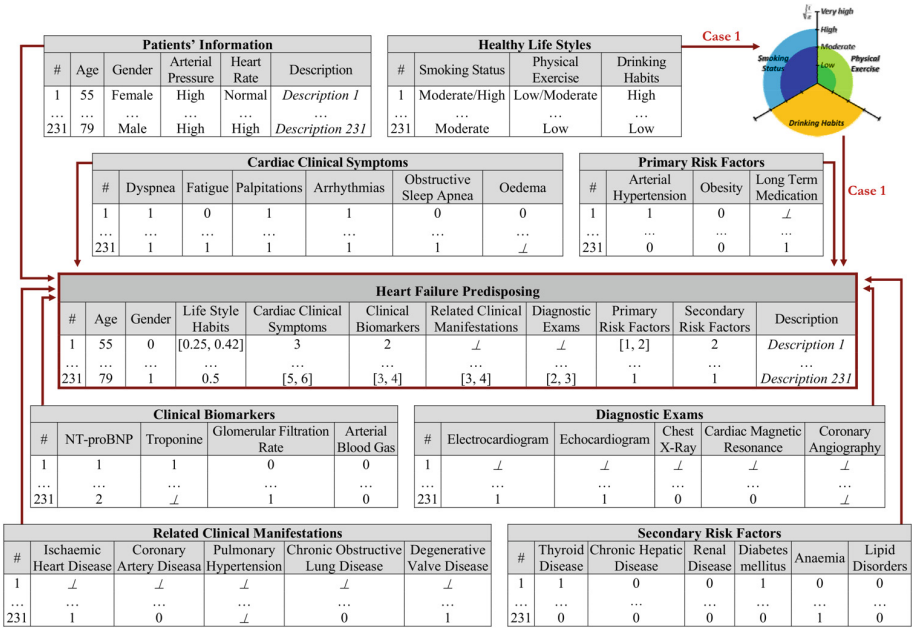
Fig. 2. The updated view of the *CB* cycle [22].

$$\bigcap_{i=1}^{n} \left(\boldsymbol{B}_i,\ \boldsymbol{E}_i\right) \neq 0$$

that states that the intersection of the attribute's values ranges for cases' set that make the *Case Base* or their optimized counterparts ($\boldsymbol{B}_i$) (being n its cardinality), and the ones that were object of a process of optimization ($\boldsymbol{E}_i$), cannot be empty (Fig. 2).

4 Case Study

As a case study consider the knowledge base given in terms of the extensions of the relations depicted in Fig. 3, which stand for a situation where one has to manage information about heart failure predisposing risk. The knowledge base includes 231 patients aged between 19 to 98 years old, with an average of 72 $\pm$ 14 years old. The gender distribution was 46.7% and 53.3% for male and female, respectively. Under this scenario some incomplete and/or unknown data is also available. For instance, in case 1 the *Related Clinical Manifestations* are unknown, which is depicted by the symbol $\perp$, while the *Primary Risk Factors* ranges in the interval [1, 2]. The *Description* column stands for free or structured text that allows for the registration of relevant patient features.



Patients' Information

#	Age	Gender	Arterial Pressure	Heart Rate	Description
1	55	Female	High	Normal	*Description 1*
…	…	…	…	…	…
231	79	Male	High	High	*Description 231*

Healthy Life Styles

#	Smoking Status	Physical Exercise	Drinking Habits
1	Moderate/High	Low/Moderate	High
…	…	…	…
231	Moderate	Low	Low

Case 1

Cardiac Clinical Symptoms

#	Dyspnea	Fatigue	Palpitations	Arrhythmias	Obstructive Sleep Apnea	Oedema
1	1	0	1	1	0	0
…	…	…	…	…	…	…
231	1	1	1	1	1	⊿

Primary Risk Factors

#	Arterial Hypertension	Obesity	Long Term Medication
1	1	0	⊿
…	…	…	…
231	0	0	1

Case 1

Heart Failure Predisposing

#	Age	Gender	Life Style Habits	Cardiac Clinical Symptoms	Clinical Biomarkers	Related Clinical Manifestations	Diagnostic Exams	Primary Risk Factors	Secondary Risk Factors	Description
1	55	0	[0.25, 0.42]	3	2	⊿	⊿	[1, 2]	2	*Description 1*
…	…	…	…	…	…	…	…	…	…	…
231	79	1	0.5	[5, 6]	[3, 4]	[3, 4]	[2, 3]	1	1	*Description 231*

Clinical Biomarkers

#	NT-proBNP	Troponine	Glomerular Filtration Rate	Arterial Blood Gas
1	1	1	0	0
…	…	…	…	…
231	2	⊿	1	0

Diagnostic Exams

#	Electrocardiogram	Echocardiogram	Chest X-Ray	Cardiac Magnetic Resonance	Coronary Angiography
1	⊿	⊿	⊿	⊿	⊿
…	…	…	…	…	…
231	1	1	0	0	⊿

Related Clinical Manifestations

#	Ischaemic Heart Disease	Coronary Artery Diseasa	Pulmonary Hypertension	Chronic Obstructive Lung Disease	Degenerative Valve Disease
1	⊿	⊿	⊿	⊿	⊿
…	…	…	…	…	…
231	1	0	⊿	0	1

Secondary Risk Factors

#	Thyroid Disease	Chronic Hepatic Disease	Renal Disease	Diabetes mellitus	Anaemia	Lipid Disorders
1	1	0	0	1	0	0
…	…	…	…	…	…	…
231	0	0	0	0	1	0

Fig. 3. A fragment of the knowledge base for heart failure predisposing risk evaluation.

The *Cardiac Clinical Symptoms*, *Related Clinical Manifestations* and *Primary* and *Secondary Risk Factors* tables are filled with 0 (zero) or 1 (one) denoting, respectively, *absence* or *presence*. The *Diagnostic Exams* table and the last three columns of the *Clinical Biomarkers* table are populated with 0 (zero) or 1 (one) denoting, respectively, *normal* or *pathological signs*. The *NT-proBNP* column, in turns, is populated with 0 (zero), one (1) or two (2) denoting, respectively, *low*, *not decisive* or *high* propensity for HF. The values presented in the *Cardiac Clinical Symptoms*, *Clinical Biomarkers*, *Related Clinical Manifestations*, *Diagnostic Exams* and *Primary* and *Secondary Risk Factors* columns of *Heart Failure Predisposing* table are the sum of the attributes values of the correspondent tables. In the *Gender* column 0 (zero) and 1 (one) stand, respectively, for *female* and *male*.

In order to quantify the information present in the *Healthy Life Style* tables the procedures already described in Sect. 2.2 were followed. Applying the algorithm presented in [22] to the table or relation's fields that make the knowledge base for heart failure predisposing risk (Fig. 3), and looking to the *DoCs* values obtained as described before, it is possible to set the arguments of the predicate ***heart failure predisposing risk*** (*hfpr*) referred to below, whose extensions denote the objective function regarding the problem under analyze:

$$hfpr\colon Age,\ G_{ender},\ L_{ife}S_{tyle}H_{abits},\ C_{ardiac}C_{linical}S_{ymptons},\ C_{linical}B_{iomarkers},\ R_{elated}C_{linical}M_{anifestations},\ D_{iagnostic}E_{xams},\ P_{rimaryRisk}\ F_{actors},\ S_{econdaryRisk}\ F_{actors} \rightarrow \{0,1\}$$

where 0 (zero) and 1 (one) denote, respectively, the truth values *false* and *true*.

The algorithm presented in [21] encompasses different phases. In the former one the clauses or terms that make extension of the predicate under study are established. In the subsequent stage the arguments of each clause are set as continuous intervals. In a third step the boundaries of the attributes intervals are set in the interval [0, 1] according to a normalization process given by the expression $\left(Y - Y_{min}\right)/\left(Y_{max} - Y_{min}\right)$, where the Y_s stand for themselves. Finally, the *DoC* is evaluated as described in Sect. 2.1.

As an example considers a term (patient) that presents the feature vector $Age = 65$, $G_{ender} = 1$, $L_{ife}S_{tyle}H_{abits} = [0, 0.25]$, $C_{ardiac}C_{linical}S_{ymptoms} = 5$, $C_{linical}B_{iomarkers} = 5$, $R_{elated}C_{linical}$ $M_{anifestations} = 4$, $D_{iagnostic}E_{xams} = [0, 4]$, $P_{rimaryRisk}F_{actors} = 1$, $S_{econdaryRisk}F_{actor} = \perp$, one may have:

$$\{$$

$$\neg\, hfpr\left(\left((A_{Age}, B_{Age})(QoI_{Age}, DoC_{Age})\right), \cdots, \left((A_{SF}, B_{SF})(QoI_{SF}, DoC_{SF})\right)\right)$$

$$\leftarrow not\ hfpr\left(\left((A_{Age}, B_{Age})(QoI_{Age}, DoC_{Age})\right), \cdots, \left((A_{SF}, B_{SF})(QoI_{SF}, DoC_{SF})\right)\right)$$

$$hfpr\underbrace{\left(\left((0.58, 0.58)(1,\ 1)\right), \cdots, \left((0,\ 1)(1,\ 0)\right)\right)}_{\substack{attribute\ `s\ values\ ranges\ once\ normalized\ \ and \\ respective\ \ QoI\ and\ \ DoC\ values}} :: 1 :: 0.84$$

$$\underbrace{[0, 1] \quad \cdots \quad [0, 1]}_{\substack{attribute\ `s\ domains \\ once\ \ normalized}}$$

$$\}:: 1$$

5 A Case Based Approach to Computing

The framework presented previously shows how the information comes together and how it is processed. In this section, a soft computing approach was set to model the universe of discourse, where the computational part is based on a *CB* approach to computing. Contrasting with other problem solving tools (e.g., those that use *Decision Trees* or *Artificial Neural Networks*), relatively little work is done offline. Undeniably, in almost all the situations, the work is performed at query time. The main difference between the new approach [16, 22] and the typical *CB* one [12, 13] relies on the fact that not only all the cases have their arguments set in the interval [0,1], but it also caters for the handling of incomplete, unknown, or even self-contradictory data or knowledge. Thus, the *Case Base* given in terms of the following pattern:

$$Case = \{< Raw_{data},\ Normalized_{data},\ Description_{data} >\}$$

When confronted with a new case, the system is able to retrieve all cases that meet such a structure and optimize such a population, having in consideration that the cases retrieved from the *Case-base* must satisfy the invariant presented in Sect. 3, in order to ensure that the intersection of the attributes range in the cases that make the *Case Base* repository or their optimized counterparts, and the equals in the new case cannot be empty. Having this in mind, the algorithm described above is applied to a *new case*, that presents the feature vector $Age = 88$, $G_{ender} = 0$, $L_{ife}S_{tyle}H_{abits} = \perp$, $C_{ardiac}C_{linical}S_{ymptoms} = [3,\ 4]$, $C_{linical}B_{iomarkers} = 3$, $R_{elated}C_{linical}M_{anifestations} = [3{,}4]$, $D_{iagnostic}E_{xams} = [1{,}5]$, $P_{rimaryRisk}F_{actors} = 3$, $S_{econdaryRisk}F_{actor} = [2{,}4]$. Then, the computational process may be continued, with the outcome:

$$hfpr_{new\ case} \underbrace{((((0.87, 0.87)(1, 1)), \ldots ((0.33, 0.67)(1,\ 0.94)))}_{\substack{attribute\text{'}s\ values\ ranges\ once\ normalized\ and \\ respective\ QoI\ and\ DoC\ values}} ::1::0.83$$

Now, the *new case* may be portrayed on the *Cartesian* plane in terms of its *QoI* and *DoC*, and by using clustering methods [23] it is feasible to identify the cluster(s) that intermingle with the *new one*. The *new case* is compared with every *retrieved case* from the cluster using a similarity function *sim*, given in terms of the average of the modulus of the arithmetic difference between the arguments of each case of the selected cluster and those of the *new case*. Thus, one may have:

$$\begin{array}{c} retrieved_{case1}((((0.77,\ 0.77)(1, 1)), \ldots, ((0.33,\ 0.83)(1,\ 0.87))) ::1::0.81 \\ retrieved_{case2}((((0.90,\ 0.92)(1, 0.99)), \ldots, ((0.5,\ 0.67)(1,\ 0.99))) ::1::0.85 \\ \vdots \\ \underbrace{retrieved_{casej}((((0.89,\ 0.89)(1, 1)), \ldots, ((0.5,\ 0.67)(1,\ 0.99))) ::1::0.83}_{normalized\ cases\ that\ make\ the\ retrieved\ cluster} \end{array}$$

Assuming that every attribute has equal weight, for the sake of presentation, the *dis(imilarity)* between new_{case} and the $retrieved_{case1}$, i.e., $new_{case\rightarrow 1}$ may be computed as follows:

$$dis^{DoC}_{new\ case\rightarrow 1} = \frac{\|1-1\| + \ldots + \|0.6-1\| + \|1-0.9\| + \|0.94-0.87\|}{9} = 0.11$$

Thus, the *sim(ilarity)* for $sim^{DoC}_{new\ case\rightarrow 1}$ is set as *1 – 0.11 = 0.89.* Regarding *QoI* the procedure is similar, returning $sim^{QoI}_{new\ case\rightarrow 1} = 1$. Thus, one may have:

$$sim^{QoI,\ DoC}_{new\ case\rightarrow 1} = 1 \times 0.89 = 0.89$$

i.e., the product of two measurements is a new type of measurement. For instance, multiplying the lengths of the two sides of a rectangle gives its area, which is the subject of dimensional analysis. In this work the mentioned product gives the overall similarity between the new case and the retrieved ones. These procedures should be applied to the

remaining cases of the retrieved clusters in order to obtain the most similar ones, which may stand for the possible solutions to the problem. This approach allows users to define the most appropriate similarity methods to address the problem (i.e., it gives the user the possibility to narrow the number of selected cases with the increase of the similarity threshold).

The proposed model was tested on a real data set with 231 examples. Thus, the dataset was divided in exclusive subsets through the ten-folds cross validation [24]. In the implementation of the respective dividing procedures, ten executions were performed for each one of them. Table 1 presents the coincidence matrix of the *CB* model, where the values presented denote the average of 25 (twenty five) experiments. A perusal to Table 1 shows that the model accuracy was 90.5% (i.e., 209 instances correctly classified in 231). Thus, from clinical practice perspective, the predictions made by the *CB* model are satisfactory, attaining accuracies close to 90%. The sensitivity and specificity of the model were 93.1% and 79.1%, while *Positive* and *Negative Predictive Values* were 91.1% and 72.3%, denoting that the model exhibits a good performance in the assessment of heart failure predisposing risk.

Table 1. The coincidence matrix for *CB* model.

Target	Predictive	
	True (1)	False (0)
True (1)	175	13
False (0)	9	34

Abreu et al. [25] addressed the problem of incomplete information. The authors present a study to predict the overall survival of women with breast cancer using a clinical dataset with 847 cases and 25% missing values. The imputation method used was the *k*-nearest neighbor algorithm and the model presents a prediction accuracy of 73%. In another study the referred authors compared the performance of three different imputation methods, i.e., mean/mode imputation, expectation-maximization algorithm and *k*-nearest neighbor algorithm. The sensitivity, specificity and accuracy range from 83.9% to 88.4%, 47.4% to 70.5% and 68.8% to 81.7%, respectively [26].

6 Conclusion

The assessment of heart failure predisposing risk has shown to be a hard task, as the parameters that cause the disorder are not fully represented by objective data. Thus, this work presents a *Logic Programming* based *Decision Support System* centred on a formal framework based on *LP* for knowledge representation and reasoning, complemented with a *CB* approach to computing that caters for the handling of incomplete, unknown, or even contradictory information. The proposed model is able to provide adequate responses once the overall accuracy is close to 90%. Indeed, it has also the potential to be disseminated across other prospective areas, therefore validating a universal attitude. Additionally, it gives the user the possibility to narrow the search space for similar cases at runtime by choosing the most appropriate strategies to address the problem. In fact,

the added values of the presented approach arises from the complementarily between *Logic Programming* (for knowledge representation and reasoning) and the computational process based on *Case Based* approach.

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Comparing Comorbidity Adjustment Scores for Predicting in-Hospital Mortality Using Administrative Data

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Abstract. The Charlson Comorbidity Index (CCI) is a method for classifying comorbidities as a single measure on a scale, based on ICD-9-CM codes over administrative databases. This study aims to compare different variants of the CCI and their relation with in-hospital mortality, using different weights associated to each comorbidity. Within the 9,613,563 hospitalizations in the 15-year studied period, the area under the ROC curve was higher considering the original Charlson weights, when compared to other more recent proposals. Also, all the indexes had an increased association with in-hospital mortality throughout time. For recent years this association is stronger, demonstrating an increased applicability of the Charlson index in administrative databases. The validity of the coding algorithms strongly depends on the completeness and accuracy of diagnostic coding, particularly considering secondary diagnoses. The Charlson index can be a valuable tool for longitudinal studies, but important differences among weights, through years, and for different main diagnoses, should be considered and discussed.

Keywords: Administrative data · Comorbidities · In-hospital mortality · ICD-9-CM · Charlson Comorbidity Index · Data quality

1 Introduction

A comorbidity is a clinical condition a patient might have, other than the disease of primary interest [1]. The Charlson Comorbidity Index (CCI) is a method for classifying comorbidities as a single measure on a scale, based on ICD-9-CM (International Classification of Diseases, Ninth Revision, Clinical Modification) secondary diagnosis codes assigned to hospitalization episodes [2, 3]. Originally the index had 19 categories, but was validated to ICD-9-CM and modified by Deyo et al. to 17 categories [3].

Among several methods, the Charlson Index is one of the most widely used indices [4]. Each comorbidity has an associated weight, based on the adjusted risk of mortality within one year, with a score of zero indicating that the individual has none of the Charlson index comorbid conditions, and higher scores indicating higher probability of death. Higher scores may also be associated with increased length of stay [5], hospital costs [6], and readmissions [7]. There is also a probable inverse relationship between

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multimorbidity (patient with several coexisting medical conditions) or comorbidity and quality of life [8]. For acutely ill hospitalized elderly patients, the CCI may also independently predict short- and long-term mortality [9].

Table 1. Charlson comorbidity weights according to different authors

Charlson comorbidity	Original Charlson weights, 1987 [2]	Updated weights, Schneeweiss 2003 [12]	Updated weights, Quan 2011 [10]
Myocardial infarction	1	1	0
Congestive heart failure	1	2	2
Peripheral vascular disease	1	1	0
Cerebrovascular disease	1	1	0
Dementia	1	3	2
Chronic pulmonary disease	1	2	1
Rheumatologic disease	1	0	1
Peptic ulcer disease	1	0	0
Mild liver disease	1	2	2
Diabetes without chronic complications	1	1	0
Diabetes with chronic complications	2	2	1
Hemiplegia or paraplegia	2	1	2
Renal disease	2	3	1
Any malignancy, including leukemia and lymphoma	2	2	2
Moderate or severe liver disease	3	4	4
Metastatic solid tumor	6	6	6
AIDS/HIV	6	4	4
Comorbidity score, maximum	29	30	24

Nevertheless, since the early development of the Charlson index in the eighties, advances in medicine, either related to effective disease management or better treatments, have occurred throughout the years and expectedly contributed to changes in the relative importance of different comorbidities [10]. Also, the evolution in the completeness of ICD-9-CM coding, with benefits from an expected quality improvement in electronic health records and corresponding coding practices [11], led to an evaluation of the proposed comorbidity weights. In fact, since the original proposed weights (Table 1) [2], others studies have proposed different comorbidity weights in the definition of the Charlson index [10, 12].

This study aims to compare different often used variants of the Charlson Comorbidity Index, i.e. using different weights associated to each comorbidity, and their relation with in-hospital mortality. Specific objectives include the study of the evolution of the relation of these scores with in-hospital mortality throughout years, and the analysis of different disease groups.

2 Methods

This study was based on data from hospitalizations in public hospitals of mainland Portugal, with discharges between 2000 and 2014. The analysis was restricted to inpatient episodes (outpatient episodes were excluded) in all Portuguese acute care hospitals. The access to the data was provided by the Ministry of Health's Central Authority for Health Services (ACSS).

As in other comorbidity studies [11, 13], the following episodes were excluded: (i) pediatric (age below 18 years), and (ii) obstetrical episodes (Major Diagnostic Category – MDC – 14, "Pregnancy, Childbirth, and the Puerperium" and MDC 15, "Newborns and Other Neonates with Conditions Originating in the Perinatal Period", considering the All Patient Diagnosis Related Groups – AP-DRG 21 – grouper). Also, patients discharged to another institution (discharge status "Discharged/Transferred to a Short-term General Hospital for Inpatient Care") or transferred to other hospitals were excluded. The initial dataset contained 22, 167, 646 (inpatient and outpatient) episodes and, after applying the exclusion criteria, 9, 613, 563 episodes remained for analysis.

The ICD-9-CM enhanced coding algorithm developed by Quan et al. was used to identify the Charlson comorbidities in any of the coded secondary diagnosis [14]. The final scores were weighted according to the original weights [2, 3], the adjustment proposed by Schneeweiss et al. in 2003 [12], and the update proposed by Quan et al. in 2011 [10].

The 2014 update of the Agency for Healthcare Research and Quality's Clinical Classifications Software (CCS) for ICD-9-CM was used to group principal diagnosis into a small number of clinically meaningful diagnosis groups.

Receiver Operating Characteristic (ROC) curves were calculated as discrimination measures. The area under the ROC curve (AUC) is equivalent to the c-statistic [15]. Also, asymptotic 95% confidence intervals were calculated for each AUC.

Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 24, Armonk, NY: IBM Corp.

3 Results

There were 22, 167, 646 episodes with discharges in the period 2000–2014 (both inpatient and outpatient). Considering the eligibility criteria, 12, 554, 083 episodes were excluded and remained 9, 613, 563 hospitalizations that met the inclusion criteria.

Over this 15-year period, the mean age was 61.6 (SD: 18.5), and 51.2% were women. Table 2 shows absolute and relative frequencies for each comorbidity included in the index, their proportion of women, average age, and related in-hospital mortality. The

Table 2. Descriptive statistics for each comorbidity (for 9,613,563 hospitalizations, in 2000–14)

Charlson comorbidity	n	%	Mean Age (years)	Female sex (%)	In-hospital Mortality (%)
Myocardial infarction	170,878	1.8	71.0	32.3	11.3
Congestive heart failure	635,828	6.6	76.7	52.6	16.4
Peripheral vascular disease	148,282	1.5	71.7	33.8	15.4
Cerebrovascular disease	514,579	5.4	75.7	48.6	16.9
Dementia	176,546	1.8	81.6	58.8	16.8
Chronic pulmonary disease	567,169	5.9	69.6	43.2	9.9
Rheumatic disease	60,547	0.6	63.5	78.8	7.3
Peptic ulcer disease	56,534	0.6	68.7	41.3	11.4
Mild liver disease	242,454	2.5	59.0	31.1	14.3
Diabetes without chronic complication	1,149,823	12.0	70.7	50.9	9.9
Diabetes with chronic complication	150,215	1.6	70.0	47.9	11.0
Hemiplegia or paraplegia	117,851	1.2	66.2	45.6	14.1
Renal disease	463,878	4.8	72.6	45.5	15.6
Any malignancy, including lymphoma and leukemia, except malignant neoplasm of skin	424,107	4.4	64.8	39.2	13.1
Moderate or severe liver disease	100,071	1.0	59.9	25.4	18.4
Metastatic solid tumor	368,812	3.8	64.2	45.0	26.1
AIDS/HIV	22,180	0.2	43.3	25.7	11.9
Total number of hospitalizations	9,613,563	100.0	61.6	51.2	6.9

comorbidity with higher frequency was “Diabetes without chronic complication” (12.0% of all hospitalizations), while that associated with higher in-hospital mortality was “Metastatic solid tumor” (26.1%).

Table 3 shows the distribution of hospitalizations according to the three versions of the Charlson comorbidity score, as well as several indicators. More than 60% of the hospitalizations had no coded Charlson comorbidities. This percentage decreased considerably between years 2000 and 2014, from 71% to 51% (both for the original 1987 index weights and for the Schneeweiss 2003 variant), and from 80% to 63% for the Quan 2011 weights proposal.

Table 3. Descriptive statistics for each comorbidity index (for 9, 613, 563 hospitalizations)

	Original Charlson index				Index with Schneeweiss weights				Index with Quan weights			
Score:	0	1	2	3+	0	1	2	3+	0	1	2	3+
Relative frequency (%)	62.3	17.2	9.6	10.9	62.9	10.3	10.4	16.3	73.5	7.1	10.5	8.9
Mean age	56.9	69.5	69.4	68.8	57.0	69.8	67.1	70.5	59.0	68.0	69.7	68.1
Median length of stay	4.0	7.0	7.0	8.0	4.0	7.0	7.0	8.0	4.0	7.0	7.0	8.0
Mean DRG based charge (Eur)	2,816	3,407	3,463	4,033	2,823	3,310	3,463	3,878	2,895	3,537	3,506	4,108
In-hospital mortality (%)	3.3	9.1	11.4	19.5	3.4	8.6	9.9	17.4	4.2	8.7	12.5	20.8

Major differences in the average age occur between the groups of patients without comorbidities (“0” group) and the 3 groups with comorbidities (average age difference varying from 9 to 14 years). The median length of stay is also considerably different between the no comorbidity group and any of the other groups (4.0 vs. 7.0 and 8.0 days). Considering the DRG based associated charges, the mean in group “0” (2800–2900Eur)

is considerably lower than in groups "1" and "2" (3300–3500Eur), and in group "3+" is substantially higher than in all other groups (3900–4100Eur). In-hospital mortality significantly increases throughout the comorbidity index groups, from 3.3–4.2% to 17.4–20.8%.

Globally, the AUC for in-hospital mortality prediction is higher for Charlson 1987 and Schneeweiss 2003 weights, respectively with 69.9 and 70.0% (95% CI [69.8–70.0] and [70.0–70.1]). In comparison, the global AUC for Quan 2011 weights was significantly lower, with 66.9% (95% CI [66.8–67.0]) (Fig. 1). All scores had a continuous significant increase in the AUC between years 2000 and 2014. The AUC for Charlson original index increased from 67.6 to 72.0%, while for Schneeweiss scores increased from 67.7 to 72.2%, and for Quan scores increased from 63.5 to 70.4% (Fig. 2).

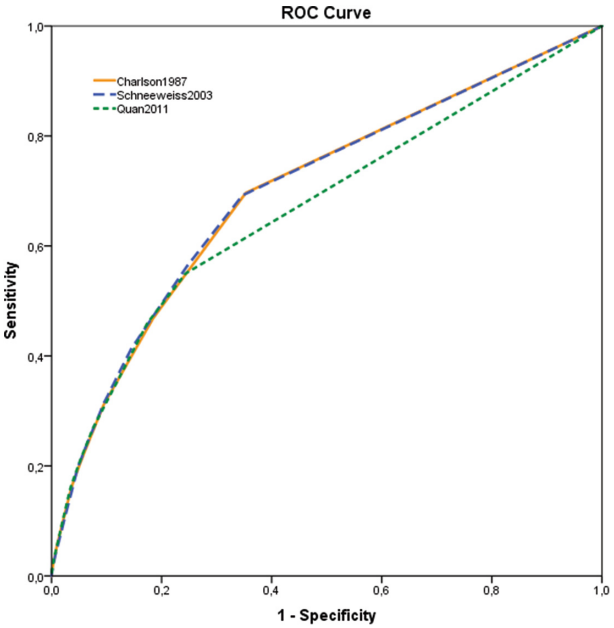

Fig. 1. ROC curves for the 3 index comorbidity approaches (for 9, 613, 563 hospitalizations)

When looking at specific diagnoses' groups, best results occurred when the principal diagnosis was of cancer diseases, particularly for CCS "Cancer of breast", with an AUC of 84.0% (95% CI [83.5–84.5]) both for the index with original scores and with Schneeweiss 2003 weights (AUC equal to 83.8% for Quan index proposal). Worst AUC results occurred for CCS "Cardiac arrest and ventricular fibrillation", with an AUC below 50%. The biggest difference between scores occurred for CCS "Chronic ulcer of skin", with an AUC of 63.0% for Schneeweiss score and 55.2% for Quan score (a difference of nearly 8%).

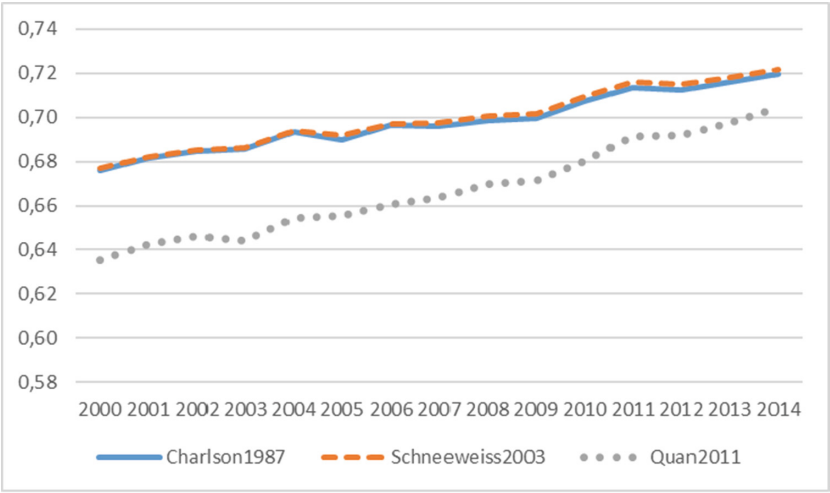

Fig. 2. Yearly evolution of the comorbidity index (AUC) considering different weights for each Charlson comorbidity (for 9, 613, 563 hospitalizations)

4 Discussion

Important differences were found between the three different approaches to compute the Charlson index. Also, major differences were found between hospitalizations without comorbidities and those with one or more. All the analyzed versions of the Charlson index had an increased association with in-hospital mortality through the years. In fact, for recent years this association is stronger, demonstrating an increased applicability of the Charlson index in administrative databases. Despite the evolution throughout years, the index both with original weights or with the ones proposed by Schneeweiss et al. had systematically better results than the index with the weights proposed by Quan et al. in 2011, when considering in-hospital morality.

This study has some limitations. Possible conditions occurred or diagnosed during hospitalization (post-admit comorbidities) were not able to be excluded. Clearly, the validity of the coding algorithms strongly depends on the completeness and accuracy of diagnostic coding in administrative databases, particularly considering secondary diagnoses. Despite potential coding bias, the introduction of hospital reimbursement systems based on Diagnosis Related Group (DRG) led to an improved coding accuracy [16].

5 Conclusion

The Charlson index can be a valuable tool when used in administrative databases, for longitudinal studies (e.g. for estimating quality indicators of hospitals/health systems, for providing better services for specific populations), but important differences among weights, through years, between age groups, and for different principal diagnosis, must

be considered and discussed. In different scenarios, different approaches can be used, with different magnitudes in the results, specifically concerning in-hospital mortality.

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New Pedagogical Approaches with Technologies

Urban Gamification in Architecture Education

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Abstract. This paper describes early stages of an educational project focused on using gamification in architecture education. The state of the art of gamification technologies applied to education, architecture and urban design, is introduced, as well as main objectives of the project. It is based on the use of virtual reality systems on urban spaces to asses motivational, social, and spatial competences in an educational context. Finally, assessment methodology and previous design concepts are discussed.

Keywords: Gamification · Education · Architecture · Multimedia · Visual representation · Urban space

1 Introduction

Videogames are increasingly part of our life; while in the past playing videogames was considered an activity restricted to the young male demographic segment, the average age of a "gamer" is currently 35 years old and the gender distribution is remarkably balanced [1]. Moreover, the use of mobile devices for leisure activities have widened the game-playing population spectrum while introducing new genres labeled as "social gaming" and "casual gaming" [2]. Videogames have also been used in sports training, where a virtual partner increases the motivation of the subject while doing exercise in a virtual environment [3], and is beginning to find its place in the educational programs of Universities [4]. At the same time, the way games themselves are played is also evolving; the rise of livestreaming is influencing how games are designed and played [5], and game-playing is becoming a spectator sport.

The project presented in this article involves computing science, architectural and multimedia engineers' education, and public urban policy for future cities [6, 7]. One of the innovative aspects of this project is to incorporate gaming strategies in an urban collaborative environment to enhance an initial design proposal. This approach aims to incorporate actively architecture students (as urban designers), multimedia engineering

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and informatics students (as multi-platform programmers), and final users. Citizens will play with virtual models and they will generate points of view that were not considered in the original proposal. This could be useful for project improvement since informal and casual perception would be incorporated to the project design. This fact would feed back into student's education, primarily oriented towards formal content so far.

2 Literature Review

2.1 Gamification in Education

Games are created by designers/teams of developers, and consumed by players [8]. They are purchased, used and eventually cast away like most other consumable goods [9]. The difference between games and other entertainment products (such as books, music, movies and plays) is that their consumption is relatively unpredictable. The string of events that occur during gameplay and the outcome of those events are unknown at the time the product is finished [10]. We can formalize the consumption of games by breaking them into distinct components [11, 12], i.e., Rules => System => Fun, and establishing their design counterparts: Mechanics describes the components of the game, at the level of data representation and algorithms; Dynamics refers to the run-time behavior of the mechanics acting on player inputs and outputs; and Aesthetics pertains to the desirable emotional responses of game interaction evoked in the player.

The gamification in classes helps improve the connection between the material and the student. It offers the opportunity to reflect on a topic in depth and allows positive changes in behavior [13]. In this approach, learning through gamming is achieved by aligning the game mechanics with Bloom's taxonomy of learning [14], allowing learning to be classified into three domains [15]:

- Cognitive, which is taught in traditional education and implies understanding and synthesis of knowledge.
- Affective (involving emotions), which reflects the attitude toward a situation.
- Psychomotor (the physical), which is activated by requiring a union of mental and physical activity.

To encourage the use of games in learning beyond simulations and puzzles, it is essential to develop a better understanding of the tasks, activities, skills and operations that different game types can offer and examine how these might correspond to the desired learning outcomes [16].

Previous studies in learning gamification were assessed in terms of increased motivation and engagement in the learning tasks, as well as enjoyment derived from partaking in them [17]. However, these studies revealed some negative outcomes that need to be addressed, such as the effects of increased competition, task evaluation difficulties, and design features [18]. Product designers are leveraging this alignment in business contexts to "make the consumers come in, bring friends and keep coming back". The reward is often not directly related to the goal achieved, but rather serves as a notification to the player and others that a level of competence has been achieved.

Progress tracking is often enabled and guided by reward systems. Similarly, progress towards an overall objective is mapped out by a sequence of intermediate goals.

2.2 3D Architecture/Urban Models Visualization

Historically, in civil and building engineering education, visualization and understanding of 3D space was typically accomplished via the classical view (physical models and drawings), in front of 3D models and using virtual specifications. This approach is changing due to a generational change and the continuous improvement and development of technology. The new systems based on VR/AR (Virtual and Augmented Reality), Geo-Referencing, and learning gamification, will gradually reduce the control imposed on the designed tasks and scheduled presentations.

Due to the potential of virtual systems, we can strengthen the spatial skills and abilities of students while also using the essential interactive and collaborative features of these processes. Students can work with peers and teachers and participate in multitasking/multi-user collaborative and instant tracking [19]. The simplicity of completing the most basic models with the creation of new objects, light treatment, materials, textures, and shadows allows a dynamic workflow that is much faster to complete than physical scale models [20].

Additionally, the versatility of virtual worlds and their use in social networking allows for creation and collaboration with heterogeneous groups from all over the world, who can collaborate synchronously in different virtual spaces. Virtual worlds provide a combination of simulation tools, a sense of immersion and opportunities for communication and collaboration that have great potential for their application in education [21, 22]. However, as criticized in [23], many of the existing educative experiences in virtual worlds only replicate traditional approaches, such as recreating the classrooms.

Focused in the urban data, [24] proposed a generic model to support a new way of visiting a city. In this approach, instead of understanding the city as a place for tourism, the students perceive it as a place for learning in which all necessary educational resources are available. The model has been conceived as a way to encourage learners to create their own educational tours, in which Learning Points Of Interest are set up to be discovered using two models—formal (conducted by a teacher) and informal outdoor mobile learning (no educator is related to the learning experience).

Merging gamification and 3D architectural models, we can find some references in the use of gamification applied to urban planning process with citizen participation:

- "Blockholm", a game based on Minecraft promoted by the Swedish Center for Architecture and Design. The objective of the game is based on designing an intelligent city of the future from the real cartography of the city where the topography, streets, lakes, rivers, etc. are included [25].
- "Play the City", of the Play the City Foundation implemented throughout the year 2012 in different cities in Holland, Belgium, Turkey and South Africa is based on a game similar to Word of Warcraft.
- "Planit", developed in 2013, is based on Internet that aspires to broaden the attractiveness of citizen participation, making of the planning one playful aspect, although

in the background in an organizer of the various mental maps of how the citizens understands the city [26].

These all cases were worked from basic zoning proposals of general uses to large-scale digital work. They all incorporate noteworthy aspects linked to informal teaching models: citizens generate series of opinions or suggestions, which help students to see different points of view; this information improves their formal knowledge, as cases were conduct outside an academic environment; They all are focused on the urban planning. In the current project proposal, it is important to work on both an architectonic project and urban design at the right scale that allows a larger level of detail and complexity.

3 The Project: EduGAME4CITY

The project will be carried out in campus. The goal of the main hypothesis is to demonstrate that virtual gaming implementation in architectural education will improve spatial perception and students design capabilities, thanks to the augmented and immersive visual technologies. As such, in the fields related to the architecture and society, the hypothesis will identify key elements to guide, help and encourage personal initiatives in both designing processes and urban transformation. On the other hand, in the field of the multimedia/IT education, students will be duly qualified to create applications/games through skill-based learning. They should not be only leisure related but also for social and educational purposes (serious games).

3.1 Main Objectives

We will focus our efforts in order to:

- Test and evaluate the education of the urban project incorporating collaborative design, immersive ICTs (goggles, mobile devices, etc.), gamification and citizen participation.
- Improve the competence of the multimedia engineering students through the design and creation of serious games adapted to other areas of knowledge such as the architecture and the town planning.
- Test and evaluate the usability and motivation by the students of the created gamification system.
- Test and evaluate the informal education of the project thanks to the simulations, tests and evaluations of the citizens.
- Study and link the technological profiles of the users of the gamification platform with the results, understanding the results as the achievement of the challenges defined in the games, the results of the work surveys and the personal interviews.
- Determine the correlation between motivation, satisfaction and use experience, and the improvement of the space.

- Increase the motivation, implication and satisfaction of the citizen in the process of taking urban decisions through the usage of ICTs, starting with the approach of various accessible technologies depending on the profiles of every user.

3.2 Assessment Methodology

Quantitative and qualitative approaches have historically been the main methods of scientific research. Currently, a hybrid approach to experimental methodology has emerged that takes a more holistic view of methodological problems: the mixed-methods research approach. This model is based on a pragmatic paradigm that contemplates the possibility of combining quantitative and qualitative methods to achieve complementary results [27]. The quantitative approach will be based on ISO 9241-11 [28], that will be used as in other previously educational cases [6, 8], which provides usability assessment guidelines of efficiency and user satisfaction. The qualitative approach will be post-visit interviews with a representative sample of the students involved in the project, who will share their experience with the appliance of this new technology into the visit. For this final stage, Bipolar Laddering Assessment (BLA) will be used, a technique previously validated in other educational experiments [20].

4 Conclusions

At the moment, the project is at an early developmental stage. On one hand, a location has been chosen in Barcelona to perform a study case (Sant Jaume square area and surroundings Fig. 1). Final gamification zones will be defined by the city hall of Barcelona. In that area, game dynamics and modelling specifications are being created as a previous test to be implemented in final locations. In this sense, Unreal was selected as the programming system, with the possibilities to add urban furniture. Users will reach points attending to criteria of design concepts, sustainability, accessibility and cost. In addition, public space definition will be settled on punctual uses performed by the citizens: gatherings, public markets, demonstrations, etc., in a way that the students can intervene in each place with proposals that are adapted depending on the situation.

Fig. 1. Pilot study zone, with basic 3D models and images.

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A Systematic Mapping Review of All-Learning Model of Integration of Educational Methodologies in the ICT

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Abstract. Technology has had a positive impact in education, which has allowed education to evolve faster. This article presents a systematic mapping review of models and methodologies integrated with information and communication technologies. In the revision of the systematic mapping, 919 articles were found in 6 academic databases and 129 relevant articles were selected according to the defined inclusion patterns. This work pretends to characterize the common elements between models and educational methodologies to find ways to integrate them with the new technologies of information and communication.

Keywords: ICT · Model · Methodology · Integration · Education · Systematic mapping review

1 Introduction

There are currently different media technologies that apply to education, to develop learning processes mediated through information and communication technologies such as electronic learning (e-learning), mobile learning (m-learning), game learning (g-learning) and Ubiquitous Learning (u-learning) [1] which have become an important support for current educational processes, nowadays an education without ICT is not conceivable due to the impact and permeability of technology in all environments and areas of society [1].

Whenever there are new ICTs that may apply to the education is possible to develop new studies and research related to the impacts of technologies in educational processes [2]. In this case it is proposed to investigate in U-Learning relating the Connective Learning and the Learning Experiences or xAPI, from the pedagogical and technological perspective [2].

This paper presents a systematic review performed in the context [3] of a doctoral research project. This research proposes the design of a new model to U-Learning [5].

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The systematic review is a literature search process to analyze, evaluate and interpret all relevant studies on a question or several research questions in particular, specific area or phenomenon of interest [3].

The methodology is used in this paper and the phases are presented below: planning the review, developing the review and generating the reports of the review [3, 4]. The paper is structured as follows: Sect. 2 explores the need for a systematic review in the area of the models that integrate the ICTs and the models, methodologies and educational strategies. Section 3 presents the methodology of the systematic review, the steps followed according to the methodology of Kitchenham [5] y Petersen [4], research questions, keywords, chosen databases, inclusion and exclusion criteria, queries, the search process and the extraction of data. Section 4 shows the results and the analysis of the data obtained in the systematic review. Section 5 discusses the conclusions and the future work.

2 Review Necessity

According to the World Bank's Learning for All [6], investment in people's knowledge and skills promotes the development of the world's population. One of the main goals of education at the global level has been to reduce the educational gap by bringing education to all people around the world [7].

This has led to a lag in education because while new students, mostly digital natives, are moving towards an interconnected education with multiple elements and devices, education continues to carry out educational processes aimed at digital migrant students [8, 9]; the needs of the education of new students are different and they need pedagogical and technological models, strategies, methodologies and updated technological paradigms that allow to visualize the education of the future to apply it in the current education [10, 11].

The Inter-American Development Bank (IDB), Education for the 2012 Transformation, indicates that education must focus on quality, preparation for global scenarios and markets, and close the gap between education and the business world, it defines real needs and educate in skills to provide real solutions [6, 12].

3 Systematic Mapping Review

A systematic literature review is a method to analyze, evaluate and interpret all relevant studies to a particular research question, or specific area, or phenomenon of interest [13]. A systematic mapping review is a new version of this technique in which the evidence is represented in the results of the search and the analysis of data [5]. Kitchenham and Charters [4, 6] propose to use this methodology in the field of Software Engineering. The systematic review is a methodology that allows to make searches of information in a rigorous way, allows to analyze, evaluate and interpret studies according to the specific research needs. In the systematic review, the methodology proposed by Kitchenham and Petersen [4, 5].

This systematic review methodology has been selected because it has all the necessary elements to carry out the search of information about the proposed topic. The importance of mapping the systematic review is found in the structure and steps it proposes to carry out the searches in an organized and methodological way which helps to generate reliable results in the investigations [4]. The process is detailed in Fig. 1.

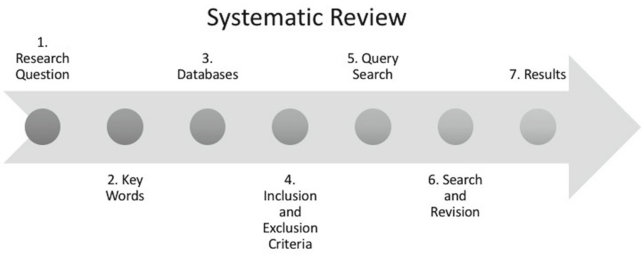

Fig. 1. Systematic review process

In the systemic review process [3], the following steps were followed: (1) two research questions were raised, (2) keywords were defined for searches in English, Portuguese and Spanish, (3) the databases to be consulted were defined, (4) the inclusion and exclusion criteria of articles were defined, as well as the range of time, (5) the advanced search strings were defined in each of the databases, (6) the process of search and revision of the articles was carried out, (7) new specific review, and (8) the results obtained in the review are presented.

3.1 Research Questions

The purpose of this work was determined by the current trends in information technologies applied to education and the need to update current educational models and methods to be applied in teaching processes. Problems have been identified in the application of new information technologies in education because current learning processes do not adequately shape students' knowledge and skills in the workplace [7]. Accordingly, the following questions have been raised.

RQ1: What models have integrated educational methodologies and the new ICTs?
RQ2: What methodologies and ICTs have been integrated to generate models?

3.2 Definitions

To have greater clarity in the terms used in the paper, a table of concepts definition was made. The concepts are related to the search strings used in the systematic review. Table 1 presents the concepts and their definitions.

Table 1. Definition of general concepts

Word	Definition
ICT	Information and communications technology or technologies is an umbrella term that includes any communication device or application, encompassing: mobile devices, computer and network, hardware and software, and various services and applications associated with them [1].
U-Learning	U-Learning is the ubiquitous learning process that can be performed at any time, place, device and context [13].
M-Learning	M-Learning or mobile learning is the learning process that is performed using mobile devices such as smart phones. Its main feature is mobility [8].
B-Learning	B-Learning or Blended learning is a term increasingly used to describe the way e-learning is being combined with traditional classroom methods and independent study [8].
E-Learning	E-Learning or e-learning is the process of learning that is done using the internet and computers to access education [1].

3.3 Key Words

For the systematic review, the search of 7 keywords in English, Spanish and Portuguese was defined, to include greater results of the searches and that allows to have a more complete review in the databases. These words are detailed in Table 2.

Table 2. Keywords for the searches in the databases in English, Portuguese and Spanish

Ingles	Português	Español
Methodology	Metodologia	Metodología
Model	Modelo	Modelo
Learning	Aprendizagem	Aprendizaje
ICT	ICT	TIC
Integrations	Integração	Integración
Education	Educação	Educación
Pedagogy	Pedagogia	Pedagogia

3.4 Database

We defined six (6) databases to perform the search for information according to the mapping of the systematic review. We chose these databases because they are the most internationally recognized in the area of engineering, computer science and education. These databases publish articles, conferences, book chapters and others. The databases are detailed in Table 3.

Table 3. Databases used in the search

Name	Link	Acronym
IEEE Xplore	http://ieeexplore.ieee.org/Xplore/home.jsp	IEEE Xplore
SCOPUS	http://www.scopus.com	SCOPUS
Science direct	http://www.sciencedirect.com	Science Direct
ACM	http://dl.acm.org	ACM
Web of science	https://webofknowledge.com	WOS
Google scholar	https://scholar.google.com	GS

3.5 Inclusion and Exclusion Criteria

The inclusion and exclusion criteria of the mapping of the systematic review were defined according to the themes that are in the project and to the research questions for the searches.

The inclusion criteria are: (1) Articles published between the years 2013-2016, (2) Articles published in conferences, congresses, journals and book chapters, (3) Articles written in English, Portuguese and Spanish, (4) Articles that are found in the databases detailed in the table of databases, and (5) Articles related to higher education, virtual education, models and methodologies integrated with information and communication technologies.

The exclusion criteria are: (1) Document not available for download, (2) Articles in languages other than English, Spanish or Portuguese, (3) Articles that are not focused on the integration of educational methodologies with information and communication technologies, and (4) Gray literature.

Once the basic inclusion and exclusion criteria were applied, we proceed to review the titles and abstract of each of the papers. With this initial review, we decided if the paper is initially included in the accepted articles. After this process, each paper is reviewed in general form, making a reading of the paper, to know if it helps to answer the questions posed in the systematic review.

3.6 Query Search

A general search string was defined based on the general concepts of the title of the search and that allowed to answer the raised research questions. For each of the databases, we reviewed how to perform advanced searches and created the search string for each one of these, allowing more specific results according to the key words raised. It should be clarified that some databases are searched by abstract, title independently, therefore in some databases were created two or three search chains.

The result of the general chain is as follows: ***((("methodolog*" OR "methodological") OR ("model*")) AND ("integrat*") AND ("educat*" OR "learn*" OR "pedagogical") AND ("ICT" OR ("information" AND "communications" AND "technology")) AND (publication year > 2013))***

3.7 Search Process

The search process is performed by accessing the six defined databases (IEEE, ACM, SCOPUS, Web of Science, Science Direct and Google Scholar), in each of the databases the specific string was defined to perform advanced search, defined keywords and search criteria. We did not consider other studies or databases for the search, once the results obtained in each of the databases, we organized the data obtained in a general spreadsheet where all the data obtained from each one of the databases, was grouped by database and assigned a code to the database.

The information to organize the obtained information was the following: (a) date of search, (b) database code, (c) database, (d) search string, (e) title, and (f) abstract.

3.8 Data Extraction

Once all the information of the searches in the databases is unified in the spreadsheet created, 919 items were found in the databases, the review process is initiated. Firstly, a general review is performed to find the papers, chapter of books, etc., 184 articles were repeated, and this is originated by the different searches in the same databases by different search chains.

Following this is a review of the titles and abstract of the papers, this review took into account the inclusion and exclusion criteria, all information relevant to the planned search and that will help to answer the research questions initially raised. The general summary of the accepted papers is detailed in Fig. 2.

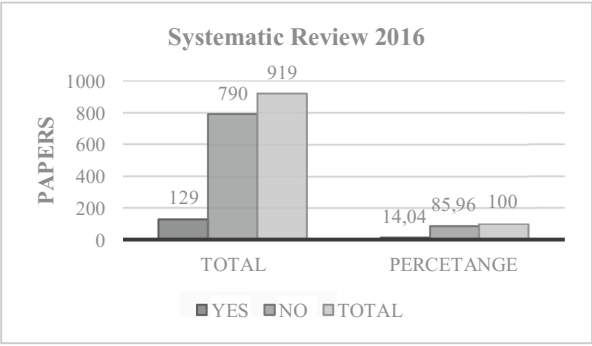

Fig. 2. Papers accepted in the systematic review

The papers included in the mapping of the systematic review were 129, which met the inclusion criteria and are relevant to answer the initial questions of the systematic review. These papers belong to the defined databases. The general summary of accepted and rejected papers by databases are detailed in Fig. 3.

According to the information obtained in the mapping of the systematic review of articles obtained in the databases, 129 articles were accepted, 790 were not accepted

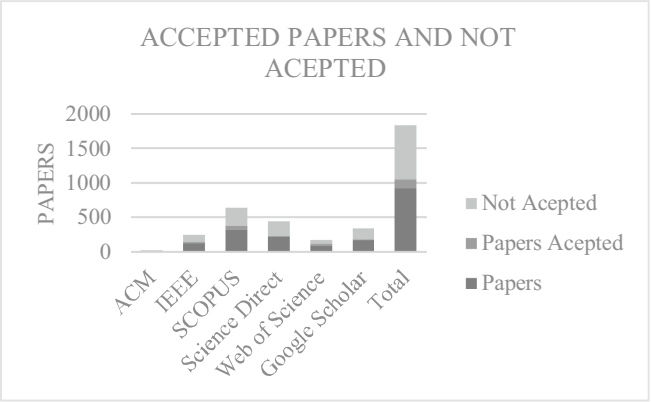

Fig. 3. Accepted and not accepted papers by database in the systematic review

and 184 articles were duplicated in the search results of the databases. The distribution of the papers according to the language in which it was written can be seen in Fig. 4.

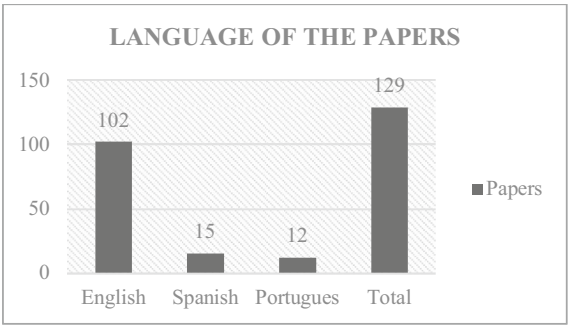

Fig. 4. Language of the papers accepted in the systematic review

4 Data Analysis and Results

Based on the 129 accepted papers in the mapping of the systematic review, most of them were found in Scopus, Web of Science and IEEE databases were 90% of accepted papers are there. In the other databases (ACM, Science Direct and Google Scholar) is the remaining 10% of the systematic review.

In the systematic review, the results of the papers were classified according to the models, methodologies and the TIC. Table 4 presents the classification of papers (Fig. 5).

The results obtained in the systematic review allowed to obtain results related to the models, methodologies and strategies integrated with ICT. These results present a great variety of topics, The results are detailed in Fig. 6.

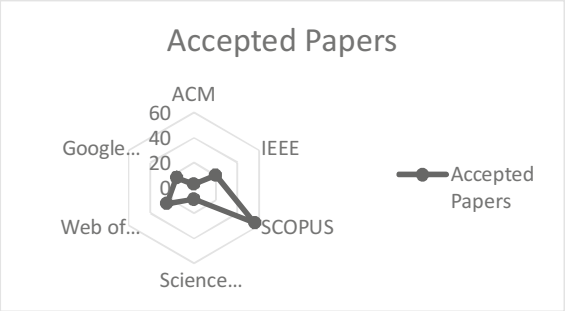

Fig. 5. Dispersion of the accepted papers

Table 4. Classification in the topical models, methodologies and ICT of the papers

Topic	Papers	Percentage
Integrated model	38	29%
Integrated methodology	20	16%
ICT	71	55%
Total	129	84%

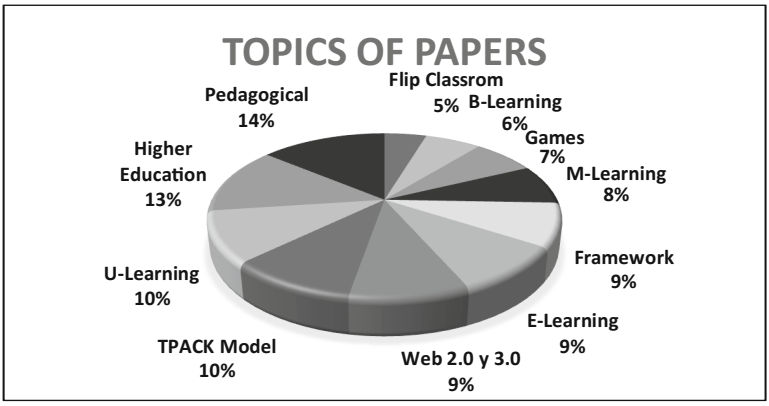

Fig. 6. Classifications of the topics papers

The papers found present different models that have integrated ICT with education. In the review, we found interesting models such as the TPACK which is a model that identifies the types of knowledge in ICT that a teacher must have to impart the teaching process effectively. In this same sense we can see the combination of pedagogical strategies in higher education supported by ICT, as well as the integration of education technology with ICT through E-Learning, M-Learning and U-Learning [14].

The research questions initially raised in the systematic review are presented in the tables and figures above. The answers to the questions guide the research of the doctoral project to a new systematic review more specialized and specific. For each review question the answers were found.

RQ1: We found models that integrate educational strategies and ICT, these models are specific and there is no general model that defines an integration. The models most important in the systematic review are: TPACK Model, Mobile Learning and Technology Acceptance Model TAM, A Maturity Model for Assessing the use of ICT, The eSG Project: A Blended Learning Model for Teaching Entrepreneurship Through Serious Games, Development of Instructional Model Base on Connectivism Learning, E-Inclusion Modeling for Blended, social ecological model analysis for ICT integration, Ubiquitous Learning: teaching modeling and simulation with technology, A cloud model for effective e-learning, innovate web 2.0 based collaborative learning and study circle model, a hierarchical model for e-learning implementation challenges using AHP and A conceptual framework for enhancing the motivation in an open learner model learning environment, the flipped classroom model at the university

RQ2: We found methodologies that integrate educational strategies and ICTs in a specific way, however in the revision there is no methodology that defines the specific steps of how to integrate education and ICT. The methodologies most important in the systematic review are: An additional content development methodology in an adaptive agent based e-learning environment, The Evaluating of Integration of ICT in Higher Education: Foundation for a Methodology, Parallel virtual urban workshop: A 'reasonable-cost' methodology for academic internationalization in problem-solving oriented postgraduate subjects and Web 2.0 tools for role-play methodology in an undergraduate interdisciplinary environment

5 Conclusions and Future Works

The selected papers are the first part of the state art in the project of a doctoral research where the purpose to design a U-Learning model based on the experiences of learning and connective learning in virtual higher education [13, 15]. This first part includes all the information relevant to the models, methodologies, strategies integrated with information and communication technologies, which are the theoretical basis of the integration model to be proposed in the U-Learning model [16].

According to the systematic review, no model was found that generally indicates the guidelines of how to integrate information and communication technologies with education focused on U-Learning [9], just models, methodologies and strategies were found for specific cases but not a general model that integrates ICT and connective learning [17, 18] into U-Learning [16].

The new systematic review will be focus on the topics of U-Learning, Connective Learning and Learning Experiences [19, 20], since they are the themes that will be taken as the basis of the integration model proposed in the research [13]. The integration will be made based on the integrated models and methodologies that were found in the systematic review carried out.

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ICT Training and Pre-service Teachers: Embracing the Challenge at Master's Level

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Abstract. In Portugal, the legal framework for Initial Teacher Education stipulates that MA programs must cover the following five domains: (i) Subject Area, (ii) General Educational Sciences, (iii) Subject Didactics, (iv) Socio-Cultural Content and (v) Pre-Service Training. Given that Educational Technologies are not explicitly included, Higher Education Institutions can decide whether to offer ICT training or not, contradicting the widely-held view that Educational Technologies should be an integral component of Initial Teacher Education. The goal of this paper will be to investigate how the Portuguese legal framework has had an impact on the inclusion of ICT in Initial Teacher Education. We will analyse a wide range of MA Programs currently being offered at Portuguese universities (for Initial Teacher Education in Middle and Secondary Education) and provide evidence which shows that universities are failing to provide pre-service teachers the necessary training to help them embrace Educational Technologies in their future teaching practice.

Keywords: Educational technologies · Pedagogical innovation · Initial teacher education · Pre-service teachers

1 Introduction

The role of Educational Technologies within Initial Teacher Education has been at the center of the educational agenda over the past decade, as can be documented by international reports, such UNESCO (2011, 2013), or European Reports, such as (Eurydice 2011). The scientific community has also been repeatedly highlighting the need for an early training in Educational Technologies and their application to the Subject or Content Areas (Brush *et al.* 2003; Kay 2006; Koehler and Mishra 2009). There is a general consensus that raising awareness of the potential of ICT in the classroom plays an essential role in ensuring that teachers make an adequate use of ICT after their pre-service training (Kirschner and Selinger 2003; Tondeur *et al.* 2012, Ottenbreit-Leftwich *et al.* 2010; Sang *et al.* 2010; Voogt *et al.* 2013).

While researchers and non-governmental agencies fully agree that young teachers need to become familiar with ICT during their early training, the inclusion of Educational Technologies within Initial Teacher Education does not seem to enjoy overall governmental support (Eurydice 2011). Within a European context, Rizza (2011) points out that while it is compulsory in some countries, in other it is not. In Portugal, for

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example, the integration of ICT within Initial Teacher Education MAs is optional. The recent legal framework - known as *Decreto de Lei 79/2014* - defines the course contents of MAs in Initial Teacher Education in Portugal, but provides no explicit guidelines about the role of Educational Technologies, assigning Higher Education Institutions autonomy on this matter.

In 2015-2016, newly created MA programs began to run nationwide, implementing the requirements of this legal framework. However, very little is known about the extent to which ICT training is currently being offered by Initial Teacher Education MAs at Portuguese Universities. The goal of this paper therefore will be to investigate the impact of the *Decreto de Lei 79/2014* on the inclusion of ICT in Initial Teacher Education Programs.

Underlying our comparative survey is the assumption that a clear picture of the ICT training provided by pre-service MA programs is needed in order to assess the need for complementary training within Higher Education Institutions. The structure of this paper is as follows: Sect. 2 sets the background of this paper. Section 3 offers an outline of the methodology adopted for our survey. Sections 4 and 5 report on the findings and discuss the results, respectively. Section 6 offers a short conclusion.

