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Innovation through Cross-Fertilization

Serious games and gamification in the EU-funded research projects

Manel González Piñero

Universitat de Barcelona

Facultat de Geografia i Història

Universitat de Barcelona School of Economics

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INNOVATION THROUGH CROSS-FERTILIZATION: Serious games and gamification in the EU-funded research projects

Presented by:
Manel González Piñero

Centre:
Universitat de Barcelona

Department:
Department of Economics, UB School of Economics

Directed by:
Dr. Lluís Bonet Agustí (UB School of Economics)
Dr. Esteve Juanola Feliu (UB Physics Faculty)

Tutored by:
Dr. Lluís Bonet Agustí (UB School of Economics)

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Complexity theory teaches us that one needs the right contextual conditions to stay at the edge and not drift away towards either extreme. This dissertation has become its own complex system consisting of ideas that interact in non-trivial ways and evolve at the edge of chaos –a state on which the author throws parts of the initial plan and agenda overboard to explore new possibilities but also pulls everything together to achieve the overall goal. I would have never completed this work without my profound appreciation and immense gratitude to many people who supported me along this process.

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Abstract

In recent years, ecosystems of innovation have gained substantial momentum in academic research. As a response to recent calls in open innovation literature for novel research, this doctoral thesis extends the study of the process and ecosystems of innovation in projects that include serious games and gamification by considering the cross-fertilization of knowledge and technologies. Organizations' orchestration of activities within their activity systems and transformation of their business models through innovation to realize opportunities with the objective to increase value creation are part of the topic of this dissertation. It has endeavoured to improve the understanding of how cross-fertilized alliances are formed, what their outcomes are, what causes them to generate value (or not) and what capabilities organizations need in order to successfully manage and reap value from the innovation process. For this purpose, two approaches that support innovation have been complementarily taken into account: the knowledge-technological perspective and the management perspective. These perspectives are analysed with the information retrieved from a database of 87 H2020 projects including serious games and/or gamification, 519 organizations and 597 observations. Later, in order to get more insights into the Innovation Management Strategies, a project coordinators survey was conducted. The **Knowledge-Technology perspective** presents how creating adequate multidisciplinary knowledge and technology is fundamental to ensuring the long-term success of an emerging technology including serious games and/or gamification, and how important is the research and innovation that takes place in the practitioners' communities. The **Management perspective** presents the analysis of the innovation management strategies that boost the cross-fertilization of technologies that include serious games and/or gamification. These strategies were analysed by considering literature on innovation and network theories, absorptive capacity and dynamic capabilities. Some personal interviews were conducted with independent experts to understand and have elements for the analysis and discussion of the previous results. Findings suggest that the multidisciplinarity of a project is highly influenced by the creation of knowledge and technology. Furthermore, the management strategies boosting high levels of cross-fertilization of knowledge and technologies -including serious games and/or gamification- are principally market and customer-oriented strategies. Practical and methodological contributions from this study could enrich innovation literature from the point of view of technological and management approaches. The thesis concludes with fruitful avenues for future research.

Resum

Al llarg dels darrers anys, els ecosistemes d'innovació han pres un impuls substancial en la recerca acadèmica. Com a resposta a les darreres crides a noves recerques en la literatura sobre innovació oberta, aquesta tesi doctoral amplia l'estudi del procés i els ecosistemes d'innovació en projectes que inclouen jocs seriosos i gamificació al considerar la fertilització creuada de coneixement i tecnologies. L'orquestració d'activitats per part de les organitzacions dins dels seus sistemes d'activitats i la transformació dels seus models comercials a través de la innovació per generar oportunitats amb l'objectiu d'augmentar la creació de valor són part dels temes d'aquesta tesi. Hi ha hagut un esforç per millorar la comprensió de com es formen aliances amb la fertilització creuada, quins són els seus resultats, què fa que generin valor (o no) i quines capacitats necessiten les organitzacions per gestionar i assolir valor a través del procés d'innovació. Amb aquest propòsit, dos enfocaments que recolzen la innovació s'han tingut en compte de manera complementària: la perspectiva coneixement-tecnologia i la perspectiva de gestió. Aquestes perspectives s'analitzen amb la informació obtinguda d'una base de dades de 87 projectes H2020 que inclouen jocs seriosos i/o gamificació, 519 organitzacions i 597 observacions. Posteriorment, amb l'objectiu d'obtenir informació addicional sobre les Estratègies de Gestió de la Innovació, es va realitzar una enquesta adreçada als coordinadors dels projectes. La perspectiva de Coneixement i Tecnologia mostra com la creació adequada de coneixement i tecnologia multidisciplinaris és fonamental per garantir l'èxit a llarg termini d'una tecnologia emergent, que inclogui els jocs seriosos i la gamificació, i com d'important és la recerca i la innovació que té lloc en les comunitats de professionals. La perspectiva de Gestió mostra l'anàlisi de les estratègies de gestió de la innovació que fomenten la fertilització creuada de tecnologies que inclouen jocs seriosos i/o gamificació. Aquestes estratègies es van analitzar a partir de la literatura en innovació i teories de xarxes, capacitat d'absorció i capacitats dinàmiques. També, es van dur a terme entrevistes personals amb experts independents per comprendre i tenir elements per a l'anàlisi i la discussió dels resultats anteriors. Els resultats suggereixen que la multidisciplinarietat d'un projecte està molt influenciada per la creació de coneixement i tecnologia. A més, les estratègies de gestió que impulsen els alts nivells de fertilització creuada de coneixement i tecnologies – inclosos els jocs seriosos i/o la gamificació- són principalment estratègies orientades al mercat i al client. Les contribucions pràctiques i metodològiques d'aquest estudi podrien enriquir la literatura sobre innovació des del punt de vista dels enfocaments tecnològics i de gestió. La tesi conclou amb suggeriments de línies de recerca futures.

Resumen

Durante los últimos años, los ecosistemas de innovación han tomado un impulso sustancial en la investigación académica. Como respuesta a las recientes llamadas a nuevas investigaciones en la literatura sobre innovación abierta, esta tesis doctoral amplía el estudio del proceso y los ecosistemas de innovación en proyectos que incluyen juegos serios y gamificación al considerar la fertilización cruzada de conocimiento y tecnologías. La orquestación de actividades por parte de las organizaciones dentro de sus sistemas de actividades y la transformación de sus modelos comerciales a través de la innovación para generar oportunidades con el objetivo de aumentar la creación de valor son parte de los temas de esta tesis. Ha habido un esfuerzo por mejorar la comprensión de cómo se forman alianzas con fertilización cruzada, cuáles son sus resultados, qué hace que generen valor (o no) y qué capacidades necesitan las organizaciones para gestionar y cosechar valor a través del proceso de innovación. Con este propósito, dos enfoques que apoyan la innovación se han tenido en cuenta de manera complementaria: la perspectiva conocimiento-tecnología y la perspectiva de gestión. Estas perspectivas se analizan con la información obtenida de una base de datos de 87 proyectos H2020 que incluyen juegos serios y/o gamificación, 519 organizaciones y 597 observaciones. Posteriormente, con el objetivo de obtener información adicional sobre las Estrategias de Gestión de la Innovación, se realizó una encuesta a los coordinadores de los proyectos. La perspectiva de Conocimiento y Tecnología muestra cómo la creación adecuada de conocimiento y tecnología multidisciplinarios es fundamental para garantizar el éxito a largo plazo de una tecnología emergente, que incluya los juegos serios y la gamificación, y cómo de importante es la investigación y la innovación en las comunidades de profesionales. La perspectiva de Gestión muestra el análisis de las estrategias de gestión de la innovación que fomentan la fertilización cruzada de tecnologías que incluyen juegos serios y/o gamificación. Estas estrategias se analizaron a partir de la literatura en innovación y teorías de redes, la capacidad de absorción y las capacidades dinámicas. También, se realizaron entrevistas personales con expertos independientes para comprender y tener elementos para el análisis y la discusión de los resultados anteriores. Los hallazgos sugieren que la multidisciplinariedad de un proyecto está muy influenciada por la creación de conocimiento y tecnología. Además, las estrategias de gestión que impulsan los altos niveles de fertilización cruzada de conocimientos y tecnologías -incluidos los juegos serios y/o la gamificación- son principalmente estrategias orientadas al mercado y al cliente. Las contribuciones prácticas y metodológicas de este estudio podrían enriquecer la literatura sobre innovación desde el punto de vista de los enfoques tecnológicos y de gestión. La tesis concluye con sugerencias de líneas de investigación futuras.

Abstrakt

I de senere årene har økosystemer for innovasjon fått vesentlig fart i akademisk forskning. Nylig har det oppstått et større behov for mer forskning i området åpen innovasjon. Som et respons til dette, utvider denne avhandlingen seg på studier om prosesser og økosystemer av innovasjon i prosjekter. Prosjektene inkluderer seriøse spill og det som kalles for gamification. Målet er å vurdere kryss-befruktning av kunnskap og teknologi. En del av tema for denne avhandling er hvordan organisasjoner, gjennom innovasjon, virkeliggjør mulighetene for å øke verdiskapning. Dette vurderes ut ifra organisasjoners orkestrering av aktiviteter innenfor deres aktivitetssystemer og transformasjon av forretningsmodellene. Det har lenge vært forsøkt på å forbedre forståelsen av hvordan kryss-befruktet allianser dannes, hva er resultatene, hva skal til for å generere verdi (eller ikke), og hvilke evner organisasjoner trenger for å kunne forvalte og innhente verdier. På bakgrunn av dette, har to tilnærminger som støtter innovasjon, blitt komplementært tatt med i betraktningen. Disse er, den kunnskaps-teknologiske perspektiv og ledelses perspektivet. Perspektivene blir analysert med informasjon hentet fra en database med 87 H2020 prosjekter, inkludert seriøse spill og eller gamification. Det er totalt 519 organisasjoner og 597 observasjoner. I senere tid, for å få et større innblikk i strategier for innovasjonsledelse, ble det gjennomført en prosjekt koordinator undersøkelse. Det kunnskaps-teknologiske perspektivet innebærer hvordan en kan skape tilstrekkelig tverrfaglig kunnskap. Her er teknologi grunnleggende for å sikre langsiktig suksess til en fremtredende teknologi, som inkluderer seriøse spill og eller gamification, og viktigheten av forskningen og innovasjonen som fremkommer i utøvernes samfunn. På den andre siden, ledelses perspektivet inkluderer analysen av innovasjonsstrategier som har som mål å øke kryss-befruktning av teknologier som inkluderer seriøse spill og eller gamification. Strategiene ble analysert ved å vurdere innovasjon- og nettverks teorier, evnen til å absorbere, og dynamisk kapasitet litteratur. For å forstå og samle elementer for analysen og diskusjonen av tidligere resultater, bestemte personlige intervjuer ble gjennomført med uavhengige eksperter. Funnene viser at flerfaglighet av et prosjekt er sterkt påvirket av etablering av kunnskap og teknologi. Videre, ledelses strategier er med på å øke nivåer av kryss-befruktning av kunnskap og teknologi. Dette inkluderer seriøse spill og eller gamification, men hovedsakelig markeds- og kundeorienterte strategier. De praktiske og metodologiske bidrag fra denne studien er med på å berike innovasjons litteratur fra det teknologiske og det ledelsesmessig synspunkt. Avhandlingen avsluttes med fruktbare veier for fremtidig forskning.

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Acronyms

3Cs	Control, Capability and Cost
AI	Artificial Intelligence
APAC	Asia-Pacific
ARG	Alternate Reality Game
B2B	Business to Business
B2C	Business to Consumer
CAGR	Compound Annual Growth Rate
CC	Clustering Coefficient
CEO	Chief Executive Officer
D2C	Direct to Consumer
DI	Disruptive Innovation
DLC	Downloadable Content
EC	European Commission
ERC	European Research Council
EU	European Union
FAD	Fostering Arts ant Design
FET	Future & Emerging Technologies
FP	Framework Programme
GDP	Gross Domestic Product
GII	Global Innovation Index
GPTs	General Purpose Technologies
H2020	Horizon 2020 Framework Programme
HCI	Human-Computer Interaction
HES	Higher Education Establishments
ICT	Information and Communication Technology
IGA	In-Game Advertising
IP	Intellectual Property
II	Incremental Innovation
KIA	Knowledge-Intensive Activities
KLS	Kobalt Label Services