2 Background

In a number of European countries, the inclusion of Educational Technologies in Initial Teacher Education is mandatory. As pointed out by Caena (2014:12), in Spain "ICT is compulsory in ITE for all levels of schooling; a mixture of theoretical and hands-on approach should enable teachers to use ICT in the classroom, reflect and investigate". Also in the case of Switzerland, the same report states that "digital competences are considered as key, and integrated in the ITE curriculum as compulsory; ITE providers often have their own Media Centres for resources and support". Not all countries however have such an explicit strategy. In Greece, the measures have mainly been taken at the level of vocational teacher education (or continuous education). As Rizza (2011:8) explains, in this country different measures have been taken to improve in-service training of ICT skills, but the inclusion of ICT in Initial Teacher Education is not addressed". As we will see next, this is also what we find within the Portuguese context.

As part of a very rigid legislation, the Portuguese Ministry of Education stipulates the scientific domains that MAs for Initial Teacher Education must offer. There are five scientific domains:

(i) Subject Area,
(ii) General Educational Sciences,
(iii) Subject Didactics,
(iv) Socio-Cultural Content, and
(v) Pre-Service Training.

Given that Educational Technologies are neither explicitly contained within these mandatory domains, Higher Education Institutions in Portugal have the freedom to

decide whether to include them as part of their MA programs. According to the OECD criteria, Portugal has been classified as a 'Category 1' country:

> "(…) countries in which there is a lack of relevant information regarding the ways in which ICT is addressed in initial teacher education. This means that either no relevant information was found or the findings suggest that no specific policy in regard to ICT and initial teacher education has been formulated." (Rizza 2011:7).

Given that universities may choose to offer very little or no training at all, our goal will be to investigate the extent to which the autonomy allowed by the legal framework has affected MA programs. The question addressed in this study therefore is the following:

- How much training in Educational Technologies is offered to pre-service teachers by the newly created MA Programs?

3 Methodology

To answer our research question, we carried out a qualitative study which is based on the analysis of MA programs for Initial Teacher Education at Portuguese Universities. To narrow down the range of MAs available in Portugal, we focused more specifically on MA programs for English Language Teachers in Intermediate and Secondary Education.

3.1 Materials

In Portugal, MAs offering Initial Teacher Education for English Language Teachers in Intermediate and Secondary Education can be of two kinds: (a) MA programs in English Language Teaching (MELT) and (b) MA Programs in English Language Teaching combined with another foreign language (MEAFL). For our study, we searched for Higher Education Institutions which offer these MA programs and found nine master's degrees at six Portuguese universities.

Our corpus therefore comprises the course structure of nine MA programs. To preserve the anonymity of the universities, we have assigned an alphanumeric code to each one, as shown on Table 1. While some universities offer only one the MEAFL MA program, others offer both the MEAFL and the MELT.

The data was collected by using two types of sources: (a) online information provided by higher education institutions and (b) online information accessible only to teachers and students. This means that the data was not complemented with surveys or with semi-structured interviews. However, it should also be clarified that the information collected through online sources proved sufficient for this first pilot-study.

Table 1. Accredited portuguese MA programs in English language teaching (MELT) and MA programs in teaching English and another foreign language (MEAFL)

MA program	University
MEAFL	U1
MEAFL	U2
MELT	U2
MEAFL	U3
MEAFL	U4
MELT	U4
MEAFL	U5
MEAFL	U6
MELT	U6

3.2 Procedures

All nine MA programs were examined with the aim of identifying the extent to which they offered training in Educational Technologies. In our analysis of the MA programs we applied the following parameters:

- Parameter 1: The MA program offers Educational Technologies.
- Parameter 2: Educational Technologies are offered as an independent course module.
- Parameter 3: The course module or course contents are exclusive to the Subject Area (i.e., English as a Foreign Language).

Parameter 1 is aimed at determining whether MA programs offer Educational Technologies or not. The goal of Parameter 2 is to identify whether training in Educational Technologies is offered as an autonomous course module (side-by-side with other course modules) or whether it is offered as part of another course module. Parameter 3 establishes whether the course module or the course contents are specific to English Language Teaching MAs or available to MA programs from other Subject Areas.

4 Results

The results of applying the three parameters to our corpus are shown in Table 2. Overall, the results reveal that Higher Education Institutions effectively adopt different strategies for the inclusion of Educational Technologies in Initial Teacher Education.

PARAMETER 1 shows that only five MA programs (out of nine) offer training in Educational Technologies, namely U1, U3, U4 and U6. It is clear that universities do not assign the same relevance to Educational Technologies in Initial Teacher Education. In addition, this parameter also reveals that, within the one and the same university, Educational Technologies may receive differential treatment. So, while U6 offers two MA programs in English Language Teaching, training in Educational Technologies is only offered in one of them.

Table 2. The inclusion of educational technologies in MAs in English language teaching (MELT) and MAs in teaching English and another foreign language (MEAFL).

MA program	University	Parameter 1: ICT contents	Parameter 2: ICT Course Module	Parameter 3: ICT module exclusive to MA English programs
MEAFL	U1	√	√	–
MEAFL	U2	–	–	–
MELT	U2	–	–	–
MEAFL	U3	√	√	–
TEAFL	U4	√	–	–
MELT	U4	√	–	–
MEAFL	U5	–	–	–
MEAFL	U6	–	–	–
MELT	U6	√	√	√

PARAMETER 2 shows that (among the five MA programs that offer Educational Technologies) only three integrate it into their curriculum as an autonomous course module, but as PARAMETER 3 indicates only one MA program (namely, MELT in U6) offers Educational Technologies applied to one specific Subject Area, while U1 and U3 offer Educational Technologies irrespective of Subject Areas. From this observation it follows that the link between Educational Technologies and Content is not a priority, this going against the Koehler and Mishra (2009)'s TPACK model (Technological Pedagogical Content Knowledge) which is grounded on the inseparable combination of technologies, pedagogy and content area.

Based on our results, we conclude that there are three scenarios for the inclusion of Educational Technologies in the MA programs surveyed: (a) training is not available (6/9), (b) training is available as a compulsory module, but not specific to any specific subject area (2/9), and (c) training is available as a compulsory module for English language teaching (1/9).

Additional information emerges from our data which shows that Universities struggle to decide how to classify Educational Technologies within the five scientific domains defined by the Portuguese legal framework (see Sect. 2). What we observe is that U1 and U3 (i.e., the Universities which offer Educational Technologies as an autonomous compulsory module) differ with respect to the scientific domain to which they associate this module. As Table 3 shows, U1 assigns the course module to the domain 'General Education Sciences', whereas U3 associates it to the domain 'Subject Didactics'. Such difference clearly indicates that the very design of the *Decreto de Lei 2014-79* is far too rigid to accommodate the interdisciplinary nature of Educational Technologies, as proposed by Koehler and Mishra (2009) for the TPACK module.

5 Discussion

The results shown in the previous section, more precisely in Table 2, are rather surprising, bearing in mind the numerous studies highlighting the benefits of showing

Table 3. Educational technologies as a general course module for MAs in initial teacher education at U1 and U3

MA program	University	ICT module extensive to all MA programs	Domains
MEAFL	U1	√	General Educational Sciences
MEAFL	U2	–	–
MELT	U2	–	–
MEAFL	U3	√	Subject Didactics
TEAFL	U4	–	–
MELT	U4	–	–
MEAFL	U5	–	–
MEAFL	U6	–	–
MELT	U6	–	–

young teachers the educational potential of ICT in their early stages of pre-service education. As numerous studies have observed, initial teacher programs help young teachers develop pedagogically adequate uses of Educational Technologies through exposure and explicit training (Brush *et al.*, 2003; Kay, 2006; Kirschner and Selinger, 2003; Tondeur *et al.*, 2012, Ottenbreit-Leftwich *et al.*, 2010; Sang *et al.*, 2010; Voogt *et al.*, 2013).

Supporting the need for an early exposure to ICT is also the observation that pre-service teachers, who are generally quite familiar with the social use of digital resources, may not necessarily be aware of their educational potential or the ways in which such resources can enhance teaching and learning (Dudeney 2007). As Hockly (2013) concludes, students who are hesitant about the benefits of using digital resources in language learning (except for the use of electronic dictionaries and online translators) will change their perception after exposure to mobile-enhanced lessons.

More reasons for ICT training during Initial teacher Education is the growing number of digital resources that become available annually. For example, Bárcena *et al.* (2003) estimate that in 2015 there were approximately 1,5 million Apps available, most of which can be put to educational uses, while many have been specifically created for language learning purposes. In addition to the sheer abundance of digital resources, challenges emerge from the need to select digital resources on the basis of the specific language skills they are aimed to develop, Kukulska-Hulme *et al.* (2015), on the one hand, and the need to use of such resources in a pedagogically sound way.

With respect to pedagogy and ICT, there has been a growing concern about the need to replace traditional teacher-centered practices with student-centered ones. In their guide for English language teachers, Kukulska-Hulme *et al.* (2015) observe that "(m)obile-assisted language learning is not simply the transfer of current teaching and learning materials and practices to a mobile device, but a complete reconceptualisation of these." As such, they propose a pedagogical framework for the careful use of mobile devices and the effective design of learning activities. All these aspects clearly support the need for explicit training of ICT skills within an educational context.

6 Conclusion

This paper has provided arguments in favor of the inclusion of Educational Technologies in Initial Teacher Education programs. In Portugal, however, such decision is taken independently by Higher Education Institutions, as a result of the Portuguese legal framework for Initial Teacher Education (*Decreto de Lei 2014/79*), in which Educational Technologies are not part of the compulsory scientific domains. Currently, many Higher Education Institutions are failing to provide pre-service teachers the necessary training to help them embrace Educational Technologies in their future teaching practice. This contrasts significantly with international initiatives which are aimed at promoting the socialization of future teachers with educational technologies at pre-service level (Caena 2014), instead of relying solely on the ICT training which teachers may choose to take (or not) during their teaching career.

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The Future of Higher Education – Students' Views About Challenges Promoted by Technologies

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Abstract. Higher education institutions are, at this moment, receiving students known as digital natives. These persons are highly technological and lack the patience to be co-enrolled in a traditional classroom. Taking into consideration these characteristics it is necessary to propose an educational reform to allow an immersion, interaction, or critical thinking. With the purpose to study these factors we asked ourselves some questions: "Is higher education taking into consideration the needs and expectations of the students regarding the use of technologies?"; "Are technologies being used in the classroom?"; "Are teachers using them?" and if not, why? In this paper we present a study done with students, from different programme of studies, and where we try to contribute to the discussion of the questions formulated before.

Keywords: Higher education institutions · Digital natives · Generation Z · Technologies · Education

1 Introduction

Students that arrive now in higher education are those for whom the 9/11 is history. For them, the world is a place where a conversation can be anywhere and at any time. They are a group which fully uses social media for contact and being in touch. Prensky calls them the "*digital natives*" [1]. These youngsters have grown up in an immersive computing environment. They come to class armed with smartphones, laptops and iPods. And this has significant implications for higher education, namely for teaching methodologies. And although we know that this generation is highly technological, the reality is that when they enter higher education, most of the times they find a more traditional way of teaching, with lectures of 45 min, a minimum use of technology and teachers belonging to other generations, most of the times to generation X, meaning not so at ease with technologies. Very often we hear that the only interest of generation Z is technology and social networks and that they cannot live without their smartphones. And this gap leads to some maladjustment. As a matter of fact, in [2] proponents for educational reform argue that students are disengaged from the learning process and that

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traditional lecture-based courses do not encourage student immersion, interaction, or critical thinking [3].

On the other hand, technology is changing the way universities teach and students learn [10]. Besides the emergence of distance education, there are several technologies and strategies that can be used in education – Computerized Grading, Electronic Textbooks, Simulation Technology, Gamification, Flipped Classrooms, Active Learning Classrooms, Massive Open Online Courses, Collaborative Distance Learning Environments, the Active Learning ForumTM platform, and Learning Management Systems. According to [10], technology had and will continue to have a significant impact on higher education, online learning is gaining a firm foothold in universities around the world, corporate-academic partnerships will form an increasing part of the university experience, university view technology as having a largely positive impact on the campuses and higher education is responding to globalization. So it seems that technology is being fully exploited in higher education and fully used by teachers.

The scenario describe above seems a bright one. However, it hides some pitfalls. The need to motivate teachers to use technology in the learning process is not new. In a report from the OECD in 2003 [4] it is stated that already at that time the Bournemouth University was using incentives to encourage teachers to adopt online learning. Among the strategies used there was the funding for learning and teaching projects, a Learning and Teaching Fellowship Scheme, the creation of a Centre for Academic Practice to focus on pedagogic research, payment for membership of the Institute for Learning and Teaching in Higher Education, and a staff development programme for Programme Leaders. Although the positive example described, this is not yet a generalized one. There are still countries/schools/teachers – in particular in higher education – that are not taking fully advantage of the use of the technologies in the learning environment.

Nevertheless, the implementation of technologies in education seems to be an important matter. For instance, the UNESCO [11] and the European Commission [12, 13] is still encouraging the use of technologies in education, namely the development of digital contents that should be open and available to everyone.

The questions that we ask ourselves at this point is “is higher education taking into consideration the needs and expectations of the students regarding the use of technologies?”; “Are technologies being used in the classroom?”; “Are teachers using them?” and if not, why?

In this paper we present a study done with students and where we try to contribute to answer the questions formulated before. The paper is organized as follows: in the next section we characterize generation Z as well as the technologies in education, and the challenges teachers are facing with their introduction in the classroom and in the pedagogy. Section 3 presents the research design and Sect. 4 the results and its discussion. We conclude with the summary of the main findings as point directions for future research.

2 Backgroud

2.1 Generation Z

Generation Z are called "*digital natives*" as an attempt to describe their relationship with technology. They are also very engaged with parents, teachers and others. Zers are less likely to resist authority relationships than Gen Yers did, but will only perform for individuals when they are engaged in intensive working relationships (motivation) (human connection). This generation more than any other suffer from the growing gap between the highly skilled and the unskilled. The technical skill gap is huge, but the nontechnical skill gap is even more pervasive. Managing Generation Z requires a huge remedial effort on broad transferable skills like work habits, interpersonal communication, and critical thinking and a huge investment in remedial technical training (skills gap).

This generation also knows more parts of the world than Gen Yers ever did, but they are likely to be far less geographically adventurous. They are plugged into the boundary less world on-line but the key to engaging them in their environment tactically is a relentless focus on the local (personalization) (global mind, local reality). The emerging Generation Z reflects a whole new way of thinking about difference. Again Generation Y was the transition, Gen Z is all the way there. They are less likely to fall into previously recognized categories and much more likely to be mixing and matching various components of identity and points of view that appeal to them. They are ever creating their own personal montage of selfhood options (infinite diversity).

2.2 Technology in Education

The ideal school is the one that meets the students' needs and expectation [5]. However, the ideal school may also mean different things to different authors, leading us to think that we need to rethink learning spaces and curricula. Ryshke [5] states that an ideal school environment is the place where the student's success is a complex goal to achieve, because it is necessary to use many tools to measure and accomplish the teaching-learning process. If teachers are going to meet the needs of all students, they must build a toolbox of strategies that is geared towards diverse learners and learn how to work effectively with each students. The idea brought forward in [5] is discussed and analyzed systematically in [6].

In a study, Lynne Jump [7] state that "*whilst there is plenty of evidence that computers and the internet have affected many aspects of daily life, there is also evidence that the use of digital technology is less embedded within university teaching*". Her results show that lecturers use technology to increase the satisfaction of their students, improve their learning or to mediate changes in their learning behaviour, and they are more likely to achieve this by using technology to teach more. Moreover, the skills and professionalism of the lecturer are key determinants of student satisfaction when technology is used to enhance their learning. According to [10], the use of technologies created wider access to education, new markets for content and expanded revenue opportunities for academic institutions. Additionally, the results of this study reveals that sixty percent of those polled say that the technological change occurring in our midst will alter the perception

of the college campus from a one dimensional (physical) concept to a multi-dimensional (physical and online) one. And this may mean that the physical learning environment is not confined to the 4 walls of the classroom anymore. Changes can be seen in the channels used to deliver education (online degree programmes and distance learning), in the campus administration (social-networking tools are helping to build connections with alumni and support career service activities. E-marketing campaigns expand the reach and success of recruiting and fundraising efforts, and drive down the cost of direct-mail campaigns. And automated, self-service programmes reduce administrative requirements, streamline course registration and enhance academic life) and also in the way teachers teach (the approaches used by the teacher to teach).

Online-collaboration tools, software that supports individually paced learning, and learning-management systems are among the communications technologies most expected to improve academics over the next five years. Web 2.0 technologies (wikis, instant messaging and social networking—which have been influential in improving connectivity in many settings and are in use now at a large number of institutions) are expected to decline in use over that period. Collectively, such advances may lead to profound changes in the way courses are taught [10].

As for the role of the teacher, it may evolve from an instructor to a mentor. And this paradigm shift offer a huge potential for increasing the quality of teaching. For instance, in the increase of interdisciplinarity, collaboration among students from multiple institutions and the possibility to offer customized degree programmes. Inside the classroom, technology may be a disruptive innovation. Other results show that pervasive multitasking between laptop, smartphone and other technologies in the classroom often distracts students. This can be true even in highly disciplined institutions like the US Military Academy at West Point [10, p. 14]. Another consequence may be the increased use of new technologies in the classroom with a rise in plagiarism and cheating [10, p. 14].

3 Research Methodology

The purpose of this section is to describe the procedures used to collect data that are the basis for this research. For the present study, we used the methodology of quantitative research, since it is more appropriate to determine the opinions and attitudes of the respondent based on structured questionnaires.

Data collected for quantitative research through the use of questionnaires requires special care because it is not enough to collect responses about the issues of interest, it is also important to know how to do statistical analysis for proper results validation. Aspects such as the sample size, the way the questionnaire is prepared, the questions formulation, data analysis, error margins, the selection of individual process of who should compose the sample, among other things, are important and they should be taken into account for any investigation [8]. This method is recommended when you want to know a population, to analyse social phenomena and, in cases where it is necessary to inquire a big number of people about a certain subject. The questionnaire before being delivered was subjected to the evaluation of four experts in the field.

The Research question that we will try answer is "*What are the expectations of students concerning the use of technologies in the classroom?*"

We developed a questionnaire with 4 groups of questions. The group 1 comprises questions to characterize the sample, the group 2 questions about the education system (includes questions about social media, interaction, the use of technology in the classroom and by teachers), group 3 questions about global mind and local reality and group 4 infinity diversity. The questionnaire was administered to youngsters and 349 answers were obtained. Data collected were pooled and treated by using the IBM SPSS Statistics 24.0 software.

4 Analysis and Discussion of Results

The study sample consists of 337 students that answered the questionnaire. 97,6% of these were born in the decade of 1990 and the remaining 2,4% were born in the decade of 1980, 96,2% are still studying.

The respondents distribution by programme of studies is the following (see Fig. 1).

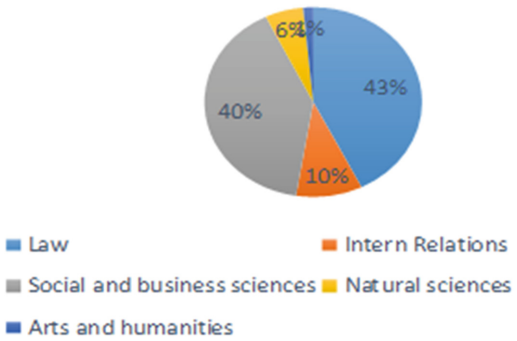

Fig. 1. Distribution of respondents by programme of studies.

The majority of respondents (84%) replied they prefer face2face learning methods. Only 12,3% said preferring b-learning method. The remaining respondents didn't reply. The majority (96,2%) also said to have a smartphone.

Youngsters were also asked which social media they use daily. Figure 2 shows the answers.

Other social media also referred by a minority of respondents were Twitter (21 answers), Skype (5 answers), YouTube (3 answers), Viber (2 answers) and then Pinterest, Outlook and Tinder with one answer each.

Youngsters were then asked if their teachers use social media in the learning process. The majority replied "No" (71,8%). Only 27,5% said "Yes". We asked then which one do the teachers. Figure 3 shows the results.

Figure 4 reveals the importance of interaction in its different formats. Respondents could choose between 1 and 10 where 1 was not important at all and 10 was very important. As we can see for the question "How important is social interaction for you?" the

answers are concentrated more between 6 and 10 (important and very important. For the question "How important is online interaction for you?" answers are more concentrated between 4 and 8 (important and not so important) while answers for the question "How important is online interaction, when offline, for you?" the answers are even more distributed. This leads us to think that interaction is important for this generation. They value online interaction but when offline, they focus on the offline relations.

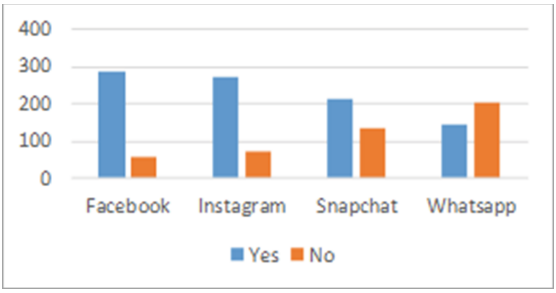

Fig. 2. Operating Social media daily used.

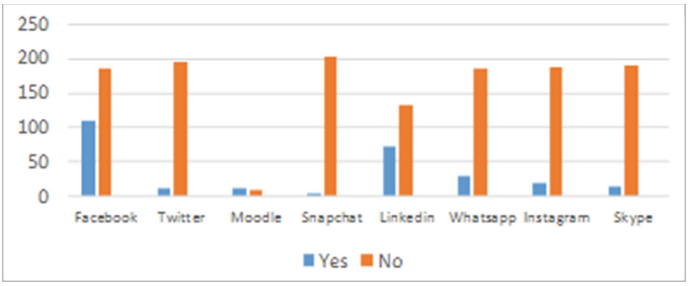

Fig. 3. Operating Social media used by teachers.

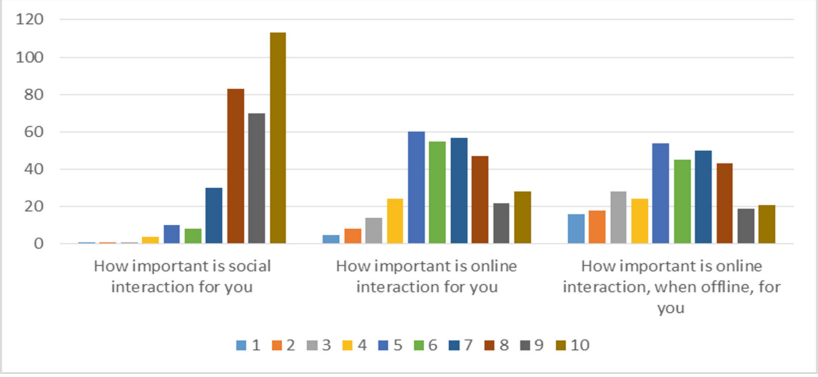

Fig. 4. Importance of the difference formats of interaction for youngsters.

When asked if they like to interact online with teachers and colleagues, 82% say "Yes".

Respondents were also asked in which situation they use technology. Table 1 presents the results.

Table 1. Situation where students use technology.

Why students use technology?	Number of answers
Information sharing	12
Study/ do homework (Moodle)	168
Leisure	21
Social networks	2
Email	10
Search	13
Download programs	1
Analysis of documents	4

As for the scientific areas where students use technology, results show they use it in all areas (methodology, law, finances, management, accounting, English, cinema, music, translation, marketing, digital marketing, accounting, photography, medicine, biological science).

By comparing Fig. 3 and Table 1 one can see something at least curious. In Table 1 respondents say they use very often Moodle to "Study/do homework (Moodle)" with 73% of the answers, while in Fig. 3 students say that teachers rarely use Moodle. However, if they use Moodle to "Study/do homework (Moodle)" this means that teachers communicate with them via Moodle. This leads us to think that there is some difficulty for teachers to transmit correct message concerning the use of the technology in the teaching-learning process when we are with a generation that has and uses technology most of the time (96,2% has a smartphone).

When asked if they would like their teachers to use technology as a support to the learning process, the majority (96,5%) say "Yes". As for how could technology be used by teachers to support the learning process, respondents said: In projects (22 answers), to support the study (31), to motivate students (28), to clarify doubts (22), to improve information sharing (21), to provide lessons (5 answers), to motivate students (5), to clarify doubts (12 answers), reduce costs (1), 3D images (1), to evaluate students without pressure (2), to facilitate communication (2), virtual lessons (1), watch videos about the content of lessons (3). Other answers are related with to improve exemplification, innovation, reduce costs, global development, and facilitate looking for a job.

The reasons why youngsters think teachers do not use technology were also asked. Answers are shown in Table 2.

Another aspect that might be interesting are the reasons why youngsters think teachers do not use technology. Students say that "Teachers have the competences but do not have time" and "The content is not adequate for the technologies", with 34% and 23% (57%), respectively. One can conclude that the students have the perception that teachers know how to use the technology but the overall process is not adequate so these

Table 2. Reasons why teachers do not use technology.

Why teachers do not use technology	Number of answers
Teachers do not have the necessary competences to do so	13
The program is very long	31
Teachers have the competences but do not have time	83
Technology should not replace face to face contact	1
The content is not adequate for the technologies	57
Teachers have the competences but are not confident enough	28
There are no technological tool adequate to the content	32

"technological" students include it in a formative natural process. To confirm this statement and the previous results, 84% of the students prefer face2face methods and only 12,3% prefer b-learning.

It is interesting to see how these results compare with ones from other similar studies. Shelton [9] studied why teachers give up using technology and social media, even when the technology is a recent one. Results show that this happens when a new technology appears and so the "old" one is replaced by the "new" one. Another factor may be related with the challenges that new technologies represent to teachers. And this may encourage teachers to abandon a certain technology and replace it by another one. The abandon may also be explained with the lack of success of students when a teachers uses a certain technology. So the "fault" of lack of success is given to the technology (and not to the method used). The lack of response of students on the use of a technology can also contribute to the decision of not using it anymore (ex: forums, blogs, etc.). This may mean that together with the focus on the student as far as the use of the technology is concerned, we also need to concentrate efforts on the teachers and on how the teacher can and should use the technology as a pedagogical tool. As a matter of fact it is not enough just to have the technology at the teacher's disposal. He/ needs to know how to use it with the students and with pedagogical purposes.

When asked if they have already participated in an online or b-learning course, the majority (87,9%) said "No".

When asked which factors are more important in a course, answers are distributed as in Table 3

Results obtained concerning the importance of the factors in a course show that there is a tendency to select 3 factors: "Employability of the course", "Access to job market" and "Reputation of the school", with 21,2%, 19,4% and 15,8% (56,4%), respectively. These results show that students have a perception slightly biased since they do not understand that, by principle, the reputation of a school may lead to a better employability.

Almost one third of these youngsters already had worked with people from other countries (64,4%). The remaining said "No". When asked in which context they had worked with people from other countries, the majority said they were in their class. (37,7%). Other answers were "they were in their school" (29,2%) and "they were in their own countries" (29,9%).

Table 3. Important factors in a course.

Important factors in a course	Number of answers	(%)
Flexibility of time	151	11,9
Reputation of school	201	15,8
Partnerships of the school	117	9,2
Space flexibility	36	2,8
Possibility to interact with colleagues	78	6,1
Employability of the course	269	21,2
Quality of teachers	170	13,5
Access to job market	247	19,4
Like of area	2	0,2

The platforms used to communicate or interact mostly used were Facebook (43%), Skype (39,1%) and WhatsApp (11,6%). 95,3% of the respondents would like to have an international experience with students from other countries.

As final comments, we can say that students prefer face to face method of learning. There are students that still do not have smartphone, but it's only a minority. The Facebook and Instagram are the social media more often used by the students. Teachers do not use social networks in the learning process. Students give importance to social interaction. Students use technology to study and do academic works and they like to use technology in the lessons. The main reasons for the teacher not to use the technology in the classroom is because he/she does not have time. The majority of students never did an online course. The main reasons to choose a school are "Reputation of school", "Employability of the course" and "Access to job market". The majority of students never had had an international experience; but they would like to have one and finally, Facebook and Skype are the platforms used to communicate with people in other countries.

5 Conclusions

The ideal school, or School ideal has been studied and researched for many years. Technology brought and created new opportunities and challenges in the prosecution of the objectives delineated at the beginning. As a complement, the generation that today arrives to higher education is, supposedly, better well equipped with technological tools (hardware e software) from the point of view of the user for personal and/or leisure use. In this context the question is to understand the "Why", at least for the 337 students that participated in this study, they prefer face2face teaching methods

As a conclusion, although students recognized that teachers know how to use technology, there is a lack of catalytic and inductive models to use technologies in the teaching-learning process allowing this use to become natural while individual and customized.

As future work we need to investigate the perspective of teachers. Do they consider that they use technologies? And if so, what kind of technologies are they using? And

with what purposes? If not, what are the reasons and how can institutions to help them to develop the necessary skills so they become confident enough to use them properly.

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Using Single Board Computers in University Education: A Case Study

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Abstract. Information and Communication Technology (ICT) has changed the traditional way of imparting education. Use of computers and mobile devices in classrooms made the teaching and learning process more interactive. However, educational institutions across the world have not yet exploited the full benefits of developments in ICT. A new breed of computing devices, called Single Board Computers (SBC), have flooded the market. These devices are being used by technology enthusiasts across the world for developing IoT (Internet of Things) projects. In this paper, we have presented the use of a SBC named Raspberry Pi in conducting theoretical and practical classes of Undergraduate programs in IT and related fields. Our case study proves that SBCs can be used to impart education in interesting as well as environment friendly manner. This case study can be used as a basis for implementing higher education in economic way in poor and middle income countries.

Keywords: University education · Single Board Computers · Raspberry Pi · Internet of Things · Arduino, Linux

1 Introduction

Information and Communication Technology (ICT) has become the backbone of the society living in this millennium. We are using ICT to run all kind of businesses and to communicate with people living in any part of the world. We are using social media to connect to friends, relatives and other like-minded people. We are collecting information through search engines such as Google and Bing to make crucial decisions in business, administration, politics and other fields. Considering the popularity of ICT in all walks of life, it was natural for academic institutions to adopt it for imparting quality education to learners. The adoption of ICT in education made the learning process more interactive and interesting than traditional whiteboard approaches. It became easier for instructors to explain complex theoretical concepts using multimedia technology.

Development of handheld devices such as smartphones and tablets brought a new revolution in the field of education. Using these devices information could be accessed anytime and from anywhere. This provided the much needed flexibility to learners to learn at the time and place of their comfort. Mobile apps were developed to learn the same content in more interesting way. This kind of learning is termed as mobile learning,

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and it has been widely accepted by students in developed countries where the learners have easy access to handheld devices and high speed internet [1].

Computers and handheld devices, though very helpful in learning, are very costly and less environment friendly. Cost of these devices may range from hundreds dollars to few thousand dollars. This can be a costly affair for billions of learners living in low income countries. Also, consumption of electricity by these devices and subsequent emission of carbon into atmosphere is a major concern for the environment. These economic and environmental concerns compelled the researchers and entrepreneurs to develop more economic and environment friendly devices called Single Board Computers (SBC). An SBC refers to a single PC board with the processor, memory and some type of I/O that allowed it to function as a computer [2]. Initially, SBCs were having very less computation power and could be used for hobby purposes only. In recent years, relatively powerful SBCs have been developed which can be used for serious scientific, industrial and academic purposes. In this paper, we are presenting the use of SBCs for imparting quality education at low cost in University environment. The remaining of the paper is organized as follow: Sect. 2 of the paper describes developments in the field of SBCs. Section 3 of the paper discusses data collection and data processing used in this research. Section 4 presents the results and discussions related to feasibility of SBCs in higher education. Section 5 concludes the research conducted in this paper.

2 Single Board Computers

The first true SBC was developed way back in mid-1970s when "Dyna-Micro" was developed [3]. However, SBCs started gaining momentum only after the introduction of low cost, easy to use microcontroller named Arduino in 2005. Arduino is an open source microcontroller that shares the details of hardware design of the board with everyone. This provided the necessary platform for the rise of modern day SBCs. Though some good SBC were launched after 2005, SBCs got real fame only after the launch of Raspberry Pi by Raspberry Pi Foundation in February 2012. Raspberry Pi Foundation has released different models of Raspberry Pi costing between US$5 to US$35. Initial models were not very powerful, but the latest model, 3B, released in 2016 is computationally powerful enough to meet routine office and personal needs of users. Riding on the popularity of Raspberry Pi, many PC hardware manufacturers, including Intel, stated developing SBCs. Today, SBC industry is approximately U$3.5 billion industry growing at 60% CAGR [4]. These SBCs are being used for developing games [5], home automation [6], designing robots [7], etc. [8].

Internet of Thing (IoT) is a buzzword in today's technological world. Broadly speaking, "The Internet of Things allows people and things to be connected Anytime, Anyplace, with Anything and Anyone, ideally using Any path/network and Any service" [9]. All devices are expected to be networked to each other using IoT framework. SBC are expected to be the main IoT hardware components for acquiring and presenting indoor information [10]. There are already many forums and communities discussing innovative project ideas and their implementation for SOC based IoTs.

3 Data Collection and Data Processing

As stated earlier in Sect. 1, the main aim of the research presented in this paper is to determine the technical feasibility of the use of SBCs in imparting education at University level programs. Accordingly, the obvious raw data for this study is the list of courses taught at Universities and software required to conduct these courses. In order to make the study more comprehensive, we studied the details of IT courses offered for Undergraduate programs in three technical institutions in UAE. These institutions are: Khawarizmi International College (KIC), United Arab Emirates University (UAEU), and Higher Colleges of Technology (HCT). We downloaded the syllabi of 41 different courses offered in Bachelor in IT Program at KIC. UAE University offers several Bachelor programs in IT which can be divided into seven tracks. We downloaded descriptions of 96 IT related courses from UAE University. Similarly, we downloaded course descriptions of all the courses offered by Computer Information Science division of HCT. We studied the courses and their software requirements in details. We classified all the software into nine major groups as given below:

- **Operating Systems** (Windows/Linux/Mac, Windows Server R2)
- **Office Productivity Applications** (Word Processor, Spreadsheets, Presentation Software, PDF reader, Front Page)
- **Programming Applications** (Visual Studio (for HTML, JavaScript, ASP, C, C++, C#, OpenGL), NetBeans (for Java, JSP, Servlets), Python)
- **Project Planning and Management Applications** (Microsoft Visio, MS Project, IBM Rational Software Architect)
- **Database Management Applications** (SQL Server/MySQL/Microsoft SQL Server, Microsoft Access)
- **Multimedia Applications** (Photo Editing Applications, Video Editing Applications, Animation Applications, Adobe Flash Media Streaming Server
- **Networking Applications** (Network Security Applications, Wireless Network Simulation (Packet Tracer), CORE IMPACT penetration testing solution, GFL Languard automatic vulnerability scanner, TamoSoft sniffers for Wired/wireless networks, TamoSoft network content monitoring tool, VisualRoute server, WebInspect NetScanTools scanner, Password policy enforcer from ANIXIS, GFI secure e-mail server, Faststream server, Cisco Adaptive Security Appliance, Cisco security manager, Ciscoworks LAN management solution, Kerio personal firewall, RSA authentication manger 6.1 software, RSA authentication agent software, Global scape secure FTP server, Global scape secure FTP client)
- **Statistical and simulation Software** (Minitab 17, SPSS, MATLAB, Win4Lin Terminal Server)
- **Applications to design and implement electronic circuits** (Xilinx webpack, ModelSim, Xilinx chipScope pro, SMP cache simulation, Cadence EDA tools, Silvaco EDA tools, Simon CAD software, Optical design software and PC accelerator, iRoomba Education kit)

Besides the software listed in above categories, these institutions use special hardware such as Virtex-4 FX ML410 Embedded Development Platform, Labvolt trainer

circuits, Education and system development kits form Altera, oscilloscopes, signal generators, multimeters etc. Obviously these labs cannot be conducted with SBCs alone. Similarly, software applications categorized into "Applications to design and implement electronic circuits" are device specific. Therefore, we shall exclude these labs from our discussion.

4 Result and Discussion

In this section, we shall describe how all the software applications required to run courses in IT and related area can run using SBCs. We selected Raspberry Pi Model 3B as our SBC to run these software applications. Raspberry Pi 3B was launched in February 2016. It is a credit card-sized computer that can be plugged into TV and a keyboard [11]. It can be powered via micro-USB connection like mobile phones or tablets. This model costs US$35, uses a 35 1.2 GHz 64-bit quad-core ARM Cortex-A53 CPU, has 1 GB RAM, integrated 802.11n wireless LAN, and Bluetooth 4.1.

Operating Systems: The Raspberry Pi supports several distros of Linux operating systems. Raspbian, a Debian based Linux operating system, is officially supported default operating system for Raspberry Pi. Raspberry Pi supports other operating systems such as Ubuntu Mate (https://ubuntu-mate.org/Raspberry-pi/), Snappy Ubuntu Core (https://developer.ubuntu.com/en/snappy/start/#snappy-raspi2), Windows 10 IOT Core (https://developer.microsoft.com/en-us/windows/iot/Downloads.htm), Open Source Media Core (https://osmc.tv/), LibreELEC (https://libreelec.tv/), PiNet (http://pinet.org.uk/), RISC OS (https://www.riscosopen.org/content/downloads/Raspberry-pi), and Weather Station (https://downloads.Raspberrypi.org/weather_station/images/weather_station-2016-03-24/). Till the writing of this paper, there is no support for Mac OS from Raspberry Pi.

Office Productivity Applications: Microsoft Word, Excel, and PowerPoint are most used applications in home and academic institutions. However, these are paid software. LibreOffice (https://www.libreoffice.org/) is default office application suit in most of Linux distributions designed for SBCs including Raspberry Pi. It is a free and powerful alternative to Microsoft office suit. Adobe acrobat pdf reader is most widely used PDF reader in Windows environment. There are many alternatives of Acrobat PDF readers available in Linux. However, we chose Qpdfview for Raspberry Pi. Qpdfview (https://launchpad.net/qpdfview) is a simple but powerful tabbed document viewer. It provides many features including annotation of the pdf documents. Linux on Raspberry Pi supports all major browsers such as Google Chrome, Firefox. The default browser in Raspbian Operating system is Epiphany browser (https://launchpad.net/ubuntu/+source/epiphany-browser).

Programming Applications: The Raspbian operating system, with its strong community base, can support a large number of development tools. It provides a large number of packages and Integrated Development Environments (IDEs) to write and execute programs written in languages such as C, C++, C#, OpenGL, Java, Python,

Perl, etc. We observed that all the programming languages taught in the institutions can be covered using two IDEs named MonoDevelop (http://www.monodevelop.com/) and NetBeans along with necessary packages (https://netbeans.org/). We wrote C# programs and ASP.net projects using MonoDevelop on Raspberry Pi. We wrote web based program using HTML, CSS and JavaScript in IDE NetBeans on Raspberry Pi. We also wrote C, C++, Java, and JSP codes using NetBeans on Raspberry Pi. To write computer graphics codes using OpenGL, we need to install some packages namely freeglut3-dev and messa-common-dev. After installation of these packages, any OpenGL code can be run using Linux terminal. Python is very important language being used in a lot of physical computing projects. Therefore, the Raspberry Pi provides IDE for Python 2 and Python 3 with its preinstalled operating system.

Project Planning and Management Applications: Raspbian operating system provides several project planning and management applications. LibreOffice Draw, a good alternative to Microsoft Visio for drawing process flowcharts etc., is already a part of LibreOffice suit preinstalled in Raspbian operating system. Similarly, there are many alternatives to Microsoft Project software. We installed GanttProject (https://www.ganttproject.biz/) as alternative to Microsoft Project because it is a free and open source software. We selected BoUML (http://www.bouml.fr/) as an alternative to IBM Rational Software Architect for drawing UML diagrams.

Database Management Applications: SQL Server/and Microsoft SQL Server are popular database servers in Windows environment. As these database servers are not supported in Linux environment, MySQL Server (https://dev.mysql.com/downloads/mysql/) is the best alternative database server. We installed MySQL server on Raspberry Pi to perform database operations. A very good alternative of Microsoft access is LibreOffice Base. LibreOffice Base is already a part of Raspbian Operating system.

Multimedia Applications: From our study of course descriptors of multimedia courses in academic institutions, we observed that these courses require photo editing, video/audio editing applications, and animation applications. There are many photo editing applications available in Linux. But the best alternatives matching in power to Adobe Photoshop is GIMP (GNU Image Manipulation Program, https://www.gimp.org/). Like photo editing applications, there are many video editing applications available for Linux. The most popular Linux alternative to Adobe Premiere is OpenShot (http://www.openshot.org/). There are many free animation software. But, Blender (https://www.blender.org/) is most popular as it supports 3D animation as well. We installed OpenShot and Blender on Raspberry Pi for multimedia operations. Adobe Flash Media Streaming Server costs $995 for standard version, and $4500 for professional version. One popular alternative for Adobe Flash Media Streaming Server on Linux platform is Plex Media Streaming Server (https://www.plex.tv/). We can install media streaming server also on Raspberry Pi. But, it will increase load on Raspberry Pi which already have web server, a database server and other servers installed during the research work for this paper.

Networking Applications: The academic institutions use various networking applications to achieve functionalities of small and medium networks. For the purpose of this research, we surveyed many open source network application which are supported by Raspbian operating system. One of the widely used Wireless Network simulator is Cisco Packet Tracer. The most popular open source alternative of Cisco packet tracer is GNS3 (https://www.gns3.com/) in combination with other applications such as Dynamips. One of the widely used network penetration testing software is CORE IMPACT penetration testing solution. We selected sqlmap (http://sqlmap.org/) as an alternative to CORE IMPACT penetration testing solution. We also surveyed a number of application for network functionalities such as network vulnerability scanner, sniffers for wired/wireless networks, network content monitoring tool, network infrastructure configuration parser, network security analysis, IP Scanner, network debugging tool, among others. Due to space constraint, we are ignoring the description of these tools.

Statistical and Simulation Software: Most commonly used statistical and simulation software in academic institutions are: Minitab 17, SPSS and, MATLAB. However, all of these are paid software and cannot run in Linux environment. R (https://www.r-project.org/) is a free software environment for statistical computing and graphics. RStudio IDE (https://www.rstudio.com/) is a powerful and productive user interface for R. It is a free and open source software and works great on Windows, Mac, and Linux. We installed R and RStudio on Raspberry Pi and analyzed some sample data to plot suitable graphs. Octave (https://www.gnu.org/software/octave/) is a computer program for performing numerical computations usually done with MATLAB. It is part of the GNU Project. It is a free software under the terms of the GNU General Public License. We installed Octave on Raspberry Pi and tested with sample function to generate contours. Wolfram Mathematica (https://www.wolfram.com/mathematica/) is a computational model tool. Mathematica is not a free tool but Wolfram has agreed to provide a copy of Mathematica with each piece of Raspberry Pi (http://www.wolfram.com/raspberry-pi/).

From the above discussion, we can conclude that most of the software applications required to conduct theoretical and lab classes are available in Raspbian operating system. Though we selected Raspberry Pi for our research, many other SBCs are available in the market which are equally capable as Raspberry Pi. Due to space constraints of the paper, we are not including details of those SBCs. Also, most of those SBCs are costlier than Raspberry Pi.

However, SBCs are not without drawbacks. Constrained with less powerful microprocessors and limited primary memory size, SBCs performance start degrading when we run many applications together.

5 Conclusion and Future Scope

The cost of higher education is increasing worldwide. The cost in buying the software, hardware devices, and power consumption by these devices also contribute in increasing the cost of already high running cost of institutions. SBCs are very cheap and environment friendly devices. Also, they create some sense of familiarity with hardware for

many learners who never get opportunities to look into the hardware of laptops/desktops and mobile devices. Therefore, we selected one of the popular SBC, Raspberry Pi to conduct research presented in this paper. As Raspberry Pi consumes very less electricity, it generates very less carbon into environment compared to desktops and laptops. At the same time it is, for all regular uses, as powerful as laptops. We proved that SBCs are economically and technologically viable alternatives for imparting technical educations in higher educational institutions. With the increasing popularity of IoT, the universities have to adjust their curricula to embrace more courses related to embedded systems and cloud computing. The SBCs are getting more powerful with every new model. People have started developing IoT projects using SBCs. With more powerful SBCs in future, technical institutions will be left with no choice but to use SBCs at large scale.

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Classroom and Interactivity: New Spaces with an Interactive Computer Operating System Customization

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Abstract. The Information and Communication Digital Technology has widely modified learning spaces providing greater interactivity. The use of the interactive computer involves students in it. The digital whiteboard allows them to interact with didactic resources over the classes through the dynamic touchscreen projection. These devices are used in class by teachers, who face technical problems, like the permanent installation of softwares because the current Operating System which is not definitive, i.e., restarting them, the system returns to the factory mode with a default configuration. This article aims to report a personalized process of a Free Operating System with softwares used at schools of the municipality of Fortaleza to simplify the routine. So, it wouldn't be no longer necessary for teachers to perform a new installation of the required software, allowing the use of the interactive computer in its completeness, including the digital whiteboard, providing more time to the teacher's pedagogical interventions.

Keywords: Digital didactic resources · Interactivity · Free software

1 Introduction

The Information and Communication Digital Technology (ICDT) are increasingly used in the classroom and also several education levels. That's happens because it's necessary to encourage digital natives [1]. They were born in a digital world where technology is a prevalent key in many areas.

Notebooks, datashows, tablets, smartphones, netbooks, ultrabooks and interactive computers are ICDT that excel in education. Interactive computers deserve special attention because it is a computer, a projector and a digital whiteboard that changes vertical spaces, such as whiteboards or walls, into interactive whiteboards. A projection,

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on a blackboard or wall, creates a touchscreen "screen" that allows student/student, student/content, and student/teacher interactions.

The interactive computer presents itself as an important ICDT in education, and thus it should be better exploited to promote teaching and learning, mediated by the teacher's action. For [2], contemporary students are no longer interested in exclusively expositive classes, then a question rise up from this issue: why is it important to modernize the classroom by exposing materials in an interactive way?

The National Program for Continuing Education in Educational Technology (ProInfo Integrado) was created by the Brazilian Federal Government, through the Ministry of Education (MEC) and the National Fund for Education Development (FNDE), which aims the use of the ICDT in education, either didactically and pedagogically, enabling public schools to acquire lightweight and portable interactive computers to be used in the classroom by teachers and students [3].

Thus, the Municipal Department of Education (SME) of Fortaleza in Ceará acquired 374 interactive computers, Daruma PC3500wi model, by Positivo, through the 71/2013 session of the FNDE. These equipments were acquired by the municipality public schools to be used as technological resources to support the educational process.

These computers have a Free Operating System available from factory mode with limitations concerning to the installation of new softwares. In order to use educational softwares, teachers have to install the required softwares at each boot.

In the Brazilian context, teachers are experts in various areas and have served the city council for many years. They have little experience with ICDT. This scenario turns it difficult and also reduces the use of this device as a didactic-pedagogical resource.

This article aims to study the possibility of the permanent installation of educational softwares in the interactive computer, aiming to stimulate, thus, the increasing use of this ICDT by teachers.

So, this article is organized by 6 sections, presented following: Sect. 2 will be approached the theoretical basis. Then, in the third one, the description of the methods is presented. In Sect. 4, the results will be presented. In Sect. 5, a discussion of the results is performed. Finally deals with bibliographic references.

2 Theoretical Fundamentals

Interactivity, according to [4], is related to a computerized communication system that enables interaction with the user. For [5], we are at the Age of Interactivity, which, in fact, is an evolution of the Information Age. The Information Age focused on the provision of digital information and in the era of interactivity, information is seen as the goal of interaction, that is, "something which and around people interact with" [5].

The changes brought about by interactions in communications and relationships have a profound impact in Education, both professional and social spheres, "since learning occurs only when there is motivation and interaction" [5]. It is essential that the students participate in this interaction, with teacher's support, in order to make them active participants in their learning, since regular education, in which the teacher is the center, is no longer sufficient for this new scenario of emerging and contemporary interactivity.

An education based on interaction and interactivity requires the student to be the focus and autonomous, so "with the introduction of active learning methodologies, the student develops the ability to learn to learn, that is, to become an independent learner" [5].

According to [6], "teachers see in the use of teaching material opportunities to provide an active participation of students during classes". The author affirms that, in many times, the speech of teachers is not strong enough to provoke the interest in students. The teaching materials are efficient resources, because "they break the excess of verbalism and concretize the subject explored by the teacher, facilitating the student's learning, reducing the teacher's efforts" [6], making the class more enjoyable and useful for teachers and students.

For [7] the student is not a passive receiver in the meaningful learning. He must take advantage of the purchased content to grasp the essence of educational material. In addition, the student's willingness to learn and the potentially meaningful material are fundamental aspects for meaningful learning, in which this material can encourage students in their own learning and also assist in the transition between new and prior knowledge.

Monteiro *et al.* [8] state that "it is possible to realize that the theory of meaningful learning extends the efficacy of the use of a digital learning object since it considers the cognitive processes and the formation of concepts in the cognition of the learner".

In this way, it is possible that Educational Software and Learning Objects can be considered as potentially significant materials when accompanied by interactivity within ICDT, since in meaningful learning the learner is not a passive receiver, but the one who has a prior knowledge, and that the active learning encourages autonomy.

Therefore, the digital whiteboard is capable to provide classrooms a potential for learning and interactivity, since it is a touchscreen device where its projection is displayed, generating a large sensitive screen, in which teacher and student can interact in a direct way. A digital whiteboard is composed by a projector, a computer and a sensor which is able to detect touches in its projection. There may be variations from one model to another, making it necessary to use a digital pen. Then, the interactive whiteboard can be turned as a software, that can be installed in the own digital whiteboard or in the computer depending on the model [9].

The interactive computer consists in a portable computer, projector, and digital whiteboard. It was developed to provide new experiences in the educational field and to facilitate the use of the digital whiteboard as an interactive resource in classes.

The Ebeam Uboard digital board, which makes up the PC3500wi interactive computer, uses the Mint Interactive program to make the digital whiteboard a truly interactive ICDT. This program bringing new functions to the touches of the digital pen that also operates as a mouse and adding tools, such as, Geometric drawings, pencil, marker, brush, rubber, navigation, access to the main menu, among others.

The following topic deals with the technical specifications, operations and capabilities of the interactive computer, main target of this study.

2.1 Interactive Computer: Technical Specifications and Operation

The Government of Fortaleza has acquired, at 2015 September 29, through the FNDE, 374 interactive computers. It was distributed in the Educational Units according Table 1 to meeting demand of the schools.

Table 1. Equipment per educational units

Educational unit	Amount	Interactive computers
Municipal school	270	1
Fulltime municipal school	17	3 or 4
School extension	9	1
Early childhood education center	27	1
ASTEINF (for training)	1	2
Total	324	374

Interactive Computer Daruma PC3500wi (Fig. 1) was conceived by FNDE 71/2013 trading and mounted by Positivo. It incorporates INTEL® Celeron® 1007U de 1,50 GHz processor, 4 GB DDR3 memory, hard drive SSD SATA 16 GB, Optical disc writer / recorder (CD /DVD RW), compact keyboard and optical mouse. It access Internet by Wired (Ethernet) and wireless (WiFi) network interface. It has connectors for USB, Audio and Video devices.

Fig. 1. Interactive computer daruma PC3500wi.

The interactive computer has a built-in projector of EPSON EB-W03, yellow color, with contrast ratio 10000: 1, resolution WXGA (1280 × 800), projection size from 33 to 318 inches. For a projection of 60 inches, the distance between 1.60 and 2.00 m it is ideal.

Its lamp has a lifespan of 5,000 h in high brightness and 6,000 h in low brightness. The PC3500wi contains an interactive whiteboard, an interactive digital pen and the Mint Interactive application. Interactive whiteboard is a Bluetooth Transmitter/Receiver system installed next to the projection screen with a maximum operating distance of 5 meters away from the device [10].

The next session explores related works.

2.2 Related Works

According to [11], the digital whiteboard is an example of technological advancement that brings contributions for teaching, since it provides interactivity, the author also proposes a mini-course presenting the interactive computer (Daruma PC3500wi) offered by MEC, emphasizing the necessity of the use of Learning Objects to provide interactivity with the content of the classes in With the Digital Whiteboard.

Pereira and Schneider [9] analyze and highlight applications of the digital whiteboard in the classroom that allows the digital literacy. In his work, called The Interactive Digital Whiteboard that provides digital literacy at municipality public schools network in Aracaju-Brazil, simple applications are proposed in order to facilitate the introduction of these new practices in daily life, such as simulating the same characteristics of chalk, eraser and the traditional blackboard.

Navarro and Kalinke [12] present the teachers' unpreparedness to deal with new technologies as a problem. The Digital Board kit, at the school that was the target of his research, was used only as a projector, when it was used. Through appropriate training, this barrier was successfully broken by bringing the digital whiteboard into the classrooms (Fig. 2). Teachers began to use the digital pen, internet, educational softwares and Learning Objects to support teaching, encouraging the student to participate as an active character of his own learning process.

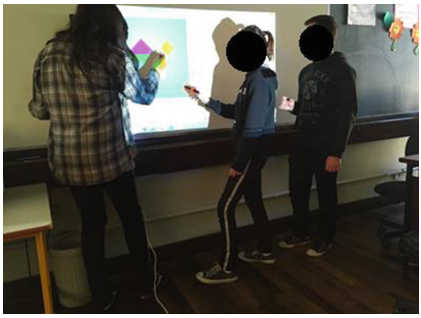

Fig. 2. Use of tangram at the digital whiteboard.

The following section shows the method of solving the problem.

3 Operating System Customization

This section describes working method for the free operating system customization and installation in the 374 interactive computers of the municipality of Fortaleza. This process happened in five stages: Analysis of the problem, list of software, choice of a Linux distribution according to the requested programs, installation of the Operating System and installation of software and drivers.

With the problem identified it was necessary to do a detailed analysis of the problem seeking a list of possible solutions. The factory operating system of the interactive

computer has been studied in detail. It is an educational Linux provided by the Ministry of Education (MEC) based on Ubuntu 12.04, which in turn has been modified to meet the overall demand for the equipment. This demand would be to provide a free, stable, high-usability OS with basic functionality in perfect operation, such as internet access, access to the office pack, software and drivers required to use the interactive whiteboard - Ebeam Uboard - which is part of the interactive computer.

The factory operating system is designed to use a temporary file system. This is to prevent the user from making major changes and providing stability to the system. The user can install software only temporarily, that is, when the interactive computer restarts the installed software will no longer be present in the list of OS programs. Some changes are allowed, such as connecting over wireless networks, saving files in the user's folder. These changes remain intact after OS reboots.

When the teacher wants to use educational software on the interactive computer, he needs to install this software before each use, because with each reboot all the installed softwares are lost. After several tests it was observed that the permanent installation of educational software was not possible, because the factory OS file system cannot be changed because it is a temporary file system.

The factory operating system cannot be changed because it is a live-HD system. This type of system uses a portion of the RAM for loading the file system, a kind of ramdisk or ramfs. This memory when disconnected loses all stored information [13]. The factory OS is installed on the 16 GB solid state disk (SSD) of the interactive computer. When you turn on the machine, the file system loads the Linux files into RAM. Based on this analysis, it was concluded that SO provided with the interactive computer does not meet the pedagogical demand of the City of Fortaleza.

Based on these facts, the Information Technology Coordination (COTECI) of the Municipal Department of Education (SME) of Fortaleza (Ceará) and the Technical Advice of Educational Technology (ASTEINF) of the SME decided, in common agreement, to install and customize a new Linux. ASTEINF is a department responsible for the creation and standardization of digital educational resources and for the training of municipal education teachers. The software list used in training is shown in Table 2.

According to the list of softwares available in Table 2, the Linux Operating System Ubuntu 12.04 (32 bits) was chosen because it is an LTS (Long Term Support) Operating System which is characterized by being a stable version with extended support [14]. It has long-term support, for 5 years, guaranteeing this support is the canonical that provides software update only after widely tested bringing greater stability. This type of system is suitable for equipments that do not need regular updates [15].

The compatibility of the programs used in the municipal network, including the software of the Ebeam Uboard Digital Board and the support to offline installation of the software Luz do Saber, were also decisive factors in the choice of Linux Ubuntu 12.04.

Luz do Saber is a didactic free resource, available online on the website of the Secretariat of Education of the State of Ceará (SEDUC). This software is important in municipal education because it is literacy software for children that promote inclusion in the digital culture [16], and that is why the availability of this software in offline version is important.

Table 2. Educational software used in the municipal schools

Educational	Multimedia	Production
Luz do Saber	Audio player	Mint Interactive (digital whiteboard)
GCompris	Video player	Text editor
TuxMath	Disc recorder	Spreadsheet editor
Tux Paint	Sound editor	Presentation editor
KTuberling	Sound mixer	Document reader (pdf)
Marble		Browser (Firefox)
KStars		Image viewer
KGeography		KolourPaint
KmPlot		
Kalzium		
Geogebra		
Calculator		

In order to make Luz do Saber offline, it is necessary a Web Server (apache) and a database server (postgresql), both installed by means of scripts provided by SEDUC. Mint Interactive, Ebeam Uboard Digital Slate software, provided on the manufacturer's website also needs to be installed and the Operating System updated. Drawers®, software chosen to group by categories and easily configurable, was installed using developer's Personal Repository (PPA), by Berke's [17].

With these three functional programs, the other ones were installed through the apt-get command using the default Source List of Ubuntu 12.04. To facilitate the use of the interactive computer was created a teacher user, who has all the permission to install programs. The login is automatically done on this user, and any user wishing to make changes will be authorized simply by typing the "sudo" command before the program installation command, without even requesting a password for that.

Three solutions have been integrated into the Operating System to extend the service life and improve the usability of the system, reducing the need for technical intervention for maintenance: exclusion of user files saved in inappropriate places, operating system restoration and optical removable disk system backup.

At login time a routine developed in ShellScript is executed to delete all files from the user's folder, including the icon and shortcut settings. The installed programs and the Documents folder are kept intact to allow teachers to save offline activities or installing new educational softwares.

A restore partition, with an image created using the Clonezilla software, is done as prevention in cases of compromising the stability of the Operating System due to some program installation, for example. This partition is available on the interactive computer HD and can be accessed using Grub, an operating system loader created by GNU project. From this anyone with proper instruction or a step-by-step tutorial can restore the operating system of the interactive computer.

If any advanced configuration made by the user compromises the integrity of the restore partition, an ISO image for optical disks has been produced to be capable of completing installation or restoration of the interactive computer that will be provided for each school on 2 DVD's.

The evaluation of the results was performed with ASTEINF, through a structured questionnaire, and answered at the time of the official presentation of this new operating system for the team responsible for interactive computer training. Written forms were used to collect satisfaction with the new operating system.

The following section presents the results and a satisfaction survey discussion, highlighting the relevance of the research performed.

4 Discussion of Results

For technical and pedagogical evaluation, the ASTEINF training team was invited, which selected two training teachers to present the new resources implemented in the interactive computer, from the working area personalization up to the maintenance routines of the system stability and usability.

At the end of this presentation, a satisfaction survey was applied to determine the satisfaction of the trainers with the old operating system of the interactive computer, making a parallel with the satisfaction with the new one. In the second phase there was a presentation for the entire team of ASTEINF who, in turn, had the opportunity to respond to this research.

The evaluation form took into account technical aspects and the facilitation of pedagogical praxis in the daily use of the interactive computer. It was initially answered using printed form and in sequence was replaced by a Google form. Nine ASTEINF trainers agreed to participate in the satisfaction survey and the results of their responses are compiled below.

Table 3 shows the satisfaction of the trainers with the new system in a comparison with the factory system. In addition to the questions asked showed ate the same table, the questionnaire covered questions regarding specification of improvements, the use of the tool, suggestions for new softwares and future improvements.

Table 3. Comparison: satisfaction with the new system with the system factory.

	Yes	No
Factory system attends the demands of the school	66.7%	33.3%
Factory system has got all the Educational Softwares required	77.8%	22.2%
Teachers need Educational Softwares in class	100%	0%
Personalized system presents improvements	88.9%	11.1%

In terms of the factory system improvements, stability and usability were qualities indicated by 55.6% of those who answered the questionnaire (Table 4). Allowing the installation of softwares was chosen by 100% of the participants; among other qualities it is highlighted: “organization of icons in the working area, customization of the operating system, reduction of digital pen shadow and interactivity between software with the whiteboard”.

Table 4. System improvements.

Qualities	Percent
Stability	55.6%
Usability	55.6%
Allow Software Installation	100%
Performance	44.4%
Other	44.4%

The interviewees agree (77.8%) and fully agree (22.2%) that the above improvements function as a facilitator for the use of the interactive computer in the classroom and that the pedagogical practice of the teacher will be favored with the use of this tool.

Proposals are presented for future improvements by the trainers in the satisfaction survey, such as inserting a folder with Learning Objectives, dictionary, and Portuguese games. The importance of a system that allows modifications and customizations is emphasized, since each teacher will be able to install their defendant programs in addition to those which were chosen by ASTEINF, and, therefore, the system continues within the context of free software.

5 Final Considerations

This work aimed at meeting the technical and pedagogical need reported by the Technical Advice of Educational Technology of SME. The problem is the operating system of the interactive computer Daruma PC3500wi does not allow permanent installation of educational software. This problem was solved by customization of the Ubuntu Linux Operating System and development of development of quick installation techniques to spread this new system to the 374 Interactive Computers of the city hall of Fortaleza.