LEITs	Leadership in Enabling & Industrial Technologies
MSCA	Maria Sklodowska-Curie Actions
MUD	Multi-User Dungeon
OECD	Organization for Economic Cooperation and Development
OTH	Other organizations
PRC	Private Companies
PUB	Public Sector
R&D	Research and Development
R&D&I	Research, Development and Innovation
R&I	Research and Innovation
REC	Research Organizations
RQ	Research Question
SEL	Social and Emotional Learning
SG	Serious Game
SME	Small and Medium Enterprise
SRL	System Readiness Level
STEAM	Science, Technology, Engineering, Art and Math
TRL	Technology Readiness Level
UK	United Kingdom
US	United States

CHAPTER 1
General Introduction

1.1. Theoretical introduction

Open innovation has impacted and enhanced organizations' collaboration strategies and public policy programs as EU-H2020. This new paradigm emerged from businesses' needs to adapt to changing circumstances after a global recession. In this new wave of innovation, companies refocused on organic growth and on their customers and consumer markets to enrich their business units and new corporate venturing initiatives. So, open innovation gained importance in organizations' innovation and new strategies as the cross-fertilization of knowledge and technologies became a path to develop new technological applications and market opportunities. Moreover, given the need for innovation systems that require the collaboration between organizations on local and international levels, governments are designing new programs and strategies to capture the benefits of investing in R&D programs. The EU-H2020 Framework Programme provides a balanced response to the main challenges faced by Europe: firstly, the need to maintain a strong expertise in key technology value chains; secondly, the necessity to move quicker from research excellence to market.

The video game industry is in constant evolution, concerned to know better the end user and incorporate him/her in the development process, integrating the latest technological advances in creation and distribution, cross-fertilizing with other fields to provide the user with better gaming experiences, thereby obtaining significant economic returns. This innovative characteristic of the field generates new relationships that push companies to determine the best approach for managing direct-to-consumer relationships, troubleshooting game issues, reducing gamer churn and preventing loss of gamer engagement. The digital end points, the lower barriers to entry for low-cost alternatives, and the need to innovate and join the group of disruptors are more critical than ever. This innovative character makes gaming one of the most competitive and attractive investment sectors, with an audience that grows from year to year in non-existing percentages in any other sector. Two of the video game applications that generate great opportunities in terms of cross-sector applications and impact on the market are: serious games and gamification.

The serious games market is promising in terms of research and development; however, it also represents a scattered industry with a variety of application areas and characteristics. As of today, there is no serious games market breakthrough. Reasons for these grand challenges include socio-economic aspects (development costs, quality, cost-benefit ratio), legal aspects (data protection and privacy), and a number of research and technical development related issues. Nevertheless, serious games provide a good opportunity for developer studios to cross-finance their own technology development or to bridge time between big(ger) entertainment productions eventually popping up due to unforeseen events. Gamification, as opposed to serious gaming, focuses on the integration of certain elements and mechanics from the field of gaming and game design into an existing (non-gaming) environment (Klevers *et al.* 2016). The business community is starting to realize the power it has to improve customer engagement, build loyalty, and incentivize employees and partners to perform at high levels. And the concept has the potential to solve a variety of problems outside the business world as well, in areas such as: health, education, public policy, tourism, sustainability, personal development –and the list continues to grow.

This thesis seeks to get insights about the innovation and technology challenges existing in the cross-fertilization of technologies when serious games or gamification are included, from basic research through technological commercialization, exploring the specificities of capabilities required to get a successful technology transfer process. In fact, the complete technological and innovative lifecycle of new products must solve the gap between academia, industry and market known as the "Valley of Death" (Debackere 2000; Flynn and Wei 2005; Linton and Walsh 2008; European Commission 2012; Mahroum and Al-Saleh 2013) and the so-called "European paradox" (Pavitt 1998; Debackere 2000; Flynn and Wei 2005; Linton and Walsh 2008; Mahroum and Al-Saleh 2013) which suggests a contradiction between higher levels of scientific performance on the one hand and the minimal contributions to industrial competitiveness and new venture entrepreneurship in Europe on the other (Paez-Aviles 2016).

Overcoming this gap to reach commercial success and the social return of research could be a difficult process if innovation challenges are not addressed. In fact, the future of industry will rely on its ability to innovate in high-tech activities that can offer a differential added value, rather than improving existing technologies and products (Juanola-Feliu *et al.* 2012; Motyl and Filippi 2014). Cross-fertilization of knowledge and technology is an innovation strategy. Most of the approaches of cross-fertilization have been focused on inter-disciplinarity (Egenfeldt-Nielsen 2008; Frans 2009; Hacklin *et al.* 2009; Porter and Youtie 2009; Rafols and Meyer 2010; Pilon and Tremblay 2013; Sedighi 2013; Schummer 2004) and partial technological convergence (Dang *et al.* 2010; No and Park 2010). Previous works have also analysed the cross-fertillization process by focusing on the inter-disciplinarity of research collaboration (Rafols and Meyer 2010; Van Rijnsoever and Hessels 2011; König *et al.* 2013; Sedighi 2013) but little attention has been paid to address innovation and technology transfer challenges for the successful commercialization of outcomes including serious games or gamification applications. This work contributes to a better understanding of the processes and ecosystems of innovation and thus, to reduce the Valley of Death gap between research and market.

The present thesis is the result of three years of research with a previous year of prospection and analysis of the video game industry ecosystem. The research was principally developed at the Economics department of the Universitat de Barcelona School of Economics and always inspired and supervised from the Physics Faculty of the Universitat de Barcelona. Additionally, there has been a research stay at the Senter for Innovasjon i tjenesteyting (Faculty of Economics and Social Sciences) of the Inland Norway University of Applied Sciences and at the Kunnskapsverket- Nasjonalt senter for kulturelle næringer.

1.2. Research motivation, objective and structure

Advancing on the introduction to this thesis, it becomes evident that research on innovation strategies is a growing and influential literature stream. The rapidly changing competitive landscape challenges organizations to become more innovative. Instead of falling prey to ever-changing market forces, some firms show great agility and strategic renewal as they relentlessly change and transform their business models in terms of innovation. Driven by a continuous quest for opportunities that put their activities and resources to better and more profitable use and allow them to create and capture more value, companies (but not only) frequently and consistently introduce new value propositions and new ways of value appropriation. Organizations' orchestration of activities within their activity systems and transformation of their business models through innovation to realize opportunities with the objective to increase value creation is part of the topic of this dissertation. Especially, how cross-fertilization of knowledge and technology creates adequate multidisciplinary knowledge and technology (Van der Bergh 2008; Adler and Heckscher 2006; Van Rijnsoever *et al.* 2015) to ensure the success of an emerging technology, and how important is the research and innovation that takes place in the practitioners' communities (Starkey and Madan 2001; Søraa *et al.* 2017); and a second view, how the management perspective presents the analysis of the innovation management strategies that boost the cross-fertilization of technologies (Almeida and Phene 2004; Maine *et al.* 2014).

Funding instruments can be used as a tool for policy makers to influence organizations and their level of technological diversity (Adler and Heckscher 2005; Edquist and Hommen 1999) and thus to secure the long-term viability of technology. Also, the use of specific technologies is encouraged to be recombined with others creating new applications or developing new uses to existing technologies. From an innovation perspective, concepts as serious gaming or gamification are an example. The creation and persistence of knowledge and technological multidisciplinarity depend on learning from their neighbourhood and network externalities. There is little empirical evidence about the characteristics of innovation projects that influence multidisciplinarity. Van Rijnsoever *et al.* (2015) demonstrated that diversity created by an innovation project is related to the network position and organization composition of a project. Adding to insights from innovation systems (Edquist 1997), Van Rijnsoever *et al.* (2015) argue that it is also important to consider the structure of the network to make a technology successful in the long term.

The international multidisciplinarity of collaborative research projects should be beneficial to technological diversity creation, but this implication has not been tested empirically. From this knowledge and technology perspective, these current approaches are extended by the study of the influence of the characteristics of EU-funded serious games and gamification related projects on the creation of multidisciplinarity. Additional novel variables that have a plausible influence on diversity creation are included in the study.

Furthermore, to understand technological multidisciplinarity, a deep analysis of the content of the documents is needed. An approach is to look at the network of citations of the documents (Rafols and Meyer 2010). A different one is using pre-existing categories like patent classes to measure diversity (Jonard and Yfldizoglu 1998; Rafols and Meyer 2010). Yet, these approaches are mainly applicable to patent, Web of Science categories or publication data, and not to H2020 projects. Hence, to study multidisciplinarity, topic modelling was applied (Leydesdorff *et al.* 2014) as a novel approach to categorize the most relevant topics and thematic areas that are described in 87 projects including 519 organizations. This method allows calculating multidisciplinarity in an efficient manner (Paez-Aviles 2017).

The change in knowledge and technological diversity caused by a project was related to the independent variables mentioned above and results have shown that the largest contribution to diversity comes from the multidisciplinary nature of a project and the knowledge base of the organizations in a project. Moreover, the obtained results largely confirm the results by Van Rijnsoever *et al.* (2005) and Paez-Aviles (2017). These results aim to open the reflection as how policy makers can use public subsidies to influence the level of diversity in a technological field.

The importance of having mechanisms for systematic management of innovation has been widely recognized and investigated (Burns and Stalker 1961; Parker 1982; Kanter 1983; Leonard-Barton 1992; Christensen 1997). Chiesa *et al.* (1996) developed an innovation audit model that tests a set of organizational innovation management good practices, in order to determine the firm's innovation capabilities. This model is based in the exploration of "key" innovation processes (new concept generation, new product development, process redefinition, technology acquisition) plus other "support" activities (leadership and culture, resource allocation, organizational systems). Other models of functional analysis were proposed by Yam *et al.* (2004) and Heinz *et al.* (2006).

Technological diversity leads to opportunity creation (Pisano 2006; Subramanian and Soh 2010) and there is enormous potential for innovation from the confluence of technologies (Sharp *et al.* 2011). Maine *et al.* (2014) go a step forward and explore how the convergence of technologies can lead to the creation of radical innovation and subsequently the emergence of new industries. According to Maine *et al.* (2014) there are three central innovation management strategies in this convergence: i) *to import ideas from broad networks*, ii) *to create environments for deep collaboration* and iii) *technology-market-matching*. The first strategy refers to the search and synthesis of ideas that could be taken up from networks with different technology streams. The second strategy involves the dynamic collaborative flow of knowledge between R&D groups. Finally, these two strategies need to be complemented by considering market needs, which is the third strategy (Paez-Aviles 2017).

The present study is based on the three aforementioned strategies, considering also other aspects related to network theories, absorptive capacity and dynamic capabilities' literature. The aim is to obtain an expanded vision of these three strategies and the possible influence they could have on the cross-fertilization of technologies including gamification and serious games. To that end, a survey addressed to all the project coordinators of H2020 projects including gamifications or serious games technologies was answered by the 74% of the sample. It was focused on the strategies defined by Maine *et al.* (2014) in order to get insights about the level of applicability of these technologies and their organizations, the level of cross-fertilizations in their projects, and their innovation management strategies.

This thesis is structured as follows. Chapters 2 and 3 present the themes that will be the base for introducing the research questions that structure this thesis. Common themes that emerged from studying innovation strategies and the underlying dynamics in EU-funded research projects including serious games and gamification are highlighted (chapter 4). And a brief overview of the essays that comprise this thesis is presented in the reminder of this chapter. The subsequent three chapters of this thesis are followed by a presentation of the final conceptual framework of innovation through cross-fertilization, integrating the preceding research, its outcomes and contributions. This final chapter discusses the overall theoretical and managerial implications of the dissertation, emphasizes its contributions, outlines the limitations, and presents the avenues for future research.