The new system of the equipment allows the use of the interactive computer in the classroom of the schools of the city hall of Fortaleza without the necessity of installing new additional software. It has all the software recommended by SME. When the teacher wants to install other software, the system will keep the modifications made. The new system facilitates the daily performance of the teacher.

The interactive computer can promote classroom interactivity using an active methodology. The student participates, performs practical activities and acts as an active in his / her learning.

Educational software and learning objects in association with the digital whiteboard and interactivity can be scored as likely potentially significant materials. These materials associated with students' prior knowledge can enable meaningful learning.

It was observed that the customization of the operating system of the interactive computer contributes significantly to the municipal schools. This customization facilitates the use of equipment by teachers and makes available all educational software offline. The off-line version is useful when Internet unavailability occurs.

Future work proposes a set of training for the teachers of municipal schools and an evaluation of the use and impact of this system by teachers and students in school units.

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Pervasive Information Systems

Pervasiveness in Digital Marketing – A Global Overview

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Abstract. The adoption of digital marketing techniques, along with eGov tools, allows to create value to the organization and increase the proximity with customers. After selecting a good practice, it should be optimized for the target client, divulgated on the right platforms, implemented, and finally analyzed throughout the implementation process of a good practice. The platforms present in the paper were selected for the analysis, divulgation and optimization of the information of a municipality. The municipalities have problems related to the monetary funds, reason why, they were surveyed free and paid platforms (market leaders). Most of the tools presented are based in pervasiveness concepts as is mobile, available anywhere and anytime and ubiquity.

Keywords: eGov · Digital marketing · Optimization · Divulgation and analysis

1 Introduction

To make a great marketing, customer and data analysis is constant, everything is saved and analyzed. One must have a sense of what is working, how implement new solutions and put the organization's efforts efficiently to reach the target audience. To increase the results, it's necessary create a long-tail (multi-word) keywords so the information reaches the intended audience more easily and accurately.

Since municipalities are entities with limited economic power, they must apply free or inexpensive methods to obtain better resources for the divulgation of their actions and the information. Applications can be easy to use, i.e. that doesn't imply the need for prior knowledge, or a not very extensive training by the organization in the learning and training of employees and customers.

Major developments in technologies such as wireless communications and networks, mobile computing and portable devices, embedded systems, portable computers, sensors, RFID tags, smart spaces, middleware, software agents and the like, have led to the evolution of pervasive computing. The term Pervasive Business Intelligence is defined as providing quality information to anyone, anytime and anywhere. They have some characteristics: ease access to information; Indicators easy to understand; Reliability of the information; Availability; Usability; Ubiquity and Intuitive [19, 21]. Pervasive computing is the result of computer technology advancing at an exponential speed. Pervasive computing surpasses the scope of personal computers: it is the idea that

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virtually any device, from clothes, tools or gadgets can be docked with plugs to connect the device to other devices. The goal of pervasive computing is to create an environment where device connectivity is embedded, discrete and always available, thereby enhancing a human experience and quality of life without explicit awareness of the underlying communication and computing technologies [11, 21]. In the case of Digital Marketing the consumer is called to participate in the process using pervasive tools.

A brief background and related work is presented on Sect. 2. Section 3 presents the platforms of Digital Marketing. Section 4 addresses an introspective discussion of this work. Section 5 presents the Conclusion and future work.

2 Background

2.1 eGov

EGov is defined as, how governments use information and communication technologies (ICTs), in particular using the Internet, to provide for citizens and organizations better access to government information and services. eGov provide better opportunities to participate democratically in institutions and processes. In short, it aims to promote more

Table 1. Platforms of digital marketing

Platform	Specificity	Benefits
Blogs	Divulgation	Free; reach the target audience
Feedly	Analysis and divulgation	Organize the information and the social networks
Ginzametrics	Optimization	Optimization of SEO
Google analytics	Analysis	Free; availability of measurement of various indicators
Google trends	Analysis	Free; analysis of information over time
HubSpot	Analysis and optimization	World leader in information optimization marketing
Mailchimp	Divulgation	12000 free emails for month, good to newsletters
MarketingCloud	Optimization	Good for collecting and maintaining information
MOAT	Analysis and Optimization	Easy-to-use; Good for information collecting and analysis
SEMRush	Optimization	Optimization of SEO
Social networks	Divulgation	Free; a lot information; easy-to-use
Survey monkey	Analysis	Create surveys and analysis the results
Traffic travis	Analysis	Free; Analysis the SEO health
Website	Divulgation	Store information and content about organization
Youtube	Divulgation	Free; Easy-to-use; Divulgation of videos

effective government, make government services more accessible, more public access to information and make government more accountable to citizens [20] (Table 1).

According to the European Commission [5] the eGov covers the whole area of activities carried out by public organizations and which they are an essential part of government. For them, the great advantage of this new practice is the digitization of the documentation, faster and cheaper services to the citizens, also allowing their participation and collaboration. Thus, eGov allows for transparency between governments, allowing citizens to move between borders without having administrative problems. While the definitions of eGov have a central point in common, eGov involves the use of information technology, to improve the delivery of government services to citizens, businesses and other government agencies, to the relations between the population and the government, through the use of information and online services. This focuses on transforming government services to make services more effective and more efficient.

2.2 Digital Marketing

Digital Marketing drives the creation of the product/service using the Internet as a key, satisfying the demands of new forms of innovation. The web offers to consumers more choice, more influence on decisions, and more power. Organizations have new ways to selling, reaching more people simply [17]. According to Jim Blythe [2], Digital Marketing has emerged with the exponential growth of digital technologies of network communication, mobile phones and digital television. The search for products and services by citizens is more accentuated. Organizations should expand their thinking, not only for the internet, but also for all the means and platforms that allow them to do business electronically. For Ryan and Jones [12], Digital Marketing is about marketing and helping organizations to connect with their consumers to build relationships and to drive sales. However, the use of technology allows the organization reaching consumers in more ways.

The platforms of Marketing were researched according to some specifics: Analysis, Divulgation and Optimization of content. The research was carried out through keywords like: Best Digital Marketing tools, search engine optimization optimizers (SEO) and content optimizers. The platforms were found with base in three specificities: (1) Analysis - tools that allow analyzing the data on the various platforms. They allow to create reports on the use and the behavior of the visitors in the diverse platforms. Many indicators are used to provide a number of different studies in order to improve the deficit indicators; (2) Divulgation - platforms to divulge information and content that the organization intends to provide; (3) Optimization - tools to improve the performance of organization's platforms, that is, tools that give platforms visibility and make them more attractive. Digital marketing strategies aims to increase their membership and come closer the municipalities and citizens through the divulgation of the good practices. So, the eGov combined with a good marketing strategy allows the municipalities to have a privileged interaction with their citizens [3, 4].

3 Platforms of Digital Marketing

50 free and paid platforms in the area of digital marketing was analyzed. These platforms can be integrated, among them, for better results. To select these 15 platforms were searched for free and easy to use platforms. Paid platforms are the market leaders. All were selected through the use and feedback of different users. They present the name, specificity and finally the description of the platform.

3.1 Divulgation

Blogs → Provide information and posts about the topics to which they are proposed. Many cameras use blogs to get feedback from users, on various news and topics, that are posted on the blog. They can reach the population that is registered in the blog.

MailChimp → Tool that allows to send 12000 emails per month up to a maximum of 2000 clients for free. It's a good form of newsletter for the organization's disclosure of existing services and products to its consumers [14].

Social networks → Social networks are the most widely used form of information passing, at this time. There are social networks of work, leisure, socializing and discussion. Usually, free and allow information easily, quickly and with a wide audience.

Website → The website is present in 100% of the municipalities in Portugal. This should have a particular purpose and contain information and relevant content for the citizen. Citizens are one of the largest sources of publicity and may contain information that supports other media. This platform covers, virtually, all age groups.

Youtube → Channel used for divulgation of videos. Essentially used to publicize events occurred in the municipality and to publicize, others that will still occur, through commercials in video format. This allows users to enjoy videos, or not, know the number of users who viewed the video, and allow videos to be commented.

3.2 Analysis

Feedly → A single place to easily read all the news within certain concepts to keep ahead. Feedly organize all favorite publications, podcasts and YouTube channels into collections and receive updates, when new stories and videos are published [6].

Google Analytics → offers to customers a different view of the data. It´s possible define their marketing strategy, to boost sales and optimize the data [8].

Google Trends → is a platform owned by Google and it allows to analyze the evolution of organization's keyword searches over time on a given platform. It reveals user trends in the searches they make about a given keyword, allowing estimates of the potential traffic of platform usage [9].

MOAT → The company includes: Moat Ad Search, Moat Pro and Moat Analytics. Moat Ad Search is a search engine for free display ads. Moat Pro is a comprehensive real-time search solution, providing in-depth information on the brands, publishers and technology of the various ads. Moat Analytics is a proprietary solution where advertisers and publishers can measure the effectiveness of ads [10].

Survey Monkey → Application with support and connection to other platforms. This application allows to create questionnaires that can be sent, in web, through mobile devices, or social media. It allows to analyze the answers with different filters. It has a free subscription and a Pro subscription, each of which has its limited functionality according to the package that is intended [18].

Traffic Travis → This platform allows to perform a complete SEO health check of any site, discover technical mistakes that can affect rankings, keep track the competitors to detect keywords they should use, monitor rankings to know where focus the efforts, locate and build links, with quality, easily. It is a free and intuitive platform for easy use by the organization [1].

3.3 Optimization

Ginzametrics → Started by discussing the best way to scale SEO through the dozens of sites that customers owned. Thus a powerful, easy-to-use application was created to solve the problems of large-scale SEO projects. The goal is for customers get the information they really need when and where they need it [7].

HubSpot → is an entry-level marketing software platform, that helps businesses attract visitors, convert leads and keep customers close. The platform helps to create content, optimize it for search engines, and share it on social networks. It then intends to engage its potential customers with organization pages, drawing its actions to the pages associated with the organization [16].

MarketingCloud ExactTarget → Salesforce finalized acquired ExactTarget in July 2013. This fusion of technology and culture has brought a leading platform for cloud marketing, this being the number 1 CRM platform in the world. Today, the world's most innovative brands rely on cloud marketing to help to them build personalized customer service paths for each customer [13].

SEMrush → Platform is a service that provides competitive intelligence for optimization in Search Engine Optimization (SEO) and social networks. The goal is collect data from competitors to analyze and suggest keywords for the divulgation of websites. It is paid software that helps optimize existing organization platforms [15].

4 Discussion

The features of pervasive can be achieved in marketing digital by making it available anywhere and anytime, sending alerts, penetrating, mobile, web, enable the use of more effective digital marketing platforms. As the goal of marketing is get information to the target consumer simply, the use of pervasive methods allows the information to be available anywhere, anytime. This allows the users to have quick and effective access to all the information that is divulgated by the organizations.

4.1 Analysis

At the analysis level, there are many free applications to analyze the data. For example, the free platforms by Google (Google Analytics, Google Trends). These platforms allow to analyze how the platforms use information and communication technologies (ICTs) by measuring data. Google Trends analyze which trends users have when using multiple words, in this case related to the municipality and its services.

Feedly, also free, is easy to use and it is available for desktop and mobile devices so it is a platform that can bring a better view of the organization. At the level of paid applications, Hubspot, MOAT and SurveyMonkey allow to create analyzes with various purposes and modes of information visualization, suggesting possible improvements that can be used. Everyone has free samples so the customer can try out the software and all have good feedback from the users. The Hubstop application, in addition to analysis, also enables optimization and provides users with free training courses for employees. These courses are free and certified for any user. MOAT lets analyze and report the effectiveness of marketing. SurveyMonkey allows to create quality questionnaires and surveys and store the data.

4.2 Divulgation

To divulgation, many of the platforms are also free. The case of social networks is the most relevant in this type of specificity. We have the case of Facebook, Twitter, Google+, Linkedin that allow to pass information easily and publicize the events and news that happen in the municipality. Email is one of the most widely used means of divulgation, but many times this is referred to Spam. However, the use of softwars such as Mailchimp allow create quality newsletters and avoid the spam box. This is free for up to 2000 subscribers. Blogs, websites and Youtube, are good ways of disseminating information and existing occurrences. These media, together with good analysis and optimization tools, create content that is relevant to the intended audience.

4.3 Optimization

In this specificity is the tools that are usually paid. These tools enable the creation of content and forms of information to be good and to reach the maximum of users. Platforms that contain this specificity allow the organization to create content and optimize it.

That it is distributed through the right platforms. These platforms thus enable information to be beneficial, reliable and accessible to consumers. For this, there are platforms that help create good content and disseminate it. Usually they are search engine optimization (SEO) platforms and social networks. Platforms such as Ginzametrics, SEMRush and Traffic Travis allow optimization of SEO and the careful divulgation of information on social networks. Hubstop create customized content for the target customer. The use of information in the Cloud like MarketingCloud help create personalized information, thus converting customers and optimize campaigns.

The purpose of pervasive computing is to make "smart" devices, thus creating a network of sensors capable of collecting, processing and sending data. Ultimately communication as a means to adapt to the context and activity of data and improve the human experience. This allows the information to be optimized in a better way so that the client receives the content that he intends in an easy and objective way.

5 Conclusion and Future Work

Good publicity of projects, from egov, through digital marketing is extremely necessary. For this, information should be optimized for example with SEMRush software, essentially divulgated in social networks, websites and blogs, and finally analyzed with tools such as Google analytics. Content optimization, divulgation and analysis allows the organization to have a circle of continuous improvement of its information. For the success of the selected projects, the use of free tools, for cost reduction, is the best solution. Analytics tools like Google Analytics offer a great analysis of indicators and data analysis to get a sense of how information reaches citizens. Divulgation tools focus on social networks, websites and blogs at the level of computer media and the spread of placards, radio and television as more conventional alternatives. Finally, for information optimization, media such as SEMRush are used to optimize URLs and present information, so as to arrive at more reliable and better quality information for platform users. The next step is optimizing the information disclosed by these platforms described. The platforms must be used by the organization in order to be able to analyze later the success of the analysis, divulgation and optimization made by the organization.

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Wargames Applied to Naval Decision-Making Process

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Abstract. This research aims to establish the applicability of open source simulator Combat Global Blue, as a support tool for planning, at the stage of Confrontation Courses of Action of Naval Decision Making Process. The strategy proposed to carry out this research included in principle a thorough study of the relationship between planning, war gaming and simulation. After developed the analysis of the characteristics and limitations of the proposed simulator, was conducted a case study in which the tool was used, determining lessons learned and benefits extended by the system; especially related to the delivery of results in order to develop a solid base of information for the Commander take a reasoned and sufficient evidence decision. The results were satisfactory, since ultimately the capabilities of this simulator to represent virtually aspects of reality as operational factors force, time and space in a synthetic computing environment, make this a tool that despite its limitations, it's suitable for use in the confrontation in action courses.

Keywords: Simulators · Wargames · Battleship Intelligence Planning · Decision-Making Process

1 Introduction

Since the adoption of Naval Decision Making Process (NDMP) in the Navy of Ecuador, has remained constant efforts to achieve improvements in this process; it has been important for the significant contribution of Advisors, Officers Plant, and Official Students of the Naval War Academy. This process is based on the use of some tools to support planning, which requires imagination and creativity to develop elements to improve results in the solution of a military problem.

This work aims to achieve an additional contribution, through the incorporation of a new tool to support the planning, the computer simulation. So, the purpose of this research is to demonstrate the applicability of the open source simulator Global Conflict Blue 2 for the development of Wargame in the third stage of NDMP: Confrontation of

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Courses of Action (CA). The results of this research will be useful as a guide and tools for Student Officers of the Naval War Academy, the Commanders, the Chief of Staff and Planning team, in the process of Wargames, in the third stage of NDMP in operational and tactical levels, especially considering that this stage is in the heart of the process.

In the Sect. 2, the problem is posed, its causes and effects, and projected the results to be achieved. The Sect. 3, use an exploratory and descriptive study, presenting a retrospective of the stat of art of Wargames and simulation as planning tools, including some related concepts. In Sect. 4, a correlational study is developed by linking the capabilities of the proposed options required in a Wargame, and then through a case study will be establish the applicability of the proposed system as a support tool for planning, and their use in the confrontation. Finally, in Sect. 5, the conclusions and recommendations of the research will be presented.

2 Problem Statement

The Naval Decision Making Process was approved in its second edition as a doctrinal body in the Navy of Ecuador in the year 2013 with the coding AGUENA-PLANAV-01-2013. The military planning is structured as a broad process, allowing commanders and their staff or planning teams, at all levels, to make reasoned decisions and solve complex military problems. In this process commanders visualize a desired final state and then determine how that state will be reached [1]. Currently, NDMP is composed of seven stages: (1) Analysis of the Mission and Battleship Intelligent Preparation, at this stage the assigned mission and the essential and implicit tasks are reviewed. The BIP is developed and assumptions and limitations are reviewed; (2) Development of Courses of Action, the analysis of the relative powers of combat is made, the critical capacities and requirements are identified and related to the center of gravity, then producing the Action Courses (AC) that manage to balance capacities with vulnerabilities; (3) Confrontation of Courses of Action, the confrontation of the ACs against the Action Courses Enemies (CAE) is developed, guiding the process to establish the final feasibility and acceptability [2], the Wargame is the fundamental tool of this stage; (4) Comparison of Courses of Action and Decision, a comparison of the Conservation Action Courses (CAC) is carried out, based on the governing factors, after which the Commander takes "The Decision", selecting at his discretion and based on the information from the previous process the best CA that solves the military problem; (5) Development of Plans and Orders, communicates the commander's intent, guidance, and decisions in a clear and useful format that is readily understandable to those who will execute the order; (6) Transition, it is sought that the subordinates or those who must execute the planned achieve a detailed understanding of the plan developed in the previous stages; (7) Monitoring Planned Action, is the process of recognizing the differences between what is planned and what is being implemented, of appreciating the effects, and of considering adjustments in a timely manner [1]. This sequence of steps is intended to assist the commander and his staff to planning naval operations, based on

the concepts of logic state decision-making. Decisions must be timely, reasoned, reliable and adequate solution to a military problem.

In this planning process much emphasis is given to the importance of the third stage, which is in the heart of the process, whether it is called to this stage as "Analysis of Courses of Action (Wargame)" in the publication NWP 01.05 [3]; its purpose is to create a solid basis for defining the feasibility and final acceptability of the courses of action and check their advantages and disadvantages. The third stage of NDPM assumes most importance, by adding value to the process, the Wargame, that defines in large part the product quality, which will be vital for justified the commander informed decision-making. The problem is that the resources planning support used in the Naval War Academy for the development of Wargame in the third stage of NDMP, difficult to develop a solid base of information, to further define the feasibility and final acceptability of Courses of Action and check their advantages and disadvantages.

This research will focus on the use of simulation tools in the confrontation of courses of action in third stage NDMP, in planning naval operations, exercises or didactic Wargames, particularly in the Academy of Naval War oriented operational and tactical levels of conduction, in a pervasive environment context.

This paper will seek to answer the following question: What is the applicability of open source simulator Conflict Global Blue, in the development of Wargame in the third stage of NDMP: Confrontation of Courses of Action?

The results of this research will be useful as a guide for Officers students from Naval War Academy, and to the Commanders, Staff and Planning team to develop the Naval Planning Process to solve a military problem at the level operational and tactical.

3 Background

For Craig Orme, "simulation is not about technology – it's about culture. Simulation is about being willing to be confronted directly by your strengths but, more importantly, alsoyour weaknesses. It is about learning how to deal with complexity, risk, uncertainty, chaos and ambiguity" [4].

A Wargame is not an analysis in the classic sense of the word, since it does not quantitatively decompose the military problem. It is in essence the interaction between human decisions and the game of events. Mathematical models are essential in the simulation of such events; the results of the application of such models should serve as inputs to the game process, and should not be taken as a result of the Wargame itself [5–7]. The Wargame is a tool to better understand the dynamics of war. It constitutes a source where a series of questions must be originated, whose answers must be found during the course of the exercise. Therefore, a Wargame must be used in the investigation of processes, of designs, not to calculate results, but to achieve improvement or establish their validity for solving a problem. This is where the importance of playing several alternatives for solving a military problem - the, courses of action - lies in the fact that its maximum exploitation will be aimed at establishing if the conception and design of a military operation satisfies the operational functions, or operational requirements of the needs of the sequence of tasks considered and whether their synchronization is adequate to achieve the desired

final state at the end of operations. The questions that arise in the Wargame should be oriented to improve the design or to take considerations to solve the problems that appear [5, 6]. Therefore, when technical, statistical or physical parameters are of greater interest than the study of human decisions, then this tool is relegated and it is preferable to use other research methods such as operational analysis [7]. Francis J. McHugh, a Naval War College Advisor, NWC, in one of the naval classic books, "Fundamentals of Wargaming", incorporates aspects related to computer-assisted Wargames and computer Wargames, main advantages and disadvantages. Highlighting, the computer Wargames as a powerful tool for analysis and investigation in the future of naval operations. Although at that time, computer science and computers had not achieved the current levels of progress. His work already emphasizes the importance of technique and the main advantages, without neglecting the true classic purpose of the Wargame. This work has a relevant importance, based on the fact that nowadays a personal computer is able to execute a number of operations as complex as the large and complex computers of the late sixties [8]. Gerald, G., Carlyle, M., Kelton, D. and Salmerón, in the research paper "Operational Planning Tools for US Navy Maritime Commanders", developed at the Naval Postgraduate School (NP), present an assessment of various decision support tools to support the maritime operational planning process. In this context it is highlighted that the NPS has been developing for more than fifty years, scientific tools to support the planning process of military operations. Was performed a analysis of three computational tools to support operational planning, which normally had specific objectives for certain areas of planning, nevertheless it is proposed that integrating them allows to achieve a very significant improvement of the planning [9].

In the Thesis titled "Operational Level-Naval Planning Using Agent-Based Simulation", from Naval Postgraduate School, is presenting an interesting research report on the use of the agent-based simulation technique to be used as an operational support tool in the Naval planning process at the operational level. Through the model developed during this research, it was sought to deliver to the commanders a tool that being employed in the planning process allows them to make decisions with a larger information base. In this case, the agents represented in the model the opponent of the naval commanders of the operational level, since they had the capacity to carry out the deployment and to develop the maneuver based on the perceptions of the virtual operational environment, attributes and movements of the adversary, with demonstrated that agent-based simulation has as characteristic its ability to capture many of the dynamic aspects of the planning process, establishing an initial planning tool [10]. Arthur Bettega, emphasizes the level of realism that the modeling and simulation tools have achieved, which has allowed the Brazilian Navy to use computer simulators for its tactical and operational Wargames, which provide the right tools for the representation of Scenarios, entities and interactions between players. However, he details that at the strategic level the seminar method is still used without using a robust virtual environment available for Wargames at this level of conduction; So his research aimed to examine the feasibility of using a synthetic computational environment in Wargames of the strategic level in the Brazilian Navy, taking into account the greater complexity of the required models, and formulate the perspectives of scientific growth and Technological and potential opportunities that arise from their use by the Brazilian Navy [11].

The emphasis of pervasive Wargames on decision-making entails that it must be structured to help players make decisions and enable them to learn about the effects that they produce [12]. The pervasive game concept was inspired by pervasive computing [13], with a multitude of intelligent objects embedded in a computer network [14]. Pervasive games expand the spatial, temporal, and social limits of traditional games, and are usually played by certain people at a given time in a specific place [15]. Even though many games follow different structural approaches, such as the study of a campaign by a group of amateurs, or those professional Wargames that a planning team with a large number of advisors develops to investigate potential for future war, a good Wargame will always need some essentials elements [10]: purpose or aim; scenario; database; models; rules and procedures; participants (players, controllers and observers); analysis; culture and environment; and auditorium.

4 Case Study

In this section, through a correlational study, the concepts of planning, Wargames and simulation will be associated to identify and evaluate the main characteristics of the open source simulator Global Conflict Blue to establish the limitations, and through a case study: Amber-Pearl Planning, developed by the Command Course, based on its results, develop the lessons learned and establish the applicability of this simulator as a tool to support planning in the Wargame that takes place in the third stage of the NDMP.

The GBC simulator of the naval war was developed by Dewitt Colclough employing the languages of programming C ++ and Phyton. The official portal of this application is the site www.gcblue.com, where you can find support information, progress reports of development projects to optimize the simulator and reports of failures. The main features that this simulator has are the following: global cartography, including bathymetry of the oceans; realistics models regarding the dynamics of aircraft flight, maneuvers of naval units, sensors, fuel consumption and ammunition; realistic dynamics of time and space incorporates a basic model of sea conditions, sound velocity profile and ray tracing; Man-Machine Interface (HMI) with contextual menus and easy-to-use commands; 3D graphics with the possibility of being visualized in real time, although with very basic functionalities; Incorporates a basic radar cross-section model; Incorporates a basic model of damage to the platforms that integrates physical effects like fragmentation and blast wave; An editable database for scenarios, which can be recorded for later playback; an editable database for platforms, which includes a large number of platforms with their weapons, sensors and associated equipment (this is one of the main features that differentiate it from other simulators); time control, which allows the acceleration of time up to 30 times; all menus, platforms, 3D models and symbology have an open format, and can be customized through their own developments; designed for large-scale games, with the possibility of managing more than 1000 units and installations of all types (ships, submarines, merchants, fishermen, aircraft, bases, ground-based radars, refineries, poliducts, airports, etc.); designed to be executed in multi-player mode through the use of a PC that acts as a server; launches a report of interactions through

an information window, and the GBC simulator it's compatible with personal computers, being undemanding at the level of necessary requirements.

In the Command Course at AGUENA, a planning exercise "Amber-Pearl" and two Wargames were executed. GBC simulator was used as a tool to support planning, in conjunction with other software to support decision making, during two of these events. Initially, the Amber and Pearl cells were organized, led by operational and intelligence officers. The Chief of Staff acted as an organizer and arbiter. The first step was to integrate into the geographical area of the Indian Ocean, the Mascarene Islands, Amber Island and the coasts of East Africa, the naval media, aircraft, own airports and adversaries. For this it was necessary to be guided by the information produced by the development of the mission analysis, development of the BIP and the development of the Courses of Action. According to the Guide of the Games of War developed, the two CAs were played against the two CAE, using the sequence method of essential tasks (critical events).

In the first confrontation CA 1 was played against CAE 1, the first critical event, which was: "Interrupt the LL.CC.MM. Military of the occupation forces that AMBAR maintains in the Mascarene Islands, within the Area of Maritime Exclusion established from January 23, 201X". Initially, the options menu will configure the aspects of visualization and environmental impact that will be considered, among them, fog, water reflection, aircraft enrollment times and embedded helicopters. In the scenario editing environment, the sea state information and sound velocity profile were entered. After which positioning the units in the area of operations, in this process it is necessary to restrict the information to each of the cells (closed Wargame). To position the units in the synthetic computing environment, the scenario editing tool was used. Once the own and enemy units have been positioned in synthetic, each of them is configured in the logistic aspects, this implies the configuration of ammunition and ammunition load available, which should be consistent with the information of the logistical files or order of battle. The next step in the process is to set up the Emission Control Plan, for each of the units based on what is detailed in each course of action, in this case in CA 1. Then the simulation is started in RAID 1, generating the movements and actions of the units considered in the courses of action that each cell is playing. These actions with the decisions are recorded in the worksheets, whose formats are available in the BIP. It will always be important that the records relate to the level of driving that is played, while observing the implications of each action and decision for subordinate commanders.

The units Amber and Pearl are observed during the interactions visualized from the editing environment, where it is possible to also play the actions, although it is not advisable, since it loses the sense of uncertainty that will always generate decision making in a more realistic environment and therefore better results. During the process, Staff members provided tables, logistical calculations, casualties calculations, analyzes, log files and other tools that contributed to validate the actions and results in order to better adjust the simulation to reality. Through the contribution of the members of the staff, the effects achieved with each of the decisions and actions adopted were identified and additional requirements were established for the own forces. The records were the basis of information, which based on the visualization of the events, actions, reactions, counter-reactions and effects generated by these, allowed: visualize your own strengths

and weaknesses and the enemy; determine the advantages and disadvantages of CAs; provide useful and consistent information to develop the final test of CA acceptability, in terms of: prospects of success, feasibility of execution of each CA and exploitation of critical factors; and provide useful and coherent information to develop the final CA feasibility test, in terms of: cost of success, cost of failure, available forces to face a later effort. The use of GBC simulator in the confrontation of the CA, collects the results of other Wargames in addition to the "Amber-Pearl" planning exercise, the use of a synthetic computational environment, makes it possible to appreciate the relationships of the operational factors force, time and space, which is not usually achieved with less dynamic manual simulations.

The first confrontation will always be more complex, due to lack of practice or little experience in the development of analytical Wargames, and the use of the simulator. This effect is appeased by continuing to confront the CA and CAE, depending on each of the critical events established.

It has been demonstrated that the functionalities and capabilities of GBC, allow its use to be applicable in the Wargame of the confrontation of the CA, constituting an important tool in the process of Planning, recommended to be used initially in AGUENA, in planning exercises and didactic Wargame, allowing a substantial improvement in the results of this process. Due to the possibilities of representing the dynamics of naval operations, this simulator can be used in other stages of planning, specifically in the development of CA. Since it could incorporate the means, establish the relations of command, identify the needs of grouping or separate means and manage to conceive in a virtual environment the design and the operational maneuver, this would allow to achieve a detailed concept of the operations for each course of Action, managing to integrate operational requirements and functions long before they are confronted with CAE.

5 Conclusion

The Wargame constitutes a source which must originate a series of questions, whose answers are set in their development, it constitutes a tool for exploratory research, useful in addressing complexities and uncertainties of naval operations planning phase; used in the confrontation of courses of action creates a solid base of information, useful for the commander and take a reasoned decision evidence.

A simulation is a simplified representation of reality, when applied in Wargames with the support of computers, manages to represent in the virtual domain the most important aspects of the physical domain, integrating into a single computational synthetic pervasive environment force factors, time and space, which allows us to appreciate the dynamics of naval operations and the relationships between these factors, thereby achieving a better understanding of the effects that would produce decisions on future operations. GCB simulator have the capacity to generate a synthetic computing environment, where is possible incorporate and recreate the media and own actions of naval operations, representing adequately the dynamics that characterizes them, facilitates their use, as a tool to support the planning, at the stage of confrontation of courses

of action, in order to optimize the results of this process to establish a useful basis for the decision information.

It's recommended promote the research, regarding Wargames and their potential uses with the support of simulation tools. Promote the use of the simulator GCB during the development of future planning exercises and didactic Wargames from Naval War Academy, with a view to achieving greater experiences, lessons and skills for use, so as to achieve a substantial improvement in the development stage of confrontation CA Naval Planning Process in the operational and tactical levels, so that they can project future this knowledge to the rest of the Navy through official who graduate from this institute.

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An Agent-Based RFID Monitoring System for Healthcare

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Abstract. In the last years, with the progressive expansion of Healthcare Information Systems (HISs), the healthcare platforms for interoperability and monitoring systems have become increasingly more vital sources of clinical information. In this context, in *Centro Hospitalar do Porto* (CHP), the INTCare system was developed with the purpose to create new useful knowledge for decision support in real-time. It is an unquestionable potential area to develop effective systems for the prediction of clinical events, including Decision Support Systems (DSSs), for organ failure and death in Intensive Care. The INTCare uses multiple data sources that are collected at the bedside. However, this system fails on the recognition of the patient absence in bed. Thereby, this problem led to the development of the Patient Localization and Management System (PaLMS), i.e., a RFID localization and monitoring system. Thus, this paper describes the PaLMS Intelligent Multi-Agent System for the integration of PaLMS into the hospital platform for Interoperability, Diffusion and Archive – Agency for Integration, Diffusion and Archive of Medical Information (AIDA) platform. On the other hand, a failure prevention system that actuates in the PaLMS agents, improving their availability, is also presented and thoroughly discussed.

Keywords: Ambient intelligence · Monitoring systems · Prevention systems · Intensive care unit · Multi-Agent Systems · RFID

1 Introduction

In the last years, in healthcare organizations, the constant demand to improve considerably the patient safety and the quality care boosted the adoption of Information and Communication Technologies (ICTs) in these institutions. Along with the computerization of hospitals in various aspects, a new era began in healthcare organizations. Thereby, new concepts, paradigms and methodologies to solve problems in this domain of knowledge emerged aplenty. Nonetheless, despite the Healthcare Information Systems (HIS) have been growing increasingly [1], the tools currently available for data processing are still not sufficient according to the current more demanding needs. So, nowadays, the recent technologies should support a new way of envisaging the future hospital.

Thus, the need to enhance the environment with current technology has been a concern of most researchers in this area. The introduction of sensors and networked

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devices, in order to support the health professionals in the decision-making process, has been increasingly frequent [2]. This leads to the concept of Ambient Intelligence (AmI), which is considered a new paradigm that introduces new means of communication among humans, machines and the surrounding environment [3, 4]. Due to the complexity and the heterogeneity of a hospital environment, it is expected a high success of the AmI technology in this type of environments [5]. Thus, in the last two decades, *Centro Hospitalar do Porto* (CHP) with a research group of University of Minho have been developing several solutions based on the AmI concept [4–7].

The INTCare [5] is one of these solutions and it consists of an Intelligent Decision Support System (IDSS) aiming the real-time monitoring of patients in the Intensive Care Unit (ICU). In short, it enables the prediction of the dysfunction or failure of six organic systems within a short period of time, and also the patient outcome, in order to assist health professionals in the decision-making process, namely on choosing the more adequate treatments or procedures for a patient [5]. However, after the implementation of this system in the ICU of CHP, two main problems were detected.

The first problem was the absence of the patients identification in the INTCare monitors in an automatic way. Before the implementation of the Patient Localization and Management System (PaLMS), this task was performed manually by health professionals of CHP. The main problem was that, when a patient was admitted in the ICU, rarely the professionals performed it, since there was a lot of tasks which needed to be executed in this type of situation. Consequently, the sensors collected the vital signs of the patient but his/her identification process was not done, leading to a loss of data that might potentially be important for the decision support process.

On the other hand, the second problem associated with the implementation of the INTCare system in CHP was that, whenever a patient leaved his/her bed in the ICU, e.g., to carry out an examination, the sensors that collect the vital signs were not disabled. Thus, the data collecting process was invalid. Therefore, this problem may highly influence the information provided to the healthcare professional regarding the condition of the patient, since in the dataset there is invalid data that was collected when the patient was not in his/her bed.

Thereby, to solve these problems, an architecture was developed in order to avoid the existence of invalid/wrong data in the INTCare system.

Thus, this paper presents the architecture developed and its implementation in a real environment, with real data and the proper supervision of healthcare professionals through the PaLMS. This system of automatic identification of the patient presence in bed is based on the Radio-Frequency Identification (RFID) technology, intelligent agents and Health Level Seven (HL7) standard. However, it is critical that the components of the Patient Management System (PMS), the INTCare system [5], the alert system and the bed monitoring system are fully capable of communicating with each other. To achieve this crucial point, these systems were integrated in the hospital platform for Interoperability, Diffusion and Archive – Agency for Integration, Diffusion and Archive of Medical Information (AIDA) [8, 9].

Scientifically, the solution presented in this article can be considered universal, since it can be implemented in all healthcare facilities that have an automatic acquisition of data through sensors. The PaLMS enables, with high acuity, the association between the

patient and the data collected without introducing additional information, simply by crossing information between the acquisition system (sensors) and the identification system (PaLMS).

Furthermore, this article also presents an agents' failure prevention system. This system is based on the Modified Early Warning Score (MEWS) model, used to prevent organ failures. This system aims to improve the high availability of the PaLMS agents.

2 Background

The Radio-Frequency Identification (RFID) is a technology that has been recently increasing in the Ambient Intelligence (AmI) area. Therefore, its use in healthcare has been considerably increasing too, performing an important role in monitoring systems. The purposes of the RFID in a hospital environment are to identify, to track patients with accuracy, and to process important health information [10, 11]. The RFID technology has some features that facilitate the automation and simplify the identification process of patients, professionals and objects. It also facilitates their localization and the processing of data related to them in a more secure and faster way. Thus, in health units, such as hospitals, all these advantages make the RFID an emerging technology for the healthcare area as a part of the application of the AmI [12].

The interoperability concept was one of the subjects of recommendation by the European Commission, who considers it an important step towards an highest quality and safest care of the patient, health systems, clinical research and healthcare [13]. The Health Level 7 (HL7) protocol is a set of standard formats that specify the interfaces for electronically exchanging data between heterogeneous applications in hospital environments. It is dedicated in providing a comprehensive framework for the exchange, the integration, the sharing and the retrieval of health information [14, 15].

The Multi-Agent Systems (MASs) technology has proven to be very effective in providing interoperability in health organizations through the characteristics of intelligent agents, including characteristics such as modularity, scalability and adaptability [8, 9, 16–19]. Intelligent agents and agent-oriented programming are a technology based on a distributed architecture. The agent-based systems have been changing the paradigm of conceptual analysis of problems, such as the complexity, the distribution, and the lack of interactivity of the systems [20].

The Agency for Integration, Diffusion and Archive of Medical Information (AIDA) was designed to assist medical applications. In short, it is a complex system, composed of a network of specialized subsystems understood as intelligent and flexible entities with a level of adjustable autonomy, i.e., intelligent agents in the context of this study. These entities are responsible for tasks such as the communication between heterogeneous systems, as well as the sending and the receiving of information [20]. The AIDA is implemented in *Centro Hospital do Porto* (CHP) and other health institutions in Portugal.

In the context of Intensive Medicine, as already stated previously, a system called "INTCare" was developed. The process of data acquisition, and Extract, Transform and Load (ETL) are executed automatically and in real-time whenever new data is received.

Additionally, and using online-learning, the entire process of inducing Data Mining Models (DMMs) and computation of clinical data are also realized automatically and in real-time.

In short, INTCare is a Pervasive Intelligent Decision Support System (PIDSS) [5] divided into two modules: one to monitor (insert, validate and confirm) the patient's clinical data (e.g., vital signs, therapeutics, and fluid balance, scales and procedures) and another one to create new knowledge, namely the prediction of organ failure, patient outcome, medical scores and critical events.

Before the introduction of the INTCare system, it was necessary to overcome a series of problems. The main one was related with the patient identification, due to the requirement of being necessary to execute a human task. In a real-world context, when some patient arrived to his/her bed, the nurses had to identify him/her in the vital signs monitors. Only after the completion of this task, the data was collected with the patient identification. Nonetheless, when a patient arrives to an Intensive Care Unit (ICU), treating the patient and improving his/her health is the main concern. Thereby, it is notorious that the nurses do not have time to make a correct identification of the patient in the acquisition system, and a large amount of data is lost. Without the vital signs data, it was impossible to create any type of new knowledge with them, so it was indispensable to find a solution to this problem.

Thus, in order to overcome it, a RFID system to automatically identify the patient when he/she arrives to his/her bed was developed. This solution allows to have a correct identification of which patient is in which specific bed without the needs of executing human tasks.

3 Patient Localization and Management System

The Patient Localization and Management System (PaLMS) main function is to identify automatically the presence of the patients in the Intensive Care Unit's (ICU) beds by making a correct match between the acquisition system and the patient's ID, but also to manage their localization at the same time.

PaLMS is an event-based monitoring system, which uses the technologies described in Sect. 2 ("Background"). In other words, it is a Radio-Frequency Identification (RFID) system that communicates with a Multi-Agent System (MAS) embedded in the Agency for Integration, Diffusion and Archive of Medical Information (AIDA) platform that exchanges HL7 messages among its agents to communicate with the Patient Management System (PMS), the INTCare system and the alert system.

Before, when a patient left his/her bed in the ICU for any other local, e.g., for an examination or the operating room, his/her vital signs read and stored by the INTCare system were invalid. Nonetheless, using the PaLMS, these situations are prevented through the intelligent environment created in the ICU's beds, more specifically RFID tags (bracelets) and several antennas. Each tag represents a patient and each antennas group represents a bed.

3.1 RFID Events

To manage all the patients' information stored in the AIDA platform, the MAS integrated in the PaLMS was developed based on the most common events in the patient's cycle in the ICU. These events are detected by the RFID system and they can easily be associated to HL7 events through the trigger-events [21] by using the Admit, Discharge and Transfer (ADT) messages, supplying interoperability to the PaLMS.

In this sense, Table 1 presents the events mentioned and the corresponding ADT messages.

Table 1. Description of the events in the Patient Localization and Management System (PaLMS) and the corresponding Admit, Discharge and Transfer (ADT) message

Event name	Description	ADT message
Admission Event (AE)	An RFID tag is placed on the patient's wrist;	ADT_A01
	An EPC is associated to the patient.	
Transfer Event (TE)	Transfer of the patient to another unit and the corresponding EPC	ADT_A02
Discharge Event (DE)	Discharge of the patient and the corresponding EPC	ADT_A03
Leave of Absence Event (LoAE)	For example, to carry out an examination in another unit	ADT_A21
Return from Leave of Absence Event (RLoAE)	Return of the patient	ADT_A22
Warning Event (WE)	When the tag is not detected or when it is detected but the monitoring systems are not corrected to the patient/sending values	ADT_A20

3.2 Agents' Architecture

The PaLMS was developed with intelligent agents because this system needs to react according to the messages that it receives, more specifically to the ADT messages from the HL7 standard that represent different events (Table 1).

Thus, a MAS with several intelligent agents was created, which purpose is mainly to identify and to monitor the patient presence in the ICU's bed, and to ensure the interoperability between the PaLMS and the AIDA platform.

Figure 1 presents and summarizes the communication process of the agents in the PaLMS Module, and the information exchanged with the PMS Module, the INTCare Module, the Alert Module and the RFID System. All these modules are incorporated in the AIDA platform. Nonetheless, it is important to note that the PaLMS Module is not the PaLMS itself, but simply a module integrated in the PaLMS.

- **PMS Agent:** this agent operates as an HL7 message server once it sends and receives the messages through a client-server configuration. It is inserted in the PMS, and it manages the patient information related to admissions, discharges, transfers, leaves

of absence and the corresponding returns, which is all sent from the AIDA platform through the PMS. In this way, this agent communicates with the PaLMS Agent in order to inform the RFID system which event occurred. The PMS Agent also sends instructions to the Monitoring Agent in order to execute the INTCare Module or the Alert Module;

- **PaMLS Agent:** this agent also operates as an HL7 message server and it acts according to the message received from the PMS Agent:
  - ADT_A01 (AE): the health professional in the ICU will associate a tag to the patient and the identification process will be executed. Then, the RFID system starts the readings;
  - ADT_A22 (RLoAE): the PaLMS Agent instructs the RFID system to restart the readings;
  - ADT_A02, ADT_A03, ADT_A21 (TE, DE, LoAE): this agent informs the RFID system to stop the readings.
- Besides that, the PaLMS Agent also exchanges messages with the Monitoring Agent in order to inform the INTCare and Alert modules properly.
- **Monitoring Agent:** it receives information from the PMS Agent and PaLMS Agent, and it instructs the INTCare Agent and Alert Agent in order to start, to stop or to continue the INTCare System or the Alert System, respectively;
- **INTCare Agent:** this agent communicates with the INTCare System in order to start, to stop or to continue the vital signs readings;
- **Alert Agent:** it turns on or off the alarm system according to the information received from the Monitoring Agent.

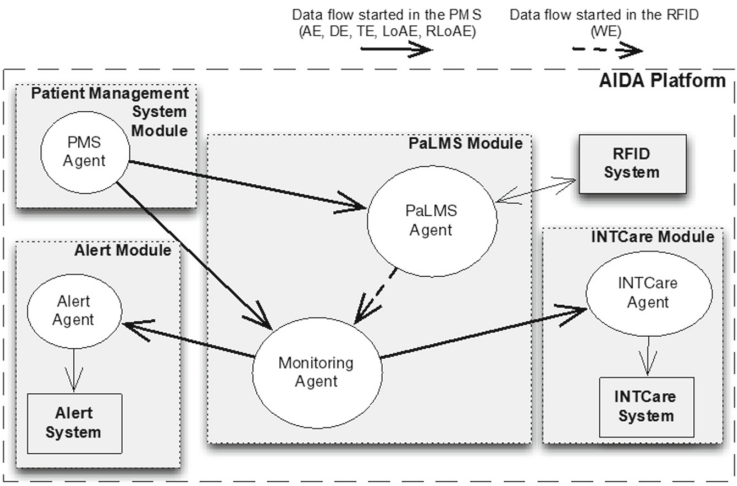

Fig. 1. Exchange of information among the four modules, namely the Patient Management System (PMS) Module, the Alert Module, the Patient Localization and Management System (PaLMS) Module, the INTCare Module, and the RFID system, all included in the AIDA platform.

3.3 PaLMS Agents' Failure Prevention System

On the other hand, in order to create a failure prevention system for the PaLMS, the Modified Early Warning Score (MEWS) model was first studied carefully.

MEWS assumes that a serious problem of health is often preceded by a physiological deterioration. The use of the MEWS model implies a strict monitoring of the patient's vital signs. Then, using the decision table (Table 2), the scores are calculated to determine the level of risk of each patient, trying to understand when a serious problem could possibly occur. The monitoring of a patient's vital signs should be continuous, and all the values must be archived so that it becomes possible to understand the behaviour of the vital signs over time [22, 23].

Table 2. Modified Early Warning Score (MEWS) scores (adapted) [22]

MEW score	3	2	1	0	1	2	3
Temperature (C)		< 35	35.1–36	36.1–38	38.1–38.5	> 38.6	
Heart rate (min^{-1})		< 40	41–50	51–100	101–110	111–130	> 131
Systolic BP (mmHg)	< 70	71–80	81–100	101–199		> 200	
Respiratory rate (min^{-1})		< 8		8–14	15–20	21–29	> 30
Blood oxygen (%)	< 85	85–89	90–93	> 94			
Urine output (ml/kg/h)	Nil	< 0.5					
Neurological		New confusion		Alert	Reacting to voice	Reacting to pain	Unresponsive

To classify the health state of a patient, the seven scores are extracted from Table 2 and, then, they are summed, obtaining the total score.

The patient's state is characterized according to the following guidelines [22, 23]:

- When one of the parameters has the score two, the patient should be observed frequently;
- If the patient's total score is four or if there is an increase of two values of the total score, the patient requires an urgent medical attention;
- If the total score is more than four, the patient is at a high-risk of life.

This model is endowed with several advantages such as: [22, 23]

- Enabling the possibility to set priorities for the interventions to be carried out;
- Knowing better the physiological tendencies of the patient's organism through the monitoring process;
- Assisting in making medical decisions, once it uses a quantitative criterion;
- Predicting situations where the patient needs internment in the ICU.

Thereby, the PaLMS agents' failure prevention system is based on a score table based on the MEWS model. To develop a prevention system, it is indispensable to realize a monitoring process. Thus, a high knowledge about the system is demanded in order to select the performance indicators properly. For the prevention of the faults, the system is based on the frequency of agents' activity. In other words, it is the frequency with which the agent is executed. It also can be interpreted as the interval of time that the agent takes in order to refresh the log file with its newest activity.

In Table 3, the score table for PaLMS agents based on their activity frequency (in minutes) and percentiles (based on the 95th percentile method [24]) is presented. Once there is one variable in the score table, the score four was added, becoming the system more accurate. After obtaining the results from the first tests of this prevention system, the Table 3 was adapted. The 95th percentile was replaced by the 97.5th percentile and, consequently, the other limits were also modified, with the purpose of increasing the system accuracy.

Table 3. Score table for the Patient Localization and Management System (PaLMS) agents based on their activity frequency (in minutes) and percentiles (based on the 95th percentile method [24])

Score	0	1	2	3	4
Activity frequency (min)	$\leq p85$	$[p85, p90]$	$[p90, p95]$	$[p95, p97.5]$	$> p97.5$

Before beginning the prediction process, it is indispensable to collect several data about the agents' activity frequency during a reasonable period of time. In this way, it is possible to evaluate the normal behaviour of the agents, and to start the prevention process based on the interpretation of the MEWS scores:

- If the score obtained is less than four, then a visual warning will be issued on the monitoring dashboards;
- If the score is equal to four, then an email is sent to the system administrators to warn them in order to take rapid actions to restore the normal workflow and to prevent future damages.

Thus, new limits are constantly calculated for each agent, improving the system efficacy. This failure prevention system intends to guarantee the high availability of the PaLMS agents, ensuring the right identification of the patients in the ICU.

4 Conclusions

After the implementation of the INTCare system in *Centro Hospital do Porto* (CHP), two main flaws were detected in the system, i.e., the absence of the patient's identification in the INTCare monitors in an automatic way and, whenever a patient left his/her bed in the Intensive Care Unit (ICU), the monitoring system (INTCare) continued to collect data.

To circumvent these two main problems, an architecture was developed in order to avoid the existence of invalid/wrong data in the INTCare system. This architecture was tested through the Patient Localization and Management System (PaLMS), which function is precisely to identify automatically the presence of patients in the ICU's beds. Furthermore, to ensure the high availability of the PaLMS, a failure prevention system was created based on the Modified Early Warning Score (MEWS) model.

Finally, PaLMS is currently implemented in CHP and it has been demonstrated highly indispensable to the proper operation of the INTCare system.

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Magni - A Framework for Developing Context-Aware Mobile Applications

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Abstract. The advent of Internet and ubiquitous technologies has been fostering the appearance of intelligent mobile applications aware of their environment and the objects nearby. Despite its popularity, mobile developers are often required to write large and disorganized amounts of code, mixing UI with business logic and interact, in a ad-hoc fashion, with sensor devices and services. These habits hinder the code maintenance, refactoring and testing, while negatively influencing the consistency and performance of mobile applications. In this paper we present Magni as an abstract framework for the design and implementation of personalized and context-aware mobile applications. The corner stone of the framework is its architectural pattern based on the Model–View–Presenter pattern in the UI layer relying in REST services the majority of the app features. This paradigm fosters the modular design, implementing the separation of concerns concept and allowing an easier implementation of unit tests. In order to validate the framework, we present a prototype for an healthcare automotive app. The main goal of the app is to facilitate the access to health related points of interest such as hospitals, clinics and pharmacies.

Keywords: Web services · Design patterns · Mobile frameworks · Geolocalization · Interoperability · Mobile healthcare · Automotive apps

1 Introduction

The increased use of mobile devices and their ubiquitous facet, fostered the design of context-aware applications that make use of data collected from the sensors' device and location services. Based on this data, a context-aware app can better understand users' current situations, and use this information to provide optimized and customized experiences.

These type of mobile apps are difficult to implement for two reasons: (1) the challenges of their ubiquitous facet and (2) the absence of a widely accepted programming model.

In the former, developers must understand that these ubiquitous computing environments pose challenges regarding communication and interaction due to

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constraints such as dynamically changing network addresses and system configurations, susceptibility to disconnection and low bandwidth [1].

The later is even more problematic. Despite the existence of multiple context-aware mobile applications, they remain difficult to develop, with no widely accepted programming model available. In most cases, developers find themselves mixing UI aspects with logic and data layers, with no sense of design patterns. Other developers write a large amount of code locally to recreate existent services, increasing redundancy and harming code maintenance and testing.

In order to facilitate the development of such applications, several frameworks appeared in recent years to help developers to abstract, modularize and optimize their work. Some frameworks [2–4] focus on a specific platform (Android) rather being a multi-platform framework. Other approaches aim to provide location-specific information and services [5–7] through a central information system, which is responsible for storing, maintaining and communicating all location specific data. Finally, other frameworks [8,9] are built as a layered architecture in order for portions of application components to be adapted based on current contextual information. None of these frameworks is concerned with software design patterns. In addition, none of them abstracts the use of ubiquitous platforms such as wearable and automotive platforms.

This paper presents Magni – a framework for developing context-aware mobile applications. Magni suggests the use of software design patterns for code organization in the UI layer relying on Web services for the majority of the app supported features. These patterns foster automated unit testing and the separation of concerns in presentation logic, improving the consistency of the application. Based on this framework, we created an automotive app prototype called MyHealth for a healthcare case study.

This work is organized as follows. Section 2 discusses some key concepts on context-aware frameworks such as the software patterns used, the mobile platforms supported and the domains adequacy. In Sect. 3, we present the Magni framework that was designed to help programmers in the development of context-aware mobile applications. Section 4 evaluates the proposed framework through the creation of a prototype for an healthcare case study. Finally, we enumerate the main contributions of this work and future directions.

2 Mobile Framework Facets

Mobile frameworks have multiple facets. In this section we detail their design patterns, supported platforms and domains.

2.1 Software Design Patterns

Nowadays, the majority of mobile applications use an ad-hoc Model-View architecture. In this context the components of the UI (e.g. Activities or Fragments in Android) implement logic, handle UI aspects and control the flow between data objects and UI. Using this approach, UI programmers end up with complex

and massive monolithic code where everything is connected to everything and the work between the programmers team is chaotic.

In software engineering, a software design pattern is an abstract, general and reusable solution to a commonly problem. It cannot be transformed directly into source code, instead, it describes how to solve a problem. Thus, design patterns are formalized best practices that provide programmers with the tools needed to solve common problems when designing an application [10]. Other important advantage of the use of design patterns is that it decouples development allowing multiple developers to work simultaneously.

There are several software design patterns for implementing user interfaces on computers, the most popular are: Model-View-Controller (MVC), Model-View-Presenter (MVP) and Model-View-Viewmodel (MVVM).

MVC was introduced in the 1970s. Although originally developed for the UI layer, MVC has been widely adopted as an architecture for WWW applications through several Web frameworks. MVC pattern divides an application into three major components: Model, View, and Controller. The model component manages the business and the data model. It also defines the business rules for data defining how the data can be manipulated. The View represents the user interface components (e.g. Activity/Fragments in Android, HTML/CSS in Web) responsible for the data visualization received from the controller. The controller is the mediator between the View and the Model. It gets the input from users via the View, then processes the user's data through the Model, passing back the results to View.

MVP is an evolution of MVC, wherein the controller is replaced by the presenter. The Presenter is responsible for addressing all user interface events on behalf of the view. The View and the Presenter are completely separated, unlike View and Controller, and communicate to each other by an interface. The Presenter also doesn't handle the incoming request traffic like controller.

MVVM pattern supports two-way data binding between View and View-Model. This fosters automatic propagation of changes between ViewModel and the View. Generally, the ViewModel uses the observer pattern to inform changes in the ViewModel to the Model.

Regardless of the pattern choice, the most important is to use a software design pattern during the design and implementation of a mobile application.

2.2 Platforms

Mobile apps are not confined only to smartphones and tablets. In fact, other mobile platforms appeared in recent years, synchronized with the technology and economy evolution of societies. Some important examples are multimedia devices (e.g. TVs), automotive devices (e.g. cars, plains) and wearable devices (e.g. watches, fitness trackers).

One emergent industry is the automotive sector. In the United States, 17.5 million vehicles were sold in 2015, and expect to reach 20 million in 2019. Sales have also improved in the European Union since the financial downturn. In 2015, new car registrations in the E.U. hits the 12.6 million units.

In fact, the ubiquity of the car, plus the simultaneous convergence of information and communication technology with both the automobile and some industries (e.g. healthcare, tourism), now provide some potentially promising opportunities for linkups. Based on these facts, automotive companies are investing in the mobile experience seeking to create a more rich connected car experience which means including 4G/LTE hotspots in a car so mobile devices can connect to the Internet or creating a closed integration through mirror frameworks (e.g. Android Auto for Android and Apple CarPlay for Apple) allowing drivers interact with their mobile devices from the car's Head Unit.

2.3 Domains

There are several domains where context-aware mobile apps can act. The predictable choice would be tourism where apps can help tourists to easily locate and access points of interest based on the user's location. Other important sector is healthcare. The health care industry incorporates several sectors that are dedicated to providing health care services and products.

Mobile Health (ou mHealth) as been defined as a reference to using mobile communication devices, such as mobile phones and tablet computers, for health services. A growing percentage of health-related smartphone apps are available, and some estimates predict 500 million patients will be using such apps by the year 2015 [11]. Merging with the previous section, the health and automobile sectors account for an annual 2.7 trillion and 1 trillion dollars respectively in the United States. Both industries are looking at various ICT-oriented solutions toward a "smart-health-oriented" car. With this in mind, the first Smart Seating applications were mainly related with improving in-car sitting posture. Beyond that, the automotive industry is now transforming the car into a connected component to healthcare and wellness services, with apps covering such areas of health as monitoring diabetes and the driver's heart rate.

3 The Magni Framework

This section presents a proposal for a context-aware mobile framework called Magni. The Magni framework is an abstract framework that can be used by developers to create well organized and sophisticated code based on software design patterns. We believe that the use of these patterns will improve code maintenance and test and create consistent apps. Magni relies all typical features of these kind of apps to a network of services (e.g. authentication, location, storage). In the following subsections the framework is described based on two models: architectural and integration models.

3.1 Architectural Model

The Magni framework is the basis for the design and implementation of Magni instances as realizations of the framework for specific domains (e.g. healthcare, tourism, computer programming learning).

The Magni framework suggests the use of a client-server architecture in which presentation, application processing, and data management functions are physically separated as a multitier architecture (e.g. three-tier architecture). In this architecture, Magni emphasizes the UI layer, decoupling tasks through the Model-View-Presenter (MVP) design pattern (Fig. 1). MVP is a user interface architectural pattern created to facilitate automated unit testing and improve the separation of concerns in presentation logic. Thus, a Magni instance (mobile app) will be organized in

- The **View** is a passive interface that displays data (the model) and routes user commands (events) to the presenter to act upon that data.
- The **Presenter** acts upon the model and the view. It retrieves data from repositories (the model), and formats it for display in the view. The Presenter is responsible for addressing all user interface events on behalf of the view. It receives input from users via the View, then process the user's data through the Model that passes the results back to the View.
- The **Model** is an interface defining the data.

Unlike the MVC pattern, in this model the View and the Presenter are completely separated, from each other and communicate to each other by an interface. This design pattern allows also the systematic use of abstraction mechanisms supporting a variety of implementation options.

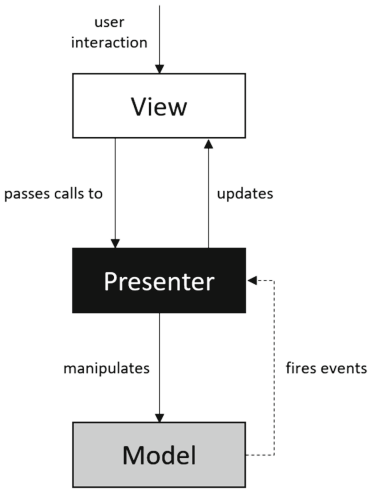

Fig. 1. Magni framework pattern UI Model

3.2 Integration Model

The Magni specification also comprises an integration model. This model recommends specifications for the communication between the Magni instance and the

services. A Magni instance can include several features related with authentication, location awareness, places discovering, sensing, rating, gamification, and many others. Instead of implementing all theses features, the Magni framework suggest that instances should stay small (thin clients) and rely all the "hard work" on services in the cloud. Services in the framework are organized in two groups based on its importance: **core and secondary**.

Core services are mandatory services that a context-aware app should have. For instance, one of the unique features of mobile applications is location awareness. Mobile users take their devices with them everywhere, and adding location awareness to a mobile app offers users a more contextual experience, with automated location tracking, geofencing, and activity recognition.

Secondary services are complementary services that complement the core services in a specific task, although its absence does not alter the execution flow of a feature process. Usually these services do not have graphical interfaces and are more specialized than the core services. An example of this kind of services is an adaptation service. Taking the previous example, an adaptation service could adjust the presentation order in accordance with the effective proximity of the points of interest. Another example of a secondary service is a social media service that resides on the cloud and can be used to integrate social features from a Social Media Platform (SMP) such as Facebook or Twitter in the Magni framework. In this context, a social service could set/get information to/from social networks.

This integration model relies on web services for communication among systems. Web services can be used mostly in two flavors: SOAP and REST. SOAP web services are usually action oriented, mainly when used in Remote Procedure Call (RPC) mode and implemented by an off-the-shelf SOAP engine such as Axis. Web services based on the REST style are object (resource) oriented and implemented directly over the HTTP protocol mostly to put and get resources. Both specifications have matured in distinct periods and they coexist nowadays: SOAP started earlier and now the trend is REST as stated from a directory of 3200 web APIs listed at ProgrammableWeb (http://www.programmableweb.com/). Regardless of these trends, the Magni specification does not encourage the use of any flavor in the communication specifications detailed in the following subsections. As far as possible, Magni tries to keep an equidistant position from both flavors.

This section analyses the communication specifications for the interaction with three core services typically found in context-aware apps: **authentication/storage services, location services and social services**.

Authentication/storage Services. User authentication is an important requirement for most mobile apps today. By being able to securely authenticate users and identify them your app can offer users a customized experience based on their interests and preferences. At the same time, data persistence is crucial. Despite some data can be stored in the device itself (e.g. user preferences, binary files and small databases emulating caching features), other data should

be stored remotely and centrally. In order to not reinvent the wheel, many apps rely on cloud services for this bureaucratic work.