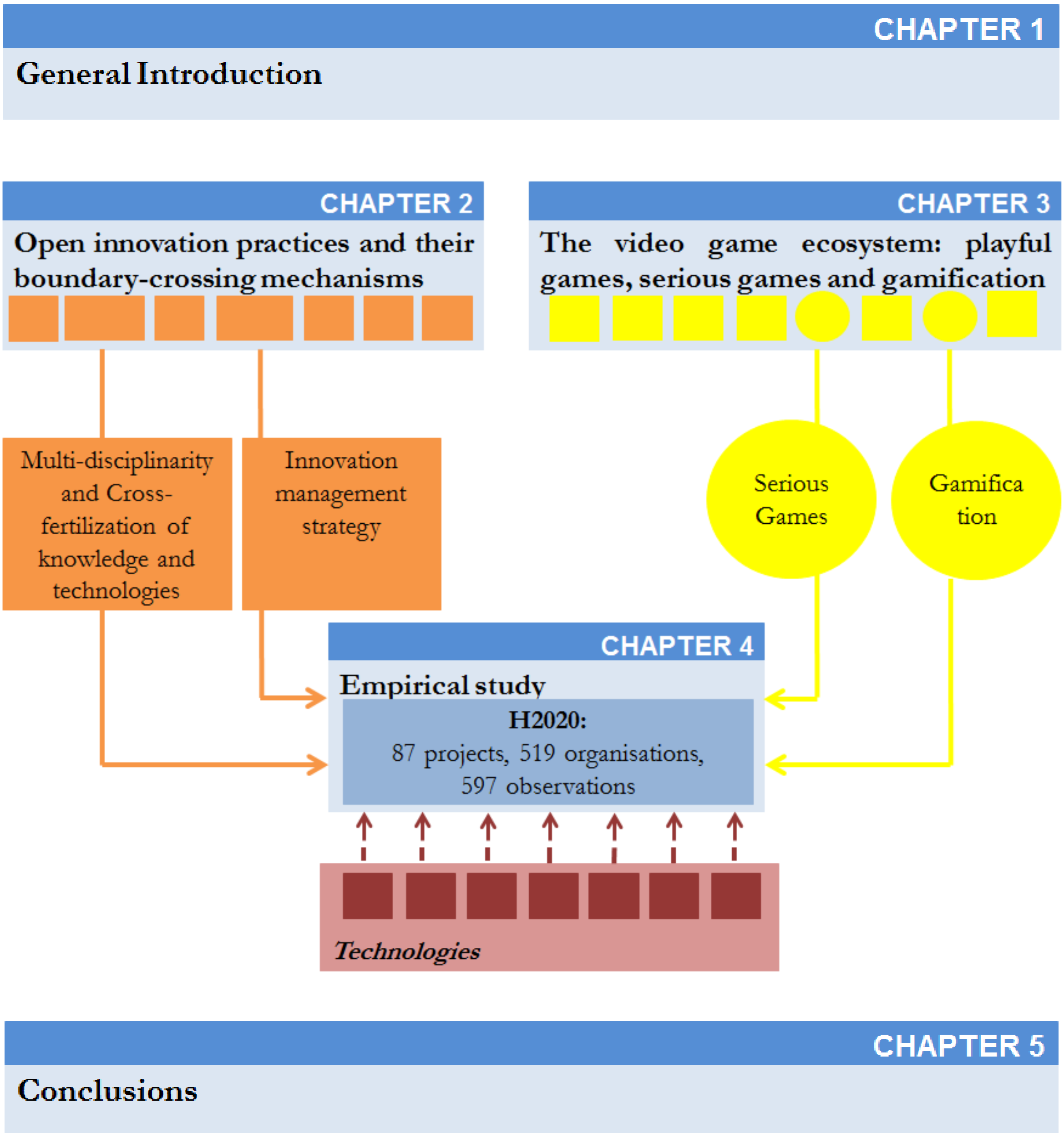


Figure 1.1. Structure of the dissertation

1.3. Research questions

This thesis seeks to get insights about the innovation and technology challenges existing in the cross-fertilization of technologies when serious games or gamification are included, from basic research through technological commercialization, exploring the specificities of capabilities required to get a successful technology transfer process.

The research focus of this work takes into account public funding, focusing on the relations inside the innovation ecosystems and how collaborative consortia add value along the value chain. Following up on these motivations, the general question this dissertation aims to answer to complement the burgeoning research in this area is:

How is the process of cross-fertilization of knowledge and technologies in H2020 projects including gamification and/or serious games?

As cross-fertilization of technologies is a highly complex phenomenon, this research has focused on de-structuring the phenomenon into four research questions addressed in two specific perspectives: Knowledge-Technology and Management. These research questions I ask in chapter 4 are the following:

RQ1. Is there a high degree of Multidisciplinary Knowledge and Technology in projects including Serious Games and/or Gamification?

RQ2. Is importing ideas from broad networks in projects including Serious Games and/or Gamification an indispensable innovation management strategy to increase the creation of knowledge, processes or services for being transferred to the market and fulfilling market needs?

RQ3. Is creating a collaborative environment in projects including Serious Games and/or Gamification an indispensable innovation management strategy to increase the creation of knowledge in order to obtain or improve products, processes or services ready for being transferred to the market and fulfilling market needs?

RQ4. Is the technology-market matching in projects including Serious Games and/or Gamification an indispensable innovation management strategy to increase the creation of knowledge in order to obtain or improve products, processes or services ready for being transferred to the market and fulfilling market needs?

1.4. Research design

1.4.1. Sample selection

The study focused on those projects in which serious games and gamification are one of the technologies included. Specifically, all the projects including serious games and/or gamification and funded by the European Union through any Horizon 2020 work programme have been selected as subject of study.

Horizon 2020 is the EU Research and Innovation programme with nearly €80 billion of funding available over 7 years (2014 to 2020) and is divided into 3 three pillars and 2 specific objectives corresponding to its main priorities:

- Excellent Science
- Industrial Leadership
- Societal Challenges
- Specific objective 'Spreading excellence & widening participation'
- Specific objective 'Science with and for society

The study sample were the granted projects covering the period between 2014 and 2016 (April), selecting only the 87 projects including serious games and/or gamification technologies. The EU contribution received by these 87 projects was 201,714,160 €.

These projects are shown below (**Tables 1.1, 1.2, 1.3, 1.4**), classified under the specific funding schemes of each pillar or specific objectives. The total number of projects is shown with their funded budget and the total budget of the six years. In terms of number of projects (43) and funded budget (122.78 € millions), the Industrial Leadership pillar (**Table 1.2**) is the most relevant category for the projects including Serious Games and/or Gamification. Concerning the number of projects, the second most important pillar is Societal Challenges (**Table 1.3**) with 27 projects followed by Excellent Science (**Table 1.1**) with 16; but in terms of funded budget the amount of the Excellent Science category (38.56 € millions) is superior to the Societal Challenges pillar (36.4 € millions). All the funded projects under study are included in the following categories:

1. Excellent Science:

The Excellent Science part of H2020 supports world-class science in Europe, by developing, attracting and retaining research talent and supporting the development of the best research infrastructures.