A Backend-as-a-service (BaaS) is a cloud computing service model acting as a middleware component that allows developers to connect their Web and mobile applications to cloud services via application programming interfaces (API) and software developers' kits (SDK). BaaS features include cloud storage, push notifications, server code, user and file management and user authentication and management as well as many other backend services. These services have their own API, allowing them to be integrated into applications in fairly simple way. One impressive example is the Firebase BaaS that offers free services such as analytics, crash reporting, user authentication, and cloud messaging.

Location Services. One of the unique features of mobile applications is location awareness. Mobile users take their devices with them everywhere, and adding location awareness to a mobile app offers users a more contextual experience. For instance, the location APIs available in Google Play services facilitate adding location awareness to mobile apps with automated location tracking through the Location API. Other features are supported by this API, such as the geofencing and activity recognition. The former combines the awareness of the user's current location with awareness of the user's proximity to locations that may be of interest. In this case, it is possible to define and adjust the proximity for the location, through coordinates (latitude and longitude) and a radius. These data define a geofence, creating a circular area, or fence, around the location of interest. For each geofence, the Location Services send entrance and exit events, or it can be specified a duration within the geofence area to wait, or dwell, before triggering an event. The later offers developers a powerful tool to augment the user experience. By getting information about the user's activity, apps can make intelligent decisions catering the application experience. For example, by asking if the user is starting to exercise so you can keep track of it with a fitness app (e.g. Google Fit), or preventing notifications from being sent when the user is driving.

Social Media Services. OpenSocial is a set of three programming interfaces (APIs) for web-based social network applications created by Google. The OpenSocial API covers a broad range of capabilities such as, profile information (user data), relationships information (social graph) and activities (e.g. news feed). The main goal of OpenSocial is to provide a common framework to be used by developers to guarantee interoperability across several social networks on the Internet, which act as containers for each OpenSocial-compliant application. This specification provides a REST and RPC API communication flavours through which OpenSocial-compliant applications and containers interact with each other, transmitting user data, friend lists and activities. These protocols support various data exchange formats such as XML, JSON and ATOM. In order to authorise access to data stored in social networks, these APIs rely on the OAuth specification. The lack of adoption by major players such as Facebook

affects negatively the OpenSocial adoption. In order to get around with this issue other alternatives can be used. A well known approach is to build API wrappers that map the OpenSocial API to the native APIs. In 2015, W3C and the OpenSocial Foundation announced that OpenSocial standards will take place in the W3C Social Web Working Group, of which the OpenSocial Foundation is a founding member.

4 Evaluation

In order to validate the framework, we instantiate it through the creation of a prototype for a health-care case study called **MyHealth**.

MyHealth is a healthcare automotive app whose main goal is to facilitate the access to points of interest related to health (e.g. hospitals, clinics, pharmacies). Through a map and GPS, the user can see, in the car, available POIs nearby (sorted by various filters) and make the choice through voice recognition. The application will suggest the best directions and, using a rating functionality, the patient can post and access the feedback from other patients, ensuring quality and community building, while helping to improve the service.

Based on the framework, MyHealth relies all the authentication and storage stuff in the Baas Firabase. In order to add location awareness it uses the Location API from Google Play Services. Finally, the integration with Facebook and Twitter is ensured with the OpenSocial API. Figure 2 illustrates the integration model of the automotive app:

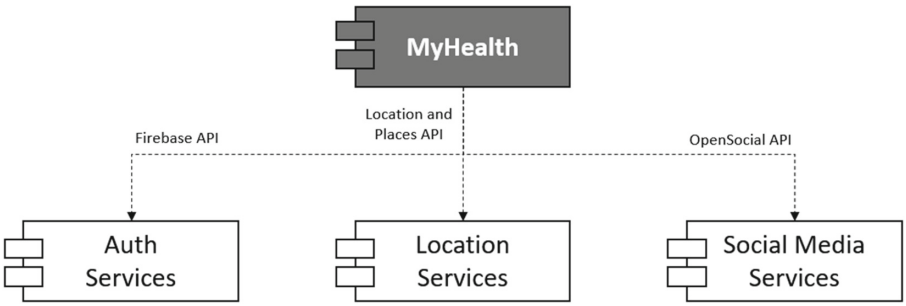

Fig. 2. MyHealth integration Model

Figure 3 illustrates the mockup of the app's main view:

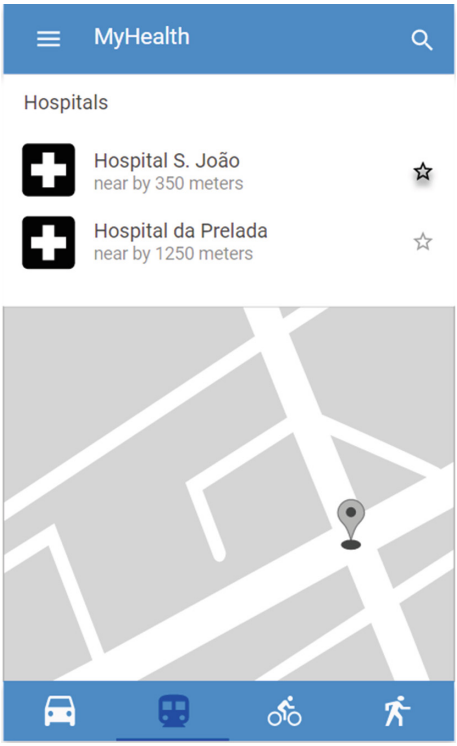

Fig. 3. Mockup on the main view of the MyHealth app

5 Conclusion

This paper presents Magni as a framework for the development of context-aware mobile applications. Magni differs from current frameworks by its emphasis on software design patterns and abstraction to different platforms. The architectural model of Magni is based on the MVP pattern in the UI layer and the remain components are accessed via REST services. This type of model will potentiate the maintenance and testing of the app's code. In order to validate the framework, an instance of Magni was created for the healthcare domain. The validation is still unfinished since only the mockups were created. Thus, the future work will be, to finish the prototype. In addition, there are other projects, in the tourism domain, that can be used to test and tune the framework.

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On the Optimal Processor Assignment for Computing the Steady State Kalman Filter in Parallel and Distributed Systems

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Abstract. Kalman filters have many practical applications in various fields such as sensor networks, image and video processing. Therefore, their fast computation is of paramount importance. In this paper distributed implementations for the steady state Kalman filter are proposed. The distributed algorithms are based on partitioning the measurement vector, the state vector or both of them. The number of processors is determined a priori. The optimal distribution of measurements/states into parallel processors minimizing the computation time is also a priori determined.

Keywords: Kalman filter · Steady sate · Distributed algorithms

1 Introduction

The discrete time Kalman filter [1] is the most well-known estimation algorithm. Estimation plays an important role in many fields of science. Many real problems have been successfully solved using Kalman filter: applications to aerospace industry, chemical process, communication systems design, control, civil engineering, filtering noise from two dimensional images, pollution prediction, power systems are mentioned in [2].

The estimation problem arises in linear estimation and is associated with time varying systems described by the following state space equations:

$$\left\{ \begin{array}{c} x(k+1) = F(k+1,k)x(k) + w(k) \\ z(k+1) = H(k+1)x(k+1) + v(k+1) \end{array} \right\} \quad (1)$$

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where $x(k)$ is the $n \times 1$ state vector, $z(k)$ is the $m \times 1$ measurement vector, $F(k+1, k)$ is the $n \times n$ transition matrix, $H(k)$ is the $m \times n$ output matrix, $w(k)$ is the $n \times 1$ state noise and $v(k)$ is the $m \times 1$ measurement noise at time $k \geq 0$.

The statistical model expresses the nature of the state and the measurements. Basic assumption is that the state and the measurement noises are white noises (white noise is a white process, i.e., a stochastic process with values uncorrelated from instant to instant. A white noise stochastic process has constant mean (usually zero mean)): $\{w(k)\}$ is zero mean, Gaussian process with known covariance $Q(k)$ of dimension $n \times n$ and $\{v(k)\}$ is zero mean, Gaussian process with known covariance $R(k)$ of dimension $m \times m$. The following assumptions also hold: (a) the initial value of the state $x(0)$ is a Gaussian random variable with mean x_0 and covariance P_0, (b) the state noise, the measurement noise and the initial state are independent. The estimation problem is to produce an estimate $x(k/k)$ at time k of the state vector $x(k)$ using measurements till time k.

There are two approaches to produce the estimates: the centralized approach, where all the measurements are transmitted from the local sensor to a central processor and the decentralized approach, where the data are obtained by the different sensor subsystems, processed locally and the results are transmitted to the central processor which combines the information from the local subsystems to produce the estimate. This approach has been used in order to partition the measurement noise process into statistically uncorrelated parts: these parts are not necessarily equal [3–6] but can be equal [7]. In this paper we use the ideas in [3–7] in order to derive distributed implementations for the steady state Kalman filter. The novelty of this paper is the derivation of distributed algorithms partitioning the measurement vector, the state vector or both of them.

The paper is organized as follows: In Sect. 2 the steady sate Kalman filter is presented. In Sect. 3 three different parallelization approaches for the steady sate Kalman filter are proposed and their cost is analyzed. Based on the cost analysis in Sect. 4 the optimal assignment of processors to computations is derived for uniform distributions. Experimental results with an OpenMP parallel implementation are presented in Sect. 5. Finally, Sect. 6 summarizes the conclusions.

2 Steady State Kalman Filter

For the invariant systems described by (1) with:

$$F(k+1,k) = F, \;\; H(k+1) = H, \;\; Q(k) = Q, \;\; R(k+1) = R \tag{2}$$

the time varying Kalman filter is summarized in the following:

$$\left\{ \begin{array}{c} x(k+1/k) = Fx(k/k) \\ P(k+1/k) = Q + FP(k/k)F^T \\ K(k+1) = P(k+1/k)H^T \left[HP(k+1/k)H^T + R\right]^{-1} \\ x(k+1/k+1) = [I - K(k+1)H]x(k+1/k) \; + K(k+1)z(k+1) \\ P(k+1/k+1) = [I - K(k+1)H]P(k+1/k) \end{array} \right\} \tag{3}$$

$k = 0,1\ldots$, with initial conditions $x(0/0) = x_0$ and $P(0/0) = P_0$.

The Kalman filter equations compute iterativelly the prediction $x(k+1/k)$ of the state vector and the corresponding prediction error covariance $P(k+1/k)$, as well as the estimation $x(k+1/k+1)$ of the state vector and the corresponding estimation error covariance $P(k+1/k)$. The matrix $K(k)$ is the Kalman filter gain.

For time invariant systems, it is well known [2] that if the signal process model is asymptotically stable, then there exists a steady state value of the prediction error covariance matrix. This value remains constant after the steady state time is reached. In the steady state case, there also exists a steady state value of the Kalman filter gain as well as a steady state value of the estimation error covariance matrix. The corresponding discrete time Riccati equation results from Eq. (3) and has as follows:

$$\begin{aligned} P(k+1/k) = {} & Q + FP(k/k-1)F^T \\ & - FP(k/k-1)H^T\left[HP(k+1/k)H^T + R\right]^{-1}HP(k+1/k)F^T \end{aligned} \tag{4}$$

The solution of the Riccati equation [2, 8, 9] is the steady state prediction error covariance P_{p}, which satisfies the algebraic Riccati equation:

$$P_p = Q + FP_pF^T - FP_pH^T\left[HP_pH^T + R\right]^{-1}HP_pF^T \tag{5}$$

Then, the steady state Kalman filter gain is:

$$K = P_pH^T\left[HP_pH^T + R\right]^{-1} \tag{6}$$

and the steady state estimation error covariance is

$$P_e = [I - KH]P_p \tag{7}$$

Furthermore, from the Kalman filter Eq. (2), the estimation is derived:

$$x(k+1/k+1) = A(k+1)Fx(k/k) \; + K(k+1)z(k+1) \tag{8}$$

where

$$A(k+1) = [I - K(k+1)H]F \tag{9}$$

The **Steady State Kalman Filter** is then derived:

$$\begin{aligned} & x(k+1/k+1) = Ax(k/k) + Kz(k+1) \\ & k = 0, 1 \ldots \end{aligned} \tag{10}$$

with initial condition $x(0/0) = x_0$.

The coefficients are constant and are calculated off-line by first solving the corresponding discrete time Riccati equation, then computing the steady state Kalman filter gain using (6) and finally computing:

$$A = [I - KH]F \tag{11}$$

3 Parallel Steady State Kalman Filter

Using the ideas in [3–7] we are going to derive Parallel Kalman Filter implementations partitioning (A) the measurement vector, (B) the state vector (C) both the measurement and the state vectors.

(A) **Parallel Steady State Kalman Filter – measurement vector partition**
The measurement vector $z(k)$ is partitioned into p_{m} parts where

$$\sum_{i=1}^{p_m} m_i = m \tag{12}$$

$$\max\{m_i\} = M \tag{13}$$

The **Parallel Steady State Kalman Filter – method A** is then derived:

$$\begin{aligned} &\text{Central Level} \qquad x(k+1/k+1) = Ax(k/k) + \sum_{i=1}^{p_m} K_i z_i(k+1) \\ &\text{Local Level} \qquad\quad K_i z_i(k+1), \quad i = 1, ..., p_m \end{aligned} \tag{14}$$

(B) **Parallel Steady State Kalman Filter – state vector partition**
The state vector $x(k)$ is partitioned into p_{n} parts where

$$\sum_{i=1}^{p_n} n_i = n \tag{15}$$

$$\max\{n_i\} = N \tag{16}$$

The **Parallel Steady State Kalman Filter – method B** is then derived:

$$\begin{aligned} &\text{Central Level} \qquad x(k+1/k+1) = \sum_{i=1}^{p_n} A_i x_i(k/k) + Kz(k+1) \\ &\text{Local Level} \qquad\quad A_i x_i(k/k), \quad i = 1, ..., p_n \end{aligned} \tag{17}$$

(C) **Parallel Steady State Kalman Filter – state and measurement vectors partition**
The measurement vector $z(k)$ is partitioned into p_{m} parts and the state vector $x(k)$ is partitioned into p_{n} parts, where (12), (13), (15) and (16) hold and

$$\max\{N, M\} = L \tag{18}$$

The **Parallel Steady State Kalman Filter – method C** is then derived:

$$\begin{aligned} &\text{Central Level} \qquad x(k+1/k+1) = \sum_{i=1}^{p_n} A_i x_i(k/k) + \sum_{i=1}^{p_m} K_i z_i(k+1) \\ &\text{Local Level} \qquad K_i z_i(k+1), \quad i = 1, ..., p_m \text{ and } A_i x_i(k/k), \quad i = 1, ..., p_n \end{aligned} \tag{19}$$

Notice that in all cases the coefficients are known and are calculated off-line. Due to the fact that the Steady State Kalman Filter algorithm is iterative, in order to compute the computational time, we have to derive the per-iteration calculation burden required for the on-line calculations; the calculation burden of the off-line calculations is not taken into account.

The implementation of the Steady State Kalman Filter algorithms requires matrix operations, which involve scalar additions and scalar multiplications. Let scalar multiplication = c · scalar addition, where $c \geq 1$. Depending on the application, but also on processor technology, $c \approx 1$. For instance, [10] reports the same latency but different throughput for the two operations. Then Table 1 summarizes the calculation burden of each of the three parallelization approaches discussed above.

Table 1. Parallel steady state Kalman filter calculation burden.

		Operation	Dimensions	Burden
Method A	Local	$K_i z_i(k+1),\ i = 1, ..p_m$	$(n \times m_i) \cdot (m_i \times 1)$	$(c+1)nM - n$
	Central	$Ax(k/k)$	$(n \times n) \cdot (n \times 1)$	$(c+1)n^2 - n$
		$\sum_{i=1}^{p_m} K_i z_i(k+1)$	$(n \times 1) + (n \times 1)$	$n(p_m - 1)$
		$Ax(k/k) + \sum_{i=1}^{p_m} K_i z_i(k+1)$	$(n \times 1) + (n \times 1)$	n
	Total burden: $f_A = (c+1)n^2 + (c+1)nM - 2n + p_m n$			
Method B	Local	$A_i x_i(k/k),\ i = 1, ..p_n$	$(n \times n_i) \cdot (n_i \times 1)$	$(c+1)nN - n$
	Central	$Kz(k+1)$	$(n \times m) \cdot (m \times 1)$	$(c+1)nm - n$
		$\sum_{i=1}^{p_n} A_i x_i(k/k)$	$(n \times 1) + (n \times 1)$	$n(p_n - 1)$
		$\sum_{i=1}^{p_n} A_i x_i(k/k) + Kz(k+1)$	$(n \times 1) + (n \times 1)$	n
	Total burden: $f_B = (c+1)nN + (c+1)nm - 2n + p_n n$			
Method C	Local	$K_i z_i(k+1),\ i = 1, ..p_m$ $A_i x_i(k/k),\ i = 1, ..p_n$	$(n \times m_i) \cdot (m_i \times 1)$ $(n \times n_i) \cdot (n_i \times 1)$	$(c+1)nL - n$
	Central	$\sum_{i=1}^{p_m} K_i z_i(k+1)$	$(n \times 1) + (n \times 1)$	$n(p_m - 1)$
		$\sum_{i=1}^{p_n} A_i x_i(k/k)$	$(n \times 1) + (n \times 1)$	$n(p_n - 1)$
		$\sum_{i=1}^{p_n} A_i x_i(k/k) + \sum_{i=1}^{p_m} K_i z_i(k+1)$	$(n \times 1) + (n \times 1)$	n
	Total burden: $f_C = (c+1)nL - 2n + (p_n + p_m)n$			

Summarizing, the computational burden of the Parallel Steady State Kalman Filter algorithms in (14), (17), (19) are given by the following three equations:

$$f_A = (c+1)n^2 + (c+1)nM - 2n + p_m n \tag{20}$$

where $\sum_{i=1}^{p_m} m_i = m$ and $\max\{m_i\} = M$

$$f_B = (c+1)nN + (c+1)nm - 2n + p_n n \tag{21}$$

where $\sum_{i=1}^{p_n} n_i = n$ and $\max\{n_i\} = N$

$$f_C = (c+1)nL - 2n + (p_n + p_m)n \tag{22}$$

where $\sum_{i=1}^{p_m} m_i = m$, $\max\{m_i\} = M$, $\sum_{i=1}^{p_n} n_i = n$ and $\max\{n_i\} = N$, $\max\{N, M\} = L$

4 Optimal Load Distribution

The basic idea is to partition the measurement/state vectors into equal parts. Then uniform distributions are derived. These uniform distributions have the advantage that all local measurements/states processors perform the same calculations concerning quantities of the same type and dimensionality; thus, all local measurements/states processors have the same structure and therefore, low hardware cost is required for the implementation of the decentralized algorithms.

From (20)–(22) we conclude that we are able to determine the optimal uniform distributions, minimizing the computation time of the parallel algorithms. The calculation burden are functions of M, p_{m}, N, p_{n}. Then, the minimization of the calculation burdens leads to the following optimal distributions:

4.1 Method A: Measurement Vectors Partition

The measurement vector is partitioned into p_{m} equal parts; then p_{m} parallel processors are used with $M = \dfrac{m}{p_m}$ measurements in each processor, i.e. $m_i = M,\ i = 1, \ldots, p_{\mathrm{m}}$ and the following relation holds:

$$p_m M = m \tag{23}$$

The total calculation burden can be written as a function of p_{m}:

$$f_A^u = (c+1)n^2 + (c+1)n\frac{m}{p_m} - 2n + p_m n$$

The first and second derivatives of this function with respect to p_{m} are:

$$\frac{\partial f_A^u}{\partial p_m} = -(c+1)\frac{nm}{p_m^2} + n = n\left(1 - \frac{(c+1)m}{p_m^2}\right)$$

$$\frac{\partial^2 f_A^u}{\partial p_m^2} = \frac{2(c+1)nm}{p_m^3} > 0$$

Then the function has minimum when

$$\frac{\partial f_A^u}{\partial p_m} = 0 \Rightarrow p_m^2 = (c+1)m \Rightarrow p_m = \sqrt{c+1}\sqrt{m}$$

and then:

$$M = \frac{m}{p_m} = \frac{m}{\sqrt{c+1}\sqrt{m}} = \frac{\sqrt{m}}{\sqrt{c+1}}$$

The optimal uniform distribution is:

$$M = \frac{\sqrt{m}}{\sqrt{c+1}}, \quad p_m = \sqrt{c+1}\sqrt{m} \tag{24}$$

and the total minimum calculation burden is:

$$f_{A,\min}^u = (c+1)n^2 + 2\sqrt{c+1}\sqrt{m}n - 2n \tag{25}$$

4.2 Method B: State Vectors Partition

The state vector is partitioned into p_n equal parts; then p_n parallel processors are used with $N = \frac{n}{p_n}$ states in each processor, i.e. $n_i = N,\ i = 1, \ldots, p_n$ and the following relation holds:

$$p_n N = n \tag{26}$$

The total calculation burden can be written as a function of p_n:

$$f_B^u = (c+1)n\frac{n}{p_n} + (c+1)nm - 2n + p_n n$$

The first and second derivatives of this function with respect to p_n are:

$$\frac{\partial f_B^u}{\partial p_n} = -(c+1)\frac{n^2}{p_n^2} + n = n\left(1 - \frac{(c+1)n}{p_n^2}\right)$$

$$\frac{\partial^2 f_B^u}{\partial p_n^2} = \frac{2(c+1)n}{p_n^3} > 0$$

Then the function has minimum when

$$\frac{\partial f_B^u}{\partial p_n} = 0 \Rightarrow p_n^2 = (c+1)n \Rightarrow p_n = \sqrt{c+1}\sqrt{n}$$

and then

$$N = \frac{n}{p_n} = \frac{n}{\sqrt{c+1}\sqrt{n}} = \frac{\sqrt{n}}{\sqrt{c+1}}$$

The optimal uniform distribution is:

$$N = \frac{\sqrt{n}}{\sqrt{c+1}}, \quad p_n = \sqrt{c+1}\sqrt{n} \tag{27}$$

and the total minimum calculation burden is

$$f_{B,\min}^u = (c+1)nm + 2\sqrt{c+1}\sqrt{n}n - 2n \tag{28}$$

4.3 Method C: State and Measurement Vectors Partition

The measurement vector is partitioned into p_{m} equal parts; then p_{m} parallel processors are used with $M = \frac{m}{p_m}$ measurements in each processor. So $m_i = M,\ i = 1, \ldots, p_{\mathrm{m}}$ and the following relation holds:

$$p_m M = m \tag{29}$$

Also, the state vector is partitioned into p_{n} equal parts; then p_{n} parallel processors are used with $N = \frac{n}{p_n}$ states in each processor. So $n_i = N,\ i = 1, \ldots, p_{\mathrm{n}}$ and the following relation holds:

$$p_n N = n \tag{30}$$

In addition, the same uniform distributions of the measurement and the state vectors is assumed, i.e. the following relation holds:

$$N = M \tag{31}$$

The total calculation burden can be written as a function of p_{n} and p_{m}:

$$f_C^u = (c+1)nL - 2n + (p_n + p_m)n$$

where $L = \max\{N, M\} = \max\left\{\frac{n}{p_n}, \frac{m}{p_m}\right\}$.

Then we take:

$$L = N = M = \frac{n}{p_n} = \frac{m}{p_m}$$

The total calculation burden can be written as a function of p_{m}:

$$f_C^u = (c+1)n\frac{m}{p_m} - 2n + \left(p_m\frac{n}{m} + p_m\right)n = (c+1)\frac{nm}{p_m} - 2n + p_m\left(\frac{n}{m} + 1\right)n$$

The first and second derivatives of this function with respect to p_{m} are:

$$\frac{\partial f_C^u}{\partial p_m} = -(c+1)\frac{nm}{p_m^2} + \left(\frac{n}{m} + 1\right)n = n\left(\frac{n}{m} + 1 - \frac{(c+1)m}{p_m^2}\right)$$

$$\frac{\partial^2 f_C^u}{\partial p_m^2} = \frac{2(c+1)nm}{p_m^3} > 0$$

Then the function has minimum when:

$$\frac{\partial f_C^u}{\partial p_m} = 0 \Rightarrow p_m^2 = (c+1)\frac{m^2}{n+m} \Rightarrow p_m = \sqrt{c+1}\frac{m}{\sqrt{n+m}}$$

and then:

$$M = \frac{m}{p_m} = \frac{\sqrt{n+m}}{\sqrt{c+1}}$$

It is then obvious that:

$$p_n = p_m\frac{n}{m} = \sqrt{c+1}\frac{n}{\sqrt{n+m}}$$

and

$$N = \frac{n}{p_n} = \frac{\sqrt{n+m}}{\sqrt{c+1}}$$

The optimal uniform distribution is:

$$N = \frac{\sqrt{n+m}}{\sqrt{c+1}}, \quad p_n = \sqrt{c+1}\frac{n}{\sqrt{n+m}}, \quad M = \frac{\sqrt{n+m}}{\sqrt{c+1}}, \quad p_m = \sqrt{c+1}\frac{m}{\sqrt{n+m}} \tag{32}$$

and the total minimum calculation burden is

$$f^{u}_{C,\min} = 2\sqrt{c+1}\sqrt{n+mn} - 2n \tag{33}$$

By comparing (25), (28) and (33) it can be shown (proof omitted) that method C accounts for larger speedups compared to the other two.

5 Experiments

The results of the previous section are confirmed through examples assuming multi-measurement, multi-state, and multi-state and multi-measurement systems: the speedup for the parallel steady state Kalman filter is shown in Table 2.

Table 2. Parallel steady state Kalman filter speedup examples.

	Example 1 n = 4, m = 1000	Example 2 n = 100, m = 4	Example 3 n = 100, m = 200
Method A	20.9063	1.0147	2.5168
Method B	1.0015	5.9143	1.4028
Method C	22.5506	7.3929	12.4792

Equations (24), (27) and (32), which show the optimal processor assignments, are not directly applicable in the case where the available processors are bounded. This is of particular interest for method C which also involves a split of processors between state and measurement computations. Proving the optimal split of a bounded number of available processors was omitted due to space limitations. In this section we also provide

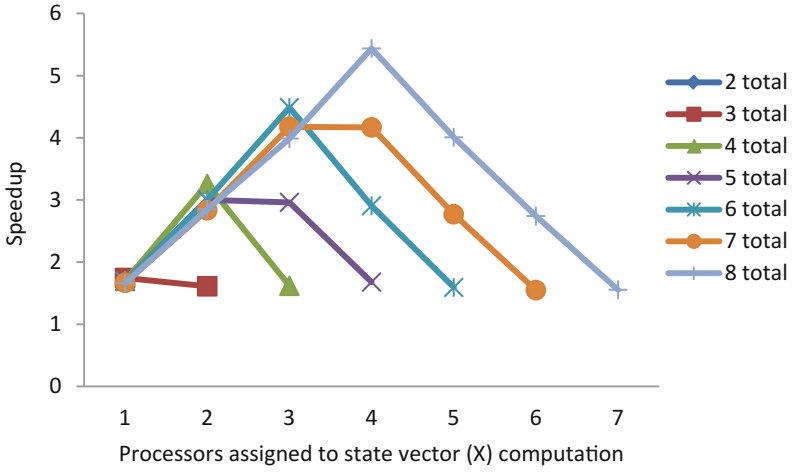

Fig. 1. Speedup for various CPU core assignments. Each plot depicts the total number of cores used (x-axis values show the cores assigned to state vector computation).

some empirical results obtained by implementing method C using OpenMP and running experiments on a machine with 8 CPU cores. Figure 1 shows speedup results versus a sequential execution, when the measurements and state vectors were of size 5000. It can be observed that regardless of the total cores used, a judicious split of the assigned cores between measurement and state computation is needed in order to achieve the best speedup results.

6 Conclusions

In this paper we studied three different parallelization approaches for the computation of steady state Kalman filter, namely, parallelizing only the measurement vector, parallelizing only the state vector and parallelize both. The last one was shown to be the most promising approach. The optimal processor assignment between the state and the measurement vectors was derived for uniform distributions.

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Intelligent and Collaborative Decision Support Systems for Improving Manufacturing Processes

The Topological Impact of Discrete Manufacturing Systems on the Effectiveness of Production Processes

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Abstract. The structure of a manufacturing system plays an important role in the effectiveness- and the work-in-progress- of production processes. In this paper, the impact on the throughput and average lifespan of products of different topologies, within a discrete manufacturing system, including production resources and buffers, is analysed. In order to analyse the behaviour of the system's computer simulation software, *Tecnomatix Plant Simulation* is employed. The topology of the system is expanded from the simple production line to the rather more complex structure of two production lines with different, interconnection variants between buffers and production resources. For each topology of a given manufacturing system, a set of simulation experiments is prepared. The input values of the simulation experiments, along with the different allocation of buffer capacities, is taken into account. The output values are the manufacturing system's throughput, along with the average lifespan of the products, which indicate the work-in-progress.

Keywords: Discrete manufacturing system · Computer simulation · Buffer allocation problem · Throughput · Lifespan of products

1 Introduction

Computer simulation is the research method of choice for the analysis of behaviour within discrete manufacturing systems [1]. Using computer simulation, the impact of different parameters on the effectiveness-and on the work in progress- of discrete manufacturing systems, can be evaluated. In the paper, the change of topology within a manufacturing system is examined. The structure of the manufacturing system investigated is consistent with the manufacturing resources, that is, with the CNC machines and buffers allocated between resources. It is assumed that the discrete manufacturing system is fully automated and is a fully flexible, manufacturing system and that the availability of resources is determined as 95%. The discrete manufacturing system model is based on an actual production system in an enterprise within the automotive sector.

Simulation is a very important research method for the modelling, analysis and development of manufacturing systems. Many scientific papers include the application of computer simulation and the buffer allocation problem in the general design of discrete manufacturing systems and in analysis of operational, production planning and

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in the scheduling of the systems [2, 3]. The problem of maximising the throughput of production lines, by changing buffer sizes, or locations, using simulation methods, was studied by Vidalis et al. [4]. The critical literature overview regarding buffer allocation and production line performance was done by Battini, Persona and Regattieri [5] while Demir, Tunali and Eliiyi proposed a classification scheme to review the studies and presented a comprehensive survey on the buffer allocation problem in production systems [6]. Stanley and Kim presented the results of simulation experiments carried out for buffer allocations in closed, series-production lines [7]. Yamashita and Altiok [8] proposed an algorithm for minimising the total buffer allocation for a desired throughput in production lines with phase-type processing times. They implemented a dynamic programming algorithm which uses a decomposition method to approximate the system's throughput at every stage. Gurkan used a simulation-based optimisation method to find optimal buffer allocations in tandem production lines where machines are subject to random breakdowns and repairs, and the product is of the fluid-type [9]. He explored some of the functional properties of the throughput of such systems and derived recursive expressions to compute one-sided directional derivatives of throughput, from a single simulation run. Trojanowska et al. analysed the impact of selected methods of production flow control based on Theory of Constraints on the effectiveness of production process [10, 11].

In the paper, the impact of different topologies of discrete manufacturing systems, on the throughput and average lifespan of products, is analysed. The research problem can be formulated as follows: '*Given that a discrete manufacturing system includes production resources and buffers, how does the allocation of buffer capacity and the topology of the system - that is, the interconnections between resources and buffers- influence the throughput and lifespan of products?'*

In the next chapter, the buffer allocation problem is described and discrete manufacturing system models are presented.

2 Models of a Discrete Manufacturing System

For the simulation research, three general models of discrete manufacturing systems are considered. The systems include, respectively, one, two and three production lines. Each line includes two manufacturing resources and two intermediate buffers. For the systems, different interconnections between buffers and manufacturing resources are proposed. Simulation experiments are prepared for different buffer capacities as input values.

2.1 The Buffer Allocation Problem (BAP)

The buffer allocation problem (BAP) is one of the most important questions facing a serial production designer. It is a combined, NP-hard, combinatorial, optimisation problem when designing production lines and the issue is studied by many scientists and theorists around the world. The buffer allocation problem is concerned with the allocation of a certain number of buffers P, among the N-1 intermediate buffer locations of a

production line, in order to achieve a specific objective. A production line consists of machines working in sequence, separated by buffers (Fig. 1) where the machines are denoted as M_1, M_2,…, M_N, and the buffers as B_1, B_2,…, B_{N-1}.

Fig. 1. A production line with N machines and N−1 intermediate buffers.

In the literature, several types of production lines are taken into account.

The classification of production lines can be based on: the blocking type, that is, those which block either before or after service; job transfer timing, such as, asynchronous, synchronous, continuous; production control mechanisms, such as, push and pull; types of workstations and whether they are reliable or unreliable and career requirements, whether open or closed. BAP can be formulated in three cases, depending on the function of the objective. In the first case, the main objective is maximisation of the throughput rate for a given, fixed number of buffers. The first BAP case is formulated as follows (1), (2) and (3):
find

$$B = \left(B_1, B_2, \ldots B_{N-1}\right) \tag{1}$$

so as to

$$\max f(B) \tag{2}$$

subject to

$$\sum_{i=1}^{N-1} B_i = P \tag{3}$$

Where B represents a buffer size vector and f(B) represents the throughput rate of the production line as a function of the size vector of the buffers and P is a fixed, non-negative integer denoting the total buffer space available in the manufacturing system.

The second BAP case is formulated as follows (4), (5) and (6):

$$B = \left(B_1, B_2, \ldots B_{N-1}\right) \tag{4}$$

so as to

$$\min \sum_{i=1}^{N-1} B_i \tag{5}$$

subject to

$$f(B) = f^* \tag{6}$$

where f^* is the desired throughput rate. The third **BAP** case is formulated as follows (7), (8), (9) and (10):
find

$$B = \left(B_1, B_2, \ldots B_{N-1}\right) \tag{7}$$

so as to

$$\min Q(B) \tag{8}$$

subject to

$$f(B) = f^* \tag{9}$$

$$\min \sum_{i=1}^{N-1} B_i \leq P \tag{10}$$

where Q(B) denotes the inventory of the average work-in-process as a function of the size vector of the buffers and f* is the desired throughput rate. This formulation of the problems expresses maximisation of the throughput rate for a fixed, given number of buffers which achieves the desired throughput rate, with the minimum total buffer size- or with the minimisation of the inventory of the average work-in-process- which is subject to the constraints of total buffer size and the desired throughput rate.

2.2 Models of Discrete Manufacturing Systems

The first structure of a manufacturing system (L_1) is presented in Fig. 2 and consists of intermediate buffers B_1, B_2 and manufacturing resources CNC11, CNC12. The model is prepared using Tecnomatix Plant Simulation software.

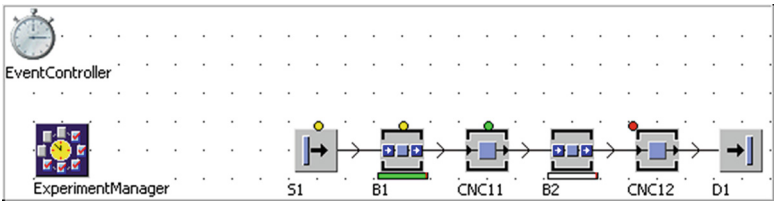

Fig. 2. A production line, with buffers B_1, B_2 and manufacturing resources CNC11, CNC12 – first model of manufacturing system L_1

The operation times of manufacturing resources are determined as Uniform distribution. Uniform distribution can be used for the modelling of random numbers which are located between the *'start and stop'* interval limits. This is useful when little is known about the distribution of random numbers. The function of the density of the probability of distribution for values between $start < x < stop$ has the following form:

$$f(x) = \frac{1}{stop - start} \tag{11}$$

where the average value of the distribution is

$$\mu = \frac{start + stop}{2} \tag{12}$$

and the variant takes on the value of

$$\sigma^2 = \frac{(stop - start)^2}{2} \tag{13}$$

An example of uniform distribution is presented in Fig. 3. The processing times for all production resources of the models investigated are defined as *start = 3:00* and *stop = 5:00*. It is assumed that the availability of manufacturing resources is 95%.

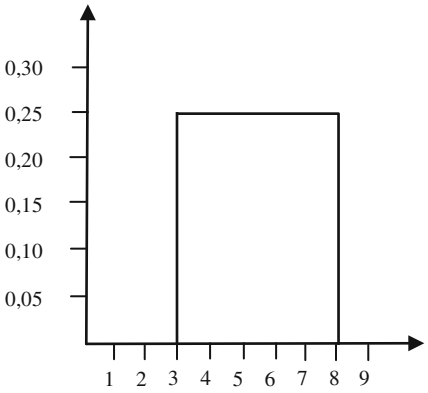

Fig. 3. An example of *Uniform distribution* where *start* = 3 and *stop* = 8

For model L_1 of the manufacturing system, 28 experiments for different combination of B_1 and B_2 buffer capacities were conducted. The buffer input values are presented in Table 1.

Subsequent models (L_2, L_3) of manufacturing systems, include two production lines where each production line consists of two buffers and two production resources. The operation times and availability of resources are determined as being the same as for model L_1(Fig. 4).

Table 1. Buffer capacities as input values of simulation experiments for model L1

	B_1	B_2		B_1	B_2		B_1	B_2
Exp 01	1	1	Exp 11	15	15	Exp 21	5	5
Exp 02	2	2	Exp 12	20	20	Exp 22	6	4
Exp 03	3	3	Exp 13	10	9	Exp 23	3	4
Exp 04	4	4	Exp 14	1	10	Exp 24	7	4
Exp 05	5	5	Exp 15	1	9	Exp 25	7	3
Exp 06	6	6	Exp 16	2	8	Exp 26	4	3
Exp 07	7	7	Exp 17	3	7	Exp 27	8	2
Exp 08	8	8	Exp 18	7	8	Exp 28	9	1
Exp 09	9	9	Exp 19	8	7	Exp 29	10	1
Exp 10	10	10	Exp 20	4	6			

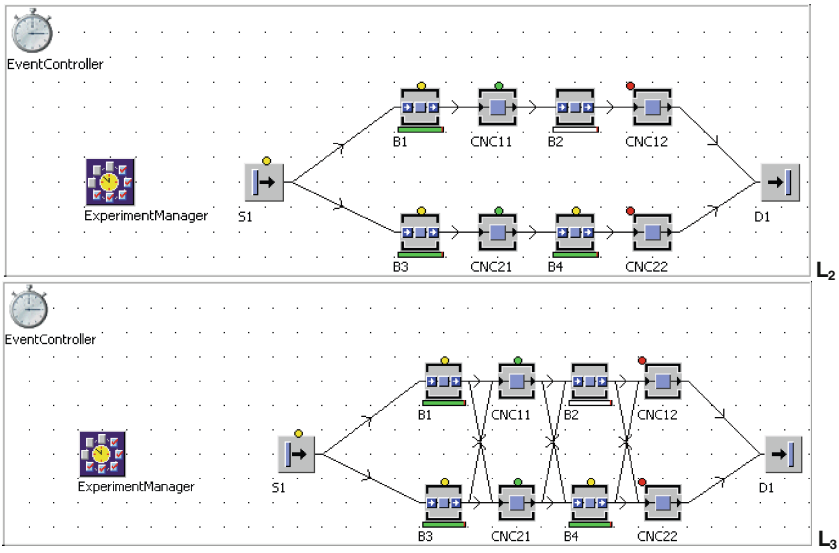

Fig. 4. The manufacturing system models (L_2 and L_3 respectively) with four buffers B_1, B_2, B_3, B_4 and four manufacturing resources CNC11, CNC12, CNC21, CNC22.

Models L_2 and L_3 are different topologies of connections between buffers and resources. Because the number of buffers changes, new combinations of buffers are prepared for simulation experiments (Table 2).

For the models of the manufacturing systems presented, the simulation experiments are conducted using the data presented in Tables 1 and 2.

The results of the simulation experiments are presented in the next chapter.

Table 2. Buffer capacities as input values of simulation experiments for model L_2 and L_3

	B_1	B_2	B_3	B_4		B_1	B_2	B_3	B_4		B_1	B_2	B_3	B_4
Exp 01	1	1	1	1	Exp 12	4	4	4	4	Exp 23	5	10	5	10
Exp 02	2	1	2	1	Exp 13	4	5	1	4	Exp 24	7	8	9	10
Exp 03	2	1	1	2	Exp 14	5	5	5	5	Exp 25	10	9	1	8
Exp 04	2	1	2	2	Exp 15	10	5	10	5	Exp 26	10	9	8	7
Exp 05	1	2	2	2	Exp 16	3	9	1	4	Exp 27	5	9	6	6
Exp 06	2	2	2	2	Exp 17	5	9	7	10	Exp 28	6	4	3	4
Exp 07	7	1	6	6	Exp 18	10	10	10	10	Exp 29	4	3	3	4
Exp 08	6	1	7	6	Exp 19	15	15	15	15	Exp 30	1	10	10	1
Exp 09	10	10	10	1	Exp 20	20	20	20	20	Exp 31	10	10	1	1
Exp 10	10	1	10	10	Exp 21	1	10	10	10	Exp 32	6	6	10	1
Exp 11	3	3	3	3	Exp 22	10	10	1	10	Exp 33	10	1	10	1

3 The Results of the Simulation Experiments

The output values of the simulation experiments are the throughput, *per* hour, and the average lifespan of the products of the systems studied. In Fig. 5, the throughput values for model L_1 are presented. The smallest throughput value is achieved for experiments Exp 01 ($f_{01}(3) = 16{,}9$), Exp 28 ($f_{28}(11) = 16{,}9$) and Exp 29 ($f_{29}(11) = 16{,}9$) where at least one buffer capacity is equal to 1.

The throughput of the system increases *in tandem* with the increasing capacity of both buffers B_1 and B_2 and reaches the greatest values ($f_{11}(30) = 18{,}53$ and $f_{12}(40) = 18{,}56$) for experiments Exp 11 and Exp 12 where both buffer capacities are respectively 15 and 20. For the model of the system presented, the B_2 buffer has the greater impact. Compare, for example, Exp 17 where B1 = 3and B2 = 7 and throughput is $f_{17}(10) = 18{,}37$ and Exp 25 where $B_1 = 7$ and $B_2 = 3$ and throughput is $f_{25}(10) = 17{,}9$).

An increase in the capacity of the buffers, results in an increase in the average lifespan of the products and in the work in progress (see Fig. 6). The relatively small lifespan level for Exp 14 and Exp15 ($l_{14} = 24{:}48$ and $l_{15} = 23{:}48$) is achieved by relatively high throughput levels ($f_{14}(11) = 18{,}44$ and $f_{15}(10) = 18{,}40$). In the next simulation experiments, model L_2 is taken into account. The results of the simulation experiments are presented in Fig. 6.

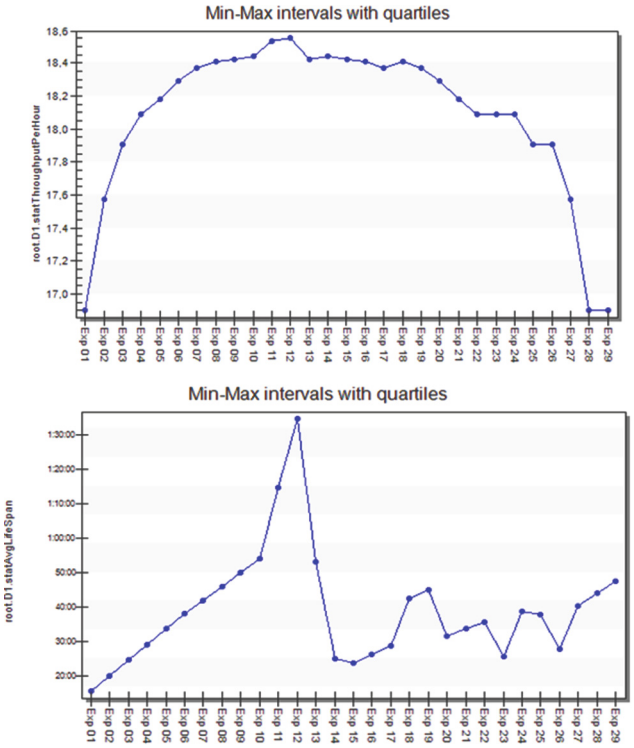

Fig. 5. The results of simulation experiments for model L1 – throughput and average lifespan of products

The maximum throughput of model L_2 is f(80) = 37,4 products per hour for Exp 20 (*an average of* $f_{20}(40)$ = 18,7 for each line) and for all buffer capacities, equals 20; analogous to model L_1-the average lifespan is greatest for this experiment. A relatively high level of throughput and low lifespan is achieved for experiments Exp 22 and Exp 23 where $f_{22}(31)$ = 37,1; l_{22} = 40:24 and $f_{23}(30)$ = 37,1;l_{23} = 38:47. The results of simulation experiments for model L_3 are presented in the Fig. 7 where the maximum throughput and lifespan of the product is achieved for Exp 20; ($f_{20}(80)$ = 37,64 and l_{20} = 1:27:51 for each line throughput is $f_{20}(80)/2$ = 18,82 products per hour). As is the case with model L_2, a satisfactory *throughput-to-lifespan* proportionality can be achieved for experiments Exp 22 and Exp 23 where $f_{22}(31)$ = 37,5; l_{22} = 36:32 and respectively $f_{23}(30)$ = 37,5; l_{23} = 34:56. The behaviour of model L_3 is quite different for Exp 7, Exp 8, Exp 9 in comparison with model L_2 where throughput decreases. To find the best relation between the throughput and average lifespan of the system, the production flow index is proposed as $\theta = f_i(B)/l_i$ for model L_1 and $\theta = f_i(B)/l_i$ for models L_2 and L_3.

The values of the flow indices for the three models are presented in Fig. 8. The best relation between the throughput and lifespan have values $\theta \approx 0{,}8$.

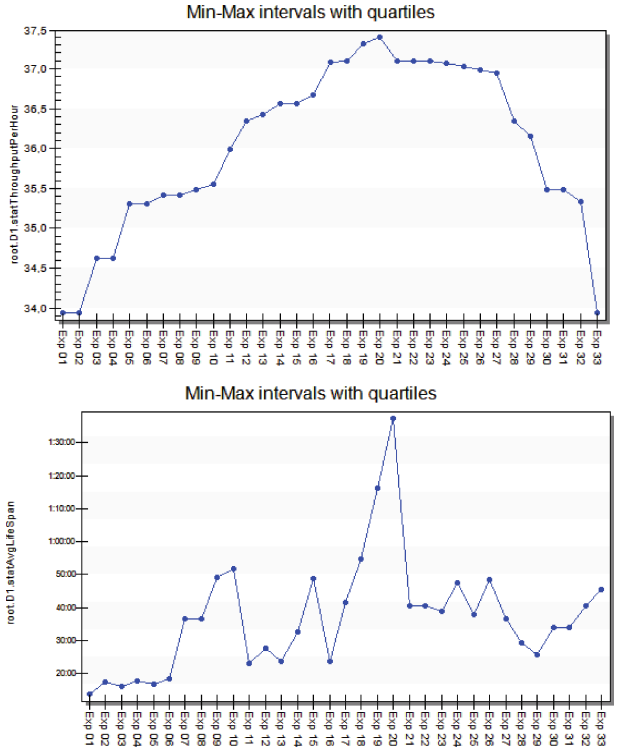

Fig. 6. The results of simulation experiments for model L2 – throughput and average lifespan of products

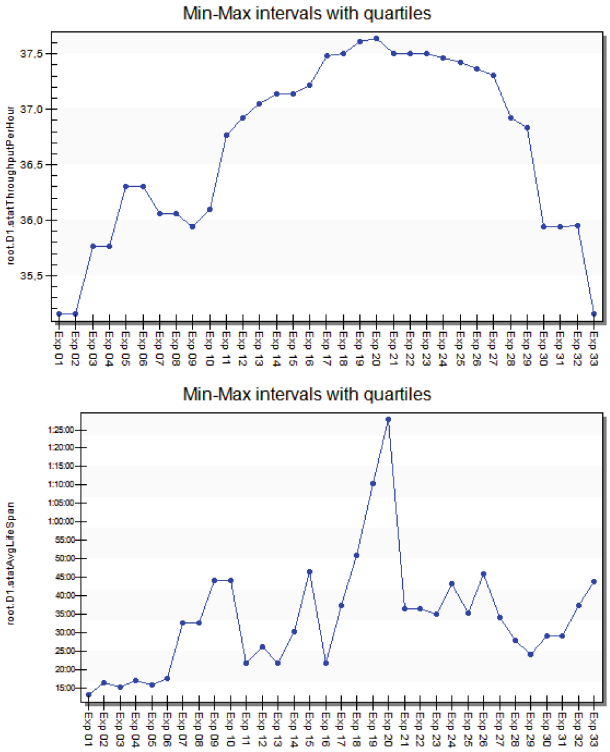

Fig. 7. The results of simulation experiments for model L3 – throughput and average lifespan of products

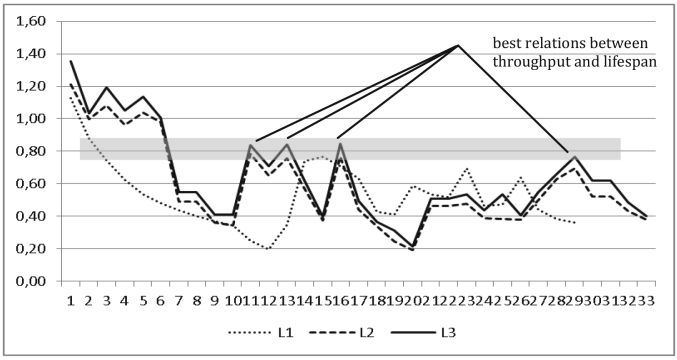

Fig. 8. Production flow index values for models L_1, L_2 and L_3

4 Conclusions

In the paper, the impacts of buffer allocation and the topology of a manufacturing system on throughput and lifespan, using computer simulation, is studied. Three models of production systems are analysed. On the basis of the simulation experiments conducted, the following conclusions can be formulated:

- the allocation of buffers has a significant impact on the throughput and lifespan of products in the manufacturing system investigated,
- changing the topology of the manufacturing system, enables better values of throughput for an individual production line, to be obtained
- the best proportionality between throughput and average lifespan is to be found using the production flow index.

In previous research, the best relationship between the throughput and average lifespan of products was analysed using Pareto efficiency and fuzzy similarity [12].

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Application of the Grey Clustering Analysis Method in the Process of Taking Purchasing Decisions in the Welding Industry

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Abstract. The publication presents the results of analyses developed for supporting the process of purchasing materials in the manufacturing process in the welding industry. The principal research problem in the article was to select a minimum number of features essential in taking decisions related to purchasing fluxes for welding processes carried out using the SAW method. To this end, the Clusters of Grey Incidence procedure, developed as part of Grey System Theory, was used.

Keywords: Grey system theory · Clusters of grey incidence · Decision process

1 Introduction

Decision-making processes in purchasing processes are saddled with numerous errors resulting from, among others, a large number of alternatives available on the market, usually short time to take a decision, as well as risk and uncertainty connected with the market. In such a context, the problem of selecting feedstock and materials may be considered as a multiple-criteria decision problem [1, 2].

The example dealt with in the present paper is a question of making decisions related to purchasing additional materials – fluxes for Submerged Arc Welding (SAW). It is a welding method consisting in joining metal elements by means of an electrode under a blanket of granulated flux. Due to high temperature generated by an electric arc, flux, when melting, creates a protective layer of slag covering the joint and preventing it from being oxidized [3].

The question of selecting decision support methods in the range of additional materials in welding processes is analyzed using methods such as Data Mining [4, 5], DRSA [6], clustering [7].

Fluxes in the process in question perform a protective role similarly to an electrode shield in manual arc welding, i.e. protect the molten metal from atmospheric contamination, support stable glowing of an electric arc, enable to refine weld metal introducing alloy elements and shape the joint. Welding technology under flux allows to use high electric current intensity and high welding speeds. The type of flux used has a fundamental influence on functional properties, first of all, on the resilience of welded joints.

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From the point of view of selecting fluxes in the welding process, one should pay attention to chemical parameters. Fluxes can be principally classified into: acidic, neutral, basic and high basic. Acidic and neutral fluxes show a lower melting temperature than weld metal, which results in good welding properties. However, more elements reducing the resilience of the joint appear. The use of basic and high basic fluxes leads to obtaining joints of higher purity, which increases resilience in low temperatures [8].

In the flux selection process, a number of criteria are taken into account, e.g. the value of Boniszewski's basicity index, content of selected chemical elements, mechanical properties of joints, price, etc. A large collection of features describing technological properties of fluxes, as well as their variety, causes the issue of identifying a minimum number of features which may form sufficient criteria for taking decisions to be important. The reduction of criteria taken into consideration increases the effectiveness of decision processes and eliminates the problem of information redundancy. In view of the above, in order to identify features which are essential in the analyzed question relating to welding fluxes, the Clusters of Grey Incidence method was used [9]. It allowed to introduce subgroups in a large collection of selected criteria related to assessing the quality of fluxes and on this basis to point out redundancy and mutually substitutable features in the process of making rational purchasing decisions.

2 Research Methodology

The starting point for research was data acquisition. It ran in several steps. In the first one, five biggest flux producers on the Polish market were specified. Next, on the basis of product information furnished by particular producers, a set of criteria concerning the assessment of fluxes was determined. The criteria included features shown in Table 1.

Table 1. Decision criteria related to flux selection(elaboration by own)

Id	Name of flux feature
X_1	Boniszewski's basicity index
X_2	Percentage of carbon in the joint after welding [%]
X_3	Percentage of silicon in the joint after welding [%]
X_4	Percentage of manganese in the joint after welding [%]
X_5	Percentage of molybdenum in the joint after welding [%]
X_6	Percentage of chromium in the joint after welding [%]
X_7	Percentage of nickel in the joint after welding [%]
X_8	Ultimate tensile strength of the welded joint (Rm) [N/mm2]
X_9	Yield limit of the welded joint (Re 0.2%) [N/mm2]
X_{10}	Lengthening of the welded joint (A5) [%]
X_{11}	Resilience of the welded jointKv (20° C) [J]
X_{12}	Resilience of the welded jointKv (−20° C) [J]
X_{13}	Price of flux [pln/kg]

In the next step, empirical material, which consisted of information concerning 13 purchasing decision criteria for each of 28 fluxes analyzed during research, was collected. Fluxes were made by various producers. Due to the fact that the collected empirical material contained a relatively small amount of data, a decision was made to use a method that comes from grey system theory, a method that is adequate to analyze scanty, missing and incomplete data [10]. In connection with the research problem, i.e. a reduction of the set of decision criteria in the purchasing process, the Clusters of Grey Incidence method was used. The analysis using Clusters of Grey Incidence consists of the following stages [10]:

Step 1. Computing zero starting point of images of X_i and X_j

Let us assume that:

X_i and X_j belong to a set of criteria $\{X_1, \ldots, X_{13}\}$,

$$X_i = \{X_i(1), \ldots, X_i(n)\},$$

$$X_j = \{X_j(1), \ldots, X_j(n)\},$$

where, $n = 28$, is a number of fluxes taken into account in the analysis

Respecting the above assumptions, we calculate zero starting point of images of X_i and X_j in the following way:

$$X_i^0 = \{x_i^0(1), x_i^0(2) \ldots, x_i^0(n)\}$$

$$X_i^0 = \{x_i(1) - x_i(1), x_i(2) - x_i(1) \ldots, x_i(n) - x_i(1)\}$$

$$X_j^0 = \left\{x_j^0(1), x_j^0(2) \ldots, x_j^0(n)\right\}$$

$$X_j^0 = \{x_j(1) - x_j(1), x_j(2) - x_j(1) \ldots, x_j(n) - x_j(1)\}$$

Step 2. Find $|s_i|, |s_j|, |s_j - s_i|$

$$|s_i| = \left|\sum_{k=2}^{n-1} x_i^0(k) + \frac{1}{2}x_i^0(n)\right|$$

$$|s_j| = \left|\sum_{k=2}^{n-1} x_j^0(k) + \frac{1}{2}x_j^0(n)\right|$$

$$|s_j - s_i| = \left|\sum_{k=2}^{n-1} \left[x_j^0(k) - x_i^0(k)\right] + \frac{1}{2}\left[x_j^0(n) - x_i^0(n)\right]\right|$$

Step 3. Compute the absolute of grey incidences

$$\varepsilon_{ij} = \frac{1 + |s_i| + |s_j|}{1 + |s_i| + |s_j| + |s_j - s_i|}$$

Step 4. Creating matrixes $\left[\varepsilon_{ij}\right]$

$$\left[\varepsilon_{ij}\right] = \begin{bmatrix} \varepsilon_{11} & \varepsilon_{12} & \ldots & \varepsilon_{1n} \\ & \varepsilon_{22} & \ldots & \varepsilon_{2n} \\ & & \ldots & \ldots \\ & & & \varepsilon_{nn} \end{bmatrix}$$

$$\varepsilon_{ij} = \varepsilon_{ji} = 1 \; \varepsilon_{ii} = \varepsilon_{jj} = 1$$

Step 5. Grouping features on the basis of an arbitrarily adopted index.

The principle of grouping features in Clusters of Grey Incidence consists in comparing the magnitude of the arbitrarily adopted index $r \in [0, 1]$ with $\varepsilon_{ij} \geq r, i \neq j$. And so, if: $\varepsilon_{ij} \geq r, i \neq j$, features X_i and X_j are treated as similar and are placed in the same classification group.

3 Research Results

At the first stage of computations for the collected empirical data from Attachment 1, ε_{ij} was calculated for each pair of variables X_i and X_j As a result of this operation, $\left[\varepsilon_{ij}\right]$ matrix was obtained.

$$\left[\varepsilon_{ij}\right] = \begin{bmatrix} 1 & .05 & .22 & .34 & .23 & 0.35 & 0.28 & .50 & .50 & .66 & .50 & .51 & .44 \\ & 1 & .53 & .51 & .52 & .51 & .52 & .50 & .50 & .51 & .50 & .50 & .50 \\ & & 1 & .61 & .93 & .61 & .72 & .50 & .50 & .47 & .50 & .50 & .53 \\ & & & 1 & .39 & .95 & .60 & .50 & .50 & .41 & .50 & .49 & .58 \\ & & & & 1 & .62 & .74 & .50 & .50 & .47 & .50 & .50 & .53 \\ & & & & & 1 & .57 & .50 & .50 & .41 & .50 & .49 & .59 \\ & & & & & & 1 & .50 & .50 & .45 & .50 & .50 & .55 \\ & & & & & & & 1 & .96 & .02 & .26 & .16 & .03 \\ & & & & & & & & 1 & .02 & .26 & .16 & .03 \\ & & & & & & & & & 1 & .51 & .52 & .39 \\ & & & & & & & & & & 1 & .42 & .04 \\ & & & & & & & & & & & 1 & .10 \\ & & & & & & & & & & & & 1 \end{bmatrix}$$

Using $\left[\varepsilon_{ij}\right]$ matrix and assuming $r = 0.6$, the following group of criteria was obtained: $A = \{X_3, X_4, X_5, X_6, X_7\}$ and $B = \{X_1, X_2, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13}\}$.

Next, taking into account only B_{set} and assuming the value r = 0.6 two consecutive groupings were obtained $\{X_{10}, X_{11}, X_{12}\}$ and $\{X_1, X_2, X_8, X_9, X_{13}\}$. Hence, the final division into groups looks like: group I $\{X_3, X_4, X_5, X_6, X_7\}$, group II $\{X_{10}, X_{11}, X_{12}\}$, group III $\{X_1, X_2, X_8, X_9, X_{13}\}$. The results of clustering are presented in Fig. 1.

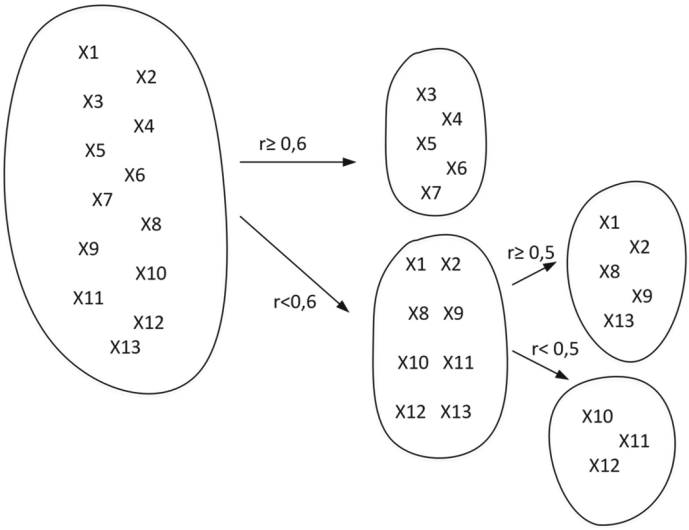

Fig. 1. Results of clustering by clusters of grey incidence method

4 Conclusions

Purchasing decisions, as was pointed out in the first part of the paper, require, apart from precision, speed in order to be taken efficiently. As the purchasing policy in the welding industry shows, decision-makers are obliged to take into consideration dozens of variables when taking decisions. Reduction in the number of criteria involved in the decision-making process may significantly shorten the time of the entire process. In the example dealt with in the paper and related to the decision process of selecting from the list of twenty eight fluxes, one took into account twelve technical criteria and one market criterion. A decision-maker, forced to analyze criteria for each flux and each producer, allocates to this process time which, as was proved in the paper, can be shortened by creating groups of criteria, which can be internally viewed as coherent.

Having used the Clusters of Grey Incidence methodology, 3 groups of decision criteria were obtained. The first group covered (with r ≥ 0,6) the criteria of percentage content of: silicon, manganese, molybdenum, chromium and nickel in the joint after welding. Next two groups of indicators in the assessment of selecting fluxes were created from the division of the group of the remaining decision criteria. The second group (r < 0,5) covered: lengthening of the welded joint, resilience of the welded jointKv (20° C), resilience of the welded jointKv (−20° C). The third group of criteria (with r ≥ 0,5) covered criteria such as: Boniszewski's basicity index, percentage of carbon in the joint

after welding, ultimate tensile strength of the welded joint, yield limit of the welded joint and the price of flux.

Grouping such a large set of selected criteria of assessing the quality of fluxes and on this basis specifying redundant and mutually substitutable features significantly shortens the time of the decision process and facilitates taking rational purchasing decisions. Thanks to such an approach to the classification of criteria in case of repeatable decisions, it is possible to select one criterion from each group and limit the analysis to three criteria, and not thirteen.

Appendix: Technical and Economic Fluxes Information of Selected Welding

Id	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}
1	2,6	0,07	0,15	0,5	0	0	0	445	355	26	180	100	8,93
2	2,6	0,06	0,25	1	0,5	0	0	570	480	26	130	80	8,93
3	3,2	0,07	0,22	1	0,5	0	0	580	500	25	140	80	14,18
4	3,2	0,1	0,21	1,45	0,5	0	0	620	540	24	170	140	14,18
5	3,2	0,06	0,25	1	0	0	0,9	560	470	28	195	160	14,18
6	1,5	0,05	0,3	1,35	0	0	0	510	410	29	135	80	8,83
7	1,5	0,05	0,4	1,4	0,5	0	0	580	500	24	125	60	8,83
8	1,5	0,09	0,4	1,65	0	0	0	580	480	29	130	90	8,83
9	1,5	0,09	0,5	2	0	0	0	580	480	28	150	95	8,83
10	1,5	0,09	0,4	1,6	0,5	0	0	620	535	27	120	70	8,83
11	1,5	0,08	0,5	1,3	0	0,3	0,7	580	490	27	120	70	8,83
12	0,6	0,07	0,8	1,5	0	0	0	610	510	25	80	40	8,98
13	1,7	0,02	0,8	1,3	3,1	22	9	780	630	30	140	125	21,04
14	1,0	0,06	0,5	1,2	0,4	0	0	550	460	19	60	28	13,9
15	1,0	0,06	0,5	1,2	0	0	0,7	530	460	19	60	28	13,9
16	1,0	0,06	0,5	1,2	0	0	0	550	420	20	100	50	13,9
17	0,9	0,05	0,2	1,1	0	0	0	490	400	22	40	27	20,03
18	0,9	0,05	0,2	1,3	0	0	0	520	420	22	40	27	20,03
19	1,0	0,05	0,9	1,7	0,5	0	0	600	480	22	65	35	9,07
20	1,0	0,04	0,8	1,3	0	0	0	460	360	24	90	30	9,07
21	1,0	0,05	0,9	1,7	0	0	0	530	400	24	90	35	9,07
22	1,7	0,07	0,2	1	0,5	0	0	550	480	20	90	40	9,41
23	1,7	0,07	0,2	1	0	0	0	450	400	24	150	90	9,41
24	1,7	0,07	0,3	1,5	0	0	0	500	400	24	160	100	9,41
25	2,7	0,05	0,25	1,3	0	0	0	540	450	25	200	140	13,73
26	3,1	0,07	0,2	0,8	0,5	0	0	570	490	20	140	100	11,89
27	3,1	0,07	0,3	1,1	0,3	0,15	1,15	500	420	24	150	100	11,89
28	3,1	0,07	0,3	1,2	0	0	0	530	420	24	170	120	11,89

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Data Analysis in Production Levelling Methodology

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Abstract. The article describes an original computer program developed by the authors to aid data analysis for the purposes of production levelling methodology. Individual stages of the methodology are connected with analysis of multiple types of data. The program AnaPro enables analysis of manufacturing process data to separate product families, specify the demand for products and implement production. Functions of the program are described along with examples of data analysis.

Keywords: Production levelling · Analysis of production processes · Lean manufacturing

1 Introduction

Dynamic changes in economy along with continuously increasing requirements of clients force production companies wanting to maintain their position on the market to seek for solutions to facilitate manufacturing processes and cut down production costs. When performing subsequent operations the value of manufactured products is generated, thus generating a value stream. It is important to ensure that the values adding up to a product price are acceptable to clients. The improving actions concentrate in two basic areas: eliminating loss connected with implementing specific production tasks and organization of production flow. The first one is usually connected with optimization of specific manufacturing technique [1–6]. The improvement actions in the area of production flow are connected with application of tools and methods developed under such concepts as Lean Manufacturing or Theory of Constraints [7–11]. One method of improving production flow is the so-called heijunka, which is production levelling, aimed mostly at eliminating the changeability in production plan [12].

The present article describes an original production levelling methodology of which individual stages of implementation are supported by AnaPro software.

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2 Production Levelling

The concept of levelled production was developed by Toyota more than 50 years ago [13]. The first descriptions in literature began to appear already in the 1960 s [14, 15]. Since the very beginning levelled production has been associated with lean manufacturing and it has been described as one of its foundations [16, 17]. Production levelling is applied currently not only by automotive industry but also by processing and food industry [18–20]. Production levelling is construed as a method of determining product sequences to prevent from sudden changes in the quantity of manufactured products, which contributes to enhancing efficiency and flexibility, as well as to minimizing differences in workplace load [21].

The main objectives of levelled production include mostly:

- continuous flow throughout the entire supply chain [22];
- eliminating peaks in production [23];
- reduction of stock levels [24];
- avoiding work overload [25];
- enhancing production capacity [26];
- maximizing efficiency of production resources [21];
- increasing company competitiveness [23].

3 Production Levelling Methodology

The authors perceive production levelling as determining the sequence and the volume of product flow from production to the warehouse of finished products, to ensure that current client's demand is entirely satisfied with goods from the warehouse or from the supermarket, not causing sudden changes in the production plan or schedule. It is assumed that production plan in the given period of time does not change. The time depends to a significant degree on the seasonality of production. The main assumption is to manufacture products in a specified sequence and in lots of fewest parts possible. The figure below pictures such a levelled production (Fig. 1).

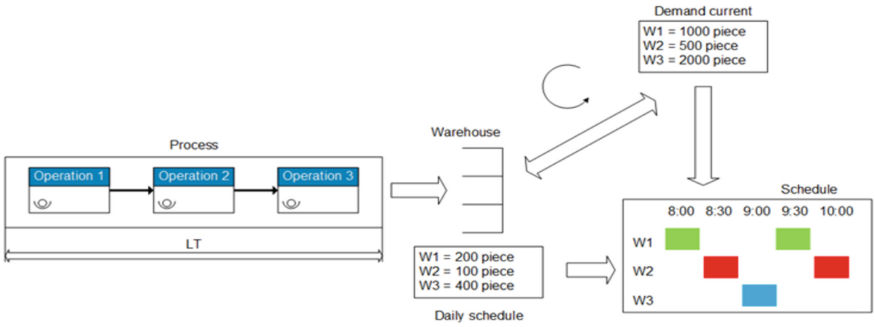

Fig. 1. The principle of operation of the production leveling. Source: own study

The authors' methodology of levelled production includes the following stages:

- Determining a group of products for which levelled production will be introduced – a selection of products that are sold in largest quantities /fastest turnover.
- Division of selected products into families – determining technological similarity of products.
- Analysis of client orders – analysing the frequency and number of orders.
- Determining stock levels – calculating stock levels at the supermarket.
- Determining the frequency of repeating the production of product families – determining the period of time in which a given quantity of products should be manufactured.
- Establishing a levelled production plan – determining the sequence and quantity of manufactured products.

Further stages of the methodology are connected with analysis of data concerning sales and technological process with consideration of production resources. In order to shorten the time of analysis and to eliminate potential errors and mistakes a computer program called AnaPro was developed.

4 Functional Scope of AnaPro

The program structure includes a database and analytical functions which enable data analysis. The databases contain the following information:

- products – specification of products and their structure,
- technology – structure of technological process (or its options) in the form of subsequent technological operations and their characteristic data: cycle time and change-over time,

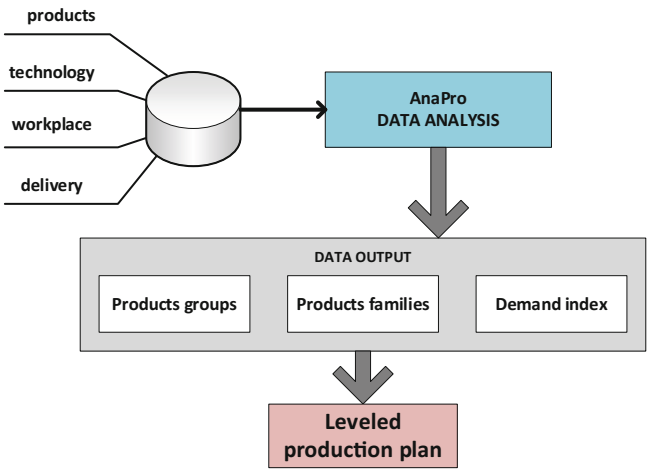

Fig. 2. The functional scope of the program AnaPro in the methodology of leveling production. Source: own study

– production stations – production system resources used during production,
– sales – quantitative and time-related specification of subsequent consignments connected with sales of products.

Primary function of the program is to provide data that allow to develop a recurring production plan which is the final result of the production levelling methodology (Fig. 2).

4.1 Separating Product Groups

According to levelled production methodology, those products that are manufactured in largest quantities at the given company and are characterized by the highest turnover of sales should be separated as first. That group of products will be later subject to further stages of production levelling. Products are classified on the basis of ABC sales rotation analysis and Glenday sieve. Both analyses are performed on the basis of data concerning quantitative sales of individual products where the division is established pursuant to other criteria. The rotation analysis divides products into three groups: fast-moving (A), medium-moving (C) and slow-moving (C) and Glenday sieve divides them into four categories.

The analysis is performed in AnaPro on the basis of input data in the form of a list of products and a quantity specification of product sales in an assumed period of time. In both cases group 1 (products of highest sales) or group A (fast-moving products) is selected for further stages of the methodology.

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The analysis is performed in AnaPro on the basis of input data in the form of a list of products and a quantity specification of product sales in an assumed period of time. In both cases group 1 (products of highest sales) or group A (fast-moving products) is selected for further stages of the methodology.

4.3 Dividing Selected Products into Families

Based on the sales specification the selected group of products is further analysed to separate product families that are technologically alike. A product family is a set of products which technological processes are implemented at the same production stations. The division aims at pointing out the relations between the resources used in

the production process, and thus to determine the direction and parameters connected with material flow.

Product families are separated in AnaPro by a functionality in which a matrix of relationships between the products and production stations is the input information. The relationship matrix contains information that specifies which production stations are used in the technological process of a given product. The information on products, production stations and technology are collected automatically from databases. If a given production station is used in a technological process of given index, it is marked as BS (basic station). A matrix also contains information about alternative stations which can be used in a technological process of a given index and these are marked as A (alternative).

Products are divided into families using an algorithm which is based on exponentiation of the matrix relation "product – station" and sequencing the values which are sums of powers for a given product (Fig. 3).

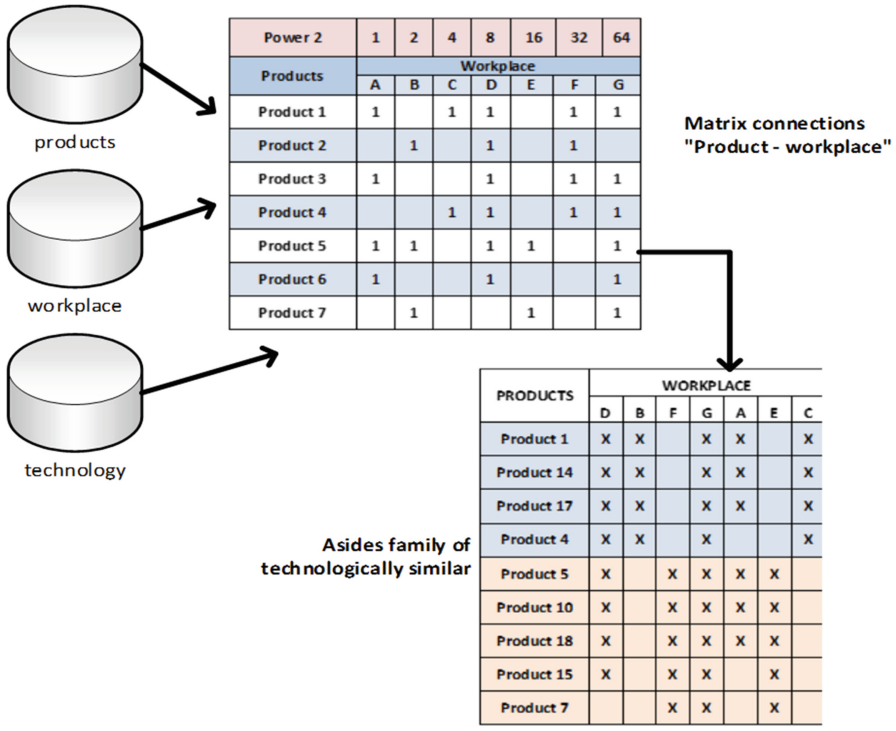

Fig. 3. Schema evolution families of technologically similar. Source: own study

4.4 Analysis of Client Orders

Another group of analyses regarding the levelled production methodology aims at determining basic indexes connected with product sales. The AnaPro functionality enables

determining: average monthly and daily sales, average sales frequency, minimum and maximum consignment lot size (Fig. 4).

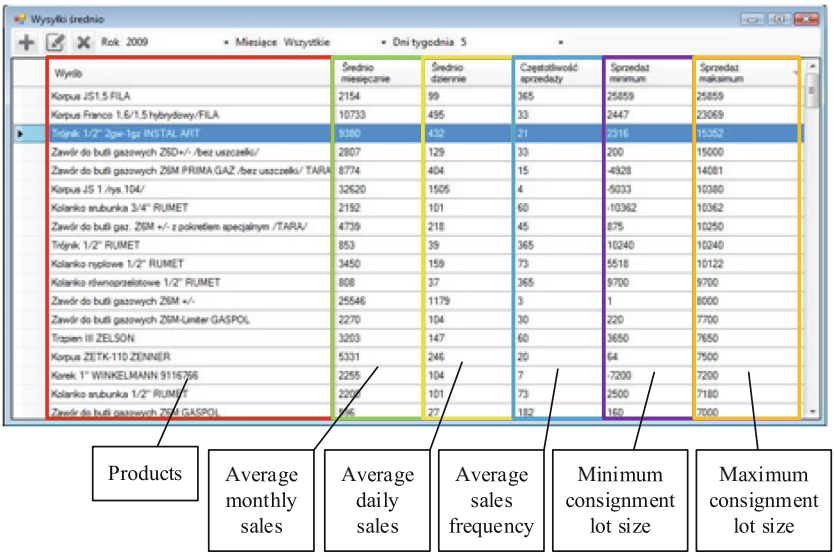

Fig. 4. Window analysis of orders for products. Source: own study

This stage of production levelling methodology serves defining parameters of demand which are taken into consideration when preparing a recurring plan of product flow.

4.5 Determining the Frequency of Repetitions in Product Manufacturing

The frequency of repetitions in product manufacturing is determined with use of EPEI (Every Part Every Interval) index. The index indicates how often it is possible to manufacture an assumed quantity of all the products manufactured at individual work stations [6].

$$\frac{\text{LPA}}{\text{MLP}} = \text{EPEI} \tag{1}$$

where:

- NDP – the number of different parts or the number of changeovers which should be performed to manufacture one sequence of products,
- NPC - the number of possible changeovers during that period.

The EPEI index of the entire manufacturing process is as high as the greatest value of the index of all the work stations. Therefore, if maximum EPEI index equals 1.0, it

means that once per one period (e.g. 8-h working shift) all the products can be manufactured in the process.

4.6 Determining Stock Levels

Another step is to determine stock levels for finished products at the supermarket. This stage is very important, since in levelled production the ongoing client orders are processed from the supermarket, without changing the production plan and schedule. The supermarket is a warehouse where products have their assigned locations, the FIFO (First In First Out) rule is applied and the maximum and minimum stock levels are clearly determined.

The following three types of inventory are distinguished in the supermarket:

- rotating stock – products necessary to cover normal demand of clients;
- buffer stock – products necessary to cover variations in clients' demand;
- safety stock – products necessary to cover internal loss.

Total supermarket stock is the sum of rotating, buffer and safety stocks.

4.7 Establishing a Levelled Production Plan

The final step of the methodology is establishing a levelled production plan. At this stage it is necessary to determine the amount of time required for manufacturing a given product family. The rotating stock, process passage time of the product and the assumed number of downtimes should be taken into account. Figure 3 shows an example of such a plan. (Fig. 5)

Dzień/Godzina	1	2	3	4	5	6	7	8
Poniedziałek	AEG			BC			DF	
Wtorek	AEG			BC			DF	
Środa	AEG			BC			DF	
Czwartek	AEG			BC			DF	
Piątek	AEG			BC			DF	

Fig. 5. Leveled production plan. Source: own study

5 Conclusions

The authors' methodology described in the paper depicts individual stages of implementing a levelled production. The methodology was established on the basis of authors' own reflections as well as analysis of both Polish and world literature. The methodology requires multiple data analyses as regards functioning of the manufacturing system. For this purpose the authors developed the AnaPro software. It provides assistance in collection and analysis of manufacturing data and product sales: separating families of products which are technologically alike, determining the specification and division of products due to sales rotation. The data provided by the software make it possible to

implement stages of the methodology connected with developing a repeatable product manufacturing plan.

Functions of the software shorten the time required for analysing and eliminate calculation errors. Therefore, implementing production levelling methodology can be more effective.

Both the described methodology and the AnaPro software are currently under development. Another step in work over the methodology will be its verification in real conditions. The program is further developed in the scope of assistance in subsequent production levelling methodology stages. The authors primarily focused on developing planning module, whose task will be to create levelling production plan.

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Development and Studies on a Virtual Reality Configuration Tool for City Bus Driver Workplace

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Abstract. The paper presents development process and studies of a digital, Virtual Reality based tool for assisting the decision making process in configuration of driver's workplace in city buses. The development methodology is presented with an end result. The studies, carried out after implementation in an industrial company, were based on human-computer interaction tests and evaluation comparative to previous configuration methods available in the company. The assumed and presented methodology based on Knowledge-Based Engineering allowed to build and implement the tool very rapidly. The post-implementation studies allowed to find that employees of different divisions in a company perceive such a tool in very different ways, forming various directions of future development.

Keywords: City bus · Virtual reality · Human-computer interaction · Design · KBE

1 Introduction

Virtual Reality (VR) systems allow users to explore artificially created, three-dimensional worlds and interact with them in real time [1, 2]. During the last two decades, the VR environments developed from simple applications with non-complex graphics to graphically and logically advanced systems [2]. They allow conducting of engineering education [2, 3], traditional education [2, 4] or medical training [5, 6]. They can be used in aiding engineering design processes [7, 8], simulations of machines operation [9], decision-making in engineering processes [10] and eco-design [11].

Application of visualization and interaction in VR is increasingly widespread–many companies build their own VR centers, cooperating with R&D centers [12]. Automotive manufacturers focus their interests mostly on the design and virtual prototyping stage for new products [13, 14]. Virtual prototyping allows elimination of errors in design, as well as quicker and less costly preparation of a new product fulfilling clients' requirements the best way possible [13, 14].

The VR technologies are also used in design processes of new variants of existing products. Among the most common industrial interactive 3D applications, the visual

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product configurators should be mentioned in the first place. They allow a designer to select and visualize features of new variant of a given product in cooperation with future user [15, 16]. They have found many applications, especially in the automotive branch, where range of variability of features (mostly visual ones) among products belonging to one family (vehicles of a given model) is particularly wide.

Visual product configurators available for the end users aid the decision-making processes during the design phase and help practical realization of a concept known as the mass customization [17]. The concept assumes connecting advantages of mass and piece production [16, 18] and is particularly important in scope of the Industry 4.0 vision [16]. The configurators can be used as an interface between an automated manufacturing system and client of a company.

Visual configurators have generally positive influence on final quality of obtained product [15]. Still, there is a problem of how to use them effectively in cooperation with clients. This paper presents studies on building and implementing a configurator of city bus driver's workplace. Solutions developed in some previous studies were applied to accelerate process of building the configurator. Then it was subjected to tests and discussions with participation of various divisions of a company.

2 Materials and Methods

2.1 Aim of the Studies and General Methodology

Aim of the studies presented in this paper was to create a solution for visual configuration of city bus driver's workplace, to use in different divisions of a selected, specific company, with focusing on cooperation with a client to aid decision-making processes in driver's workplace design. The application was prepared partially using the MOKA methodology, used to build Knowledge Based Engineering systems [19]. There are six main stages in the methodology:

1. Identification – aims and scope of the solution.
2. Justification – determination of resources, costs and risk.
3. Acquisition – gathering knowledge and recording it informally.
4. Formalization – processing knowledge to be understood by a computer system
5. Application – preparation and tests of the computer-based solution.
6. Implementation – launching the system in a final environment.

At stage 1, aims and assumptions were determined. A model of driver's workplace, most frequently used in the company, was selected – it was the FAP, manufactured by Continental. Usual process of configuration of this model takes long time and many corrections, due to lack of 3D visualization of the final variant, as results from the company's experience to date. The following assumptions were made:

1. Full configuration compatible with manufacturing capabilities, available options and logical limitations.
2. Minimization of time of solution preparation by application of already existing VR design system – Visual Design Studio, VDS (Fig. 1).

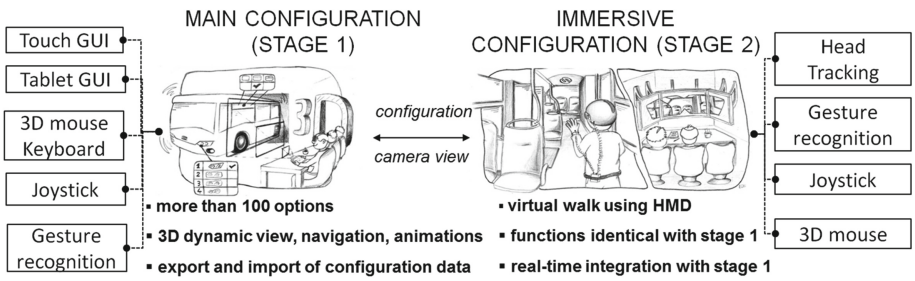

Fig. 1. Main features of virtual design studio framework

3. Minimization of time of input data preparation by using CAD models, 2D data and existing specifications readily available within the company.
4. Minimization of work on graphical user interface (GUI) by using VDS-inherited, PHP-based mechanism. Simultaneous preparation of visual concept of a dedicated solution (with no functionality).
5. Implementation in the company as a module of the already existing VDS system in the so-called showroom (Fig. 2). Making it available for the Technical Department, Project Management and Sales Departments.

Fig. 2. Virtual design studio – practical implementation in city bus manufacturing company

6. Gathering feedback of functionality and added value of the solution from employees of mentioned divisions, during 30-min sessions. Survey studies after testing.

The Virtual Design Studio system, already existing in the company as implemented before by the authors, was used as a framework. The new configurator was built as an additional module, using available, dedicated tools for adding and updating content. The VDS system is a prototype of a computer system, using advanced VR technologies to aid configuration of vehicles (city buses). The tool is based on EON Studio engine and it improves communication with client, allowing to avoid many problems and faults related to lack of visualization on different stages of vehicle design and manufacturing. It is also possible to save bus specifications, integrate them with PLM systems and adding new content easily by dedicated VDS Admin software.

Gathering the assumptions ended the stage 1. At the stage 2, risk, costs and resources were estimated. The work was undertaken by a scientific team from outside the company,

within a scope of own research on VR use in design. That is why risk and costs were assessed as minimal. The team comprised of three persons in total, additionally consulting with more than a dozen of specialists from both the company and the scientific team. Application of VDS system and MOKA methodology allowed reduction of time of preparation of the solution in comparison with traditional, from-the-scratch approach – it was estimated as 3–4 months of work of the team.

2.2 Scope of Configuration of City Bus Driver Workplace

After concluding the stage 2 with proper justification, work was undertaken to determine and acquire knowledge necessary to build the solution. The selected driver's workplace (FAP, see Fig. 3) has a very wide configuration scope. There are 42 positions in total, where different rectangular and round buttons, blinkers or additional elements (retarder lever, ignition switch etc.) can be mounted.

Fig. 3. Selected model of driver's workplace – FAP [20]

In general, the following configuration possibilities must be distinguished:

- selection of central part arrangement (tachometer or lack thereof),
- selection of an element mounted in a selected position in the side parts (plug, button), with separate positions for rectangular and round buttons,
- in case of selection of a rectangular or a round button in a given position – selection of one of few hundred available pictograms (icons),
- selection of pictograms for blinkers in the central part,
- change of color of the round buttons,
- selection of additional elements (non-button – retarder, ignition etc.)

The VDS system allows defining different option types. The four main types are: component switch (change or turn off a 3D model), texture switch (change of 2D pattern on an unchanged 3D model), color switch of a surface and arrangement switch (position change). In total, 73 configuration options were obtained, as below:

- 32 component switches (from 2 to 4 values each),
- 36 texture switches (7 to 690),
- 4 color switches (4 predefined colors for all),
- 1 arrangement switch (2 possible arrangements).

As regards the range of possible values, it is the widest for the button pictogram selection (texture switch) – for example, there are 690 possible pictograms for rectangular buttons. Figure 4 shows examples of pictograms for buttons and blinkers.

Fig. 4. Examples of pictograms of different types, (a) rectangular button (total 690 possibilities), (b) round button (total 27 possibilities), (c) blinker (total 107 possibilities)

There is a number of logical connections between the options. Most of them are obvious, such as no option of selecting a pictogram if there is a plug and not a button in a given position. There are also non-obvious relations between certain option values – selection of certain sets of buttons is not recommended due to work logic in the driver's workplace. There are also requirements related to a particular bus specification – for instance, if a bus has 4 doors, there should be a corresponding selection of buttons for opening them. Some of these logical requirements were planned for implementation, other were left aside as recommendations for the future configurator users.

2.3 Input Data and Preparation Methodology

The configurator input data can be divided into: 3D data – 3D model of the driver's workplace and its equipment, 2D data – textures (pictograms) for buttons and other elements and metadata. The metadata consist of formal recording of the visualization structure (meshes, materials, textures, positions), configuration scope (options and values), logical connections (enforcements and exclusions of options and components) and export mechanism. Preparation of the data and their structuring was part of the stage 4 (knowledge formalization) according to MOKA. A CAD 3D software (Inventor) was used to extract and process already existing 3D model and its supplementation with additional elements. Then, the model was processed in 3DS Max software (Fig. 5), where geometry was transformed into polygonal meshes and textures were mapped to it. Finally, 3D models were exported and implemented in the VDS system library using EON Raptor plugin and the VDS Admin software.

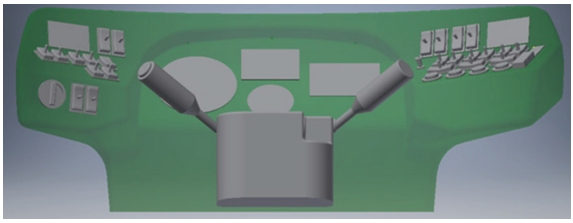

Fig. 5. 3D model of driver's workplace in 3DS Max software

The 2D data was prepared using standard raster graphics processing tools. The 2D data and the metadata were prepared in an appropriate way, according to scope and requirements of the configuration process. They were imported to the VDS system library and structured properly using the VDS Admin tool.

2.4 User Interface and Export Mechanisms

There are two types of graphical user interface in the VDS system – a dedicated module for a given product and a universal, simplified PHP interface. The dedicated interface requires considerable time of preparation. To minimize risk, only its concept was presented graphically for further evaluation. Interaction was therefore based upon the simplified interface, presenting options and values in form of an icon list (Fig. 6).

Fig. 6. Final effect – driver panel visualization (right) and user interface (in background)

In terms of export mechanism, the VDS system generates PDF reports automatically, with screenshots and tables with option values. It is also possible to transfer a binary save file to a PLM system. This mechanism was left unchanged and a conceptual scheme of automated specification export into Excel spreadsheet was developed for future evaluation. The spreadsheet is a form used in the company to communicate final specification between client, bus manufacturer and driver workplace supplier. Both conceptual solutions were presented during system tests.

2.5 Human Testing Procedure

During the tests of an implemented solution, persons from several divisions of company were involved directly:

- Technical Department (PLM, electrical engineers) – total 5 persons,
- Project Department and Sales – total 4 persons.

The main difference between the two distinguished groups is that the Technical Department is not in direct contact with clients, as opposing the Projects and the Sales. Apart from the company, 3 persons from the scientific team took part in the tests. They did not participate in building the solution, but were otherwise experienced with VR solutions and product configurators. Task of the testers was to configure a selected variant of driver's workplace and generate a report, on the basis of loosely defined functional requirements (based on previously realized contracts). After the tests, the participants were asked to form specific conclusions, as well as answer a set of predefined questions. The following features were surveyed:

- functionality (is it possible to obtain a required solution?)
- interface intuitiveness (how quick is finding and adjusting an option?),
- faithfulness of graphical representation (is visualization acceptable?),
- general impression (subjective evaluation of the whole configurator),
- potential for use in daily work for decision-making with clients.

Each of the above mentioned questions was assessed using a 5 point scale.

3 Results and Discussion

3.1 Final Effect and Implementation

As a final effect, working prototype of driver's workplace configurator was obtained, implemented in a company as an update pack to the already existing VDS system. The conceptual mechanisms and designs for future development were only presented during tests and not included in the final deployment.

The view of a configurator with a simplified interface is shown in Fig. 6. Two ways of working were tested – two-screen with separately displayed interface and single screen, with purpose of launching on a mobile computer, e.g. at client's place.

Table 1 presents time consumption of particular stages of building the solution. Total of 3 persons were involved in parallel works, the whole solution took 3 months to obtain a working prototype. The data preparation took the longest time, because of very wide configuration scope for the side buttons.

Table 1. Labor consumption of consecutive stages of building the VR configurator

MOKA stages	Work description	Working hours
1 & 2	identification and concept	15
3	preparation of 2D data	100
3	preparation of 3D data	40
4	configurator logic preparation	40
5	user interface and programming	40
5	export mechanisms	10
6	implementation and tests	15

3.2 Human Test Results and Discussion

During the tests, particular departments have formulated the following remarks:

1. Technical Department:
   - there is no need of immersive visualization of a workplace for the Technical Department, as it is not needed for decision-making in this department,
   - to make the tool available for the salesmen, additional logical restrictions must be applied to programmatically eliminate unpractical configurations, to present clients with more standardized solutions, as a non-standard solution may only be designed by the Technical Department,
   - dedicated export mechanism (spreadsheet generation) is necessary to make the configurator competitive with other available configuration solutions (e.g. web-based tool offered by domestic part supplier),
   - simplified PHP interface is unsatisfying as it takes long time to filter out proper pictograms, the conceptual dedicated interface is far better and should be fully developed.
2. Project and Sales Departments:
   - immersive 3D visualization is very helpful while working with a client, as he would always want to know what he is ordering and decide on the basis of visual clues, it is an advantage which other available solutions do not have,
   - it is a viable option to work directly with the client, although mobile solution (laptop-based) is necessary to work at client's place,
   - dedicated mechanism of export is needed, but not immediately,
   - simplified interface is good enough to work with clients, considering economic advantages (prepared practically costless and effortless), dedicated interface development must be considered with caution,
   - the standard PDF export mechanism can be used for Quality Control for internal checking, during the final reception by the client, as well as in overall process of communication with the client to help him make decisions.

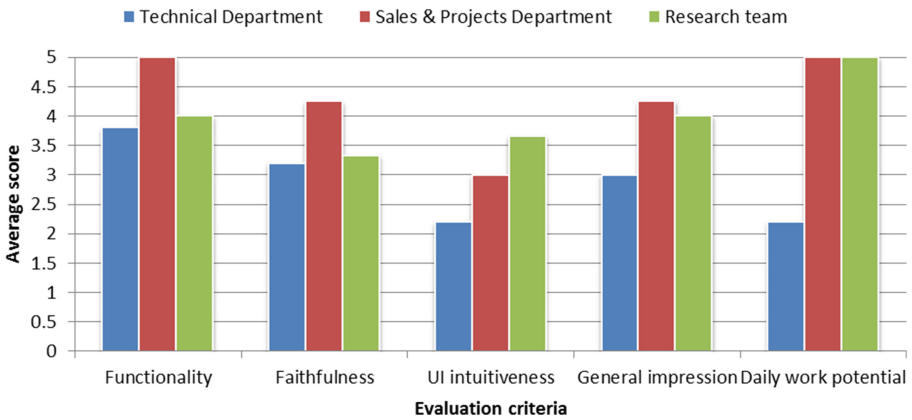

Fig. 7. Evaluation of obtained configuration tool by particular test groups (average values)

Figure 7 presents results of surveys on test participants. The results were divided into 3 groups, by affiliation of testers. The company representatives were divided into 2 groups as above, while the scientific team testers are presented separately.

4 Conclusions

The solution created during the work was implemented in the company for further evaluation and tests. It has been proven in the studies that it can be helpful for decision-making in the driver's workplace design. To become a daily-use tool, it requires further development along directions indicated in the previous chapter. Obtained test results are ambiguous, if treated as a whole. They gain certain clarity only after dividing them by affiliation of the tested persons. Employees not working directly with clients do not see a direct need of applying such a solution, even if – objectively – it helps to improve customer-manufacturer relations and accelerates preparation of technical documentation in the whole product lifecycle. Advantages of implementation of such a solution in the decision-making processes are seen only by employees having experience with client cooperation and realization of his requirements. These persons were also able to formulate new guidelines regarding further configurator development, they also showed increased tolerance on evident imperfections of the tested solution (simplified interface, numerous content errors).

Thanks to using the VDS system as a framework, time of logic programming was significantly shortened than in a hypothetical case of working from the scratch. Still, it needs to be stated, that structure of the VDS system itself has certain limitations, related, among other things, to the interface and working logic of visualization (e.g.: strictly separate windows for visualization and GUI). This makes it difficult to fulfill all the requirements towards the configurator. The most labor consuming stage was the data preparation, because of vast scope of configuration possibilities and many possible option values for particular positions of the driver's workplace.

However, the main barrier of implementing such solutions is the human factor – diversified requirements of particular departments, as well as lack of standards and scenarios of using such a solution. In a wider view, research and development work is necessary to build specific standards of operation. These standards should be valid for creating, implementing and use of such solutions, to minimize risk of the whole operation. They would also allow minimizing time and cost, as usually linear increase in universality (freedom) results in squared increase of preparation time. It is noteworthy, that such configurators seem to bring more flexibility to a client on one side (creating good impression with product visualization), while in fact they are decreasing a number of his choices, somehow constricting his imagination and limiting amount of decisions to be taken to a finite pool of options. Ultimately, the authors think that this is with benefit for all the parties involved. Hence, it must be said, that such solutions, based on Virtual Reality, will eventually become a part of routine daily work in companies dealing with design and manufacturing of new individualized products, so they must be further studied.

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Selection of Optimal Software for Immersive Virtual Reality Application of City Bus Configurator

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Abstract. The paper presents selection process of an appropriate engine to build a dedicated visual configuration system based on Virtual Reality, in cooperation with a city bus producer. The aim was to build a methodology of selection of such a software for a large visual configuration system and to validate it in practice, as there are no available software benchmarks in VR branch. To aid the decision making process, the Analytical Hierarchy Process method was proposed. Several most popular engines were taken into account. Final solution using the selected engine is also presented in the paper as a practical validation example.

Keywords: Virtual reality · Decision making · Analytical hierarchy process

1 Introduction

Increasing competition and changing requirements of clients enforce the companies to take actions aimed at constant development and improvement of their resources and processes. One of such actions is expansion of range of offered products and making them more attractive, e.g. through giving clients possibility of configuring available products [1]. It is often realized using special computer software applications, known as configurators.

Product configurators made available for the clients, meaning end users, allow realization of idea of so-called mass customization [1, 2], which joins advantages of mass and piece production. This strategy is often realized by building automated design systems, which allow preparation of entirely new product variant even by unqualified persons [3]. Such systems have positive influence on final quality of products, thanks to better matching it to recipient's needs [4]. A known problem is, however, ability of representatives of companies to use them effectively in cooperation with clients.

A VR system can be defined as an interactive, immersive, three-dimensional computer simulation [5], using appropriate equipment. Initially, due to high costs of efficient computer hardware, such simulators were used only for military purposes, in advanced medicine or in some other, special industry branches [6]. Increase of performance level of computer systems with simultaneous decrease of hardware prices allowed to make the VR technology more widespread during recent years. As a consequence,

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building an effective VR system for professional applications (e.g. in industry, medicine etc.) is today more cost-effective and easier than any time in the past. Virtual Reality is used, for example, in prototyping of industrial workplaces [7], ecodesign [8, 9] for medical training applications [10] or visualizations during design and analysis of a new product of complex kinematics [11].

In parallel, thanks to improvement of quality of visualization and development of peripheral devices, a phenomenon of immersion – feeling of being physically present in a non-physical environment – gains more importance. Effect of immersion can be achieved thanks to strong engagement of user's senses into interaction with a virtual environment [12]. A relevant influence on the immersion level is caused by quality of prepared graphics, which is affected, among other things, by level of detail, textures of objects and lighting. In most cases, this work needs to be done in an external modeling software and then transferred to the virtual environment using one of available data exchange formats. Selection of an appropriate VR software system to build an immersive configurator of a variant product with very rich and diversified offer available in the market can be a difficult task, as parameters and available functions of a VR system decide about the immersion level, which also decides about success of implementation of the whole system. A base for searching a solution of this problem is a detailed analysis of the designed immersive application. The designer must determine requirements that are set by the industrial client. In many cases, the most important quality of such a system is its price.

After determination of final requirements regarding the system qualities, it is necessary to define requirements defined by programmers and graphic designers responsible for creating the application, including: (possibility of using selected script languages, communication interfaces with peripheral devices, data formats and possibility of their dynamic loading from external files possibilities of generating stand-alone applications, stability of the system).

This paper presents a decision making process regarding selection of such a software system, based on a mathematical method, leading to a final decision which was crucial in terms of building a solution ready to be implemented in an industrial company.

2 Materials and Methods

2.1 Case and Problem Definition – Immersive City Bus Configurator

This paper presents a problem of selection of VR software for building multimodal and interactive system of configuration of visual and technical features of a city bus. This system, named Virtual Design Studio (VDS) by the authors, consists of several subsystems, using various Virtual Reality techniques. These solutions are based on devices allowing intuitive interaction with objects placed in a virtual environment and on devices for projection of stereoscopic image. The VDS system was prepared as a cooperative project between university and a large industrial company.

The proposed system is intended to accelerate and facilitate selection of variant of a product, appropriate for a given user. Application of realistic stereoscopic visualizations and immersive environment allows to test a selected variant in a way similar to

testing a real product (by virtual walk and intuitive interaction). This can help to avoid problems and mistakes which, as the company's practice shows, happen often in case of city bus variant selection in a traditional way (without aid by 3D and VR technologies). These problems cause additional costs related with introduction of structural changes after the manufacturing process is finished, if the final product is not satisfying for the recipient. The described system is currently in work and will be fully implemented by the company and used with clients during sales negotiations. Its main distinguishing features are:

- Free configuration of selected features of a city bus (more than 100 options), The configuration and using all the functions of the system is based on graphical user interfaces. The main concepts and assumptions of the VDS are shown in Fig. 1.

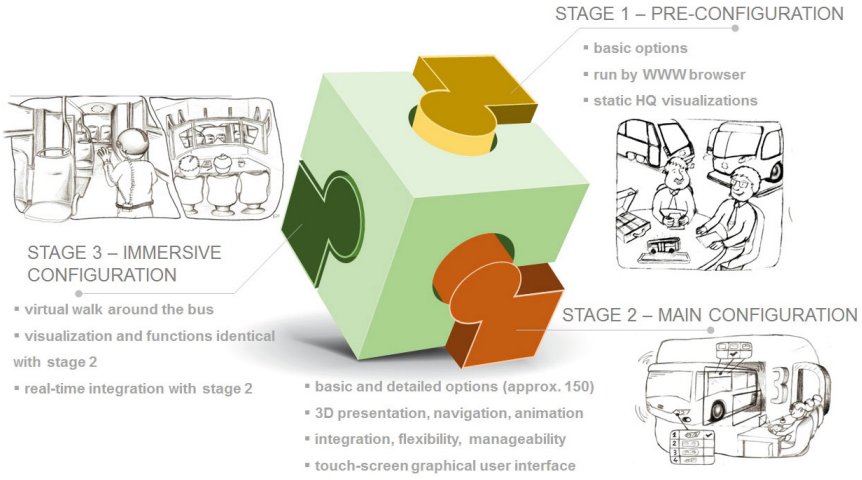

Fig. 1. Basic modules (configuration stages) of the Virtual Design Studio system [13]

- Introduction of possibility of testing bus functionalities from the viewpoint of a passenger and a driver
- Full synchronization between subsequent configuration stages in real time, which is especially important between the second and the third stage of configuration.
- Data exchange interface between the VDS system and the CAD and PLM systems used in the company, allowing quick preparation of documentation necessary for designing a variant of a city bus selected by the client.

All the above mentioned features, as well as requirements defined in Chap. 1, were assumptions made before building the system. In initial phase of the project, various VR software systems were tested for their capabilities regarding creation of such an advanced solution. In the medium phase of the project, a decision had to be made regarding the best software. This is a specific problem, as there are no reliable benchmarks of VR software and the assumptions of the VDS system allowed to think about

it as a unique solution. The research team decided to make a comparison based both on objective and subjective criteria.

2.2 Analyzed VR Software

After analyzing the tasks in which VDS will be used the detailed requirements for the software were defined:

- visualization and real – time rendering, allowing visualization of a selected technical specification on client's demand to avoid problems and mistakes related to incompatibility of a real product with the client's imagination of it,
- easiness of operation and programming – software should be intuitive enough to allow employees of the company, after a brief training, to modify some functions,
- Programming possibilities – the more programming capabilities the software provides the easier it is to solve problems in the process of building the system,
- Application of peripheral devices – peripherals increases opportunities to interact with the virtual world. The more peripheral devices are supported by default, the less work should be put in their integration into the system,
- 3D data import – 3D data used in application comes from different CAD software which use different data formats
- Dynamic loading of external data – to allow easier modification of files such as textures, it is important that they are embedded into application, those files should be read on a regular basis from hard drive,
- Manageability of structure and functions of application
- Stand-alone application possibility –reduces the need to purchase additional licenses for client workstations
- Price – is crucial from the point of view of the project budget.

To fulfill all requirements regarding the VDS system, the authors have made a preliminary selection of VR systems available on the market at the time of making decision about final software used for the VDS system development. A base for including a given system into the comparison was possibility of using it (access) to build a sample interactive visualization, as well as availability of experts' opinion about its properties and capabilities. The expert group consisted of 6 persons with many years of experience in preparation of visualization data and building Virtual Reality applications using multiple systems. The group contained three researchers from VR laboratory (whose task was to build the VDS system) and three independent experts: a 3D graphics designer, a programmer and an expert from an external company developing VR solutions. These persons have considerable theoretical knowledge and practical experience with different VR and visualization systems and are able to make an objective evaluation.

During comparison of systems, all the important features, both from the viewpoint of a client and a programmer/graphics designer must be taken into account. Quantity of these features and difficulty of comparing systems regarding some of them made the authors narrow the criteria down to these presented in Table 1. They are all relevant regarding building the VDS system. Some other features were simply left out of consideration, if they were not relevant in terms of fulfilling the assumed capabilities of the

final configuration system. Each feature was assigned a positive integer number from 1 to 5, with 1 being the lowest and 5 the highest grade. Some of the grades are mostly subjective, such as the graphics quality, where individual preferences of experts are the main factor behind a given grade.

Table 1. Evaluation of selected features of Virtual Reality. KA - graphics quality, KB - easiness of operation and programming, KC - programming possibilities, KD - application of peripheral devices, KE - 3D data import, KF - dynamic loading of external data, KG - manageability of structure and functions of application, KH - Stand-alone application possibility, KI - price.

Evaluation criterion	VR software system					
	VRED 2014	EON STUDIO Studio 8.2.1	Quest3D 4.3	Quazar3D 1.0	Unity3D 4.3	Vizard 4.0
KA	5 /3*	3	3	2	4	2
KB	4	4	3	3	1	1
KC	Python, little possibilities (2)	visual progr.,VB, JScript, SDK (5)	vis.progr., LUA, SDK (4)	vis. progr., C ++ (5)	C# (4)	Python (4)
KD	heavily limited (1)	full, easy implementi ng (5)	full, easy implem. (5)	not full, easy implem. (4)	full, difficult implem. (3)	full, easy implem. (5)
KE	15 formats, including critical** (4)	>20 formats including critical** (5)	6 formats (2)	4 formats, incl. crit.** (2)	5 formats, incl. crit.** (3)	12 formats, incl. crit.** (4)
KF	partially (3)	present (5)	partially (4)	partially (4)	present (5)	present (5)
KG	limited (3)	full (5)	partial (4)	full (5)	full (5)	full (5)
KH	no possibility (1)	free viewer(4)	standalone (5)	free viewer (4)	standalone (5)	standalone (5)
KI	29 000€	9 000€	9 000€	5 000€	1 500€	5 900€

* static/dynamic graphics quality (certain effects not included in dynamic graphics)
** critical 3D formats: OBJ, 3DS, FBX, VRML

The graphics quality itself was evaluated partially on the basis of available functions and their parameters (such as types and parameters of shadows, reflections, lights, occlusion effects, bump mapping capabilities etc.) and partially on comparative evaluation by the VR experts gathered by the authors. The final grades were calculated as averages between varying assessments from different experts. The full methodology of assigning grades in all criterions is too complex to present it here.

The data gathered in the table above gives a general idea about considered systems however, it is not an unequivocal indication in form of a single value showing which system will be the most beneficial in context of assumed criteria. Such a support can be given by use of advanced, analytical methods aiding the multi-criteria decision-making

problems. There are many mathematically advanced methods for solving such problems, among others: TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution), DRSA [14, 15]entropy, expectation maximalization method [16], AHP (Analytical Hierarchy Process) and methods based on fuzzy logic. The authors have analyzed these methods and on the basis of literature study of numerous cases it was decided to select the AHP, as a method fulfilling all the assumed requirements and possible to use for selection of appropriate software.

3 AHP Analysis for Selection of Virtual Reality System

The task presented in this paper – building a VR system for configuration of a city bus – was aided by the AHP method, selected by the authors as a decision-making support tool to select a software system. The AHP method was created in 1970 and is well known in literature, it has many documented cases of practical applications [17, 18]. Its creator is American scientist Thomas L. Saaty. The AHP method helps to make a decision in situations, where the final choice is affected by many independent factors, including human subjectivism [19].

As input data to the AHP procedure, the following matrices were used:

- results of pair comparison of importance of selected criteria (Table 2), based on experts' opinion,
- results of pair comparison of selected systems regarding particular criteria

Table 2. Pair comparison of importance of selected criteria.

Criterion	KA	KB	KC	KD	KE	KF	KG	KH	KI	Sum
KA	1	0.5	1	3	3	1	2	2	1	14.5
KB	2	1	1	3	2	2	5	2	1	19
KC	1	1	1	1	3	2	2	1	0.5	12.5
KD	0.33	0.33	1	1	1	0.33	2	3	0.33	9.33
KE	0.33	0.5	0.33	1	1	2	2	3	0.5	10.66
KF	1	0.5	0.5	3	0.5	1	2	1	0.5	9.5
KG	0.5	0.2	0.5	0.5	0.5	0.5	1	0.5	0.33	4.2
KH	0.5	0.5	1	0.33	0.33	1	2	1	0.125	6.66
KI	1	1	2	3	2	2	3	8	1	22
Sum	7.66	5.53	8.33	15.83	13.33	11.83	21	21.5	5.291	105.03

After using the AHP procedure according to methodology that can be found in literature [17, 20], the obtained results were put in Tables 3 and 4. Table 3 contains ranking of criteria, while Table 4 contains final ranking of VR systems considering all the criteria.

Table 3. Juxtaposition of weight coefficient of assessment criteria.

Criterion	Weight	Ranking
Graphics quality (KA)	0.14	3
Easiness of operation and programming (KB)	0.18	2
Programming possibilities (KC)	0.12	4
Application of peripheral devices (KD)	0.08	7
3D data import (KE)	0.09	5
Dynamic loading of external data (KF)	0.09	5
Manageability of structure and functions of application (KG)	0.05	9
Stand-alone application possibility (KH)	0.06	8
Price (KI)	0.20	1
Sum	1.00	

Table 4. Final ranking of VR systems.

VR system	Assessment	Ranking
VRED	0.14	5
EON Studio	0.19	2
Quest	0.14	5
Quazar3D	0.15	4
Unity3D	0.23	1
Vizard	0.16	3
Sum	1.00	

4 Discussion of Results

The obtained results indicate, that among the VR systems considered for building the immersive bus configuration application, the most suitable software is Unity 3D, with the EON Studio system coming in close second. Results of the performed analysis indicate, that the least suitable systems for the defined task are VRED and Quest3D. In case of VRED, its low score was caused mostly by high price, low programming possibilities and limited possibilities of using various peripherals.

The price factor has a huge influence on presented results. Weight of this criterion is 0.2 (Table 2). That is why after discussing results with the experts, the calculations were performed once again without the price criterion, which favored the Unity 3D system (the cheapest one). After leaving the price criterion out of the analysis, there was a change in the ranking – the EON Studio software was named a leader, according to the used criteria. It needs to be emphasized, that differences in scores of particular systems were much smaller when the price criterion was not considered, as presented in Table 5. The most expensive system – VRED – did not become a leader, however it obtained higher position than in the original ranking. Significant changes in the ranking dependently on selection of the particular criteria is one of known flaws of the AHP

method. That makes it even more important to define them properly and determine their weights reliably.

Table 5. Ranking of VR systems without the price criterion.

VR system	Assessment	Ranking
VRED	0.16	4
EON Studio	0.20	1
Quest	0.15	5
Quazar3D	0.15	5
Unity3D	0.18	2
Vizard	0.17	3
Sum	1.00	

5 Summary

After discussions in group of experts, it was decided to use EON Studio 8.2.1 software to use the immersive configuration system. The project was finished with success – a solution fulfilling all the requirements was created (Fig. 2), including time of its preparation without any delays. The system was preliminarily implemented in the company [13] and it obtained positive assessment by its users. The solution is constantly developed – new functions and modules are added and new data keeps being added. It can be stated that the prepared solution meets the needs of the company and helps it work more effectively.

Fig. 2. Visualization module of the VDS system created using software selected by AHP method

Therefore, on the basis of the obtained results, it can be said that the AHP analysis can be an effective tool aiding decision-making in terms of selecting software for immersive VR simulations, if such a choice needs to be made. It is, however, necessary to properly determine criteria, on which the choice is made. As proven in the calculations, omitting a single criterion (price, in this case) can have a significant influence on ranking position. The AHP method is also highly prone on subjective opinions of experts – a different team of VR experts would probably give the selected systems entirely different grades in the initial comparison.

Moreover, in terms of VR software itself, it needs to be emphasized that gathered input data as well as experts' opinions are quickly becoming outdated. The research and

the analysis was performed in 2013, in case of a branch developing as rapidly as VR, 2,5 years spent on realization of the project caused the market to change entirely.

Using the selected software, the authors intend to build a number of immersive solutions, such as a training solution for glass manufacturer, immersive training medical simulations and various immersive configurators. These applications will make use of low-cost HMDs, with selection of ultimate solution preliminarily performed using the AHP method. Then, a wide-scale studies are planned, for potential users to test available solutions and evaluate them in a survey study. It will allow comparison of expert assessments with evaluation by the end users.

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The Tool Supporting Decision Making Process in Area of Job-Shop Scheduling

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Abstract. Today most manufacturing companies from machine building industry are operating in single unit or short-run production which is very complex in terms of decision making processes in production planning area. The difficulty in decision making in the area of scheduling is caused by the necessity of analysing multiple factors and evaluating various scheduling options due to numerous criteria. The article presents the author's tool supporting decision making in the area of job-shop scheduling. The tool introduced in the article enables scheduling based on author's priority rule allowing maximum usage of the most loaded resource (known as critical resource), which determines efficiency of the production system. The tool has been designed and verified as a part of PhD dissertation research.

Keywords: Job-shop scheduling · Decision making process · Interactive application

1 Introduction

In contemporary world efficiency of manufacturing companies depends not only on production resources available, but also on how well they are used. The problem of using resources the right way is strictly connected to the problem of scheduling production flow. The fact that there are numerous external as well as internal factors influencing production processes makes production scheduling a very complicated issue. Available literature analysis shows that the scheduling problem is one of the most important and complicated problems which has been known as NP-hard and very challenging combinatorial optimization problem since 1950s [1, 2] in machine scheduling. With such high complexity of the problem and in keeping with goal criterion which usually is to minimize the time of every operation in a given process it is difficult to find acceptable

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solution [3] and in most cases an optimum solution cannot be found in reasonable time [4].

Today most manufacturing companies from machine building industry are operating in single unit or short-run production which is very complex in terms of decision making processes in production planning area. Range of manufactured products in single unit as well as in short-run production is usually very wide and very unstable at the same time. It is very difficult to predict demand and probability of spreading potential orders over time in advance. On top of that, average time frame from the moment an order is placed to its completion gets shortened [5–7]. Decisions made in the production planning area relate to balancing manufacturing capacity in terms of quantities, quality, delivery dates and costs of production with customer's requirements. The necessity of analysing numerous factors causes manufacturing companies to use tools helping with decision making in the area of scheduling processes.

2 Job-Shop Scheduling

The first function of business management is planning, which is based on an optimal development of work time and resources [8]. Production planning is done as part of a hierarchical planning process, where the production plan is cascaded down to a more detailed production schedule. The objective of scheduling is to schedule or sequence production tasks, in order to minimize a certain performance measure of customer satisfaction [9].

Scheduling algorithm is selected based on production system characteristic, set of orders to be executed and on encountered constraints. Among scheduling algorithms available in literature on the subject there are two types of scheduling systems: simple and complex. The simple scheduling system is described as single-machine scheduling and parallel-machine scheduling, while the complex system is described with the use of flow-shop scheduling, job-shop scheduling and open-shop scheduling. Numerous scientific publications concerning production tasks prove that job-shop scheduling problems are a current research problem.

Job-shop scheduling problem consists of a finite jobs set, Ji(i = 1,2,…,n) to be processed on a finite machine set Mk(k = 1,2,…,m) [10]. According to its production routine, each job is processed on machines with a given processing time, and each machine can process only one operation for each job [11]. Job-shop scheduling can be thought of as the allocation of resources over a specified time to perform a predetermined collection of tasks [12]. Researchers developed several methods to deal with the job-shop scheduling problem. Scheduling problem solving methods can be divided based on type of generated solution into exact methods and approximation methods.

Scheduling problem solving exact algorithms can be used on condition that the system structure is defined, certain task types and certain constraints are defined. The general approach of these methods is to consider the problem in its total system form of scheduling *n* jobs on *m* machines. In the literature on the subject exact algorithms are solved with the use of mathematical programming. Mathematical programming is an optimization problem with conditions constraining decision making and a goal function

being a decision making evaluation criterion. There are a few methods of mathematical programming, such as: partial enumeration, linear programming, integer programming, dynamic programming, branch and bound, branch and dominate [13–15]. Exact methods of scheduling problem solving are applicable in a small group of defined problems, where every solution can be assessed. With the increase of complexity of a problem, waiting for solution time is extended and a need to use high computing powers machines arises.

Approximation methods, also known as heuristic methods, do not guarantee finding optimum solution, however, they allow finding acceptable solution in a shorter time that exact algorithms. Shorter time needed for finding solution causes that these methods are used in real production systems, where planning multiple complex manufacturing orders with numerous constraints are needed. In the literature on the subject the following heuristic methods can be found [13, 16]:

– local search methods, e.g. ant colony optimization or tabu search,
– evolutionary methods, e.g. genetic algorithm or differential evaluation,
– constructive methods, e.g. priority despatch rules.

The above methods are widely described in literature. The solution presented in this article is one of heuristic methods and is based on priority rules.

Priority rules indicate how to assign a specific job to a specific machine at a given time, when a machine becomes available for process [17–20]. Literature [21, 22] classified over 100 priority rules.

During scheduling process, the major issue is choosing appropriate priority rules that will help achieve projected criterion. There are multiple studies comparing how priority rules work in job-shop scheduling [22–24]. For example, minimizing manufacturing process cycle criterion is best achieved with the use of the shortest operation time rule and with the minimal sum of weighted task time.

Scheduling quality measure is represented by goal function created on the base of evaluation criterion. Main criteria of scheduling evaluation are completion times and delivery times parameters. Most common scheduling evaluation criteria are [6, 22, 25–27]:

minimizing total manufacturing time, known as minimum makespan C_{max}
minimum average makespan $C_{śr}$
minimizing maximum flow time J_{max}
minimizing maximum delay L_{max}
minimizing average delay $L_{śr}$
maximum delay $T_{max,}$
average delay $T_{śr,}$
maximum flow time $F_{max,}$
average flow time $F_{śr.}$

Newest literature sources on job-shop scheduling have been collected in studies [14, 28], in which the authors research problem solving methods paying special attention to their influence on scheduling evaluation criteria.

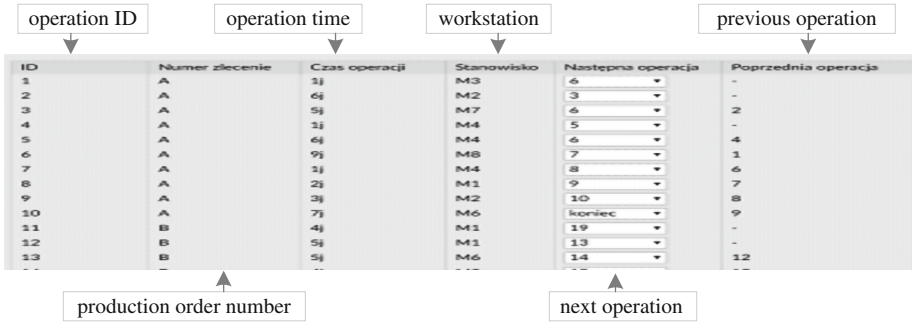
Job-shop scheduling problem and adopted building schedules criteria have been described in [29–31]. Due to the large number of criteria to be considered in scheduling problem, it is recommended to used methods supporting decision-making, which effectiveness is proven in numerous publications [32–40]. Useful tool helping decision making in the area of scheduling is simulation. Simulation can be applied to many aspects of manufacturing systems [41]. In job-shop scheduling the simulation of dispatching rules and the assessment of the effect of different rules on the shop's ability to meet delivery dates and utilize the machines. The first application of simulation was computer simulation studies of different priority rule have been carried out. Today many of such methods are available through integrated scheduling systems. Examples of such systems, available and free to be used through the Internet, include the LEKIN [42], and Lisa [43], among many others.

For example popular LEKIN Software is a tool with the main purpose of introducing the main scheduling theory and demonstrating the capabilities of several scheduling methods [44].

However, author's tool supporting decision making in job-shop scheduling presented in this paper is a computer application allowing generating schedules in accordance with a chosen priority rule and then comparing results with chosen criteria.

3 An Interactive Scheduling Application

Developed computer application takes the form of interactive scheduling system for machine environments, which can be used for scheduling tasks in real life manufacturing or in research, as it has an option of generating sets of orders. The generator allows to define quantity of orders in each set and number of production operations in each order. Duration of each production operation and workstation where each operation takes place are chosen with equal probability from a defined set of numbers. However, in case sets of orders are entered into the system individually, it is possible to define every single parameter of production orders.



ID	Numer zlecenie	Czas operacji	Stanowisko	Następna operacja	Poprzednia operacja
1	A	1j	M3	6	-
2	A	6j	M2	3	-
3	A	5j	M7	6	2
4	A	1j	M4	5	-
5	A	6j	M4	6	4
6	A	9j	M8	7	1
7	A	1j	M4	8	6
8	A	2j	M1	9	7
9	A	3j	M2	10	8
10	A	7j	M6	koniec	9
11	B	4j	M1	19	-
12	B	5j	M1	13	-
13	B	5j	M6	14	12

Fig. 1. Set of orders as tabular data

Set of production orders is presented as a table (Fig. 1) containing:

- production order number
- operation time
- workstation, where an operation is realized
- next operation
- previous operation

and graphically (Fig. 2) presenting the structure of each order.