Table 1.1. Funded projects including serious Games and/or gamification in the Excellent Science category

Excellent Science: Categories	€ million Total funding 2014-2020	N	€ million Funded Budget 2014-2016 April
European Research Council (ERC) Frontier research by the best individual teams	13095	8	18.73
Future & emerging technologies Collaborative research to open new fields of innovation	2696	2	6.16
Marie Skłodowska-Curie actions (MSCA) Opportunities for training and career development	6162	6	13.67
Research infrastructures (including e-infrastructure) Ensuring access to world-class facilities	2488	0	0
TOTAL	**24441**	**16**	**38.56**

2. Industrial Leadership:

The Industrial Leadership supports key technologies, such as microelectronics, advanced manufacturing, etc. across existing and emerging sectors. It also aims at attracting more private investment into R&I and supporting the increase of innovative SMEs in Europe.

Table 1.2. Funded projects including serious games and/or gamification in the Industrial Leadership category

Industrial Leadership: Categories	€ million Total funding 2014-2020	N	€ million Funded Budget 2014-2016 April
Leadership in enabling & industrial technologies (LEITs) (ICT, nanotechnologies, materials, biotechnology, manufacturing, space)	13557	ICT 35 (12 are from ICT-24-16 Gaming and Gamification) Nanotechnologies: NMP 1 Manufacturing: FoF 1	118.76 4.02 0.05
Access to risk finance Leveraging private finance & venture capital	2842	0	0
Innovation in SMEs Fostering all forms of innovation in all types of SMEs	616	SMEInst 4 INSO 1 INNOSUP 1	0.2 0.05 0.08
TOTAL	**17015**	**43**	**122.78**

3. Societal Challenges:

The pillar of Societal Challenges supports R&I that target society and citizens (climate, environment, energy, transport, etc.). It supports the development of breakthrough solutions coming from multidisciplinary collaborations, which include social sciences and humanities.

Table 1.3. Funded projects including serious games and/or gamification in the Societal Challenges category

Societal Challenges: Categories	**€ million Total Funding 2014-2020**	**N**	**€ million Funded Budget 2014-2016 April**
Health, demographic change & wellbeing	7472	PHC 5	21.72
Food security, sustainable agriculture and forestry, marine/maritime/inland water research and the bio-economy	3851	BBI 1 WATER 1 WASTE 1	1.35 1.21 8.82
Secure, clean & efficient energy	5931	Sesar 1 EE 6	1.00 11.38
Smart, green & integrated transport	6339	0	0
Climate action, environment, resource efficiency & raw materials	3081	SC5 2	3.31
Europe in a changing world - Inclusive, innovative & reflective societies	1310	YOUNG 1 CULT-COOP 1 INSO 1	2.56 2.37 0.05
Secure societies	1695	FCT 6 DRS 1	31.40 5.00
TOTAL	**29679**	**27**	**36.40**

4. Specific objectives: 'Spreading excellence & widening participation' and 'Science with and for society'

Table 1.4: Funded projects including serious games and/or gamification in the Specific Objectives category

Specific objectives: Categories	**€ million Total Funding 2014-2020**	**N**	**€ million Funded Budget 2014-2016 April**
Spreading excellence & widening participation	462	0	0
Science with and for society	462	SEAC 1	3.97

H2020 also provides funding for research partnerships that boost the competitiveness of EU industry in strategic sectors. These big groups of projects are the Joint Technology Initiatives and the Joint Programmes of Member States**.** These initiatives have their own calls for proposals but in this case of study no project including serious games or gamification has been identified.

It is striking that 35 projects were granted under the Information and Communication Technologies Call (ICT), considered a priority in the Leadership in enabling & industrial technologies (LEITs) actions. Furthermore, 12 of those 35 projects are from ICT-24-16 Gaming and Gamification, the second time that the European Commission creates a specific challenge for those technologies –the first time was the call ICT-21-14.

The **ICT-Leadership in Enabling and Industrial Technologies (LEIT)** Work Programme under H2020 provides a balanced response to the main challenges faced by Europe in the field: firstly, the need to maintain a strong expertise in key technology value chains; secondly, the necessity to move quicker from research excellence to the market.

It combines a strong support to industrial roadmaps with new mechanisms to encourage disruptive innovation. The former will reinforce medium to long term commitment to industrial strategies and provide continuity and stability. The latter will offer flexibility and openness and will help develop dynamic eco-systems in which innovators can operate. Both strands will require the involvement of new actors, on one hand to exploit and leverage new technologies and on the other to initiate and drive change.

Six main activity lines have been identified in the ICT-LEIT part of the Work Programme:

1. A new generation of components and systems
2. Advanced Computing
3. Future Internet
4. Content technologies and information management
5. Robotics
6. Micro- and nano-electronic technologies, Photonics

In addition, the Work Programme features several cross-cutting topics addressing cyber-security, Internet of Things and research on a Human-centric Digital Age. All activities are complemented with support to innovation and take-up, international cooperation and a dedicated action for SMEs to propose bottom-up innovative ideas, using the SME instrument.

Inside ICT-LEIT we find two specific calls in Gaming within the Horizon 2020 program: **the ICT 21-2014 (Advanced digital gaming and gamification technologies)** and the **ICT 24-2016 (Gaming and gamification)**. On the one hand, advanced gaming concepts are seen as both a promising innovative technology and a key driver of creative industries in Europe. These calls explicitly include serious games as those using game concepts and game technologies in an application area beyond entertainment. On the other hand, the calls address the field's current complexity, variety, and diversity, resulting in a scattered industry. Serious games and gamification are implemented in manifold application areas (Sawyer and Smith 2008) with different stakeholders involved as well as specific technological and socio-economic characteristics. These calls in Gaming were the following:

- **ICT 21-2014: Advanced digital gaming and gamification technologies**

  Digital games and gamification mechanics applied in non-leisure contexts is an important but scattered industry that can bring high pay-offs and lead to the emergence of a prospering market. Digital games can also make a real change in the life of a large number of targeted excluded groups, enhancing their better integration in society. This requires however the development of new methodologies and tools to produce, apply and use digital games and gamification techniques in non-leisure contexts, as well as building scientific evidence on their benefits - for governments, enterprises and individuals. 4 of the analysed projects received funds from this call.

- **ICT-24-2016: Gaming and gamification**

  This specific call[1] for Gaming and gamification demonstrates how strategic these technologies are for the European Commission and 12 of the analysed projects

[1] HORIZON 2020 – Work Programme 2016-2017, Information and Communication Technologies: http://ec.europa.eu/research/participants/data/ref/h2020/wp/2016_2017/main/h2020-wp1617-leit-ict_en.pdf

were funded under this call. The software games business is growing fast. Its technological and methodological underpinnings have been laid down in years of research and development. At a significantly lower scale, they are now finding their way into non-entertainment contexts, helping deliver substantial benefits, particularly in education, training, research and health. Recent European research projects identified comprehensive roadmaps and created resources and state-of-the-art knowledge for European players to develop applied games more easily, faster and more cost-effectively. The challenge is to mainstream the application of gaming technologies, design and aesthetics to non-leisure contexts, for social and economic benefits. Supporting the expansion of applied gaming and gamification would not only create new solutions and methodologies to address societal issues, but it would also help SMEs to seize new business opportunities.

The scope defined by the call focuses on the technology transfer through small scale experiments on developing and validating open gaming technologies and mechanics including from sectors other than the gaming industry into non-leisure situations and scenarios for training and motivational purposes. Actions should integrate contributions from game developers, researchers from social science disciplines and the humanities, publishers, educational intermediaries and end-users. Activities should include work on gaming technologies (augmented and mixed reality, 3D audio and video, virtual worlds, interactive storytelling, narratives, modelling and data, etc.), learning and behavioural triggers (pedagogical effectiveness, engagement, creativity, collaborative behaviours, proactive) and social science aspects (potential risks and challenges, privacy, gender and ethical issues etc.).

The expected impact emphasizes the increased take up of gaming technologies in non-leisure contexts – and specifically in education and for social inclusion, measured by the number of new businesses and applications generated by the action. It demonstrates how the focus on Serious Games and Gamification is very strategic for this call, encouraging the use of the gaming technologies and its mechanics in new sectors, exploring new non-leisure situations and scenarios.

After having presented the *Information and Communication Technologies Call (ICT)* and specifically the *ICT-21-2014: Advanced digital gaming and gamification technologies* and the *ICT-*

*24-2016: Gaming and gamificati*on (and the importance of the Serious Games and Gamification for the European Commission), the focus is placed again on the sample selection of the present study.

The study is based on the data obtained from the Community Research and Development Centre (http://cordis.europa.eu/), a public repository and open access portal of the EC providing information of EU-funded research projects. **Figure 1.2** summarizes the pathway for selecting the cases.

A total of 87 projects were obtained and 519 organizations as coordinators and participants were retrieved. Since some organizations participate in more than one project, a total of 597 observations have been considered for the descriptive analysis. All the organizations were classified into five categories according to the established categories from H2020:

- **Higher or Secondary Education Establishments (HES).** They are legal entities that are recognized as such by their national education systems. They can be public or private bodies.
- **Research Organizations (REC).** They are legal entities that are established as non-profit organizations and whose main objective is carrying out research or technological development.
- **Private for-profit entities** (**PRC**). They are organizations from the private sector, including small or medium-sized enterprises and excluding Universities and Higher or Secondary Education Establishments.
- **Public bodies** (**PUB**). They are any legal entity established as public body by national law or an international organization. Research Organizations and Secondary or Higher Education Establishments are excluded.
- **Other (OTH)**. Any entity not falling into one of the other four categories.