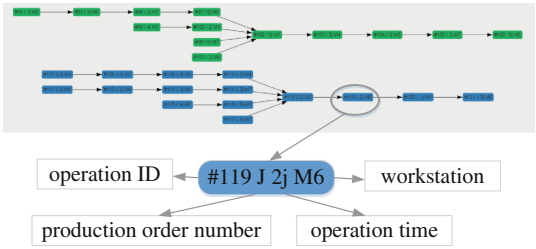


Fig. 2. Set of orders as pictorial data

The application allows to generate a schedule created in keeping with the chosen priority rule:

- Shortest task time (STT), a local and static rule that minimizes average task production cycle [45–47].
- Longest task time (LTT), which maximizes average production cycle as well as average number of tasks waiting in queues. However, for job-shop task set it minimizes average workstation-consumption of operations waiting in queues thanks to the fact that the highly workstation-consuming operations are realised faster [22].
- Shortest processing time (SPT), a local and static rule which minimizes average task production cycle and percentage of delayed tasks in job-shop order sets [22, 48].
- Longest processing time (LPT) is a local static rule that has a proven efficiency for production systems with numerous machines and production equipment. LPT also minimizes makespan for simple systems.
- First in first out (FIFO) causes waiting time of operations in queues to extend and, at the same time, extending production cycles times [22].
- Priority rule for the smallest total workstation-consumption of workstation orders from the set of chosen chains of workstation orders realized before the critical resource (CR)

Priority rule for the smallest total workstation-consumption of workstation orders from the set of chosen chains of workstation orders realized before the critical resource is the author's priority rule designed for a PhD dissertation. Critical resource is defined as production system resource, which due to work load in job-shop set of production orders determines the efficiency of the whole production system. The superior characteristic of the critical resource among all production workstations is the highest labour-hour load. The designed priority rule demands that from all waiting orders the one with the smallest total workstation order realization time of orders in given chains is chosen.

Own research showed that applying the priority rule for the smallest total workstation-consumption of tasks in the set of chosen chains of operations realized before the critical resource maximizes the usage of the critical resource, which leads to shortening of the average time of realization of a production order set.

The result of scheduling for each of the chosen priority rules is generated graphically as schedule (Fig. 3) and as tables containing information concerning:

- order number,
- order start time,
- order end time,
- total time of an operation in a certain order,
- time of a machine work load start,
- time of a machine work load end,
- total machine working time,
- total time of machine pauses.

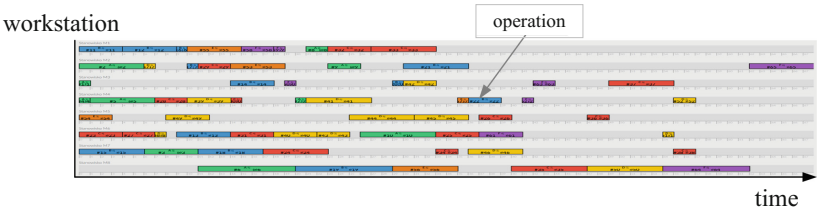


Fig. 3. Results presented graphically

Collective results concerning scheduling developed for a given set of production orders in keeping with all available in the application priority rules are presented in the form of a table in spreadsheet MSExcel (Fig. 4). The table contains information concerning makespan (C_{max}), critical resource work load (wCR) and the amount of work in progress (WIP). Decision-maker gives validity all criteria by determining their weights. The weights can be from 1 to 5. The application create the ranking takes into account all the criteria simultaneously.

		priority rules					
	weight	STT	LTT	SPT	LPT	FIFO	CR
C_{max}	5	35	38	37	42	45	32
wCR	2	10	14	11	12	17	8
WIP	3	20	18	25	19	20	20

C_{max}	175	190	185	210	225	160
wCR	20	28	22	24	34	16
WIP	60	54	75	57	60	60
total	255	272	282	291	319	236

ranking	2	3	4	5	6	1

Fig. 4. Spreadsheet

The application helps production planner to make decisions in choosing the best schedule for a certain set of orders in keeping with chosen criteria. The possibility of manually modifying weights of each criterion of evaluation makes the application versatile and allows it to be used in a variety of production conditions. The versatility of the application is also proven by the fact that the critical resource can appear multiple times and at any stage of technological process in the structure of a given production order. It is assumed though that the operation realized with the use of the critical resource must not be repeated between the first and the last operation of the same path. Currently works on expanding the application's capabilities with the module allowing rescheduling are being conducted.

4 Conclusion

The tool supporting decision making introduced in this article has been designed as a part of research for a PhD dissertation at Poznan University of Technology. The tool was preliminary implemented in three manufacturing companies in Greater Poland area. The companies confirmed the efficiency of the described tool in supporting decision making in the area of production scheduling.

The application is also successfully used for research in the area of job-shop scheduling. Currently works are conducted on defining rules for scheduling conversion and adding a rescheduling module to the already designed application.

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Statistical Approach to Making Decisions in Manufacturing Process of Floorboard

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Abstract. The study was conducted at a Polish company operating in the wood industry under the R&D project "Increasing the effectiveness of use of wood in manufacturing processes", aimed at reducing raw material waste in the surface layer manufacturing process. Results of our studies on the improvement of the wet cutting technology are presented in this paper. Minimization of variability is the first step to reduce material consumption in the process of cutting wood into lamellas. Appropriate values of factors which significantly affect lamella thickness after the cutting operation can be determined through real-life experiments. The methodology is to improve and/or reduce operational allowances and to redesign the tolerance and machine parameters/setting.

Keywords: Decision support · Quality · Design of experiments · Timber-wood

1 Introduction

Contemporary production processes are often complex dynamic systems, impacted by a variety of factors and disturbances. They include controllable factors, i.e. parameters which can be deliberately set and adjusted during the realization of the process, non-controllable factors (or those offering limited ranges of control), and internal/external interferences (disturbances to the process) [1]. The outcome of the production process is a material product, which shall meet the expected requirements set forth at the product design stage. They are defined for the subsequent stages of the process and for specific features of the product. One could say that the levels of these parameters achieved in the process define the quality of the product and process.

During the realization of the production process specific amounts of resources are consumed, thus costs are incurred. The purpose of any production process is to obtain a product of specific quality with the lowest possible investment of resources. This is being achieved, among other things, by limiting process variability through the control and analysis of changes in critical features of the product (process) in time. The quick increase in requirements towards finished products with the simultaneous strive to reduce the costs of their manufacturing caused a fundamental change in the methods used in designing and optimizing of manufacturing processes [2–10]. These processes

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started to be analyzed and improved using a number of methods and techniques [11] used for supporting quality assurance such as SPC (Statistical Process Control), including MSA (Measurement System Analysis), or DoE (Design of Experiments).

SPC aims at supervising stability and capability of processes, while DoE allows for the identification of variables (referred to as factors), which have a significant impact on the outcome of the process, and on the determination of the size of such an impact. The latter also allows for the investigation of the nature of mutual relationships between the factors. In most cases, the DoE methodology is used to determine the levels at which the particular factors should be adjusted in order to optimize the process.

There are numerous applications of the SPC [12–14] and DoE tools [15–17] which justify the need to use them in the industry. The authors of the paper are also experienced researchers in this area [18, 19].

In many cases, the lack of clear guidelines for specific industrial applications is the obstacle to their effective usage in practical situations. This is the factor impairing the transfer of such concepts into practice, especially when there is virtually no information on the modeled process, or when the process is affected by several factors. Such a situation occurs in the wood industry, where the processes are highly complex, and where the high level of variability of input materials generates high production costs.

The costs incurred by a company operating in the wood processing business are mostly related to material losses due to large operational allowances. Such approach is justified by the high level of risk related to the inconsistencies of raw materials. The problem of excessive material losses also applies to the manufacturing process of the top surface layer of three-layer floorboard. According to Orłowski, in the production of oak surface layers of laminated floorboard elements the raw material costs are the most important component of the overall production costs and exceed 80%, while the tooling costs are 6% for the frame saw and 5% for the band saw technologies [20]. Therefore, in the lamella production process it is of major importance to recognize the sources of process variability and investigate adequate counter measures to minimize it, instead of a conservative adjustment of the process allowance causing excessive material losses.

The purpose of the research work undertaken by the authors of this publication was to develop principles for the selection of material allowance for the wet cutting process, taking into account the requirement to minimize the material losses. For the needs of this research objective the authors have formulated a methodology for decision support for activities aimed at improving the operations of the technological process. The article also discusses the proposed methodology based on the operation of cutting timber into lamellas, used as the top surface of three-layer laminated floorboards.

2 Research Methodology

The research focused on the manufacturing process of three-layer laminated floorboard. The top (face) layer is made of selected European or exotic timber of appropriate thickness and hardness (e.g. oak, beech). The middle layer, made of coniferous timber, is

positioned transversely to the other two layers for reduced tension and natural deformation (swelling, creaking or gapping). The bottom layer is also made of soft coniferous timber. The three cross-glued layers are additionally varnished.

The lamella is an especially important component of the floorboard. Its quality determines the aesthetic values of the face layer, and has a significant impact on the sound damping properties, maintenance of the room microclimate, durability and strength of the floor.

2.1 Object of the Study

The study focused on the process of producing lamellas from wet material. It includes five key operations: cutting, stacking, drying, grinding and formatting. The input material of the process is timber obtained by cutting logs. First, fresh timber "in wet condition" is cut using a band saw into pre-defined thickness lamellas (Fig. 1).

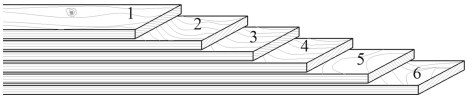

Fig. 1. Timber sliced into lamellas.

Material allowance in the analyzed process is secured taking into account three geometric parameters: thickness, width and length of both the lamella and the timber. The critical characteristic of lamella production process is thickness of the layer. This is due to the requirements of customers and industry: a cross-glued block may be classified as a floorboard if its surface layer is at least 2.5 mm thick. Otherwise, the material is not qualified as board but as a floor panel, a product of lower quality class, less profitable to the manufacturer.

In the theoretical model for the given operation of the technological process, the value of operational allowances takes into account the tolerance and variability of the processes. The size of material allowance for one lamella affects the level of material allowances in the input material and, by the same token, the geometric dimensions of the timber. For the authors of this study, this information became the basis for the formulation of the decision support methodology for selecting the material allowance in the timber cutting process.

2.2 Decision Support Methodology for Improving Manufacturing Process

The authors have proposed a methodology supporting decisions in selecting the material allowance for timber cutting (Fig. 2).

The methodology is expected to improve the process of timber cutting into lamellas by determining the machine settings (cutting speed and band saw feed velocity) allowing for the minimization of variability and curbing material losses.

The following stages have been identified in the methodology:

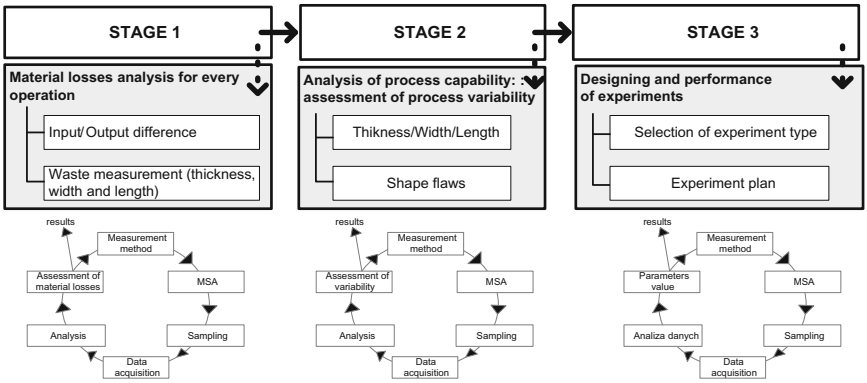

Fig. 2. Diagram of the methodology.

STAGE 1: Determination of material losses in the process – to assess the level of material losses in the process and the potential for their reduction

STAGE 2: Investigation of the capability of the process – to determine the level of variability of subsequent operations in the process

STAGE 3: Designing and performance of active experiments – to determine the level of controllable parameters in the process, allowing minimizing of the variability and material losses

Each of the stages is being carried out in a cycle of six steps:

(1) Development of a measurement method and selection of the measurement system.
(2) Assessment of measurement system suitability in compliance with the MSA methodology.
(3) Selection of sample size.
(4) Data acquisition.
(5) Data analysis.
(6) Processing of the data results and conclusions.

3 Case Study

Below, the authors present the results of studies carried out in compliance with the methodology proposed above for the operation of timber wet cutting into lamellas.

3.1 Analysis of Material Losses

3.1.1 Selection and Analysis of the Measurement System

The measurement device used to determine the thickness of the material was a digital thickness gauge, referred to as measurement claws. The metering range of the device is 0÷50 mm with a resolution of 0.02 mm. After initial measurements it has been agreed

that thickness of the material will be measured in 17 fixed metering points distributed over the surface of the lamella and timber.

The evaluation of this measurement system in compliance with the MSA methodology has indicated that the %R&R index value is at the level of 15%. This means that the system is suitable for application [21].

3.1.2 Sample Size Selection and Data Acquisition

The size of the sample was set to 100 timber pieces, 20 in each of the five classes of timber (A, B, C, D, E and F) and four size groups (I, II, III and IV). Timber- pieces from three size groups have been cut into five lamellas and in the case of group I – 4 lamellas.

For one week the timber was cut into lamellas and measurements of the thicknesses were performed. Data was logged manually into an MS Excel spreadsheet. Data analysis was performed using the Minitab ver. 17 Software tool.

3.1.3 Data Analysis and Evaluation of Material Losses – Results

Data analysis has indicated that almost 70% of the input material ends up in the process waste stream (considering the entire floorboard production process), of which the largest total percentage material loss (approximately 50%) is lost in operations related to obtaining the final thickness of the product. Material losses for the cutting operation analyzed are shown in Table 1.

Table 1. Structure and size of the sample. Material losses in the cutting operation.

	Timber-wood	Lamella		
Class	5	5	Input material [m^3]	1.411903
Pieces	20	95	Output material [m^3]	1.210678
Total	100 pcs	475 pcs.	Loss [m^3]	0.201225

Results indicate that nearly 15% of the material is lost in the cutting operation. This implies the need for improvement of the process. It is therefore crucial to assess the process variability.

3.2 Assessment of the Process Capability

In the second and third stage of investigation, the same measurement system was used, with the same method of sample selection. The analysis was performed to assess variability in timber and lamella thickness.

3.2.1 Assessment of the Capability of Timber Pieces After Sawmill

In the first step, the quality of the cutting process input material was assessed. Analysis of the capability was performed with break down into classes of wood, size groups and totals, for the timber-wood after sawmill. For example, Table 2 and Fig. 3 present the results of capability analysis for class F and total for the timber-wood after sawmill process.

Table 2. Results of timber-wood thickness data analysis (author's calculations).

		Size group					Size group			
Capability indexes	Class	I	II	III	IV		I	II	III	IV
Cp	F	3.48	3.28	3.55	1.82	All classes	2.39	2.39	1.15	1.43
Cpk		2.79	2.59	2.6	1.5		1.94	1.82	1.04	1.15
Pp		2.44	2.85	2.97	1.18		1.58	2.27	0.83	0.78
Ppk		1.95	2.25	2.18	0.97		1.29	1.73	0.75	0.63
ppm_{Within}		0	0	0	3.5		0	0.02	999.9	268
$ppm_{Overall}$		0	0	0	1879		56.87	0.11	15645	32280

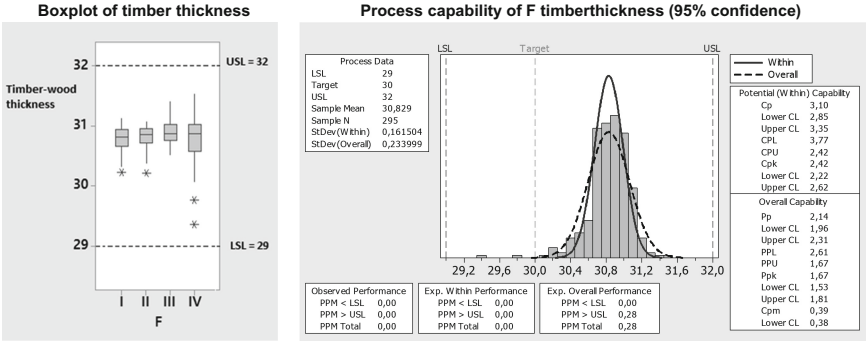

Fig. 3. (a) Boxplot of class F timber thickness after sawmill with break down into size groups; (b) Results of capability analysis for class F timber thickness (after sawmill) (Results of Minitab analysis).

The analysis indicates that the process of sawmill cutting of logs into timber is characterized by a very high capability in relation to the given range of tolerance. Thickness of timber-wood pieces in particular size-groups is characterized by a similar variability. A significant conclusion of this analysis is that the timber-woods are in average 1 mm thicker than expected (the nominal value is 30 mm).

3.2.2 Analysis of the Capability of the Lamella Cutting Process

The results of capability analysis with breakdown to size groups indicate a clear shift in the average thickness of lamellas obtained by cutting towards the upper tolerance limit (Fig. 4). This may indicate a deliberate increase in default presets of the nominal thickness by saw operators, leading to increased material losses. High variability translates to very low capability index values.

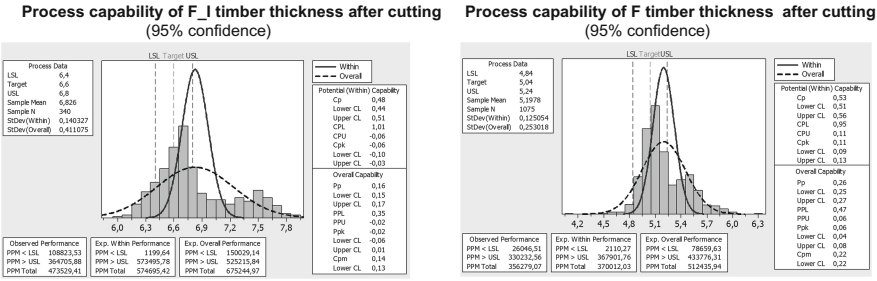

Fig. 4. Results of capability analysis for class F wood and lamella thickness after cutting of: (a) size group I; (b) size groups II–IV.

The reduction of process variability will have a significant impact on curbing material losses. This result supports the need to implement changes to the process.

3.3 Active Experiments

The subsequent stage in the optimization of material losses in the process of cutting timber-wood into lamellas was to perform an active experiment. The goal of the experiment was to indicate optimized process settings for the assumption made: minimum material losses.

It has been assumed that the current knowledge about the cutting process is of little use. Therefore, the authors decided to carry out an active experiment. As part of the experiment, 48 timber-wood pieces were cut, each into six lamellas. It has been agreed that the required thickness of the lamella is 4.0 ± 0.2 mm.

The controllable factors agreed for the active experiment included: status of the timber-wood surface, class of wood, cutting speed and feed velocity. A full 4-factor experiment on two levels was planned (Table 3).

Table 3. Table with names of the factors analyzed and their preset levels.

Nr	Name of factor	Value I (+)	Value II (–)
1	Status of the surface	Non-equalized timber-wood 30 (+2/–1)mm	Timber-wood after equalization 30 (+2/–1)mm
2	Wood class	A	F
3	Feed velocity	9	12
4	Cutting speed	32	36

The results of the experiment were analyzed for two dependent variables: arithmetic average of the lamella thickness and standard deviation of the thickness (both statistics calculated based on 17 measurements obtained for each lamella).

Of the four factors analyzed only Status of the surface demonstrated statistically significant impact on the dependent variable average thickness. This means that the average difference between the values of average timber-wood thicknesses in equalized and non-equalized statuses differed significantly. None of the remaining factors turned

out to be significant. This is visible in Fig. 5, presenting the Pareto chart of effects (in this chart, the test value for factor A – Status of the surface was the only one exceeding the critical level, designated with a dotted line).

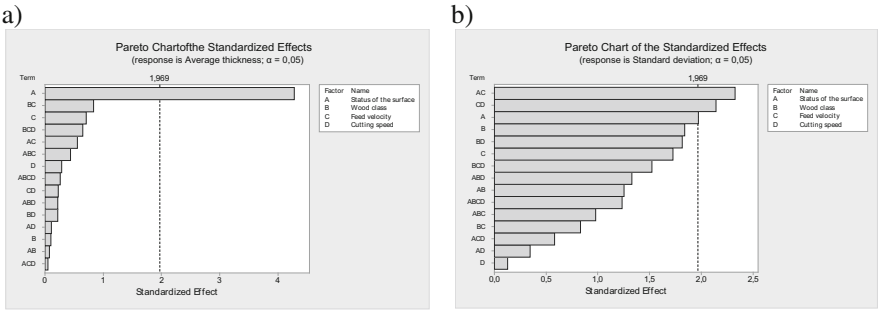

Fig. 5. Pareto chart for effects (a) for average thickness (b) for standard deviation of thickness.

The results of the study indicate that the required thickness is obtained when the levels of parameters have the following values: Status of the surface: equalized, Wood class: F, Feed velocity: 12 m/min, Cutting speed: 36 m/s.

These results should however be approached with consideration. Due to the lack of significance in parameters: Wood class, Feed velocity and Cutting speed a similar set of results is obtained when the following set of parameters is used: Status of the surface: equalized, Wood class: A, Feed velocity: 9 m/min, Cutting speed: 36 m/s.

The experimental results were also analyzed to select the factors minimizing the variability of thickness. Among the four factors analyzed in the study, only the Status of the surface parameter seemed to have an impact on the standard deviation dependent variable. This means that the average difference between the values of standard deviation in equalized and non-equalized timber-wood was statistically significant. The values of parameters, for which variability is the lowest are consistent with the results obtained for the average thickness.

4 Conclusions

The use of the decision support methodology in actions aimed at improving the process of timber cutting into lamellas allowed for the following conclusions to be made:

– The necessary condition to achieve the expected average thickness of the lamella after cutting is to equalize the timber-wood (statistically significant factor in the experiment);
– In order to achieve minimum thickness variability in the case of equalized timber-wood, the feed velocity for class A wood shall be set to 9 m/min and the cutting speed to 36 m/s; in the case of class F wood, the feed velocity shall be set to 12 m/min and the cutting speed to 32 m/s or 36 m/s.

It is assumed that when optimum settings of the technological process are determined, material losses can be minimised. The research applying the proposed decision support methodology was performed in 2016. Based on the results of the study, the company is ready to launch a new production line – a new band saw has been acquired and a timber-wood equalization process is implemented before the cutting process. The authors are currently preparing to assess the new process, i.e. to investigate the process capability and to evaluate the level of material losses after the implementation of the modifications proposed.

The methodology presented for the selected operation of the floorboard production process is universal and can also be applied to other, similar processes in the wood industry.

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Cycle Time Reduction in Deck Roller Assembly Production Unit with Value Stream Mapping Analysis

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Abstract. Cycle time reduction is of paramount importance in a manufacturing industry as the customer not only emphasizes on the quality of the product but also takes into consideration the timely delivery of the product. The proposed framework and the advanced methodology in this paper are capable of dealing with each stage of the considered manufacturing unit by maximizing the value of the product through reduction of cycle times and minimization of waste. The time required for all the processes in the manufacturing of the deck rollers is identified and are classified into value added (VA) and non-value added (NVA). Finally, the cycle times were reduced by applying the lean tools and principles on some managerial relevances. Also, Arena software was used to simulate the current and future value stream maps and the change in the cycle times, waiting times, machine utilization, etc. was determined.

Keywords: Lean thinking concepts · Value stream mapping · Cycle time · Arena simulation software

1 Introduction

Competitiveness of manufacturing enterprises depends on effective management, which can be supported by quality tools [1–4], decision-making methods [5–11], virtual reality applications [12, 13] and lean management tools. To increase efficiency, productivity and customer responsiveness in organizations a vital role plays cycle time reduction.

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Cycle time is the time taken to do any particular task from the starting point of one process on a particular machine until the end of the last process in the sequence for the production of a part. This cycle time can be measured using time study techniques such as StopWatch time study, and Maynard Operation Sequence Technique (MOST) [14]. During the time study, a process can be divided into a number of work elements and are classified into value added (VA) activities which augment the value of the product such as machining, assembling, painting, etc. and non-value added (NVA) activities which have no effect on the value of the product such as loading, unloading, cleaning the machine, material handling, dimension checking, unwanted tool and operator movement.

Lean Manufacturing manages to eliminate waste, improve throughput, reduce inventory and encourage workers to bring attention to problems and suggest solutions to fix them. It was developed by Toyota Production system and can be established as a formal approach to manufacturing that aims to reduce the cycle time of processes, improve quality and increase the flexibility. The fundamental objective of Lean Manufacturing is to maximize customer value while minimizing the waste and thus achieving the manufacturing fineness by producing more value with the minimum resource. In product development phase Value Stream Mapping (VSM) plays a vital role in designing a flawless production procedure. The procedure includes eliminating the various interruptions such as factory-specific restriction while considering the manufacturing objectives such as product quality, the time required for the product to reach customer and equipment capability. In a next stage, VSM has to take care of the customer satisfaction for which the new technologies can be used in the manufacturing.

In this research work, we have developed a framework of the proposed methodology for improving the efficiency and the effectiveness of the considered case study. A case demonstrated in this paper is based on the manufacturing unit with production and assembly of deck rollers located in India. The detailed case description is demonstrated in Sect. 3. In order to achieve the objective, i.e., cycle time reduction, the research study starts with implementing the VSM analysis and a performance check of the current production process design. It includes Gemba walk for scan and plan process object by real field visit and calculation of Takt time and cycle time to draw Pareto-diagram. Pareto diagram gives the current view of the process i.e. the state of each process. These different stages can then be used to draw the current value stream map. Value stream design starts with a cycle time reduction of the process in which real optimization is possible. After the cycle time reduction, we draw the future value stream map based on the new values calculated. Thus the paper provides a validation of the used methodology by giving the production process design with a significant decrease in cycle time with higher transparency in production control.

The paper has been organized as follows: The detailed literature review is presented in Sect. 2. A brief summary of the considered product and the company background is given in Sect. 3. Section 4 provides the detailed methodology proposed to obtain the current and future value stream map by discussing the different scenarios and the novel ideas used for the improving the efficiency of the various production methods and also visualizes the improvements through future value stream maps. The ARENA based simulation and discussion about the results have been summarized in Sect. 5. In Sect. 6

the necessary conclusions are derived depending on the results from the current and future value stream map.

2 Literature Review

Rahul [15] aimed to improve the efficiency of a multi-model assembly line by identification and elimination of non-value added activities, making changes in workstations, improvement of the layout to eliminate unwanted operator movements, and work content reduction using postural analysis of operators by implementing REBA (Rapid Entire Body Assessment) analysis. Gnanavel [16] demonstrated the implementation of a looping layout which was designed ergonomically in the assembly line of automobile ancillary unit labor demanded lean environment. The current process line and the proposed layout were simulated, and results were compared. The analysis showed a decrease in the total cycle time, increased balancing of workloads in the production line, increased alertness among workers and therefore increased productivity.

The lean thinking (LT) term was first coined by Womack [17] in his book "The Machine That Changed the World." It suggests that the fundamental concept of the waste minimization can be achieved by questioning the basic understanding of business and manufacturing. Lean manufacturing contain such tools as cellular manufacturing (CM), line balancing, value stream mapping (VSM), Inventory control, U-line system, single minute exchange of dies (SMED), production levelling, pull system, kanban, standard work, kaizen, one piece flow, poke-yoke, visual control etc.

Value stream mapping tool can be implemented effectively by forming a current state map for eliminating the non-value added activities, also to derive a future state map for reducing the cycle time and improve the process efficiency was proposed by Arvind [18]. Seifermann [19] investigated all the available analytical techniques for work measurement. The outcome was a rating of all the work measurement methods for the Cellular Manufacturing. The applicability of this approach was verified and was used as a reference for further examination of remaining lines. The cycle time analysis, together with the use of Arena software simulation was done based on the data collected by the time study. Thus, the paper aims to use the benefit value stream mapping (VSM) approach which is a lean principle to describe the expected results through its application. The authors present the proposed methodology in Fig. 2. The VSM tool simplifies the process by eliminating the wasteful or the non-value adding activities from the process rather than just analyzing the process. The next section details the implementation of the various lean tools used for reducing the cycle times of operations and further creating a sustainable production system.

3 Case Study of ABC Company

This study is focused on the manufacturing of Deck Roller assembly used in surface miners, apron feeders, materials handling, automotive, textile, etc. produced in ABC industry. ABC is a major technology, engineering, construction, manufacturing and financial services conglomerate, with global operations. It addresses critical needs in the

major sectors - Hydrocarbon, Infrastructure, Power, Process Industries, and defence - for customers in over 30 countries around the world. It is engaged in core sectors of the economy, and their integrated capabilities are focused on the concept of 'design to deliver.' With over seven decades of a strong, customer-focused approach and a continuous pursuit of world-class quality, they not only have expertise in many fields like Technology, Engineering, Construction, Infrastructure Projects and Manufacturing but also maintain leadership in all the key lines of business. The Company's manufacturing footprint extends across eight countries in addition to India. The three variants available in deck roller assembly are T13, T23 and T50. There is a total of 14 operators required for the production of these components, and the average monthly demand is 250 deck rollers. This production line has been started recently, so it requires some standardization and optimization. Out of three variants available, the operations flow chart for the T23 deck roller assembly is shown in the flowchart as an example in Fig. 1.

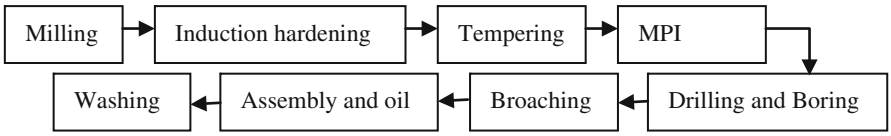

Fig. 1. Flow diagram for T23 deck roller

The time taken by each operator to do a specific process is different from each other. The workstation assigned to each operator varies according to the production schedule. The objective of this study is to calculate the cycle time of all the existing process using time study and work study techniques and then optimize them wherever possible using lean tools to reduce the overall cycle time of the process and to schedule the production accordingly.

4 Methodology

The proposed methodology for reducing cycle time is considered in a case study for the system analysis and to improve its performance by eliminating the inefficient processes. Figure 2 shows the proposed methodology approach and its step by step process of applying different methods.

These techniques include the 3G's (Gemba, Gembutsu, and Genjitsu), time study, work study and Kanban principle. Thereafter, VSM is used for drawing the current and future stream maps to compare the difference between the cycle times before and after their reduction.

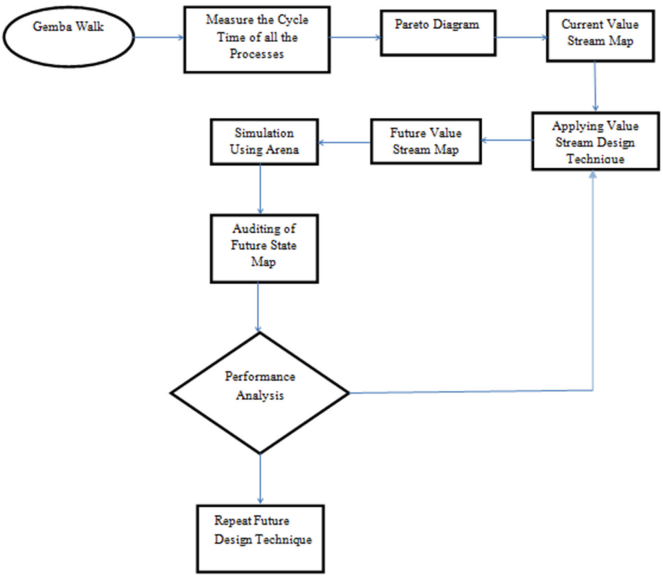

Fig. 2. Flowchart of the proposed methodology

4.1 Value Stream Mapping

The word Takt in German means rhythm or pace. Takt time is the rate at which we need to produce our product to satisfy customer demand.

$$T = \frac{T_a}{D} \tag{1}$$

In Eq. (1) T represents Takt time, Ta represents total available time and D accounts for the total demand. The Takt time is calculated for the roller. The demand for rollers is 250 per week and the available time calculated by the number of working days is 26 and number of minutes per day are 460, then for 26 days the time is 10,920 min. Thus the Takt time for the rollers was obtained as 43.68 min. The calculations were carried out based on the total time available for the production of the parts and their total weekly demands. Thus the actual rate at which the production of the parts should be carried out was determined, and they act as ideal rates by which the actual production rates can be compared and improved. Cycle time represents the total time required for manufacturing a product. It takes into account the setup time, handling time, non-operation time and the actual operation time. Cycle time can be calculated for the deck roller production using the time study and work study techniques. Table 1 denotes the cycle times for different operations in the manufacture of the four variants in the return roller assembly. The process of time study has to be carried many number of times on different days and during different shifts to get the most appropriate cycle time.

Table 1. Cycle time tabulation – roller assembly

	T13	T23	T50
Induction Hardening	116	286	617
MPI	106	245	402
Welding	516	632	1126
Turning	739	542	2434
Assembly	1000	1100	1300

The cycle from the work study can be used for finding out the observed and normal times respectively. Equations (2) and (3) represent the formulas used for calculating the normal and standard times.

$$\text{Normal Time} = \text{Observed time} * \text{Rating} \tag{2}$$

$$\text{Standard time} = \text{Normal Time} + \text{Allowance} \tag{3}$$

Based on the cycle time observed from time study, the normal and standard times are calculated which describe the actual cycle time. The standard times take into account delays due to various factors with respect to the worker and the working environment.

For the underlying problem, Pareto diagrams for the cycle times of the production of deck rollers were developed. Figure 3 represent the Pareto diagrams for the manufacture of the deck rollers giving information about the various processing times in their manufacturing. The chart depicts the cycle times for the different processes in the production of the deck roller along with the calculated Takt time. The diagram brings to attention the extra time needed in the drilling and boring process which is considered as waste and which has to be eliminated.

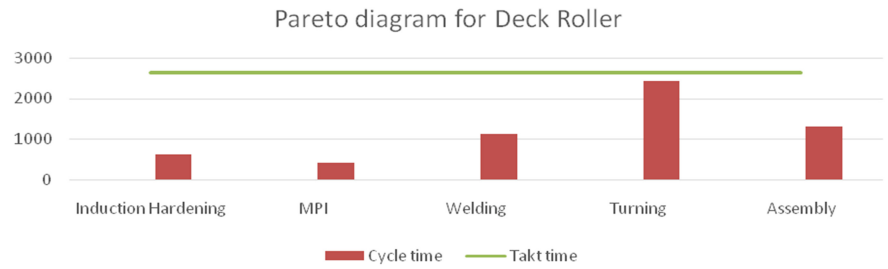

Fig. 3. Pareto diagram for T23 Deck Roller

4.2 Analysis of Current to Future Value Stream Map

The present value stream map has been generated using the information obtained from the proposed methodology. For the production of deck rollers the Takt times, cycle times (CTs) of different processes, the utilization of the machines, and convert times (Cos) were calculated.

Figure 4 demonstrates the current value stream map for the production of the T23 Deck roller. In the figure the different processes required in the manufacture of the deck roller are shown in boxes along with the information about the number of operators needed for each process. Also, every process has a data box underneath which includes the CT of the processes and the CO time. Different lead times between the various processes are also shown in the form of a timeline, which helps in analyzing the total lead time for the product that comes out to be five days. The second component of the timeline is the value-added or processing time which is approximately 6058 s along with a lead time of 29 days. This is found by the summation of the processing times of all the processes.

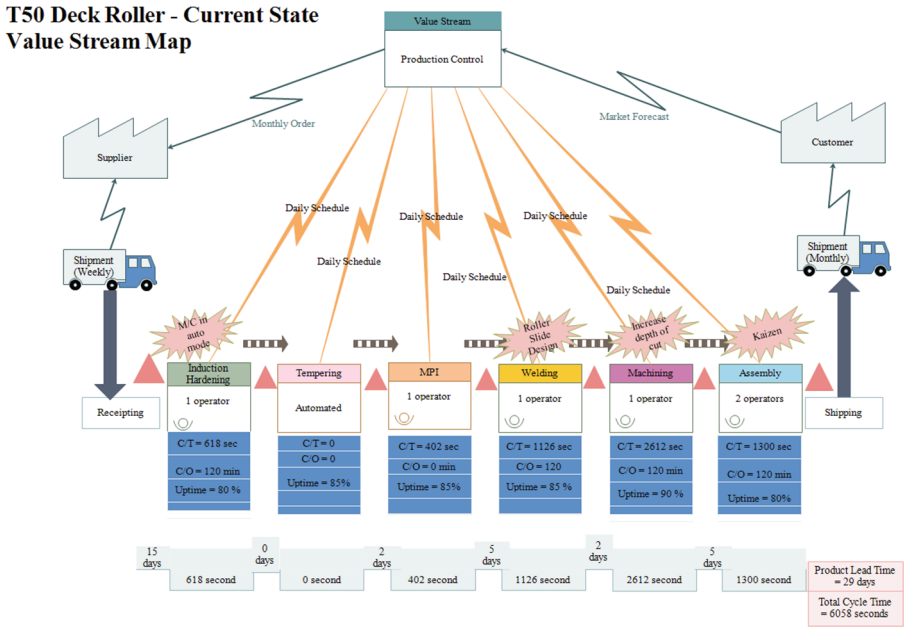

Fig. 4. Current value stream map for T50 deck roller

4.3 Managerial Relevance

The machining time of T50 deck roller was around 44 min which was twice than that required for T23 deck roller. This was due to the low depth of cut used in the CNC program. Roughing and finishing cycle were used for T50 deck roller because the amount of material to be removed was much more than that of T23 deck roller. Since the total machining time went beyond the Takt time limit, the roughing cycle was eliminated from the process. Also, the dimensions of the T50 deck roller raw material was found to be much larger than the required dimensions after machining. So steps were taken to reduce the size of the raw material and the depth of cut was also increased. The steps lead to a decrease in cycle time from 44 min to 25 min.

The improvements in the production rate of the deck roller by using low depth of cut in CNC machining can be observed through the future value stream map in Fig. 5. As shown in the figure the total cycle time has been reduced to 4628 s which in turn increased the production rate.

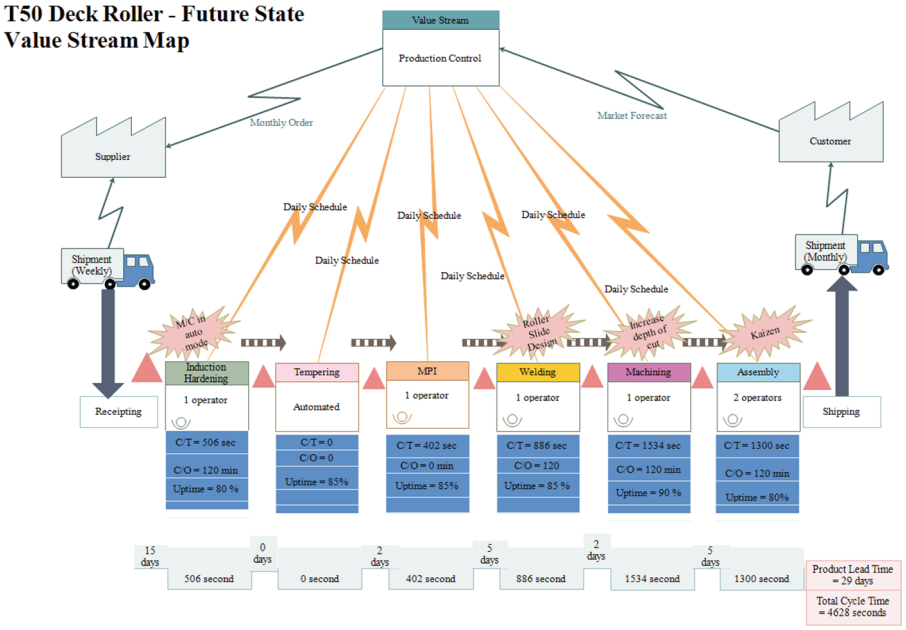

Fig. 5. Future value stream map for T50 deck roller

5 Arena Simulation and Results Discussion

The T50 deck roller production line is modeled using arena simulation software which allows to visually represents the total number of units entering the system for different processes in the T23 deck roller assembly and also shows the number of units that go out of the production sequence. Depending upon the cycle times and the mean waiting times in the queues for different processes, the utilization of the machines for the different machines is calculated via simulation and the result is depicted in the bar graph.

Table 2 represents the information regarding the enhancement in the future stream map for the production of T50 deck roller as compared to its current value stream map. This change is due to the application of low depth of cut in the CNC machining of the deck roller along with the different lean tools. The change in the machine utilization from 0.42 to 0.75 is reflected through the increase in daily production from 9 rollers to 16 rollers and decrease in the cycle time of the production from 6058 to 4628 s.

Table 2. Current state vs. future state for T50 deck roller production

	Current VSM	Future VSM
Daily production	9 rollers	16 rollers
Assembly machine utilization	0.42	0.75
Induction hardening number out	45	56
Cycle time	6058 s	4628 s

6 Conclusion

This paper focuses on the cycle time reduction in the production of deck roller in an ABC manufacturing company. Different strategies and the use of lean tools and principles achieved the goals of waste reduction leading to higher efficiency in the production of the components. The current value stream map was developed to get a comprehensive idea about the existing production system by using the 3G and Kanban techniques to eliminate the wastes from the inventory. A time study was used to measure the cycle time of all the processes while work measurement was done to categorize the work elements into value added and non-value added activities. Future value stream map was developed to study the effects of the changes included in the production system on the production parameters like machine utilization, daily production and cycle times and then was compared with the current value stream map. The experimental results obtained after comparison of the current and future value stream mapping analysis proved that value stream mapping synergized with Lean principles for optimization of cycle time. Where, for the production of deck roller assembly with around 48% improvement in daily production activities, an average of 30% improvement in the utilization of available machines and the cycle time is improved by more than 1000 s.

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Preparation and Production Control in Smart Factory Model

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Abstract. Implementing the smart factory concept places demands not only for enterprises but also for scientific units. In order to be able to effectively develop solutions in compliance with the Industry 4.0 concept, it is necessary to improve qualifications of scientific personnel and students who are supposed to implement those assumptions in practice. The paper describes the structure of smart factory model, developed at Poznan University of Technology, which enables both learning about such solutions and doing research work in that scope. The model includes issues connected with the field of production management – starting from interpretation of client requirements, to automation of product design development, to preparing and controlling the production process.

Keywords: Industry 4.0 · Smart factory · Production control

1 Introduction

The concept of smart factory, featuring highly automated and flexible production, is currently one of the most basic trends in the development of manufacturing systems [1, 2]. Thanks to solutions such as cyber-physical systems, the Internet of things or Big Data, that idea, also known as Industry 4.0, aims at maximizing production capacity in order to address the changing requirements of clients faster and more effectively [3–5]. However, it is worth to note that the concept of smart factory cannot be implemented merely by data processing and rapid exchange of information. In practice, Industry 4.0 requires systemic solutions as regards production scheduling, monitoring material flow, analysis and decision-making [6]. In this context, smart manufacturing will be possible, if the assumed control methods enable dynamic synchronizing the material and information flow under a flexible manufacturing system [7, 8, 17].

All processes implemented under an smart factory system should be coordinated and interdependent. Therefore, efficient production control is undoubtedly based on smart preparation of client orders for fulfilment [6]. In this respect, the process of designing products according to strict requirements of consumers is very important. Considering flexibility as readiness to fulfil individual requirements of clients, engineers must employ an intelligent approach to designing [9]. That is exactly what KBE-based designing (Knowledge Based Engineering) can be like [10]. Solutions of KBE class contain expert

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knowledge about how, when and what needs to be done, and the knowledge is implemented and processed by a computer system, allowing its easier application in new projects. A formal description of rules applied by design engineers helps process standardization and allows automation of repeatable tasks in the design process, while at the same time enabling quick development of variant designs. Advanced CAx (Computer Aided) systems are used for that purpose, allowing enrichment of geometrical CAD (Computer Aided Design) models with a formal description of engineering knowledge. Thanks to that, the stage of designing new variants of a given product is shortened, as the majority of work can be automatically performed by a computer system, and not human personnel [11].

Solutions facilitating evaluation of one's own ideas and comparing different solutions gain importance in design processes. This is undoubtedly made possible by virtual (and/or augmented) reality techniques [12–14]. The techniques allow design engineers to construct and verify a virtual prototype of product, which makes them one of the most basic components of cyber-physical systems.

Shortening the time of product development and sometimes even its faster manufacturing is currently also supported by fast manufacturing techniques which constitute an indispensable component of smart factory. Prototypes or finished products are manufactured directly from digital 3D models. The duration of the process is significantly shorter than when using conventional manufacturing techniques [15]. Modern additive manufacturing techniques are so advanced that they can be successfully used in developing production tools, significantly supporting conventional manufacturing methods [16].

The complexity of issues in preparing and controlling production, combined with the necessity to integrate modern technological solutions, while lacking some clear methods of joining the same, necessitates development of actual models of manufacturing systems for the purposes of scientific research, in compliance with Industry 4.0 concepts [2]. The paper describes a laboratory model which enables to simulate production management processes in accordance with the smart factory concept.

2 Smart Production System Model

A production system model is made up of the following physical components (Fig. 1):

- automated production line,
- assembly stations,
- additive manufacturing technology station,
- warehouse of raw materials and finished products.

An automated production line is made up of four conveyor loops with manufacturing stations located beside. The loops are equipped with switches that enable redirecting a pallet which carries the product to any other conveyor loop. Each pallet is RFID (Radio-frequency identification)-tagged for the purpose of identification. An RFID reader is installed at each point where the loop direction changes, or before each work station. The line is controlled by a control cabinet equipped with power supply components,

protection circuits, power adapter, PLC (Programmable Logic Controller) and safety system module. A beacon tower is also installed to display the operational status. Two industrial networks have been applied in the system to control the devices: AS-interface and ProfiNet.

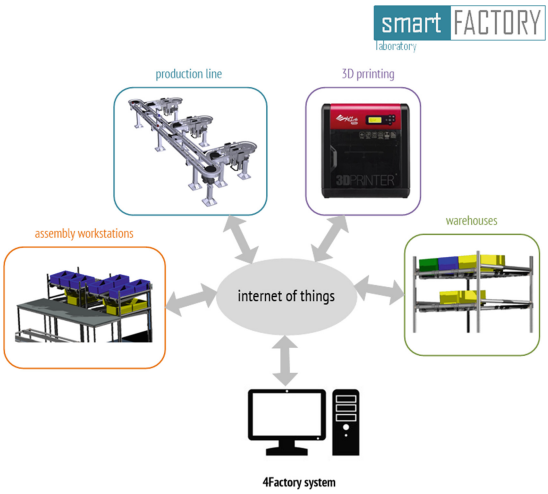

Fig. 1. Structure of the smart factory model

Assembly stations constitute independent organization cells in which subassemblies of finished products are manufactured. Manufacturing stations along the automated production line as well as the assembly stations are equipped with flow-through racks that enable storage of containers with parts and units for assembly. The racks are equipped with RFID readers to identify the transport containers.

The additive manufacturing technology station enables: manufacturing some parts according to individual requirements of clients and providing tools required for implementation of production tasks on the automated line or at the assembly stations.

Warehouses of raw materials and finished products are made of racks with certain areas designated for individual parts and subassemblies used for production. Each location is marked with a unique barcode.

The production system is managed by software called 4Factory. Communication between the system components is maintained through the Internet of things. The 4Factory system is made up of a series of modules featuring functionalities that enable production planning, supervising material flow and production line control. The system modules include:

- resources – information about the production system resources,
- indexes – specification of products and their components (production indexes, procurement indexes),
- orders – information about orders for finished products,
- technology – defining technological processes,

– production planning – tasks related to determining the progress of production orders in the production schedule,
– production control – controlling and analysing the progress of the production flow,
– warehouse – tasks related to turnover of inventory in the warehouses of raw materials and finished products.

Material flow and communication under the production system is controlled on the basis of RFID solutions and the Internet of things concept (Fig. 2).

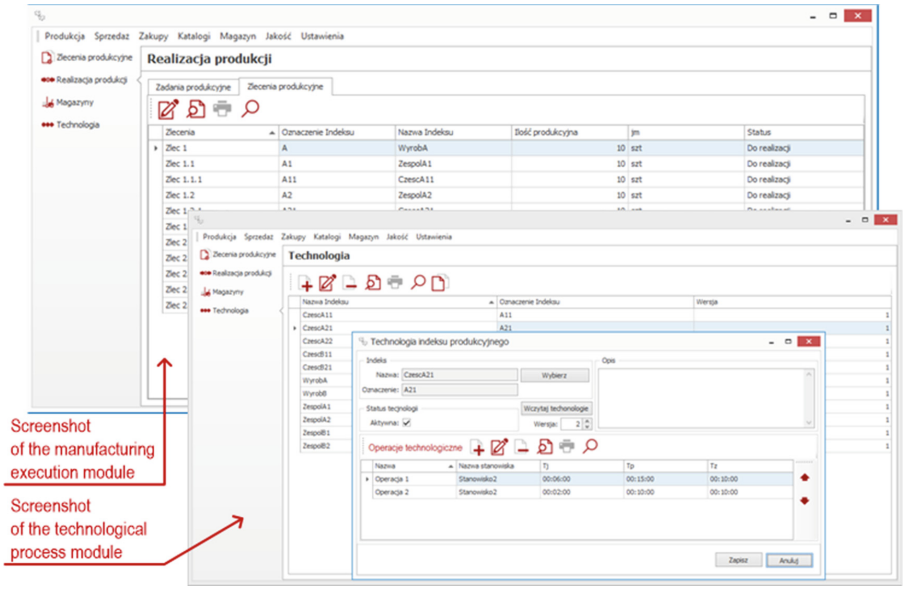

Fig. 2. Examples of screenshots 4Factory system.

3 Order Fulfilment Control System

A production system model enables mirroring the processes connected with fulfilment of client orders in compliance with the smart factory concept.

3.1 Product and Technological Process Designing

To satisfy individual needs of customers at the level of engineering design, technical documentation must be developed for each product variant adopted for manufacturing. A decision was made to combine these issues into a special IT solution (Fig. 3) which eliminates the need for a design engineer to participate in each new order, thanks to development of a KBE-class solution. Configuration of a product (herein represented by a set of bricks which unique connection symbolizes a given variant of the product) is implemented with use of previously developed computer application and intuitive user interface. Unique arrangement of the bricks is saved in form of simple text files

which are then automatically processed in CAD software. There the model is checked by internal algorithms and if a component that has never been used before is detected, it is saved in "stl" format readable for a 3D printer. Next, an adequate program which controls the machine is activated and after that the new element is transported to the production line.

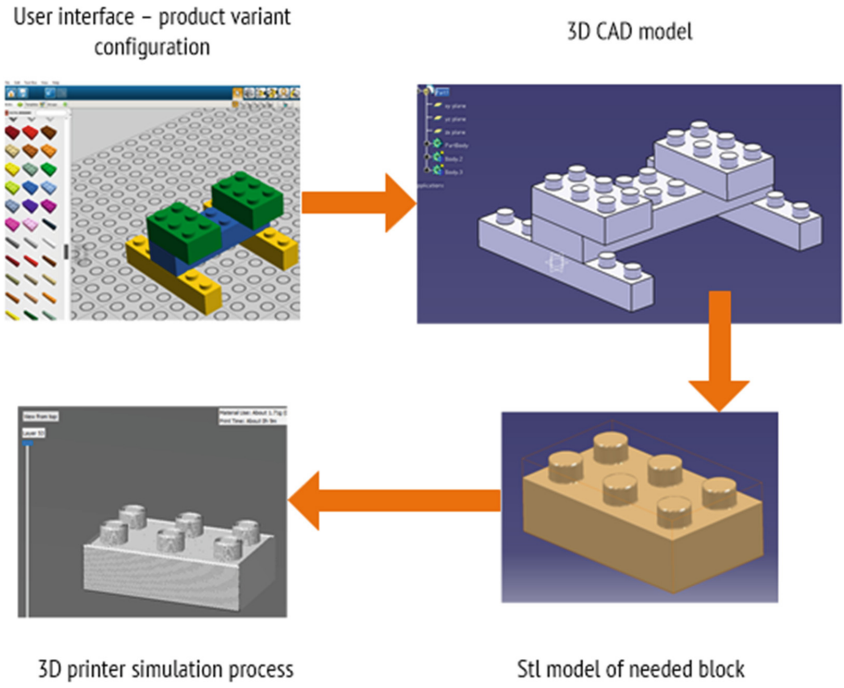

Fig. 3. Steps design variant of the product in the smart factory model

A technological process of manufacturing products and components is generated automatically on the basis of structure and technological capacity of production resources (manufacturing stations). Each manufacturing station on the automated line and each assembly station has its strictly determined technological capacity to implement a specific production task. Due to that the technological process of a product or component can have several variant ways of implementation.

3.2 Production Planning

Production is planned on the basis of information concerning orders and technological processes performed to manufacture given products. The process of production planning includes (Fig. 4):

– the analysis of demand for finished products, based on orders,
– determination of material demand,

– generating production orders on the basis of the determined material demand,
– allocation of production orders – the possibility of selecting a criterion based on which orders are allocated in order to determine the sequence of their fulfilment,
– automatic generation of the production schedule – determining the load of the production system resources resulting from performance of subsequent operations of the technological process on the basis of the assumed criteria and the availability of resources.

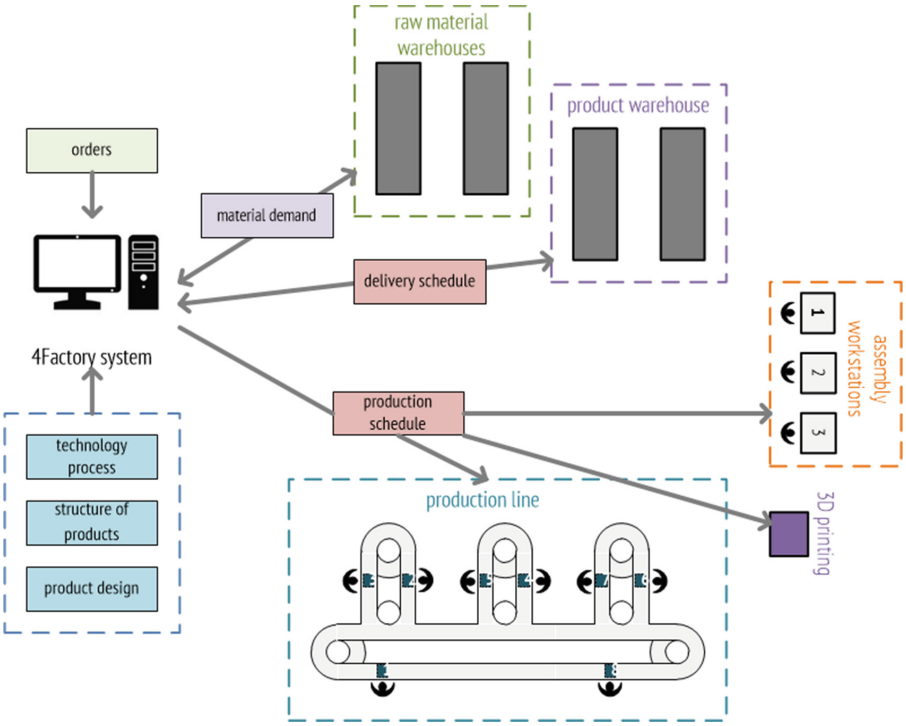

Fig. 4. Production planning of the intelligent factory model

Production planning starts with determination of demand for final products. Based on that a list is drawn up of all the finished products with determined delivery times for which production orders are defined. A production order drawn up for a finished product automatically generates orders for individual parts included in the structure of products. Orders are generated for the following three groups:

– product structure components (parts, subassemblies) which should be manufactured under the company's own production – production orders,
– tools which must be created to implement technological operations,
– materials which must be provided from the warehouse of raw materials – delivery orders.

Production scheduling follows the process of allocating production orders. The purpose of allocating production orders is to determine their sequence pursuant to which the plan of loading the manufacturing stations will be prepared – assigning technological operations to manufacturing stations over time. The process is based on priority rules. Application of the approach enables effective implementation of the scheduling process for manufacturing individual products. Above all, this enables a flexible response to various external (new orders) and internal (change in the availability of resources) factors by selecting various priority rules, while at the same time maintaining short time for implementation of tasks connected with scheduling. The applied priorities apply mostly to date of delivery, defined priority and parameters of production orders.

The defined sequence of production orders is a starting point for drawing up the production schedule. The scheduling process follows the analysis of current load of manufacturing stations (connected with ongoing production) and their system of work. Based on that, a technological operation of duration resulting from the technological process is assigned to a given manufacturing station (load).

3.3 Material Flow Control

Production process control is connected with ongoing implementation of manufacturing processes and it includes the following:

- sending information about production orders included in the production schedule to individual resources of the production system,
- collecting data about the actual implementation of production processes and the status of production resources,
- supervision over the production schedule adopted for implementation, verifying it against the actual production and correcting it, if necessary.

Tasks connected with sending and collecting information in the production system are based on the RFID tags attached to:

- pallets which transport the products along the automated line,
- packages of the internal transport,
- parts and tools created in the rapid prototyping technology,
- packages used for storage of parts and finished products in the warehouse.

A production schedule for automated line is implemented by a PLC that controls operation of the entire line. The data specified in the schedule specify subsequent manufacturing stations for a given transporting pallet, which reflects the technological process of a given product. For individual assembly stations the information from the production schedule is sent to tablets. Additionally, instructions for implementation of production tasks are displayed on them.

Identification of the progress of production processes covers collection of data about implementation of production orders:

- start time and end time of each production task,
- number of workpieces manufactured under the operation,

– number of defective workpieces manufactured under the operation.

Supervision is based on the log of events occurring during implementation of production orders. Based on that a comparative analysis of planned quantities and manufactured quantities is performed, which indicates risks connected with implemented production orders and, consequently, client orders. In the event that some departures from the production schedule are identified, resulting from delays in implementation of the manufacturing process, potential consequences of such events for timeliness in the fulfilment of production orders, and thus client orders, are analysed.

It was assumed that three basic events may occur which may necessitate modifications of the production schedule:

– non-availability of resources – failure at a manufacturing station, lack of personnel,
– lack of material,
– delays in implementing operations of the production process.

As a result of any of the above events, the 4Factory system applies principles and algorithms to introduce corrections in the production scheduling.

4 Conclusions

A factory of the future should be characterized by effective processes which enable satisfying individual requirements of clients. Manufacturing custom products requires analysis of multiple factors as regards production planning and control. Simultaneously, such actions must provide effective utilization of production resources and synchronizing the material flow under the production system. Due to that, an efficient exchange of data connected with, e.g. a structure or technology of manufacturing products, but also those related to coordination of material supplies and cooperation, is an essential requirement for factories to become smart.

The production system model described in the paper contains some basic components of smart factory as far as product design and production control are concerned. The system is managed by the program 4Factory, developed by the authors, which integrates data concerning all the technical utilities. It enables to simulate operation of a manufacturing plant on the basis of solutions that contribute to effective implementation of production processes. The production system is subject to development mostly in the area of further integration and automation of data collection (image recognition) and utilizing augmented reality to supervise production processes.

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Internet of Things for Health

Toward a Smart Health-Care Architecture Using WebRTC and WoT

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Abstract. By coupling the real-time communication capabilities of WebRTC and the advantages brought by the Web of Things (WoT), we introduce the design of a new flexible healthcare architecture, in order to propose divers e-health services. In this ongoing work, we mainly focus on the services related to the remote healthcare of patients and elderly persons. We illustrate the interest of our architecture through the analysis of three main use cases: a remote and continuous monitoring of elderly peoples and a remote medical examination of patients and emergency intervention in case of an accident.

1 Introduction

In the last few decades, with the advances in the networking technologies and database systems, Ambient Assisted Living (AAL) researches have been applied in several domains in order to ensure end-users safety and quality of life (QoL) at home. As a result, several new concepts have been introduced such as personal health management and monitoring, health prevention, healthcare and welfare, in order to provide better medical services, in particular to the persons with special needs such as elderly and disabled persons.

The notion of e-health had emerged, where an enormous amount of health data and valuable medical knowledge have been electronically available and remotely accessible by different entities, specially through the Web. Hence it becomes easier to get, store, disseminate and exploit health information, especially with the improvement in the medical embedded sensors. Currently, the use of those medical Things is significantly increasing since they can continuously and rapidly provide medical information about the patient. Thus, we need an efficient way to manage all of those Things through a WoT/IoT architecture. Moreover, we need to define a way to transmit health data to the dedicated entity (Doctor, Hospital, etc.) in real-time.

In our vision of the e-health, we want to gain better relation between the doctor and the patient, where the doctor can access the medical Things of the patient in order to get a better understanding of the state of the patient.

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Hence we propose a new concept where we benefit both from the advantages of the real-time communication, and the WoT/IoT. For instance, we propose the case of the remote continuous monitoring of disabled or elderly persons, especially in the context of an aging population.

To better understand the problems of this ongoing work, first we need to explain the main technologies that we will use all along this paper in Sect. 2. Then, we will discuss the related works in Sect. 3. Then, we present our new architecture in the Sect. 4, and next we will show how we can use this architecture in a relevant use case of the smart health, in Sect. 5. In Sect. 6, we will demonstrate the implemented part of our ongoing work. Finally, we will discuss the future perspectives of our work.

2 Technologies

In this section, we will first introduce the technology used to establish the communication between the different users of this framework. Then we will introduce the notion of the Web of Things which, will enable us to control and interact with the different smart objects in our system.

2.1 WebRTC

As described in many RFCs, WebRTC overcame the challenge of converging into a single technology two traditionally opposite side of the Web represented by the asynchronous client-server paradigm on one hand, and the domain of the peer-to-peer multimedia and real-time communications on the other hand.Technically, it allows Web-based application (running in a browser) to exploit dedicate native APIs implemented in the browser. They allow the secure exchange of media and data in real time and in a peer-to-peer fashion [1,2]. This technology is still under standardization by IETF and W3C. Currently, many browsers such as Google Chrome or Mozilla Firefox natively support WebRTC technology. It appears to be a very promising technology since it was estimated that it can have more than one billion endpoint in 2013[1]. In addition to the powerful communication capabilities provided by WebRTC, security was considered from the beginning in order to guarantee authentication, confidentiality and integrity in the system.

WebRTC uses mainly three APIs. *MediaStream* is responsible of the access to the Input/Output devices and the creation of the media stream. *RTCPeerConnection* is responsible of the creation of a secure media channel via SRTP (Secure Real-time Transport Protocol); it also encompasses signaling, NAT traversal and other important tasks. Finally *RTCDataChannel* allows the creation of a secure data channel via SCTP (Stream Control Transmission Protocol) encapsulated in DTLS (Datagram Transport Layer Security). One of the advantages of WebRTC compared to the other real-time communication technologies, is that the security have been taken into account from the beginning, by providing a strong security architecture [1,2].

[1] http://io13webrtc.appspot.com/#10.

In addition to the basic functionalities of WebRTC, sending media and data in real-time, we think that we can extend it to a whole new level of innovation. This innovation can be achieved by opening for WebRTC applications a door to the Web of Things.

2.2 Web of Things

The Web of Things (WoT) is a specialization of the Internet of Things (IoT). In one hand, all the complexity of the connectivity part of the smart objects (or Things) is abstracted. In the other hand, the WoT provides a standard application layer based on Web standards to simplify the creation of IoT applications. In the IoT, the one-application one-communication protocol overwhelms, which creates silos of users and which does not present the full potential of the IoT. One of the main interest of using the WoT instead of the IoT is the different advantages it offers. Just to mention, the simplicity of development, the loose coupling, since HTTP is loosely coupled by design, and the openness of the standards. The idea is that all the Things can communicate using a Web language by exposing a REST API. This API can be either present in the Thing itself or in an intermediary that can act on behalf of the Thing to expose the Web API [3]. This has become possible with the improvement of the embedded systems fortunately. Nowadays, we can run tiny servers inside the constrained devices such as lighttpd [4] and Nginx [5].

3 Related Works

The literature provides several examples of Web-based infrastructures aiming at improving the management of patients diseases. Some of them are based on old communication technologies such as in [6–9]. We present below a summary of the main solutions that uses WebRTC.

We will focus on recent solutions some of which use WebRTC. We provide below a comparative analysis of some representative works.

A recent work [10] uses in addition to the audio/video communication part of WebRTC, the DataChannels to exchange medical data between different medical entities. Moreover the patients have access to medical sensors. In [11], the authors propose an e-health platform, providing specific services to the diabetic persons (Type 1 diabetes mellitus (T1DM)). The proposed solution uses medical sensors and a humanoid robot. The robot interacts/dialogs with the patient in order to get better information on his state. All of the data (sensors and dialog) are collected by the robot, and then sent to the health carers. The work of [12] presents an extension to WebRTC to enable peer-to-peer exchange of sensor data, and a proposal to enable Web applications to access sensor data and to bring nearby sensor streams to Web applications and multimedia communication over the Web. They mainly propose to extend the MediaStream API of WebRTC in order to manipulate also the sensor streams and to provide them to the customers. The approach is only theoretical without any implementation.

In [13], the authors present a video conferencing system allowing online meetings between remotely located care coordinators and patients at their homes. They use a special device (TeleMedCare) to monitor the vital sign of the patients. In this work, there is no interaction with medical sensors apart from the TeleMedCare.

4 General Architecture

To develop the full potential of WebRTC, we propose innovative usages, which helps to extend its limits. It consists in adding new functionalities to control, manage and send data from/into the Things available in the WebRTC endpoint surroundings. We want indeed during a WebRTC multimedia session to be able to access the Things and to send data to the other side of the communication in real-time. This enables us to create new opportunities, since in this case, we consider that each WebRTC endpoint is a gateway to his own Things. Moreover, we can delegate the access to other persons for instance the remote person with whom we are talking. We think also that the security and the privacy aspects are very important, so we will dedicate particular interests in the problems that can occur inside our architecture.

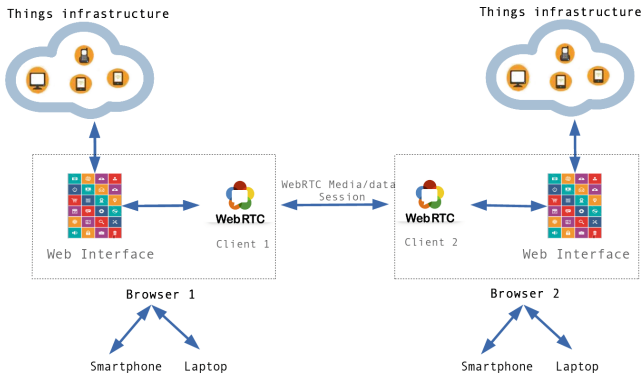

Fig. 1. Proposed architecture

A simplified view of the architecture of our platform is shown in Fig. 1. Using a WebRTC compatible browser, a user can, in one hand, communicate in real-time, and in the other hand, access his Things. Accordingly to our WoT approach, the client application should both take care of the communication and the access to the Things. We suppose that each Thing is identified using a URI and offers a Web API which allows us to access the Things resources. The Things are located in the private network of each user (his home, office, ...).

We can use this architecture in e-health, as shown in Fig. 2, where the users can be the patient/elderly/injured person in one endpoint of the WebRTC

session, and the remote medical support, such as doctor/medical relief center/hospital, in the other endpoint. The Things represent the different medical embedded devices. Finally, we have the different stakeholders that can interact directly with the patient/elderly such as nurses, paramedics, ... They also have the authorization to access the personal medical devices of the person.

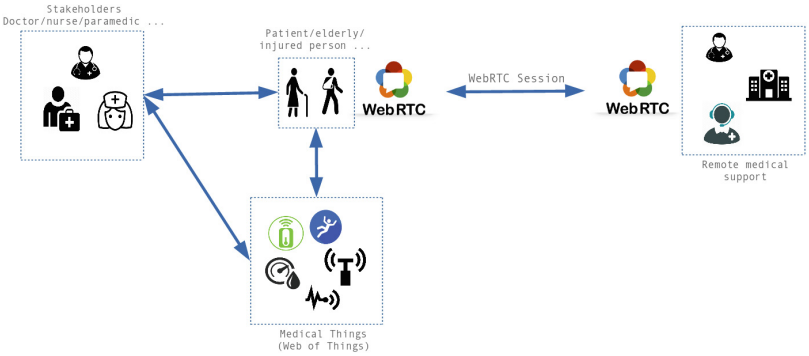

Fig. 2. Adapted architecture for e-health scenarios

5 e-Health Scenarios

To gain a better understanding of the idea behind this proposed architecture, we will illustrate it with a set of scenarios applicable in the field of the smart health (or e-health).

5.1 Continuous Monitoring

The first use case is for continuous monitoring of a patient or an older person. In this case, wearable devices (such as a falling sensor, pressure sensor, peacemaker, ...) are continually monitoring the state of the patient. In case of abnormal behavior (falling, heart problem, ...), an alert is sent to the emergency relief center or to a doctor using WebRTC. In this case, we suppose that the WebRTC session is either always set on or established urgently, as shown in Fig. 3. We can also imagine the **mobility** use case, where we continuously

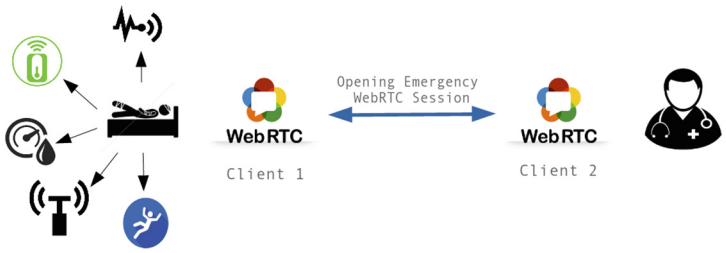

Fig. 3. Continuous monitoring of a falling

monitor the health status of a mobile patient. The patient is wearing embedded devices that continuously send health information to the medical center. This can be very useful to be able to detect abnormality in the comportment of the patient and to quickly provide medical help in the extreme case. We can also try to detect early syndromes of the most known diseases such as early detection of diabetes, AIDS, Alzheimer ...

5.2 Remote Medical Consultation

The case of a remote consultation with a doctor can be applied to disabled persons or old persons that cannot visit a doctor. We suppose in this case that, the patient has access to a set of medical devices. So, the patient starts a multimedia conversation with his remote personal doctor. At a certain stage, the doctor wants to know some health information about the patient. The patient puts on the wearable devices, accessible through the platform, and then sends the information received from those devices to the doctor. With this information, the doctor with his monitoring window showing all the information in real-time, can give advices or prescription, as shown in Fig. 4. We can also have an emergency relief center (ERC), instead of a doctor. In this case, the self quantifying sensors of the patient, and the medical sensors prescribed by a doctor, do not have to transmit their data permanently to a medical center. This alleviates the deployment constraints regarding availability of the network and legal constraints regarding the storage of private data. The patient remains master of his data produced by the different sensors and decides when and with whom they can be shared.

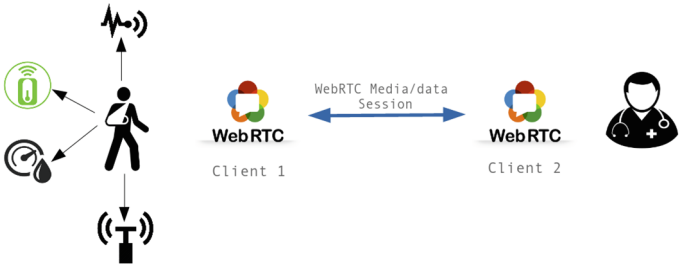

Fig. 4. General case

5.3 Emergency Intervention in Case of an Accident

The last use case is the one of an accident, as shown in Fig. 5. Once a paramedic arrives to the place of the accident, to help the injured person. First she/he will attach all the available wearable medical devices to the body of the person. We suppose that the paramedic had already an equipment that speaks WebRTC

with a doctor or with an ERC that implements our architecture (capable of accessing smart objects in this case we consider the case of medical wearable smart objects). Then, the paramedic starts a communication with the remote ERC/ doctor, and at the same time the wearable objects will start sending vital information in real-time to the ERC, using WebRTC Datachannel. The paramedic will at the same time apply first aides to the person in the simple case, and in case of serious injuries the ERC/doctor can give real-time instructions, while transporting the patient. Moreover, the ERC can also contact the different hospitals to see availability for receiving the injured person and to start preparing a room for surgery, if the person needs emergency intervention.

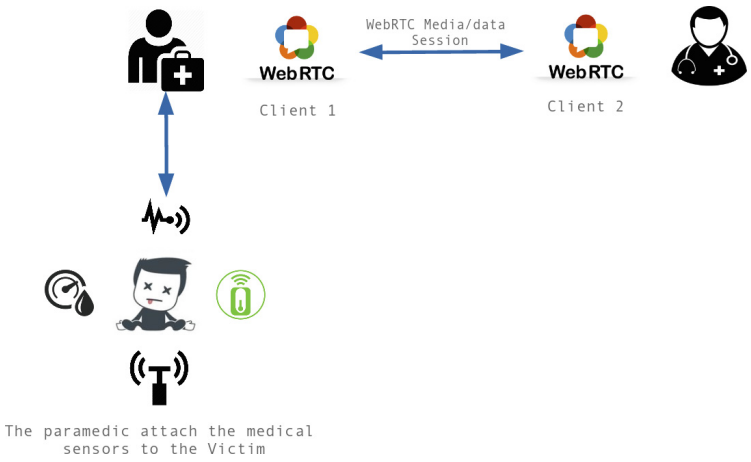

Fig. 5. Emergency intervention in case of an accident

6 Implementation

Currently, we implemented a platform using Node. js. This platform can in one hand, establish a multimedia communication between two users just using their browsers. On the other hand, it enables users to access a set of predefined Things in his possession. Each user can then retrieve data from the different Things and send them to the remote user in real-time using WebRTC Datachannel. The Fig. 6 shows that a user can access an accelerometer and an ultrasound sensor. Such an approach can be nearly extended to all kinds of Things.

The first part of the architecture is WebRTC, it is composed of two clients, a signaling server and an Identity Provider (IdP). First the client gets the WebRTC JavaScript application from the server, and execute it inside the sandbox of the browser. Then, the signaling process where the user reaches/contacts the remote part of the communication. Finally, with all the exchanged parameters,

a WebRTC media/data channel can be set. As for the IdP part, it provides the users with an identity (after a valid authentication on the IdP side), so that they can authenticate themselves to the other side of the communication.

The second part is the WoT part. Each endpoint is considered as a gateway to his set of Things. Also, each user has a control on those Things and only his can access the respective Things. In our case, the user communicate with the less constrained Things using HTTP, and using HTTP with an intermediary in case of constrained Things. The intermediary can then communicate with the constrained Things using one of the well known communication protocols (Zigbee, Bluetooth, WIFI ...). In our current platform, we have an accelerometer (ADXL335) attached to a Raspberry Pi 2, and an ultrasound (HC-SR04) attached to an Arduino UNO, which send data to another Raspberry using WIFI adapted to the Arduino. The Raspberry used in our architecture is a Model B with ARMv6 single core, 700 MHz and 512 MB SDRAM. In this case, the Web API is implemented in the Raspberry and each Thing is identified by using a URI. Each user has access to an accelerometer and to an ultrasound sensor.

In the case of the e-health scenarios, all we need to have are wearable medical Things. They can communicate with any protocol, since the WoT abstracts all the complexity of the connectivity of the Things.

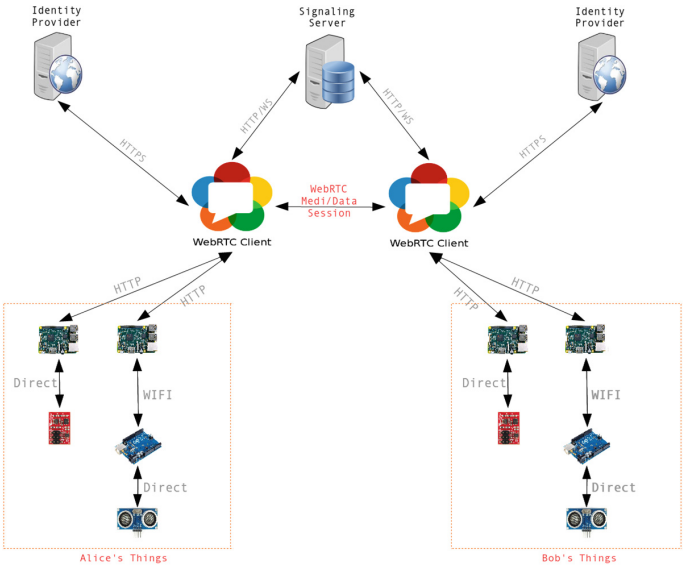

Fig. 6. Current implementation of the platform

Using the current state of the architecture, an implementation of the remote consultation use case is possible, where a doctor is communicating with a patient using WebRTC. The patient has access to a set of Things. Then, the patient can send these information to the doctor in real-time using WebRTC's Datachannel.

Finally, the doctor can monitor the received data and provide a prescription to the patient (this prescription can also be sent to the patient using WebRTC).

7 Conclusion and Perspectives

The following paper present an ongoing work for the creation of an e-health framework specially conceived for remote examination of patients and injured persons in case of accidents. Though the different use cases, we demonstrated the advantages that can be brought by such framework, such as better and more efficient interaction with the medical entities, the continuous monitoring of the patients, the remote healthcare services and so on and so fourth. Finally we presented our current implementation of this framework. We also analyzed other use cases mainly related to the emergency intervention in case of an accident, and in the case of the mobility of the patient outside his habitual system (home, hospital, ...). However, due to the lack of space, we couldn't include them in this paper.

The next step of our work is to investigate of all the security and privacy aspects of this platform. Currently, the communication between the WebRTC clients and the different Things is not secured yet. We need first to evaluate the main WoT security mechanisms existing today. CoAP/DTLS [14] seems an interesting candidate to secure the communication with the different Things. The second aspect is the access control. Only the authorized persons should access the Things. We identified several possible solutions to control the access such as RBAC [15] and ACL [16]. The delegation of the access which opens interesting use cases, can be tackled with OAuth 2.0 [17]. However, in term of performance, OAuth is not very lightweight, so we consider this solution in the case of the use of a gateway. We are also interested to analyze the introduction of the notion of the profile of the patient [18] (the persons profile can include medical record, chronicle diseases, ...). Depending on this profile, the framework will use a defined set of medical devices to monitor the physiological status of the patient. This can be interesting in case where the patient is in a hospital, the nurse can install the wearable medical devices on the body of the patient, and according his profile, the corresponding Things will transmit the medical data to the framework. This includes also, managing the transmission frequency of the different medical devices in a given environment (smart-house, smart-hospital, smart-city ...), depending on its importance/priority [19], in order to optimize our system and to have better and secure management of the data. This priority can be accorded depending on the profile of the patient. We think that this approach can open the door to the development of new healthcare ecosystems that combine the communication technologies, the WoT/IoT and the medical expertises of the different medical entities, in order to provide quicker, better and more efficient medical intervention to the persons in needs.

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ICT Solutions with Unmanned Aircraft Vehicles

3D Localization System for an Unmanned Mini Quadcopter Based on Smart Indoor Wi-Fi Antennas

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Abstract. Technology has created a new world of smart mobility with the objective of satisfying human needs with more functionality. This research work is about how to create a 3D localization system using the Angle of Arrival (AoA) technique, combined with Wi-Fi technology and motorized directional antennas. Our objective is to locate an unmanned aerial vehicle (UAV) that is driven with the help of a smart network of directional antennas. The mini UAV will automatically follow a planned route around an object, using Wi-Fi smart techniques. Our results show that a network of smart antennas can be used to locate a UAV with high precision.

Keywords: Localization system · UAV · Wi-Fi · Smart antennas · Indoor and outdoor environments

1 Introduction

Nowadays, similarly to the past years, technology has been able to show us a continuous increase of the required information that is key to different services that the global market demands. Starting in the year 2000, some scientists focus their vision in location services, which means that each object should be conscious of its location and may be regularly sending the data to a server which stores the useful information [1]. Nowadays, technology has evolved per the human needs, such as real time location, sensors and other embedded controllers that can transform everyday objects into smart objects so that they can act according to the environment [2].

Wireless Sensor Networks (WSNs) compose numerous devices associated in different areas [1, 3], allowing the control of the communication, velocity, temperature, sound and movement. These conditions have developed different systems and one example of this is the Global Positioning System (GPS), which is a localization system that provides both information of the location and time in different weather conditions [4]. GPS is a system completely based on satellites which brings its functionalities to both indoors and

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outdoors environments [5]. However, this system doesn't work as expected with the so called ubiquitous devices since they show some problems regarding interiors and urban infrastructures. The limitation of the GPS on enclosed spaces, dense forests, mountains, and other obstacles that block the line of sight doesn't allow it to work precisely, which generates a positioning error around 10 meters [3]. Solutions to this problem have come in the form of alternative systems such as the IEEE 802.11 technology [6], used in wireless communications. One of those are the smart antennas that work with Wi-Fi. These contain multiple components that receive signals that are combined in a smart way to improve the performance of the wireless system [7]. Besides increasing the range of the signal and suppressing signal interferences [8], they are used with unmanned aerial vehicles that are able to connect between them or to a base station (BS) [9].

In this context, and with the objective of guaranteeing that the development of the technology has been in benefit of indoor positioning, the navigation is detailed and shown through means of maps and models, including information of objects, people and different spaces. As such, for example, the recent developments in technology are inertial sensors like accelerometers and gyroscopes that can be found in mobile devices. This technology combines with the way images are captured with cameras, intensity of the magnetic field, detected signals or infrared images. However, the development and investigation of different navigation systems have been focused in the lowest possible error of positioning and object precision [10].

The investigation hypothesis of the present study is the distribution of smart antennas that provide a localization system for an unmanned mini quadcopter, which requires the existence of a mathematical evaluation and assesses the erroneous distance regarding the real position. The basic questions that allow the guidance of this investigation are: What technology is viable for aerial localization with the purpose of locating unmanned mini aerial vehicles? And what is the most efficient localization method to obtain the minimum distance error regarding the real scenario?

Therefore, the objective of this work is to create a UAV localization system through the means of smart motorized antennas. Our UAV follows a planned route around an object and takes some photos that are then used to create a 3D model of the object based on a 3D scanner application.

The next sections of this paper are organized in the following way. The technologies used are exposed in Sect. 2. Section 3 describes the theoretical frame in which the UAVs localization system is based. Section 4 presents some experimental results. And finally, the Sect. 5 finishes with some conclusions.

2 Implemented Technologies

This section describes the technologies that have been used to implement the described solution. All electronic devices used in this system are affordable and available to the general user.

One of the devices is a mini drone which is a UAV that can be controlled remotely and has very small dimensions compared to the more usual UAVs. It has a camera and the ability to take photos so that a 3D model can be built from those pictures. In this

implementation, the model Cheerson CX-10W has been used. It is controlled via Wi-Fi through a mobile application and has a 0.3 MP camera with a resolution of 720 × 576 pixels. It can also send a video stream to a smartphone application [11].

An ESP8266 Wi-Fi module is capable of receiving and transmitting data in a wireless fashion, as well as detecting the power of the signals transmitted by other antennas. In this project, two distinct models have been used: the ESP8266-01 and the ESP8266-12. These modules can be programmed using the Arduino Integrated Development Environment (IDE) and offer a set of General Purpose Input/Output (GPIO) pins to control external components [12].

The ESP8266-12 is used to sense the signal transmitted by the drone while the ESP8266-01 is used to send that information to a computer. When data is received, it is sent to the other module through a serial connection and then sent to the computer wirelessly. The reason for using two distinct ESP8266, per Wi-fi antenna, was to perform two Wi-Fi connections simultaneously. One to the Drone CX-10W and another to a router, without loss of efficiency.

Servo motors are types of motors that allow their rotations to be controlled with high precision. Both Direct Current (DC) and Alternate Current (AC) exist [13]. In this project, servo motors have been used to rotate the antenna so that it can sweep a given area and sense automatically the Wi-Fi signal from multiple angles. In this project, some SG90 model DC motors have been used. This model is ideal due to its size, price, and performance. This servo motor executes a controlled rotation of a Yagi antenna so that precise angle is known when the maximum Received Signal Strength Indication (RSSI) is measured.

Yagi antennas are directional antennas that are composed of multiple rods fixed on a mast. They consist on a driven dipole, a reflector dipole and one or more director dipoles. The dipoles are mounted in the same plane, attached to the mast. This setup gives Radio Frequency (RF) signals a directional boost. They are used in the field of communication and greatly used both in the military sector and by civilians [14].

In this project a Yagi antenna has been used with a receiver to identify the position at which the best Wi-Fi signal can be acquired. By rotating the antenna around a fixed point and calculating the angle at which the best signal is found give us a general idea of the direction of the Wi-Fi source (our Wi-Fi mini drone). A low-cost 3D printed Yagi antenna was used for our project based on the model [15].

The list of all required components is as follow: 1 *Drone:* Cheerson CX-10W, 1 *Receiver:* ESP8266 ESP-12 Evaluation Board, 1 *Emitter:* ESP8266-01, 1 *Router: ADB 4000N, 1 Laptop Dell Inspiron 15, 1 3D printed Yagi Antenna.*

3 System Design

This section describes the design and implementation of the system to locate UAVs through smart antennas used in indoor environments. The Fig. 1(a) shows the system architecture that has been implemented. There are four main components: a centralized computer for control, a router with Wi-Fi, a drone with Wi-Fi and a set of sensing points (directional Wi-Fi antennas with servo motors). The drone is the base component of the

whole setup. It distributes a Wi-Fi signal to which the sensing points should be connected. Each sensing point is comprised of two components: a Receiver (ESP-12) and an Emitter (ESP-01). These two components are wired through a serial connection as shown in Fig. 1(b).

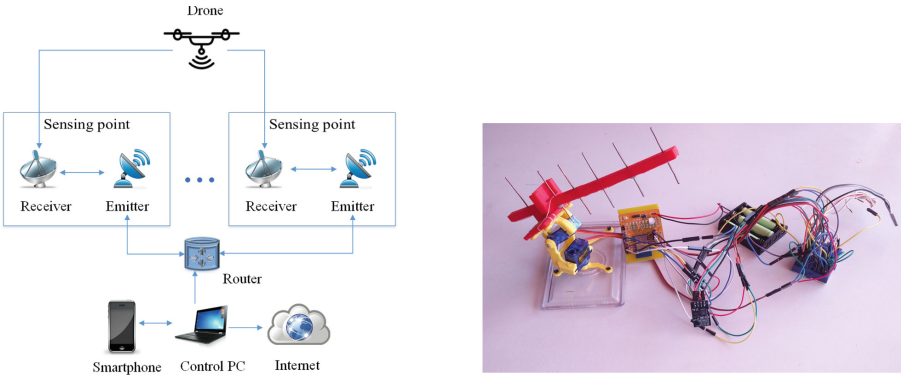

Fig. 1. (a) System architecture. (b) 3D printed robotic arm with Yagi antenna.

The Receiver is responsible for sensing the signal of the wireless network distributed by the Drone CX-10W, reading its RSSI and sending it to the Emitter. The Emitter is connected to a central router via Wi-Fi, which groups all sensing points and the control computer. This allows for an easier management and reduces the number of required connections on the computer. When an Emitter receives data from the Receiver (via serial communication), these data are immediately sent to the control computer (via Wi-Fi communication), which manages the whole operation. The computer is responsible for starting the process, receiving and processing the data, and showing the information to the user.

On the computer, the process is managed by a graphical Java application which uses the Google Maps Application Programming Interface (API) [16] to allow the user to indicate the positions and Internet Protocol (IP) addresses of the sensing points and, therefore, requires an Internet connection to show the maps. Our application also requires a smartphone to be connected so that it can take photos from the drone's camera and send them back since the video stream cannot be directly extracted from the Drone CX-10W. This smartphone communication is performed through the computer's Universal Serial Bus (USB) port.

Smart antennas based localization is performed using the AoA technique [17]. This is a method that uses the direction of the antennas to calculate the position of a station, which is in this case the UAV. To find the location, the antennas measure the RSSI and calculate the angle at which the maximum value is found. With this information, a line can be traced between the antenna and the station. By grouping at least one more antenna it is possible to find the intersection of two of those lines which should indicate the position of the station.

Assuming that there are two antennas A and B with coordinates (a_x, a_y) and (b_x, b_y), and angles θ_A and θ_B respectively and that P is the calculated intersection point with coordinates (p_x, p_y), its position can be found using the following system of equations:

$$P_x = \frac{a_x \times \tan\theta_A - b_x \times \tan\theta_B + b_y - a_y}{\tan\theta_A - \tan\theta_B}. \tag{1}$$

$$P_y = \frac{(a_x - b_x) \times \tan\theta_A \times \tan\theta_B + b_y \times \tan\theta_A - a_y \times \tan\theta_B}{\tan\theta_A - \tan\theta_B}. \tag{2}$$

Multiple intersections can be found and in this project, an average aggregation method was used [17]. With this method, assuming that we have a set of N intersection points represented by a pair of coordinates (x_i, y_i), where $i = 1, 2, \ldots, N$, the average point (x, y) of all intersections can be found using the following equations:

$$x = \sum_{i=1}^{N} x_j / N. \tag{3}$$

$$y = \sum_{i=1}^{N} y_j / N. \tag{4}$$

The average point indicated by (3) and (4) will estimate the location of the UAV. Once this point is obtained, a graph that shows the flight path of the drone is updated with the new position and its flight is adjusted to perform a new route accordingly.

4 Experimental Evaluation

This section describes how the test scenario was set up to assess the stability and viability of the system and provides a resume of our analysis and our measurements.

The tests were executed in an indoor scenario so that it is possible to have an idea of the impact of the multiple obstacles (walls, pillars, etc.) found inside buildings when compared to an open environment. Whenever it is possible, we should always minimize any factors that may cause random deviations in the measurements.

We started our measurements using a short space to drive autonomously our mini drone. A space of 3 × 3 meters was defined as a Cartesian plane. The plane had a reference point that marked the origin of two perpendicular X and Y axis. This helped the positioning calculations of our sensing points relatively to each other and also the measurements since a reference point is used.

In our indoor scenario, for each setup, three distinct sensing points were used. Since only one antenna was available in the preliminary stage, it was necessary to take the measures one at a time for different sensing positions. However, the position calculations were made as if three sensing points were used. Even though only one point was measured at a time, we can clearly see that it's is practically possible to use our configuration. In each setup, a set of ten samples was collected by rotating the sensing points around

the drone, positioned on the coordinates (1.5, 1.5), while always keeping their relative positions. Figure 2 shows how the scenario was set up. Each sensing point was rotated 10 times in steps of 10° in a counter clockwise way around the drone. In each position, the sensing point with two servo motors and a Wi-Fi antenna performed a horizontal sweep and reported the data.

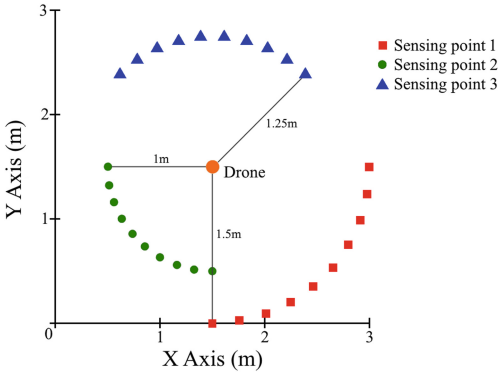

Fig. 2. Indoor measurements

In each position, the best Wi-Fi signal of all sensing points was measured. One of the two servo motors performed steps of one degree at a time, starting at the 20° and finishing on the 160° position, reading the RSSI with every step. This means that the antenna made a large sweep of 140°. When the sensing point was moved 10° around the drone, its pointing angles also rotated 10° in a counter-clockwise way (with the antennas pointed to the central position of the drone).

Table 1. Indoors test results

Test	Position	Distance (cm)
1	(1.17, 1.66)	0.37
2	N/A	N/A
3	(1.31, 1.45)	0.20
4	(1.32, 1.46)	0.18
5	N/A	N/A
6	N/A	N/A
7	(1.37, 1.49)	0.13
8	(1.64, 1.63)	0.20
9	(1.57, 1.52)	0.08
10	(1.75, 1.45)	0.25

In our indoor scenario, the results were quite positive. We obtained a maximum positioning error of approximately 37 cm with 7 valid measurements. The average Euclidean distance of all estimated points to the drone was approximately 20 cm. The distance between the centroid point of all measurements and the real position of the

drone was only 5.7 cm. However, in the set of ten measurements, it was not possible to calculate the coordinates of the drone in three positions, as presented in Table 1. This may be caused by multiple factors that cannot be controlled. For example, the presence of other wireless networks can interfere or the reflected signals can cause multipath interferences. This may result in some inaccurate results [18].

5 Conclusion

A 3D location system for UAVs was developed through a physical disposition of smart Wi-Fi antennas. The used technologies are small Yagi antennas that emit and receive electromagnetic waves in the direction of a Wi-Fi UAV. In our project, these antennas are used to read the signal and the angle of arrival of a Wi-Fi UAV. With these data, we can estimate the position of our mini UAV using an aggregation method. Our real indoor scenario measurements show us that the distance between the centroid point of all measurements and the real position of the drone was only 5.7 cm.

For future work, the usability of the system must be assessed in a 3D environment. The system is ready to support it by using both the vertical and horizontal antennas in each sensing point. Measurements must also be made regarding the time taken to read the data and verifying if it's reliable when controlling the UAV in real time.

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3D Scanner Based on an Autonomous Wi-Fi Unmanned Mini Quadcopter

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Abstract. This research is about how to create 3D model objects using an autonomous unmanned aerial vehicle (UAV). Our system is composed by a small drone that has Wi-Fi, a mini camera, and it can be controlled remotely by a smartphone. A smart network of Wi-Fi access points with directional and remote controlled antennas are utilized to determine the location of the mini drone, using the Angle of Arrival (AoA) method. By estimating its position, our mini UAV is able to follow automatically a planned route around an object. During its trajectory, our UAV takes automatically some photos that can be used to generate a 3D model using appropriate software.

Keywords: Localization system · UAV · Wi-Fi · Smart antennas · 3D scanner

1 Introduction

With the increase of the population, there has been an increase in the demand of information regarding both inside and outside spaces through means of devices that rely on easy to use high end technology. One of such cases is the use of unmanned aerial vehicles (UAV) that work in an autonomous fashion in dynamic and complex environments. These conditions are a fundamental part in the planning of some applications, both civil and military, in which the localization of objects that are found around critical infrastructures is a priority [1, 2].

UAVs are characterized by their impressive speed associated with the capacity of being remotely controlled in dangerous zones. This type of vehicles have received an increasing interest from scientific research centers since they are used as low cost testbeds for robotic studies [3]. Just like the investigations [4–7] mention, relevant challenges are mainly involved with the aerial communication system. However, some other drawbacks are the physical obstacles, the loss of quality of the connections with the increase of the communication distances, the electronic limitations, the load weight, and

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battery life of the UAVs. Currently, the scientific community has deeply focused in the progress of aerial localization.

The objective of this work is to create an affordable UAV localization system through the means of smart Wi-Fi directional antennas. Our UAV is able to follow a planned route around an object and take some photos that are then used to create a 3D model of this object based on a 3D scanner application. The validation of our solution shows that it is a viable alternative to the costly traditional localization methods [4].

The rest of the article has been organized in the following way. The used technologies are exposed in Sect. 2. Section 3 describes the theoretical model in which the UAVs localization system is based. Section 4 details the development of the software and the experimental design. In Sect. 4 some results are presented. Finally, Sect. 5 presents the conclusions and future work.

2 Implemented Technologies

UAVs, also known as drones, are remote controlled vehicles. This project will use a mini drone model Cheerson CX-10 W (Fig. 1) of small dimensions with a camera with a resolution of 720 × 576 pixels and the ability to stream video and take photos with it. This drone distributes a Wi-Fi network and can be managed through a mobile application [8, 9]. From the photos taken by it, a 3D model can be generated. Figure 2 shows an example of a 3D model generated from real photos using Autodesk ReMake [10].

Fig. 1. Drone CX-10 W for the 3D scanner [8]

Fig. 2. 3D Model-ReMake [10]

The ESP8266 Wi-Fi module allows the reception and transmission of data wirelessly as well as the detection of signals transmitted by other networks. In this case, two modules have been used to perform different tasks [11]. Firstly, a model ESP8266-12E has been used to detect the signal transmitted by the drone. Secondly, a model ESP8266-01 transmits the data acquired to a central computer wirelessly. These modules are placed in Yagi antennas which are generally used in the field of radio frequency (RF) communications [12].

In this project, 3D printed Yagi antennas were used based on the model [13] which is used to increase the reception capacities of the ESP8266-12E when reading the Wi-Fi signal of the drone and to identify its position. The antenna rotates around a point with the help of servo motors (model SG90) and performs a sweep on a given area [14], detecting and calculating the angle at which the best signal is detected. With this information, the location of the drone can be calculated using the AoA technique.

In order to generate a 3D model, the UAV takes photos of the object and passes those pictures through a software designed for this specific task. Multiple services were tested and analyzed and the chosen solution was Autodesk ReMake [10]. The model is generated by selecting a set of images that are then sent to the cloud where the whole process happens [10]. When the generation finishes, the 3D model is then sent back to the user. From all the tested services, this was the one that provided the most accurate results and had the fastest process.

3 Design and Implementation

This chapter describes the technical design and implementation of the system. It was built to make it as autonomous as possible, while reducing the number of involved components and complexity.

3.1 System Design: Wi-Fi Localization and 3D Scanner

The Fig. 3(a) shows the architecture of our 3D localization system. It is composed by four main components: a centralized computer for control, a router with Wi-Fi, a drone with Wi-Fi and a set of sensing points (directional Wi-Fi antennas with servo motors). Each sensing point is comprised of two components: a Receiver (ESP-12E) and an Emitter (ESP-1). These two components are wired through a serial connection. This setup allows the guidance of the UAV through a predefined path around an object. The sensing points are responsible for locating the drone. This is done by having the Receivers connect to the network distributed by it and reading its Received Signal Strength Indication (RSSI) as they sweep the area. It also calculates the position at which the maximum RSSI is found. This information is then sent to the Emitter which redirects the data to the control computer through a Wi-Fi link.

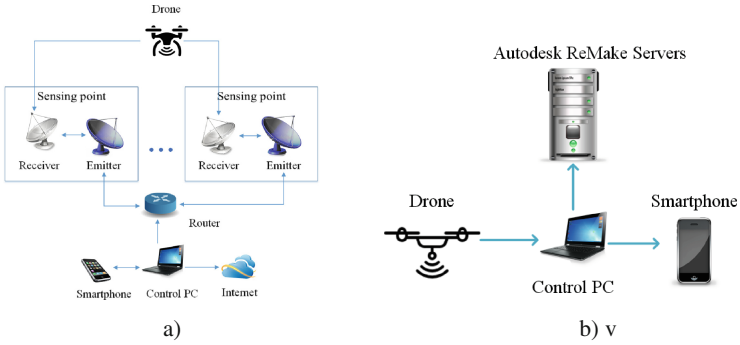

Fig. 3. Smart Wi-Fi localization system. (a) System architecture. (b) 3D scanner architecture.

The whole process is managed in the central computer by a graphical Java application. Through this application, the user can define a set of waypoints, as well as their height, that define the route of the drone, the positions in which it should take photos, and the positions of the antennas and their Internet Protocol (IP) addresses. Here, the user can also select to which network the sensing points should connect since different UAVs have distinct Service Set Identifiers (SSIDs) for their networks.

The 3D scanner, of Fig. 3(b), refers to the whole process of generating a 3D model file of a physical object photographed by the drone. There are four components involved in this process: a UAV, a computer, a smartphone and the photogrammetry service [15]. The Fig. 3(b) shows the architecture for this part of the system. A computer controls the whole process and it must be connected to the drone, so that it can control it, and must also be connected to a smartphone through a Universal Serial Bus (USB) port so that it can receive the photos. The use of the smartphone is necessary because there is no documentation about the video transmission protocol used by the Drone Cheerson CX-10 W and reverse engineering yielded no positive results. As such, a simple Android application was developed to handle this process automatically which integrates directly with the mobile application used to fly this drone. With this, it is possible to send commands from the computer to the smartphone to let it know that a photo must be taken. The connection between these two components is performed using the Android Debug Bridge (ADB).

Since Autodesk ReMake is used, the computer must have the software installed and it must be connected to the Internet. The generation process requires user interaction since the photos must be selected and the operation started manually. The images are then sent to the 3D service where they are processed [10]. When the process finishes, the 3D model is sent back to computer and it is ready to use.

3.2 Implementation

Given the complexity of the developed solution, multiple components where involved in its implementation. Starting on the sensing points, they require the use of two Wi-Fi ESP8266 modules interconnected through a serial connection. Each module is

responsible for a different task and must communicate between them. To guarantee that data is transmitted correctly and that they are aware of each other, a simple communication protocol was defined for this communication.

Starting by the Emitter, it is responsible for sending the data back to the computer and therefore, it must also have a Wi-Fi connection to it. Figure 4(a) shows the flowchart of its operation. It starts by opening the serial connection to the Receiver, connecting automatically to the router and creating a User Datagram Protocol (UDP) server connection on port 80. It then waits for a client to send a packet and reads it. This packet contains the information about the network to which the Emitter should connect to. The data sent to the Emitter should have: *(1) A string "OK"; (2) The length of the string of the network name. (3) A string with the network name.* The text "OK" helps the Receiver detect when important information is coming from the serial connection, since the antenna module can send other information that is not controlled. Then, it sends the length of the network name in a single byte to tell how many bytes will be read next and after that, it sends the name of the network as a stream of bytes. Afterwards, the Emitter module enters in a loop waiting for data to come from the Receiver to then send it as UDP packets to the connected client.

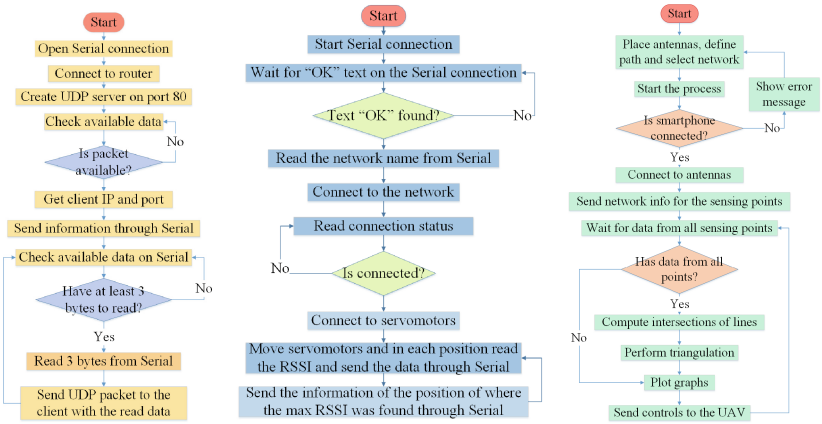

Fig. 4. Algorithms. (a) Emitter operations flowchart. (b) Receiver operations flowchart. (c) Application flowchart.

The Receiver is responsible for acquiring the Wi-Fi signal of the UAV and send it to the Emitter. To do that, it needs to know which network to connect. The Fig. 4(b) shows a flowchart of how the Receiver operates. When the antenna module boots, it first opens the serial connection to the Emitter and then listens to incoming data. It then enters in a loop until the text "OK" is found. Then, it reads the next byte which specifies the number of bytes to obtain next and reads that amount of bytes. This information forms the SSID of the Wi-Fi network. After receiving this information, the module makes the connection to it. This ESP8266 module enters in a loop until the connection is successful and, once connected, it moves the servo motors, both horizontally and

vertically, and read the RSSI for each position while saving the maximum value found and the respective position. This data is then sent to the Emitter through the serial connection.

The whole operation is controlled by a graphical Java application developed using the Google Maps Application Programming Interface (API) [16]. Its process is described in Fig. 4(c). The user starts by defining the route for the UAV and the positions of the antennas, as well as their IP addresses and angles. After that, the user chooses the network to which the Receivers should connect and then starts the process. Once started, the application will try to connect to an Android smartphone and then, it connects to the ESP8266 modules and sends the network name information to each one of them. After performing all connections, the application waits for data from all sensing points and draws graphs with all the measurements that were made. When receiving the data from the sensing points, the position of the drone is estimated using the AoA technique. Based on the calculated position, its flight is adjusted. When the UAV reaches a position where it should take a photo, a command is sent to the smartphone. The photo is taken and then sent back to the computer. When the whole process finishes, the photos are then used to generate the 3D model.

4 Experimental Evaluation

To assess the quality of the developed solution, indoors tests were performed to have an understanding of the impacts caused by the multiple obstacles that are usually found inside buildings. A set of tests were performed on a small space of 3×3 meters forming a Cartesian plane which was used to manage the drone autonomously. Despite the indoors conditions, we found that the drone positioning estimations are clearly acceptable. The maximum estimation error is approximately 37 cm to the real location of the drone. The calculated distance between the centroid point of all measurements and the real position is only 5.7 cm. The average Euclidean distance error to the drone is of approximately 20 cm.

To validate the photogrammetry software, quick tests were performed with the camera of our Drone Cheerson CX-10 W. Multiple solutions were assessed including MeshLab, 3DF Zephyr Pro, 3DSOM, 123D Catch and Autodesk ReMake. The only product that yielded acceptable results was Autodesk ReMake. Figure 5 shows the 3D object generated by the photos that our Cheerson Drone took. The process of generating the 3D model with Autodesk ReMake took around 5 min.

Fig. 5. 3D Model built on ReMake using the photos taken by our drone.

One of the problems with the final result is that no information can be obtained regarding the size and scale of the generated model. This is a limitation of our solution that rises when, for example, using multiple models generated using this method which will not have their relative sizes correctly defined.

5 Conclusion and Future Work

The purpose of this work is to construct a novel 3D scanner implemented with a mini UAV that is controlled remotely by a Wi-Fi link and is able to drive autonomously around an object, taking some photos used to create a 3D object model. Smart Wi-Fi directional antennas with servo motors have been used to perform a precise localization of the drone around the object. Our results show us a maximum error of location estimation of the mini drone lower than 37 cm. The photos that have been taken by the drone have enough quality to generate a high quality 3D model.

Our future goal is to create a completely portable system that will perform 3D localization in larger open spaces. Furthermore, a system for managing the UAV through defined routes will be used to demonstrate a practical implementation of this project in a real environment. Finally, it would be better to use a solution that generated the models locally and offline, removing the need of third party systems.

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UAV Flight Simulator to Improve Elders' Quality of Life

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Abstract. The quality of life in older people deteriorates faster, depending if these have a sedentary lifestyle. Technology is used as a tool in various fields and there are some applications that have been developed to encourage sports through entertainment, this is the case of the Nintendo Wii. The positive impact of this kind of application has been the base in the development of this research. Our proposal focuses on the easy handling of a drone by sensing arm movements through wearable devices, and providing an immersive experience of being in a different place using virtual reality glasses. The aim is to promote the user's cognitive development, due to the hand-eye coordination required to control the drone. Finally, this research, manages to integrate virtual reality with Bluetooth technologies, establishing real-time communication with wearable devices and human movement.

Keywords: UAV · Sports · Health · VR · Drone · Elders · Wellbeing

1 Introduction

Improving the people's quality of life is one of the points of interest of medical care. Contributing to the health and well-being of the elderly is an area where technology is providing space for new research. According to Gartner 2016 [1], the virtual reality and its applications are located in the development stage, being a mature technology ready to park in its full productivity stage. This motivation led the present work to use virtual reality as research and technology development, based on a research work done by [2], that propose the combination of virtual reality technology with body area networks, in order to present a simple and fun application for elders. Through virtual reality glasses, they can control an Unnamed Aerial Vehicle (UAV) using the arms' movement. This eyes-hands synchronization improves the psychomotor and cognitive capacities of the user. Additionally, it decreases the sedentary lifestyle thanks to the physical exercise that the elders must realize while using the simulator. The use of these systems avoids the sedentariness and lack of entertainment as well as stimulate their mood.

The present research proposes the development of a simulation system based on virtual reality and wearable devices that works synchronously through Bluetooth LE to

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improve elders' quality of life. In the proposed solution, simple interaction methods are used to facilitate the use and control of a Drone for a vast number of people in the target group. This is due to the fact that many elders have mobility problems (including difficulty in the movement of their arms) also emphasized with the fact that many cannot stand for long periods of time. All of these initial premises were taken into account to develop a system suitable for the elder. As future work, we intend to increase the interaction methods and add game mechanics to be applied as obstacles within the simulator. This way it will be possible to evaluate the use and improvements of the motor functions necessary to control the Drone in the virtual environment.

This paper is organized and described in five sections: Sect. 2 describes the relevant characteristics of related work; Sect. 3 presents the general architecture of the proposed solution, addressing the hardware and software components and also the communication between them; Sect. 4 covers the interaction methods, the model used to move the Drone, the medium in which the application is made, the landscapes optimized for VR applications and the camera configurations settings; Sect. 5 presents the latency test with Bluetooth LE technology. Finally, Sect. 6 present the conclusions and future work.

2 Related Work

Currently, flight simulators are commonly used in academic research, government operations, space exploration, driver training schools, the military sector, computer markets for player distraction and the medical sector.

The human factors and the ease of use of flight-simulators play a very important role in the creation of proposal that satisfies the requirements of the users. Therefore, the development of interfaces in the software-design and hardware-use must meet the requirements of coordination, adaptability, ease of use and cognitive aspects of the adult users to which the present research is focused.

In the work carried out by Bustamante et al. [2], a guide is presented for the development of a virtual reality application using the Cardboard VR Headset. The elderly performs movements with its arms and these movements are reflected in the motion of an UAV, that is in a virtual environment, supporting the improvement of the user's cognitive development (hand-eye coordination).

Another similar application is the work by Ramirez et al. [3] who developed a framework for physical rehabilitation in the upper limbs of the body through virtual reality, where the user feels motivated and is pleasant to interact by presenting a friendly VR interface.

Applications that simulate aerial vehicles include an area of study relevant to scientific technological advancement. Some examples are: Training and capacitation of pilots, militaries, expeditions, testing and management of emergent cases that include a high risk of work in complex environments. According to Sterman [4], flight simulator applications have a high impact as a tool for transmitting knowledge oriented towards constructionism, interactive or action learning.

Virtual reality provides benefits to perform tasks that may present a degree of difficulty or even risk. According to Oberhauser et al. [5], virtual reality glasses are an

instrument where the subject can experience a three-dimensional space by using a screen mounted on the head. One of the usefulness of virtual reality glasses is as an instrument to explore ergonomic aspects of aircraft booths [6].

Rivera et al. [7] designed a virtual reality application for people with aerophobia (fear of flying). This application helps overcome the difficulties generated by the phobia, allowing recreation with interactions in different environments with their fears, while the user is in a safe and protected place, resulting that the virtual reality glasses are effective as the traditional technique, even at a lower cost than using a personal computer to perform simulations.

A study by Griswold et al. [8] comprises determining the reliability and validity of physical rehabilitation exercises, through the use of virtual reality glasses for a group of elderly people. The results show that the reliability in the execution of the exercises increased 5 times. This is supported by the use of virtual reality equipment for the measurement of physical performance tests, consequently to provide a better quality of life for the elderly.

Miller et al. [9], performed a virtual reality application based on a game that allows fun and mobility in older adults, with neurological conditions. The result showed that the retention capacity was greater than 70%. However, the evaluations showed bias, given the non-consecutive attention of users to the sessions, because they presented problems due to their age.

A similar work was done by Zhang et al. [10], who simulated a real environment, in a virtual reality application, to evaluate the cognitive functions of people with brain injury versus voluntary people without brain problems. After conducting evaluations with the two groups, it was determined that the virtual reality environment, generated by the VR glasses, is a reproducible tool. Therefore, it is capable of agile the evaluation of cognitive functions in the users, providing significant help to the evaluators through early answers.

Finally, after realizing an analysis of the realized works, the contribution that offers the present research is the presentation of an application of virtual reality used with virtual glasses as a whole with wearable devices; this interaction will carry out it in a very short time of communication among the devices, to offer a real time interaction to the user.

3 Flight Simulator Architecture

3.1 General Architecture

The architecture is composed by three devices, the smartphone (Server) contains the simulator application and two Raspberry Pi devices (Clients), as remote controllers. The Server and the clients communicate through Bluetooth Low Energy Technology. The general architecture is represented in Fig. 1.

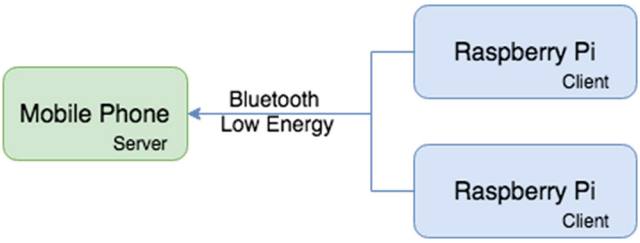

Fig. 1. General architecture diagram

Each client scans and connects to the server in order to send information from its sensors. This information is represented by the gravitational force generated by the movements of the user's arms. The server uses this information to determine the actions that the virtual Drone must execute within the simulated environment. Figure 2 represents these interactions.

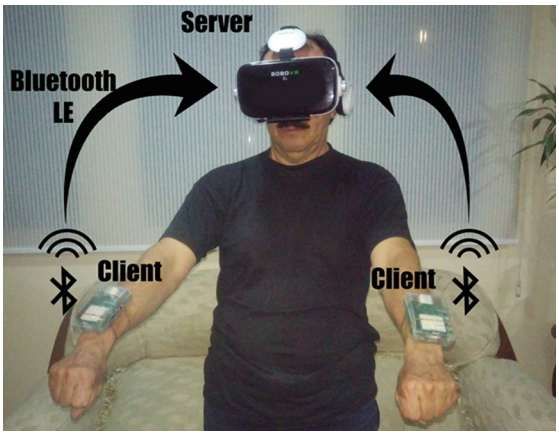

Fig. 2. General functionality diagram.

4 User Interactions

In order to plan the system for the elderly, who probably never in their life have used such technology, a special design was considered in which the user only needs to use its eyes and arms to control the system. For this reason, this system is composed of simple interaction methods based on specific movements that are easy to remember. As can be seen in Fig. 3, the services are directly related to the interactions between the movements of the user's hands and the simulator. These methods make that the user only need to remember five movements.

- **Both arms up:** this movement causes the Drone to ascend (Zb+).
- **Both arms in front:** this movement causes the Drone to descend (Zb−).

- **Right palm up:** this rotation movement causes the drone rotate to the right (Zw+).
- **Left palm up:** this rotation movement causes the drone rotate to the left (Zw−).
- **Both arms down:** This movement stops any other movement, is the default idle movement by the Drone (Zb−).

Fig. 3. Global (w) and Local (b) Coordinate systems adopted. [12]

When no action is performed by the user, the drones is in a unique automatic movement characterized by a slow forward motion. In future work this system can contain a more advanced interaction method, where the automatic forward motion will disappear.

The motion of the Drone through the user interactions was defined based on the mathematical model described in [12]. This was a starting point in order to create a simplified model for the movements of the Drone in this project.

The physics used in this system were based on [13] and implemented in the Unity3d Game Engine through the "Rigid Body Component" (shown on Fig. 4).

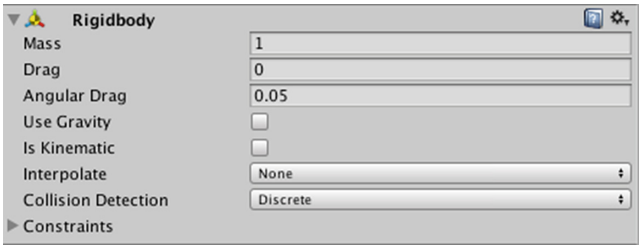

Fig. 4. Unity 3D Rigid Body Component

The flight system of a Drone completely disregards the gravity because it always remains suspended in the air, so the gravity parameter is set to zero and with this, the flight functionality is similar to a helicopter.

According to the proposed solution, the simulation of UAV will be displayed in virtual reality; therefore, the simulation will be implemented on android smartphones with any headset glasses (presented in Fig. 5).

Fig. 5. VR headset glasses.

The environment created for this simulation must be optimized to run smoothly on smartphones. In addition, internally the system renders the scene two times per frame, this is because the virtual reality system forces the GPU to process all graphic content in each of the two cameras (one camera per eye). This effect, generates an immersive experience, but it is expensive in terms of performance, because each 3D model is composed of several hundreds of polygons, so developing a realistic environment is causes too much computational effort on the GPU. In order to solve this problem the environment was generated through panoramic images. These images are part of a cube model that only have two polygons per face. This method offers a realistic setting with a minimal load on the GPU and the result is a smooth simulation with the ability to support details that maximize the realism with visual effects as falling leaves and shadows. This may have observed in Fig. 6.

Fig. 6. Panoramic Image environment

The parameters of the camera are configured with a field of view of 97.4932° and each camera is located 3.2 cm towards each end of the x-axis. This difference of distance and the same field of view generates a perfect emulation of the human visual system. These parameters are shown in Fig. 7.

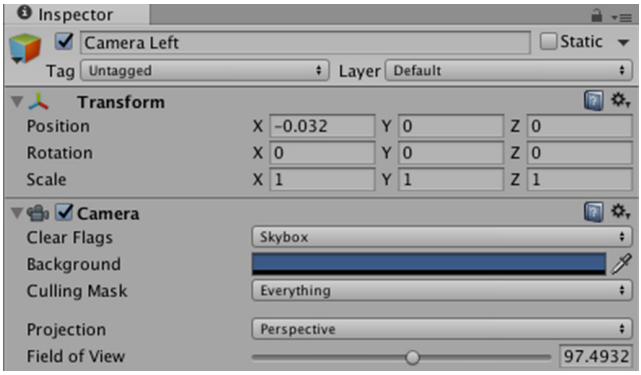

Fig. 7. Camera configuration parameters

Finally, the device responsible for managing the arms movements and interact directly with the smartphone is the Raspberry Pi. This device is a very light computer and incorporates an integrated board sensor, acting as wearable device (see Fig. 8). It runs a python script when is turned on which automatically scans the server and connects with it. After the connection, it starts the management of the sensors service and starts the interaction with the server through the Bluetooth service. This communication is done using Bluetooth LE services, and the sensor service is managed with the support of Sense Hat libraries [14]. The connection between each client and the server is automatic but must be done sequentially. This is because the Bluetooth LE not allow simultaneous connections to a server, it means that a second client must wait until the first one connects completely, since Bluetooth 4.2 will solve this problem.

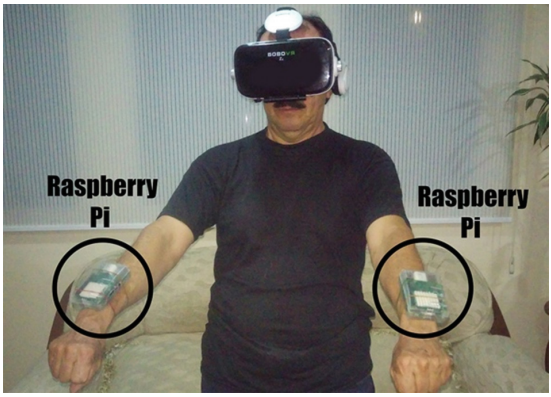

Fig. 8. Raspberry Pi nodes.

The interactions of each device are given through the flow diagrams of Fig. 9. which clearly show the actions between the two devices under their own processes. As can be seen, both diagrams show the relevant processes where they have the most important interaction between the client and the server.

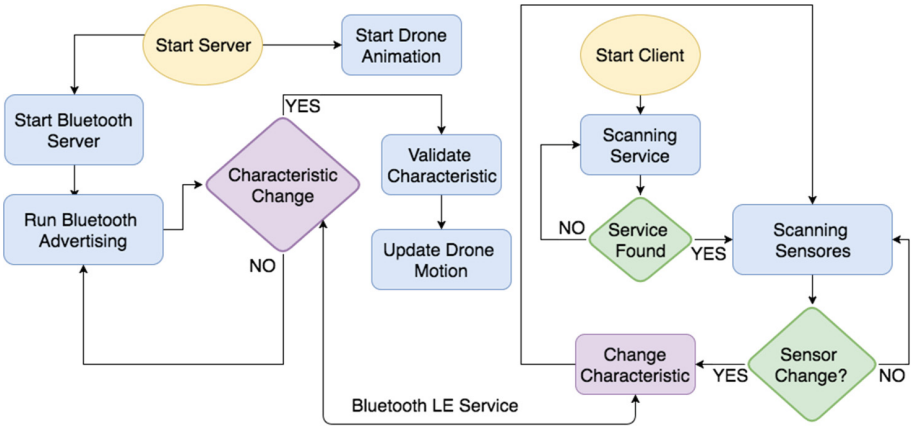

Fig. 9. Client-Server communication flow diagram

5 Real Time Communication Tests

In order to determine the performance of the communication in real time, a latency test was performed on the data transmission between the clients and the server at the same time. The test environment is performed locally on each device, while the client writes the current system time in the moment that send data, the server does the same when receiving them, all devices are synchronized with local time Quito-Ecuador so the difference of time corresponds to the latency of transmission with a minimum fraction of error. The distance from the server and the clients is always less than 1 m for that the Bluetooth signal is very strong and the latency is very low. The following Table 1 represent the values in some interactions with the corresponding latency values in milliseconds.

Table 1. Communication latency results

Average transmission information	Up (10 times)	Standby (10 times)	Left (10 times)	Right (10 times)	Stop (10 times)	Down (10 times)
Latency in milliseconds	20 ms	18 ms	21 ms	23 ms	21 ms	12 ms

6 Conclusions and Future Work

This research was able to integrate virtual reality and Bluetooth technologies to achieve a real-time communication with the wearable devices that worked as a movement manager of the arms. In addition, this system promotes cognitive development of the person; this is due to hand-eye coordination, which is required to move the drone.

In the future, it is intended to add different levels of difficulty in the simulator interactions. This will allow assessments of use and improvement of motor functions necessary to control the virtual Drone. Then, tests will be carried out in several centers of elderly people in order to validate the solution and conduct further investigation. The advantages of using a Bluetooth low energy is to have the possibility of connecting new clients, so is possible to add functionality to the system, as well as generate another type of approach or different simulation where not only the movement of arms is required, but also other parts of the body.

In future works is intended to use other wearable devices instead of Raspberry Pi and increase the number of nodes (clients) in order to emphasize the movement of the whole body.

For research purposes, the communication technology (Bluetooth LE) could be change for other research to analyze the differences, advantages and disadvantages in a system of this nature.

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Drone Automation to Monitor and Aerial Surveillance on the Group for Special Air Transport - FAE

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Abstract. Third dimension's exploitation facilitates a rapid and timely use of aerospace power. This is because, when using the airspace, free of significant obstacles; it is possible to operate with a greater degree of action. Aware of this reality, the current technology seeks to operate flight equipment autonomously and thus, obtain a greater advantage in time, space and financial resources. Aerial devices such as drones help to ground structures to have a better vision of their environment, with greater range and without the use of significant efforts. In this article, authors propose the use of an automated drone for the execution of aerial guard rounds at various military posts in a specific aerial base. This drone will be monitored by a mobile application manipulated by the guard-duty. The main goal of this research is to cover an area of military responsibility where exists aeronautical resources that need physical security, regardless of their geographical conditions, optimizing human, financial and time resources.

Keywords: Aerial surveillance · Automatization · Drones

1 Introduction

Since the beginning of time, man has wanted to conquer the airspace, which has allowed the development of several aeronautical devices ranging from a simple comet to the most sophisticated Unmanned Aerial Vehicles (UAV or drones).

Immediately, military service conceived aircrafts as weapons. First country using airplanes for that purpose was Bulgaria during the First Balkan War [1].

Aviation-related technology is advancing and continuing to advance rapidly thanks to the operational advantage that it represents in the war and the military power of a state.

Military operations that can be performed using aerial devices are not exclusively limited to attack or defense. Aviation provides other faculties such as reconnaissance, troops and authorities' transportation, aeromedical evacuation, among others.

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Regarding to authorities' air transport, in 2008 the Ecuadorian Air Force created the Group for Special Air Transport (GTAE by its Spanish acronym), which is responsible for the transportation of national authorities both inside and outside the country.

Considering that, aeronautical resources are essential for the fulfillment of the GTAE's mission; security measures to people, installations and aircrafts are extremely strict. The current security measure obey to the physical control by army guards who carry out surveillance rounds near the area. However, it should be considered that the location to place several aircrafts at the same time must be significantly large and the surveillance rounds carried out on foot implies that a geographical point A be careless at the time that a geographical point B is being verified.

In order to provide an adequate security measure, several alternatives could be considered, among them, using video cameras. Compared to traditional cameras, video cameras provide the capability to observe ongoing activities within a scene and automatically take control to the camera in order to track a specific activity [2].

Despite the benefits of using video cameras, the new technological trends have been tried to replace all types of static systems to innovate on dynamic and autonomous systems. The use of UAV for reconnaissance at low altitude has been booming in the last five years [3]. More and more people and institutions are interested in the acquisition of drones in order to monitor wide and complex territories that demand physical and economic resources [4].

The advantage of having drones performing aerial surveillance is that they have a greater range of coverage, natural principle of the air operations, especially if the area inspected is extensive and without cover as in the case of the GTAE installations.

With these security premises, the group of research proposes in the present article the automation of a drone that executes surveillance guard on the GTAE platforms.

This article is structured as follows. In Sect. 2, we present some related work. In Sect. 3, we present the structure about the solution proposed, explained in some graphics. In Sect. 4, we discuss the technologies involved in the proposed system. Finally, Sect. 5 is about conclusions and future work

2 Related Works

First related work was presented on the 1st International Conference on Technology and Innovation in Sports, Health and Wellbeing, celebrated on December 1–3, 2016 in Vila Real, Portugal. The so-called First Aid Drone for Outdoor Sports Activities consists of a GPS handle with an SOS button that will be worn by an athlete. When handle is activated, it sends the user identification number and its geographical position to a GSM station that will replicate the signal to an equipped drone with a first aid kit, which will go directly to the geographical position received [5]. This research pretends to be the continuation of the idea about using a drone for functionality activities.

Other regard is that many countries considered as development destinations for people whose seeking a better quality of life, have been suffering from massive migration, which has forced them to take stricter control measures in their frontiers. One of these particular cases is Spain, which has endured a great pressure on its frontiers due

to the phenomenon of irregular immigration that reached its highest peak since 2006 [6]. In order to complement the existing means of surveillance, some initiatives have developed; among the most prominent is the use of Remotely Piloted Aircraft RPA [7].

PERSEUS project, promoted by the European Commission [8], aims to analyze the possibility and the benefits of information sharing between agencies involved in border surveillance, as well as to seek the most effective use of platforms and sensors. The ATLANTE system, of the company Airbus Group [8], is a Remotely Piloted System whose integration into this information network was contemplate within the framework of this project. Until 2015, most of the tests performed with this kind of system were confined to military installations in segregated airspace with positive results [9].

Other proposal presents type drones helicopter (quadcopters) for searching missing persons in open or difficult-to-reach places such as mountains or snowy areas. The small size of drones allows them to be always available on the stations, greatly reducing search time. The low cost of these, compared to the cost of a traditional helicopter makes them suitable for this task (a helicopter is at least 30 to 60 times more expensive, and involves a risk of human life, high fuel consumption, etc.) [10].

As can be seen on Fig. 1, a drone used on Search and Rescue (SAR) missions can improve the responsiveness and geolocation of lost people in places that are usually inaccessible to land vehicles or even to flight equipment. The image emitted by the drone camera allows recognizing the rescue situation.

Fig. 1. Image taken by a SAR drone [10]

A last related work has been chosen due to the similarity that it has with the current project, the use of drones for monitoring and aerial surveillance. This research was carry out on Tulcán city – Ecuador and its main objective was the monitoring and aerial surveillance of several agricultural sectors of the area. In this development, a drone was sent to record videos at remote distances without the need to use a remote control, so that the device, autonomously, goes through by several predefined GPS points and returns with relevant information for their respective analysis [11].

3 Proposed Solution

The automated drone for monitoring and aerial surveillance that will be implement to perform guard rounds in the GTAE will work in the following way: first, it must be configure and program an aerial robotic platform, which may be able to perform activities through artificial intelligence.

Once configured, the drone will be on the aerial platform on land with the predefined geographical coordinates in its system, so that it performs a polygon closure of geographic points. Every two hours, the drone will carry out a monitoring flight crossing these geographical points.

As can be seen on Fig. 2, the automated drone will be in the capability to cover the area in which the different flight equipment of a military platform are parked.

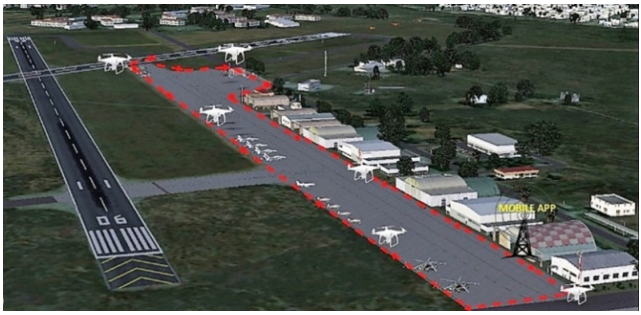

Fig. 2. Automated drone to monitor and perform aerial surveillance.

As long as the drone is conducting the reconnaissance flight, it will sending a video signal in real time to a mobile device, which will be monitored and guarded by the military that is currently on service. This will be in charge of reacting to any eventuality detected by the drone.

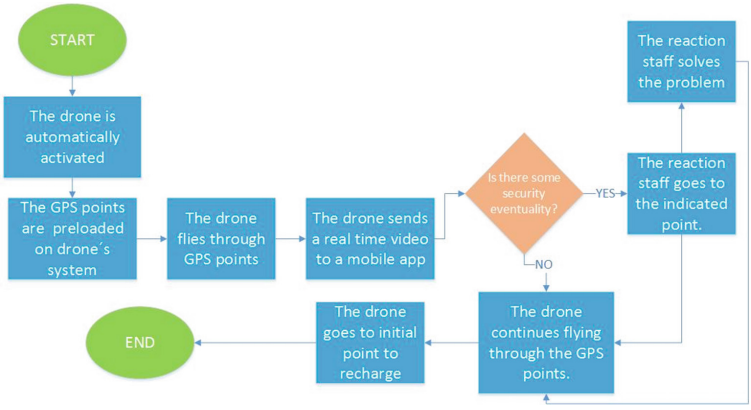

Fig. 3. Flowchart of the automated drone for monitoring and aerial surveillance.

Once the drone finishes covering all the geographic points loaded in its system, it will return to its origin point so that the military in service evaluates the change of battery, recharge the used battery and visually verifies that the equipment is located in optimal conditions for its next flight.

Figure 3 shows the flowchart as resume of the functionality of this propose. It is important to consider that the only moment when a person intervenes in this system is in the case that the drone detects any security eventuality in its aerial surveillance, considering that is the person with the mobile app who determinates if the eventuality represents a risk or not.

4 Technology Required

4.1 GPS – GLONASS Technology

GPS official name is NAVSTAR-GPS and is a fully functional Global Navigation Satellite System (GNSS) [12]. This technology uses a constellation of between 24 and 32 Medium Earth Orbit satellites that transmit precise microwave signals that enable GPS receivers to determine their location, speed, direction, and time [13].

In reference to GLONASS, it is also a GNSS, but developed by the Soviet Union. This technology uses a constellation of 31 satellites located in three orbital planes with 8 satellites each one [13]. The integration of GPS with GLONASS may be considered a major milestone in satellite-based positioning, because it can dramatically improve the reliability and productivity of indicated positioning [14].

For the present development, GPS – GLONASS technology is fundamental, because it allows giving the geographical coordinates to the device in order to fulfill its objective.

4.2 Unmanned Aerial Vehicle

The Unmanned Aerial Vehicle (UAV) is a propulsion aircraft, unmanned, reusable, operated by remote control and independently. The drone is only a platform with some kind of sensor, which aim to obtain geospatial data [15].

Figure 4 shows the basic of Unmanned Aircraft System (UAS), that comprises three sub-systems: the aircraft, the sensor payload, and the ground station.

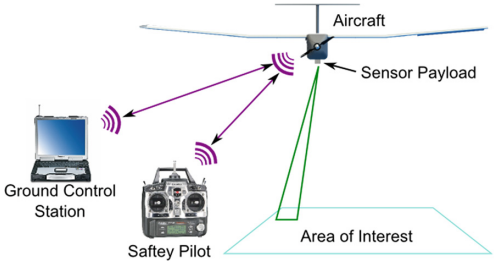

Fig. 4. Unmanned aircraft system [16]

To understand the basic differences between drones, in order to select the best choice to develop this proposal, it is shown on Table 1 the primary specifications of them.

Table 1. Comparison between drones

	Fixed wing	Rotary wing
Fly	Higher altitude and speed	Steady and stable
Maneuverability	Smaller	Higher
Autonomy	Higher	Smaller
Energy	Electric/Explosion	Electric
Payload	Smaller	Higher

Once the basic differences between the two types of unmanned aircraft are identified, (see Table 1), the use of a rotary wing aircraft is proposed for this development.

4.3 GIMBAL Camera

A GIMBAL is a motorized platform controlled by multiple sensors, including accelerometers and magnetic compass, which, by using control algorithms and PID's (Proportional, Integral and Derivate) is responsible for maintaining a fixed object. The GIMBAL is stable and allows making good catches [17].

The most common GIMBAL have two axes, allowing to have blocked most movements "roll" and "pitch" [17] and may even by assigning a channel, easily set these parameters to set new fixed positions for the camera, being of thus perfect to change plane.

Figure 5 shows the image [illustrative] that the device capture in the moment that a drone is flying over a specific area. With this image, captured by the drone, ground staff could determine if in the area of interest exists any security problem.

Fig. 5. UAV Gimbal capture

5 Conclusions and Future Work

This research was able to integrate the physical security existing in the GTAE with a technological manner to monitor and perform aerial surveillance, allowing a synergy between ground security personnel, capable of reacting to any eventuality, and a UAV device that emits an early and effective alert. It should be noted that the ability to react against any eventuality would depend on the immediate recognition by the personnel whose receive the real time video while drone is transmitting.

In the future, an attempt will be made to incorporate an artificial intelligence system that will allow for the identification of security incidents, such as unauthorized personnel, possible fire concomitants, lack of equipment, among others; in order to issue autonomously a warning signal in case the ground staff is unprepared or unable to assess the situation.

A future work will incorporate infrared equipment in the drone's chamber in the case of lack of illumination in order to reinforce this security system.

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UAV Multiplayer Platform for Real-Time Online Gaming

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Abstract. Real-time online games correspond to a growing market. Besides, the UAV development out of the military context is in a preliminary phase, which opens doors to the development of new solutions in the area. Therefore, a UAV Multiplayer Platform was developed, joining both realities in a single service, which allows to control physical UAV, "*anytime, anywhere*", through the Internet. Any user can connect to the proposed service and control a UAV settled in a remote location, for recreational purposes or to test determined conditions (which might be related to the track or the UAV itself). As shown by the results obtained after the implementation of a test scenario, this system is viable and makes a reality with potential and very possible to implement.

Keywords: "Anytime, anywhere" · Entertainment · Multiplayer gaming · Real-time gaming · Unmanned aerial vehicles · UAV Multiplayer Platform · WebRTC

1 Introduction

Until some time ago, the usage of UAVs would center in fields like surveillance and military, but nowadays the access to these technologies expanded to public in general, especially to recreational ends (e.g.: photography and video capture, competition), since the associated costs have been decreasing. Besides, the application of these vehicles is being adapted so that they can be integrated in the civil sector, to improve its constituents, namely the public security, the prevention of many occurrences (e.g.: fire and flood detection) and meticulous inspections (e.g.: infrastructures, gas and fuel) [1].

According to the studies led by Cisco's company related to the variation of online traffic values between 2015 and 2020, one of the forecasts points to the setup application of the traffic produced by *internet gaming*, which currently covers 2% of its total [2, 3].

Therefore, the objectives of this system are to associate these two worlds and concede to the users a real experience based on the remote control of unmanned aerial vehicles (UAV or RPAS [4]), "*anytime and anywhere*", through the Internet. This UAV Multiplayer Platform offers a unique experience, since it stands out from the traditional

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concept of gaming, which virtually simulates all the environment. So, besides the UAVs control, its monitorization is assured by a channel responsible for the *streaming of video* captured by one or more cameras installed in every track.

To accomplish the proposed objective, a distributed and highly scalable architecture was developed, which allows multiplayer activity without compromising the user experience, which strongly depends on the connection's speed.

Hence, the developed service follows the growth of *internet gaming* and allies it to the banalization of the UAV in the public market, to create a UAV Multiplayer Platform based on the control of real aerial vehicles [5].

Besides this section, the paper's structure goes after the following description. In Sect. 2 the theme's state of the art is studied. Next, in Sect. 3, the system's architecture that allows us to achieve the defined goal is described. In Sect. 4, we present the implementation of the UAV Multiplayer Platform. Then, in Sect. 5, we expose how the test scenario for our prototype was built. Finally, in Sect. 6, we present the conclusions obtained with this work and discuss the possibilities and ideas for future work.

2 Related Work

The number of companies operating at the level of UAV is growing. These companies offer services like personalized quadcopter construction, based on the clients' needs, as much as aerial publicity or surveillance (e.g.: Sleek Lab [6]). On the other hand, some firms focus on developing solutions to work around the primary barriers imposed to Remotely Piloted Aircraft Systems and, consequently, to improve the experience of their control. For instance, the company Flytrex [7] developed the first cloud connected UAV, through the incorporation of a 3G mobile network module in their quadcopter. Meanwhile, Sky Drone [8] built a camera able to transmit multimedia content in the same fashion as the previous UAV. These adaptations eliminate the range limitations imposed by the commonly used transmission modes (i.e.: radio transmission and Wi-Fi).

Although *multiplayer online gaming* exists for a while, its approximation to *real-time gaming* arrived later with the increment of the speed of the communication over the Internet. Therefore, nowadays there are many multiplayer videogames in real-time, which depend on the quality of their connection to the Internet to work without delay (e.g.: League of Legends, Counter-Strike) [9, 10].

On the other hand, the concept we intend to explore differs from the virtualization of a scenario. Instead, we intend to maintain a live transmission of a real environment possible to overfly with the available UAV. Regarding this purpose, the state of the art points to online casinos, which offer many options of remote gambling games to clients. These casinos excel due to the possibility given to the client to opt for the live transmission of the game environment, instead of its simulation through random variables and graphical virtualization. This *real-time streaming* makes necessary the full-time monitoring, maintained by an operator responsible for the game flow (e.g.: *croupier* dealing cards, Fig. 1), while the clients interact with the system to place a bet.

Fig. 1. Example of a live dealer associated to the software realtime gaming [11].

3 System's Architecture

The architecture idealized to fulfill the implementation of the proposed objective, concerning the remote control in real-time (Fig. 2), is made up by three main blocks. They are: the UAV Control System (1), each user (2), and each existent track (3). Every block communicates with each other through the Internet, which simply allows the decoupling between them and, also, the system's distribution anywhere in the world.

First, the user accesses to a website allocated in the UAV Control System, which provides the information about the tracks and respective existing UAVs. Afterwards, the website forwards the connection directly to the chosen track and the communication becomes peer-to-peer, directly to the UAV the user wants to spectate or control.

The block illustrated by number 1 in Fig. 2 is designated by UAV Control System and it is composed by the following members: server/platform, responsible for the management of tracks and users and the provision of the interface to the users so that they can access the UAV control; database, which allows the persistence of the information circulating in the system. The cloud designation, in the architecture, goes back to the possibility of decoupling the server(s) and the database(s) and the remaining system blocks, that might or not be near each track.

The blocks illustrated by number 2 in Fig. 2 represent the platform's users. There are two kinds of users: the players and the spectators. Both access the platform through the Internet (e.g.: through a laptop or a smartphone) and have access to the images from the camera located in the chosen track. The difference is that the spectators only observe, while the player can control the UAV.

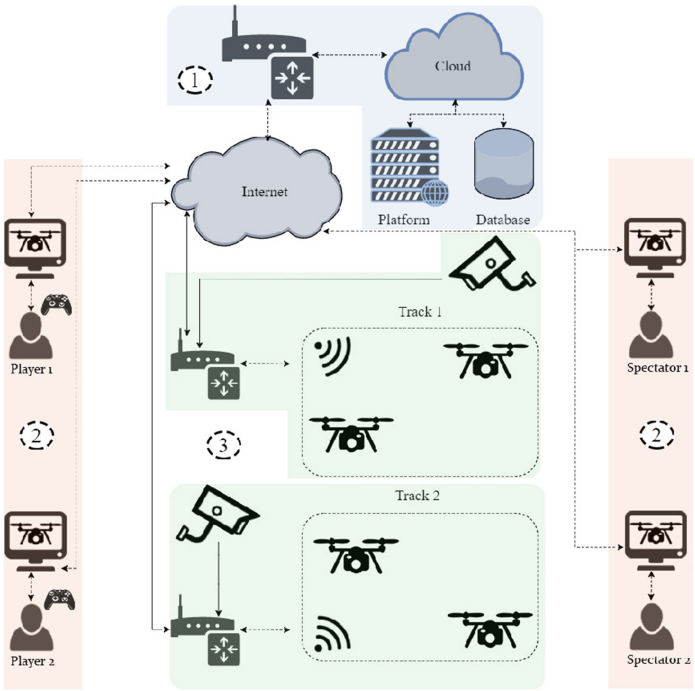

Fig. 2. Architecture of the UAV multiplayer platform. this image succinctly describes the systems's architecture of the prototype this paper is based on.

Lastly, the block illustrated by number 3 in Fig. 2 is designated by track and allows the physical control of UAV. There might be many blocks of this kind. Each track represents the place where the several UAVs, control targets, will be. Besides the UAV, the track has also a wireless router that allows the coverage of the whole area with a wireless network, to allow the communication between the users and the UAVs. To help with the UAV control, the tracks count with one or several cameras, whose transmission is sent directly to the clients.

4 Implementation

To achieve this project's objective, we created a system that grants the previously described functionalities to the user. So, we used the framework Laravel v5.3 [12], which uses the language PHP v5 [13], since it provides registry and authentication functionalities out-of-the-box.

Besides the ones used to the register and authenticate, we created two more views:

4.1 UAV Multiplayer Platform

In the initial view, the available tracks are displayed, on which the available UAVs in each one of them are listed as well, as shown in Fig. 3. Therefore, the user can select the UAV he wishes to control or to spectate. Currently, the implementation allows only to spectate the complete track, although it is ready to allow the observation through the camera of each flying UAV.

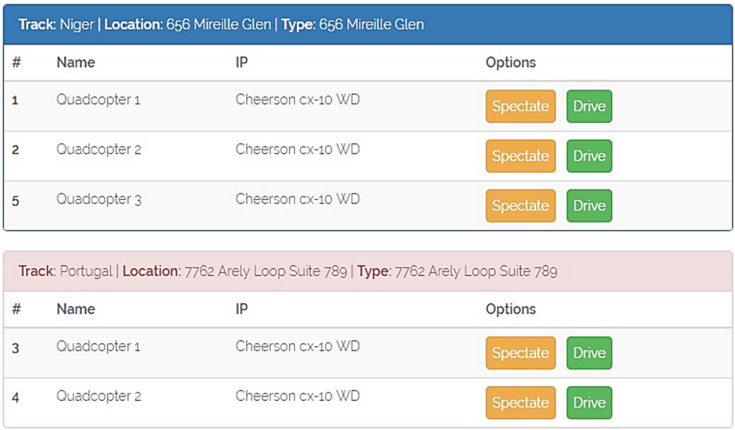

Fig. 3. Interface of the UAV multiplayer platform, showing the view with the list of tracks and respective UAVs.

4.2 Visualization and Control of the UAV

In this view, the video stream is presented, provided by the camera installed in the respective track, and, if the user is controlling the UAV, the buttons to control it are displayed as well.

The video transmission is maintained through the WebRTC technology [14], implemented through web sockets, supported by the programming language JavaScript [15]. The choice for the mentioned technology is justified with the necessity of reducing, to the maximum, the delay of the video transmission to the client, to make the control of the UAV viable.

In Fig. 4, we can see that there are 8 arrows, each one of them corresponding to a functionality. The users have the possibility to capture a photography or a video, as well. Also, we created a table that, in the future, will present the ranking of the users competing in that track.

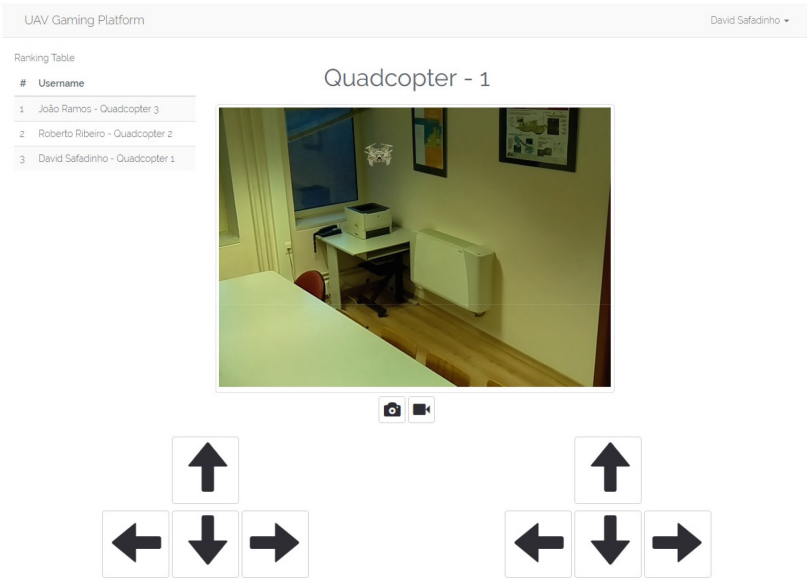

Fig. 4. Gamer view, the view with real-time visualization of the track.

5 Test Scenario

To test the solution, a test scenario similar to the proposed architecture was defined. Therefore, both the platform and the database where put in a single device (Raspberry Pi 3) [16], where the operative system Raspbian Jessie [17] was installed, running the Apache 2 server [18] and the database management system (DBMS) MySQL v.14.14 [19]. For the track's monitoring system, we used another Raspberry Pi 3 and a Raspberry Pi Camera [20] that, in the future, will be substituted by an independent camera. This implementation can be verified in Fig. 5: in the left upper corner, the platform's users are represented; on its right, the platform itself and its database system installed in the Raspberry Pi 3 are represented; below, connection to a track is represented, monitored by a camera, connected to another Raspberry. This architecture was implemented as shown in Fig. 6.

The role of the controlled UAV was tested with a Cheerson CX-10 WD, a low-cost quadcopter, as the one presented in Fig. 7. These quadcopters have a Wi-Fi module and a 0,3 MP camera, a 5 min lasting battery while airborne and a module to control it through radio transmission [21].

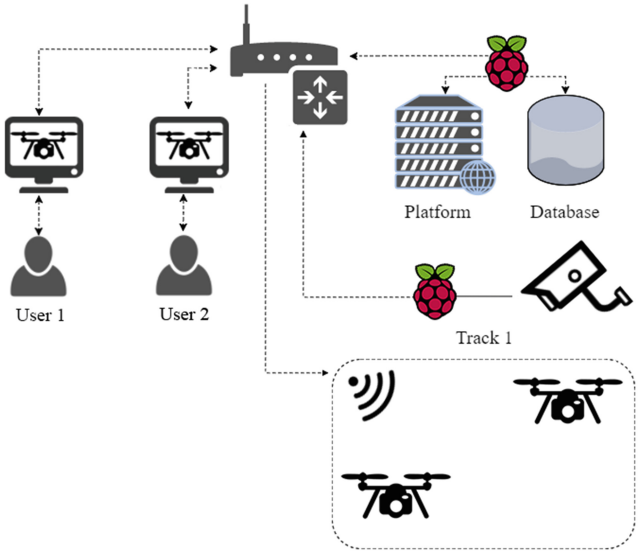

Fig. 5. Representation of the architecture of the test scenario, in which every block is connected to a single router.

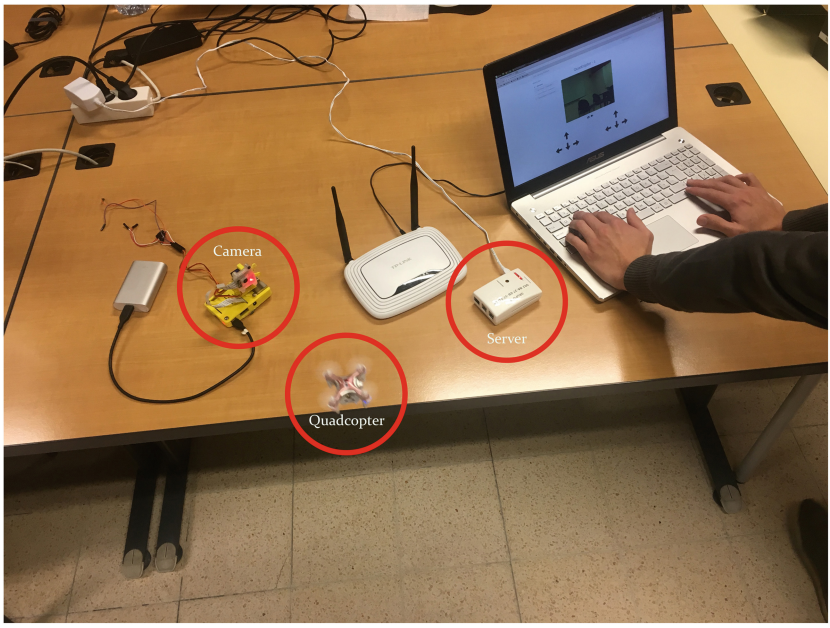

Fig. 6. Scenario in which the system was tested.

Fig. 7. Cheerson CX-10 WD quadcopter.

6 Conclusions and Future Work

With this work, we developed a UAV Multiplayer Platform that allows the control UAVs remotely, through the Internet. Building a test scenario, we could understand that it is possible to implement the objective scenario this work aims to. Joining this platform, the users will enter a new reality, *"anytime, anywhere"*, being able to control, from their house, a UAV landed in a track settled on the other side of the world. So, this project will boost the market needs, since the online gaming field is growing day-by-day, as much as the development and use of UAVs in the civil sector.

To improve the user experience, we intend to implement, as well, in each one of the UAVs a system to stream the video captured by their camera, to offer the users the possibility to control the UAV through augmented reality with the aid of a Virtual Reality set. This will abstract the users from their distance to the controlled device.

As previously referred, in the implemented test scenario, we used the Cheerson CX-10 quadcopter. The only limitation we found was the proprietary firmware installed in the tested UAV. This way, we only took benefit from the UAV's control, being left to discover the way to decode the video stream it transmits. To improve our solution, we will test the platform with different UAV, bigger and with longer lasting battery, and, therefore, learn to control them and stream the video they capture with their camera.

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Conformation of a Non Tripulated Tactical Center of the Army for Intervention in Natural or Anthropic Disasters in Ecuador

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Abstract. The Land Operations Command (LOC) of the Ecuadorian army, during the earthquake on April 16, 2016, in the province of Manabí identified the need to implement a Military Units for Rapid Intervention (MURI) to natural disasters in regional and national areas. The present document is a proposal of forming a Military Unit denominated as Unmanned Tactical Command Center (UTCC), in order to support the command and control the MURI, which is supported in the use of remotely piloted air systems and unmanned air systems (RPAS/UAS). The research problem is to determinate the magnitude of the MURI, which depends on the intensity of the event and determines the structure, organization, and equipment of the UTCC. The creation of the UTCC will permit de efficiently use and optimization of the Army resources available and will be a reference model for others entities of the country.

Keywords: Anthropic disasters · Armed Forces · Command and control · Drones · Natural disasters · Risk management · Unmanned aircraft · Untripulated systems

1 Introduction

Emergencies caused by natural or anthropic disasters can occur in any part of the country in an unpredictable way, in these circumstances, it requires institutions with immediate reaction capacity and enough logistic resource in order to operate in an uninterrupted way. Certainly, the great majority of this activities focus on the find, rescue and evacuation operations, emergency medical attention and engineering support.

The National Risk Management Secretary (NRMS) in its planning considers the active participation of the Armed Forces in all existing work groups to act in emergency and disaster events. Therefore, the Army is the institution that cover approximately 60% the members of the Armed Forces, as a result, it maintains a higher participation in all

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inherent activities to risk management such as: volcanic eruptions, forest fires, floods, earthquakes, landslides, and others.

The Ecuadorian Army has four brigade units, located in strategic locations along the country and able to comply various missions to contribute to the reach of the mission of the National Risk Secretary to prevent and management of natural or anthropic disasters.

The LOC guides the proposal for the implementation of a MURI for the fulfillment of missions in support of the operations of risk management, determining the strategic locations from which the support can be provided to all the zones of operations of the country. Therefore, it assigns to each of the Army divisions, their missions, planning, training, employment and other considerations necessary to achieve the proper implementation of these distributions. To that end, the LOC considers that these distributions must make a rapid, timely and effective deployment in the areas where the emergency presents.

In order to optimize all kind of resources, the creation of the UTCC is proposed, with the purpose to increase the capacity of military units to intervene in the face of natural or anthropic disasters and proportionated a support to the risk management. Although, the organization of the MURI is temporal, and the intervention of the Unmanned Tactical Command Center is permanent. Functionally, a UTCC must be part of the Electronic Warfare and Communications Group (EWCG), which should be considered as a technical unit capable of including unmanned aircraft technologies in the fulfillment of its missions. Moreover, these missions should be monitored by existing regulations for the use of Ecuadorian airspace.

The paper is organized as follows. Section 2, a study of the art in relation to this subject is presented, citing different works that serve as a base for the development of these paper. Section 3 gives the detailed explanation of the Unmanned Tactical Command Center, its structure, mode of operation, and form of transmission of data and communication. Section 4 details one of the unmanned worldwide technologies related to unmanned systems that provides real and immediate air information through rapid, timely and effective deployment in all operational areas of the country. Finally, Sect. 5 deals with the conclusions and future works.

2 Study of the Art

Nowadays, several proposals have been implemented in other countries and they are related to this article. Spain and Colombia are taken as referring to these work.

In [1] a complete document on the participation of the Armed Forces of Spain in natural disasters is detailed. First, this document describes a brief history of natural disasters in Spain and the participation of its Armed Forces on it. Besides, the work describes their civil national system, legal situation, organization, and processes emphasizing on the participation of the Armed Forces, its regulations, plans and way of operating, as well as its guidelines regarding the international scope. Second, describes how to respond in front of autonomous communities and analyzes the regulations and plans of the Emergency Military Unit of Spain, doing a comparison of its structure and

procedures with the situation of countries such as Germany, France, United Kingdom, USA, and Chile.

In [2] a document written by the Center for the Study of National Defense and describes multinational emergency operations. In addition, it details the involvement of the Armed Forces, non-military structures, the procedures and experiences of nongovernmental organizations in improving the efficiency and response to natural disasters. It is related to the present paper because it takes the experiences lived in Spain in order to base doctrinally on the way of operation of the military units participating in Armed Forces in purpose to determine how useful is to use the technology and the importance to have access to truthful information in order to take and make decisions.

In [3] the point of view of a high military command of the Colombian Air Force is described, on the contribution of the Armed Forces of that country to natural catastrophes, and the laws that protect its participation. Further, the work bases these laws and exposes arguments based on experiences of history citing events occurring around the world such as in Europe and United Nations about the active participation of the Armed Forces in circumstances of natural disasters, as the military units act and the complexity that they face, besides the requirement of flexibility to opt for different organization depending on the event occurred.

3 UTCC Creation Proposal

The constant appearance of new and diverse threats both internal and external require the coupling and restructuring of military units, in this case, the creation of a unit with the magnitude of one squad (28 troops), called "Unmanned Tactical Command Center".

Currently, through the investment of the NMRS of Ecuador, unmanned aircraft systems, equipped with day vision cameras, are available to operate in different operations carried out by the Ecuadorian Army in support of any kind of tactical-level emergency, allowing the timely reaction to certain risk factors such as:

- The main mission of the Army's UTCC will be to being able to support all military operations that require it at tactical level, being available to act at national level in order to contribute to the missions assigned by the Ecuadorian Army.
- The platoon should be created inside the functional organic system of the Communication Battalion No. 1 "Rumiñahui" (CB-1) belonging to the EWCG. The CB-1 consisting of two officers, one commander, and one deputy commander, in the grades from Sub-Lieutenant to Major, in command of 26 men divided into 10 operators of the RPAS/UAS, 10 support men, 4 administrative men and 2 maintenance technicians (Fig. 1).

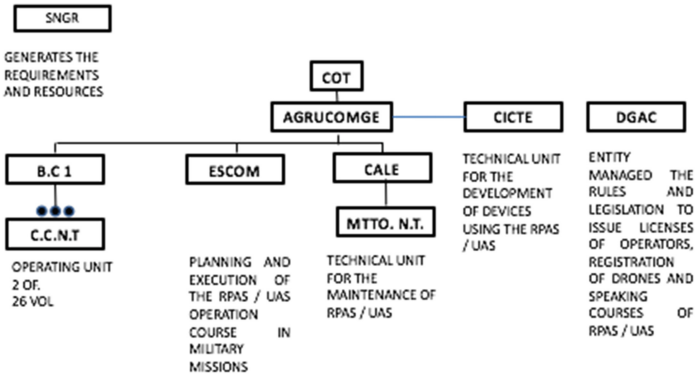

Fig. 1. Unmanned Tactical Command Center (UTCC).

- The creation of the UTCC allows military operations to be better organized and facilitates coordination between military units and support agencies such as the Fire Department, the Ecuadorian Red Cross, and the National Police, as well as optimizing economic and human resources.

For a tactical RPAS/UAS operation the minimum personnel required will be two persons, one operator, and one support man and the personnel must be aware of the rules established by the Civil Aviation General Direction (ACGD). The binomials shall consist of two unmanned aircraft systems. Also, the minimum unit to support military operations will be two drones and four people, two operators and two men support.

For the support missions execution, two operational teams will be highlighted, the first one will be in charge of carrying out the main mission, and the other will be in charge of securing, intercepting and seizing illegal drones and being able to relieve the main team, and necessarily, ensure continuity of operations. The Drone operator will be specifically responsible for piloting the RPAS/UAS and obtaining information. Finally, the support man will be in charge of providing security to the operator controlling his environment and visual tracking of the Drone (Fig. 2).

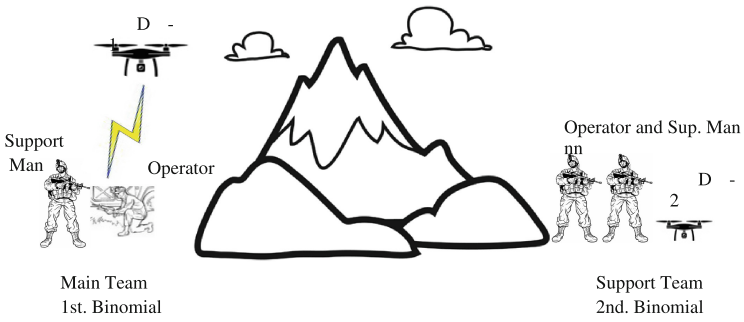

Fig. 2. Army Operation Diagram UTCC

In the personnel field requirements, it should be considered the selection of the personnel in order to be a member of the UTCC, will be in charge of the Army Human Talent Directorate, and they have to be based on the previous requirements imposed by the AHTD; The size of a basic and organic unit proposed for the operation of RPAS/UAS is one platoon; The selected personnel should not have problems either professional or administrative nature, also, neither to be in a prior promotion course or commission of services. In order to be a UTCC member, the RPAS/UAS pilot course must be held; UTCC members must be physically and psychologically qualified through appropriate examinations.

UTCC members must have prior knowledge in basic electronic and computer science, full knowledge of the capabilities and limitations of the equipment they are going to operate. Besides, selected operators (pilots) will be those who demonstrate the best conditions to fly the RPAS/UAS, and the support men will be in charge of supporting the operator with the equipment, basic knowledge on maintenance and use of the different devices and a flight license provided of the ACGD.

The support staff will assist the operator in all the activities they must perform such as take-offs, landings, data and information transmission, withdrawal and delivery of RPAS/UAS among other activities. They must have the necessary experience to be able to solve any emergency, need or requirement of the RPAS/UAS. Also, to have a full knowledge of both technical characteristics and limitations, accumulate a certain amount of flight hours with a type of system, as required by the ACGD.

The training course will be divided into two parts: the first one, will be given by the ACGD in terms of piloting and legislation, and in the second part will be covered the use of RPAS/UAS in military operations based on risk management using the guidelines of the NRMS. The second part will be dictated by the SCOM (School of Communications of the Army).

The NRMS provided to the COT eight Phantom 4 drones to support military operations in risk management. The devices that are going to be used with the RPAS/UAS will be planned and acquired depending on the type of operation to be performed and on the applications development, e.g., vision and thermal cameras, GPS, metal detectors, motion sense detector, interception network, explosive detectors, etc., all of these will be in charge of the development department of the Army.

The research and development projects related to optimization of the drones are in charge of the Scientific and Technological Research Center of the Army (STRCA), in research areas such as:

- Signal inhibitors implementation.
- Mine detectors and deactivators.
- Data and communications network management.
- Artificial vision implementation.
- Face Recognition Algorithms.

Among the capabilities that this unit would have are those to participate in military operations such as: Interception and seizure operations of illegal Drones, recognition operations in hostile areas (e.g., hydrocarbon safety, weapons control, ammunition, and explosives, border patrol and Illegal paths), in emergency and natural disasters areas

(e.g., search and rescue operations, detection and monitoring fire operations, flood detection and monitoring operations, operations of detection and monitoring volcanic eruptions), engineering support operations (e.g., geolocalization Operations, topography surveying operations, explosive mine survey operations), military Intelligence support operations, surveillance and tracking operations, internal state operations and operations in support of Psychological Operations (OSPO).

In the logistics field the specialized maintenance of the RPAS/UAS will be done by the technical unit, it is proposed that it would be through the Electronic Logistic Support Command (ELSC), and the maintenance will be performed for reasons such as: equipment need, flight time or time of life of the RPAS/UAS. If it is not possible to resolve any logistic requirements in maintenance, it will be necessary to evacuate the RPAS/UAS or equipment to the supplier's factory to provide a solution. Furthermore, the technical maintenance unit must keep a control of the work done for each of the RPAS/UAS and their equipment, trough by control sheets. Also, the technical maintenance unit must have the necessary parts and replacements equipment for each models and types of the RPAS/UAS. They will be saved in the warehouse of the UTCC, and the person in charge will not have to deliver the equipment to personnel who are not qualified to operate. In order to withdraw the RPAS/UAS, operators must have a written authorization by the commander of the unit and the request of the COT. Nevertheless, the NRMS will provide an accident and damage insurance for each device even more to third parties (Fig. 3).

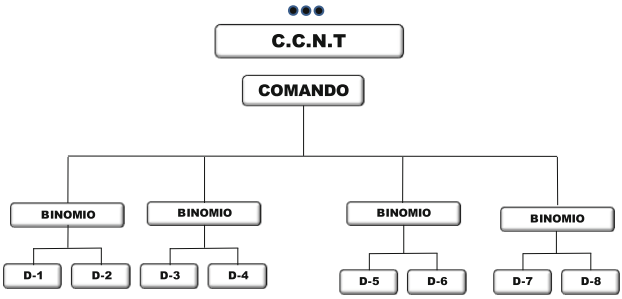

Fig. 3. UTCC organization

The UTCC is specifically for support in tactical operations to reduce the response time of military units unlike other systems that would take more time in processing the information obtained. Within the architecture of the UTCC the presentation has a special feature through developed devices in real time in order to take immediate decisions, sacrificing quality processing by the time of response is contemplated.

The structure of the proposed UTCC unit is based on the material currently delivered by the NRMS to the COT, with flexibility to be able to increase infrastructure according to future requirements and capabilities. The drones in endowment (Phantom 4, Dji) are of the latest generation, and with their intrinsic characteristics, they are optimal for fulfilling the mission of supporting risk management operations in Ecuador.

The communication system is reflected by two systems. The primary system access a video server in real-time through the internet or through a mobile application, entering a video conference section with key and user, observing the transmission of the Drone's camera that in advance its image is captured by a device of multimedia transmission and upload to the repository of the video server as we can see in Fig. 4. The second system of communication is through the support man as a radio operator, who transmits via VHF radio in endowment and directly transmitted to the command of the unit for the taking of descents.

- The GPS system to will be used in support of military operations will be the embedded Drone system itself, and its data will be displayed in the transmitted user interface.
- The UTCC will have a system of registration and monitoring of all operations materialized in Quito inside the CB-1 facilities (Fig. 5).

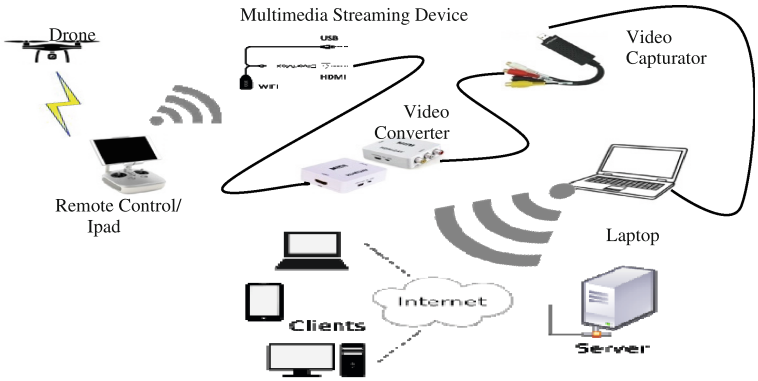

Fig. 4. Diagram of communication system via video conference

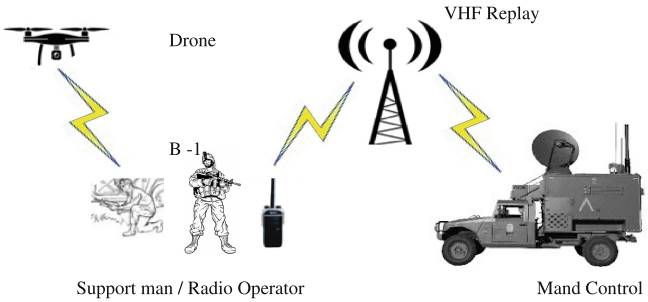

Fig. 5. Diagram of VHF communication system (Trunked System)

4 Implemented Technologies

4.1 DJI Phantom 4

The drone with vision camera with the capacity to make photographs and professional aerial videos with both devices Apple or Android. It flies intelligently, creates tracking images easily and also dodges obstacles autonomously, among other functions.

Its structure is very low weight, 1380 g. including battery and propellers. The maximum speed in ascent is 6 m/s and 4 m/s in descent. In horizontal displacement, depending on the operating mode is 20 m/s and up to 72 m/s. Its maximum performance at altitude is 19685 feet (6000 m) and its maximum flight time is approximately 28 min.

It is equipped with GPS and proximity sensors on the front, and can be stabilized on all three axes. [4]

4.2 Video Camera

The Phantom 4 camera can capture video at 30 frames per second in full HD. It is composed of a 20 mm aspheric lens with a field of view (FOV) 94°. The pictures captured by the camera can be in JPEG or DNG formats, also the video can be recorded in MP4 or MOV formats. It provides a Micro SD card with a maximum capacity of 64 GB [4].

4.3 Multimedia Content Transfer Device

It is a device that connects to the HDMI port by which applications and content can be transmitted directly to a screen from a phone or mobile device. There are two ways to transmit the screen of the mobile device, the first is through its default application and through the function Mirroring, the second option is the one that is chosen in our solution proposal as well so you can view all the information Which the Drone offers us [5].

4.4 HDMI a to RCA AV Converter

An HDMI input converter to RCA/AV output is used for the connection between the multimedia content transfer device and the video image grabber, making it possible to reproduce the contents on a television or a player as it can convert the digital signals, Emphasize that it supports NTSC/PAL format. This device requires a USB power supply.

4.5 Video Capturador

A USB video grabber was used to obtain high-quality video and audio without the need for sound cards or require any other driver. Among its specifications, we have to support NTSC.PAL formats and do not need external power supply. It was used between the HDMI converter and the computer on which we wanted to get the video.

4.6 Software for Video Transfer

For the video processing obtained by the grabber, two software were used: ManyCam and Amcam, the first allows to apply various special effects to the image. Its interface is quite simple since all the menus are in sight of the user [6].

The second program is the one that allows uploading the video to the server and starting the video conference section in a room with its respective key and user, in this case, it was done with Spontania which is the tool to organize remote meetings with its clients, from Any device in one way; Fast, simple and without major investments in their current infrastructure, on their PCs, Macs, smartphones and tablets, without any previous technical knowledge, with high quality video and audio.

It is a robust application specially designed for demanding environments where it is necessary to share video, audio, and documents with high resolution.

5 Conclusions and Future Work

With the creation of the army UTCC, it contributes to risk management by providing support to the different military operations in Ecuador, as it provides real and immediate aerial information of adverse events that can arise, such as natural or anthropic disasters, through rapid deployment, timely and efficient use of unmanned aircraft systems, optimizing resources and transmitting valuable information in real time, which is currently not done.

The formation of a unit of magnitude of a platoon, specialized in the use of RPAS/UAS, is proposed to support the units in all the operations that require it at a national area, adhering to the current regulations of the ACGD. Said unit with autonomy both in personnel and in media, contemplating the training, maintenance and logistics necessary for the efficient performance of the Army's UTCC.

It is proposed the research and development of applications for drones by STRCA, to exploit to the maximum the capabilities offered by the means provided as a complement to the Ecuadorian Army by the NRMS for intervention in natural or anthropic disasters.

The organization, employment, the technology used and means of communication are determined to be of great utility in tactical missions in which the intervention time for the immediate removal of the committed military unit, detailing the means of communication optimum to be used.

It establishes the basis for the development of a unit with greater scope and capabilities as its means and technology are increased, projecting to include in the future support for military missions such as border control, illegal steps, drug trafficking, etc.

Acknowledgments. The present work, we would first like to thank God, the National Secretary of Higher Education, Science and Technology (SENESCYT), the University of the Armed Forces (ESPE), the Scientific and Technological Center of the Army (CICTE) and the Polytechnic Institute of Leiria.

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Standardization of Policies of the Use of Distance Aircraft Systems and Aircraft Systems (RPAS/UAS) in Ecuador

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Abstract. Unmanned drones have been around for many decades. However, they have recently become much more capable, due to the arrival of cheap, reliable, and small electronic products that control the flight, collect data and communicate. The use of remotely piloted aircraft systems and unmanned aircraft systems (RPAS/UAS) is booming globally, and in order to integrate its operations routinely and safely into civil airspace, it is necessary to establish standards aligned with International law. Currently, in Ecuador, the issue has been approached in a general way, establishing basic policies that help but do not cover the full spectrum of the operation of these systems. This document provides a proposal for incorporation of norms applicable to the reality of Ecuador to be considered and applied based on international regulatory information from countries that have addressed the issue in greater depth, focusing on security, air traffic, privacy, regulation and socioeconomic impediments. It addresses specific issues and cases, encouraging the reduction of gaps and inconsistencies in the law for the operation of these systems; Anticipating the growing market today and being able to incorporate this technology into civil airspace.

Keywords: Drones · Directorate General of Civil Aviation · Airspace

1 Introduction

The regulation of RPAS/UAS changes rapidly and especially in more developed countries; Many others still lack a clear regulatory regime. The regulations for the operation of RPAS/UAS are intended to gather the best available information on the current state of standards at the global level by updating the regulations.

By having the capacity to access the databases of other countries' regulations, they serve as a basis for developing the proposal to incorporate norms for Ecuador through regulators that try to compare their policies with their international counterparts, and to be able to apply the norms developed for the current reality of the country and the forecast of a not too distant future.

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In this days we can not fail to observe that the integration of new technology in the daily life is part of the development which it is impossible to try to delay or stop, the RPAS/UAS have been used for a long time in military contexts but in the present it has been generated a reception for the domestic use of this technology so that they are taken into account more and more civil tasks making this technology more common, this is appreciable when seeing the flourishing of companies producing these devices and companies and institutions users of this technology [1].

In fact there are several countries that have regulations for the use of these systems, but they are increasingly being modified and updated according to requirements, as more and more applications and applications are being developed for the UAS/RPAS since their potential would seem unlimited, applications such as data collection and tasks of information, monitoring, public information and defense, search and rescue, mapping, delivery of small medical supplies, such as vaccines, etc. [2].

In the Americas, countries like Guatemala, Costa Rica, Panama, Bolivia, Paraguay do not register explicit regulations on the use of RPAS/UAS operations, while in Europe almost all countries have their regulations coupled with their reality. Ecuador, with its Civil Aviation General Directorate has general regulations that need to be developed in a specific way depending on the case [3]. Its use poses a great challenge to regulate its good use and guarantee its incorporation without affecting the environment in which they operate, since serious practical and ethical problems can be presented.

Their use should therefore be targeted when appropriate by promoting good practices and harnessing their potential to improve humanitarian operations and research.

The regulations issued by the Directorate General of Civil Aviation do not include many parameters and leave inconsistencies or misinterpretations in their articles especially because they are very general and do not come up with more specific issues, such as not including regulations for surveillance or fight Against forest fires, border security, research, gathering of scientific data, etc. It is a fact that following this trend and not delimiting freedom of action through a comprehensive plan to regulate this technology will then be complicated for coexistence with this omnipresent system.

The article is structured as follows. In Sect. 2, the related work is presented. Section 3 propose a solution to change the regulations. Section 4 shows the conclusions and future work.

2 Related Work

In [4] a work of the regulation in force in the USA through the intervention of the Federal Aviation Administration, the Office of the Secretary of Transportation and the Department of Transportation it is showed, in which it modifies its regulation to allow the operation of small aircraft systems Unmanned airspace in national. Those changes address the operation of unmanned aircraft systems and certification of their remote pilots. This rule regulates operations to avoid jeopardizing the safety of national airspace.

In [5] a press release describes the rules for unmanned aerial systems with regulations creating new business and government opportunities for the proper use of unmanned airplanes allowing the routine commercial use of small unmanned aircraft systems.

In [6] describes how the new regulation of drones creates uncertainty especially in sports users due to changes made in effort to regulate for hobby or recreational flight regulations, the uncertainty is based on whether or not they will be able to continue flying their aircraft to scale.

In [7, 8], it points out the problems that exist when air space is included in the technology of the RPAS/UAS in view of the companies that want to use them as means of transport for package delivery and the danger that is run When collision mishaps occur with manned aircraft, comparing the RPAS/UAS with birds that cause air accidents, in addition cites indications as the stoppage of operation of aircraft that were carrying out activities of extinguishing a fire by the presence of RPAS/UAS.

In [9] an article of the National Conference of State Legislation is presented where it indicates the requests, prohibitions and changes of laws in the years between 2013 to 2015 and in several states of the USA. It gives the general regulations to which all states are obliged to be part of the development and identification of different systems, especially their characteristics as their weight. It fixes costs of fines and deadlines to carry out activities such as the registration of the RPAS/UAS.

In [10] he talks about states where unmanned drones were considered in 2015, including graphically, including states that passed legislation, which passed unmanned drone resolutions, which states propose to A study on the use of RPAS/UAS by state and local agencies, which state created a legislative commission to study the regulation and revision of the RPAS/UAS.

In [11] presents a graphical user interface of the countries that have or have not opted for the legislation for the RPAS/UAS trought a map giving information of the regulations and the sources of searches. It can be observed that much of America and Europe already has a reference in regulations for the use of RPAS/UAS, unlike in Africa that are a minority those that have regulations of this nature. Relive a historical review of the evolution of the RPAS/UAS and give an open letter for the reception of proposals for incorporation of information using established forms.

In [12] the regulatory framework for the operation of RPAS/UAS is described by the Government of Spain through its Ministry of Public Works with its regulator, the State Air Safety Agency, and valuable information on training And certification of pilots, regulations, inspections of operators, activities, operations and information leaflets among others.

In [13] a report on drones and aerial surveillance is presented, the considerations taken for the legislature, which deal with issues such as security and privacy disruption, making another view point to be taken into account as users of this technology, although not regulated is a reference to be taken into account as it indicates a different perspective for legislators.

There are different studies with the tendency to normalize in the best way, covering all possible and possible possibilities, observing from different points of view and accepting proposals and suggestions in all parts of the world, changing them to the reality of each country since the usefulness.

3 Proposed Solution

The General Directorate of Civil Aviation of Ecuador did not have a regulation that establishes requirements for the Operation of Remote Pilot Aircraft Systems (RPAS) or Unmanned Aircraft Systems (UAS) until September 17th 2015, with the purpose safety precautions in air activities, air transport users and the general public, due to the significant increase of the aforementioned devices known as DRONES, it was necessary to establish general provisions for the operation of the aforementioned aircraft, and in accordance with the law that determines the attributions and obligations of the Director General of Civil Aviation, may "Dictate, reform, repeal technical regulations, orders, internal regulations and complementary provisions of Civil Aviation, in accordance with this Law, the Aviation Code, Convention on International Civil Aviation and those necessary for flight safety, and the protection of the safety of air transport" [15].

The Federal Aviation Administration of the United States of America on the one hand and the Spanish State Air Safety Agency of the Government of Spain on the other hand are the most notorious referents in the operation regulation of RPAS/UAS. In the USA, efforts were made through a long transition and improvement through their experiences to be an international benchmark for other countries. Within the provisions contemplated in the US and applicable in Ecuador we have not taken into account by the DGAC:

Operational constraints

- RPAS/UAS must not operate under a deck structure, or inside a covered vehicle.
- The RPAS/UAS must have appropriate collision illumination in addition to respecting the allowed hours of operation.
- The RPAS/UAS, with respect to the ground can travel maximum at 100 miles per hour (87 knots) with an operator's atmospheric visibility of 3 miles.
- Classify and identify airspaces according to their restriction for use of RPAS/UAS.
- Classify the type of RPAS/UAS to determine whether or not it needs special authorization for its operation.
- It is prohibited to perform RPAS/UAS operations from a moving aircraft or vehicle unless the operation is over a sparsely populated area.
- Negligent or reckless operations with RPAS/UAS are prohibited.
- Transportation of hazardous materials with RPAS/UAS is prohibited.
- A person can not operate a small drone if he or she knows or has reason to know of any physical or mental condition that could interfere with the safe operation of a RPAS/UAS.
- All national and foreign RPAS/UAS must be registered to be authorized to operate in compliance with all prerequisites.
- External load RPAS/UAS operations are permitted if the object being transported by the unmanned aircraft is securely attached and does not adversely affect flight or control characteristics.

Most of the restrictions mentioned above are resignable if the applicant proves that their operation can safely be carried out under the terms of a certificate of exemption granted by the DGAC.

Regarding remote pilot certification and command responsibilities

- The operator of a RPAS/UAS must hold a pilot's license at a distance or be under the direct supervision of a person holding a remote pilot's certificate. To qualify for a remote pilot license, a person must demonstrate aeronautical knowledge or pass an initial aeronautical knowledge test or completing a training course in operation of RPAS/UAS provided by the DGAC;
- O Being over 16 years of age.
- Foreign RPAS/UAS pilots must have a certificate issued by the DGAC to operate these systems in the country.

A remote-controlled pilot should:

- Make available to the DGAC, upon request, the RPAS/UAS for inspection or testing, and all associated documents/records necessary to keep under the rule.
- A report must be made to the DGAC within 10 days of any operation resulting in at least serious injury, loss of consciousness, or property damage.

Aircraft requirements

- The RPAS/UAS operator must perform a pre-check to ensure that the system (s) are able to operate safely.

Within the analysis of Public Risk

- The RPAS/UAS operation does not have the same view and ability to see other manned aircraft as an aircraft pilot. Therefore, the challenge of these operations is to ensure that the operating person is able to see and avoid other aircraft. Another safety problem with RPAS/UAS operations is the possibility that during the flight the person may lose control of the aircraft due to a failure of the control link between the aircraft and the remote control station. This is known as a loss of control and may result from a system failure or because the aircraft is out of range of the signal or in an area where control link communication between the aircraft and the receiving station is interrupted. control. A RPAS/UAS whose flight can not be directly controlled could pose a significant risk to persons, property, or other aircraft.
- The DGAC is the entity in charge of establishing the costs of courses and licenses. As well as the flight hours requirements and course contents.

All RPAS/UAS must be registered in the DGAC and identified with a plaque on a plaque in a visible place, and for this they can be registered if the RPAS/UAS is owned by an Ecuadorian citizen or by a permanent resident of Ecuador and the RPAS/UAS is owned by the government of Ecuador or a governmental institution [16].

4 Conclusions and Future Work

The technological advances associated with RPAS/UAS make it necessary to prepare to face the challenge of coexistence by incorporating this technology today and foreseeing a future not too far away in civil airspace. The regulations must be modified according to the need and case, incorporating the technology to the daily life, being coupled to the development, economical and social. It is a priority to take into account national security needs as changes in the airspace system should not leave gaps or inconsistencies in the rules of use of the RPAS/UAS currently offered in the market.

The emergence of a civil market of RPAS/UAS is booming and largely uncontrolled, since there are increasingly more specific points to be addressed and regulated so that the impact of the incorporation of these systems does not alter the Normal development of other activities, in addition to creating a social awareness of the use of this technology while continuing to support its growth.

Having an international reference and changing it to the reality of the country, ensures the development of a harmonization by incorporating in the market the RPAS/UAS, thus avoiding side effects.

Market growth, combined with the unique flight characteristics and capabilities of the RPAS/UAS, will test an air traffic system, a system designed around manned aircraft. Today we must recognize the changing environment and adapt to the changes brought about by the RPAS/UAS, so that the legislation will always be subject to changes or modifications through proposals and studies.

The Civil Aviation Directorate of Ecuador has the opportunity to take advantage of the technology related to the RPAS/UAS to ensure an adequate integration of these systems in the aviation environment, adapting and avoiding marginalization including control measures will minimize the impact of inclusion of this technology is even a great opportunity to improve air traffic and the creation of an environment conducive to coexistence between systems. These changes, if properly encouraged and managed, will help to reduce the complexity of the air traffic system.

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