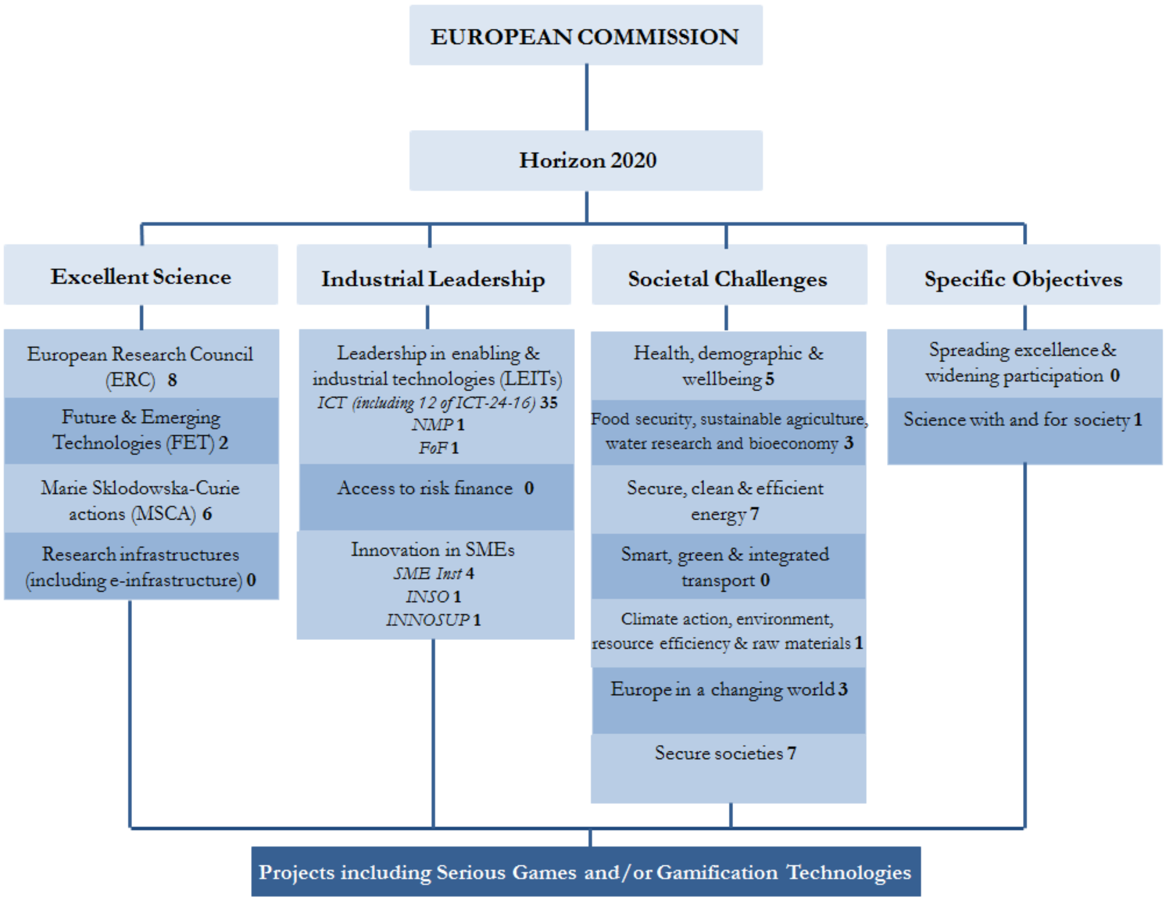


Figure 1.2. Sample selection pathway

1.4.2. Methodology

1.4.2.1. Database

In early 2016, the information retrieved from the selected projects was used to create a new database including the 87 projects with their 519 organizations and 597 observations, detailing any characteristic. Clearing, filtering and detection of errors took months of work to obtain the final database. Later, it was analysed in-depth through descriptive statistics, network graphs and text mining approaches in order to have a complete overview of the elements of study. Next, to analyse the creation of multidisciplinarity, the Topic Modelling approach was used. This is a novel text mining method for categorizing technological alternatives from text data. This method allows the calculation of multidisciplinarity creation in a more efficient manner than in conventional qualitative approaches. Finally, the analysis was complemented with the use of external databases, indexes and rankings.

1.4.2.2. Survey

In order to get insights about the Innovation Management Strategies, in middle 2017, a project coordinators survey was conducted for the second section of the study. They were contacted mainly by e-mail (in some case a phone contact was required) and this information was retrieved from the projects web sites, institutions web sites and in some cases contacting directly with the administration of their institutions.

The hypotheses formulated for this section were mainly tested through an in-depth statistical analysis. This survey was only addressed to the coordinators of the 62 collaborative projects including serious games and/or gamification technologies and funded by H2020. A total of 46 complete responses were received resulting in a 74.1% response rate. This response rate is extremely superior to those of e-mail surveys involving senior executives –typically with very lower response rates (Kriauciunas *et al.* 2011).

The survey consisted of a questionnaire that asked respondents: (a) to identify the type of organization they worked for; (b) to identify relevant project's information; (c) to identify relevant information related to knowledge and technology; (d) to indicate the importance of collaborative experience; (e) to indicate how the market orientation is in the project; (f) to make any other comments they wished about the opportunities and/or challenges presented by cross-fertilization collaborations; and (g) to indicate their acknowledgement and consent form.

1.4.2.3. Personal interviews

Some personal interviews were conducted with independent experts. The main objectives of these interviews were the following: (1) understanding the interests of the agents involved in the gaming ecosystem, (2) a better understanding of some relevant findings of the study, and (3) having elements for the subsequent analysis and discussion of the results. I divided the interviews in two blocks:

- **Face-to-face interviews with experts of the video game ecosystem**. These interviews took place at the beginning of this doctoral dissertation with an additional objective to those previously announced: to help define the object of study and design of the thesis. In order to know more about how the video game industry perceive the opportunities to mainstream the application of gaming technologies, design and aesthetics to non-leisure contexts, I decided to contact relevant experts of the Catalan video game ecosystem. The respondents were encouraged and given the opportunity to explain in detail their feelings, experiences and opinions on the focus of this study. According to the Triple Helix model originated from the study of science and technology (Etzkowitz and Leydesdorff 2000; Mirowski and Sent 2007), I divided the respondents in three groups: industry (six), university (three) and government (four). They were the following:

Table 1.5. Face-to-face interviews with experts of the Catalan video game ecosystem

COMPANIES	**Mr. Andreu Taberner** *CEO of* Creatiulab	www.creatiulab.com
	Mr. Javi Sanz *Art director and CEO of* Ravalmatic	www.ravalmatic.com
	Ms. Inma Chapín *CEO of* Omada	www.omada.es
	Ms. Eva Gaspar *CEO of* Abylight *and president of* PAD-Professional Associated Developers	www.abylight.com
	Mr. Pere Torrents *Co-director of* GAMEBCN *and Marketing Manager of* Incubio	www.gamebcn.com
	Ms. Maria Teresa Cordón *Managing director of Barcelona Studio of* UBISOFT	www.ubisoft.com
UNIVERSITIES	**Mr. Jesús Alonso** *Manager of the following Masters: Video Game Design and Programming, Digital Art and Animation, Mobile Business & Apps Design at* UPC School of Professional and Executive Development	www.talent.upc.edu
	Mr. Òscar G Pañella *Academic Director of* ENTI the Video game School *and CEO of* Cookie Box	www.enti.cat
	Mr. Sergi Grau *Dean of the Science and Technology Faculty of* Universitat de Vic	www.uvic.cat
ADMINISTRA_ TION	**Ms. Marisol López** *Digital Manager at* ICEC –Institut Català de les Empreses Culturals	www.icec.gencat.cat

Ms. Montse Basora *COO of Entrepreneurship of* Barcelona Activa	www.barcelonactiva.cat
Ms. Ana Majó *Director of Strategic Sectors and Innovation at* Barcelona City Council	www.barcelona.cat
Ms. Itziar Blasco *Head of mStartup Barcelona* of Barcelona Activa	www.barcelonactiva.cat

All these personal interviews took place between February and May 2016 in the headquarters of each organization. The respondents answered the same questionnaire, divided in seven content blocks, during a face-to-face interview. The structure of the questionnaire is as follows:

- BLOCK 1. Identification and general information on your organization
- BLOCK 2. Profile of the respondent
- BLOCK 3. Innovation
- BLOCK 4. Industry-University collaboration
- BLOCK 5. Strategy and business model
- BLOCK 6. Opportunities and future trends
- BLOCK 7. Serious games and gamification

- **Face-to-face interviews with diverse experts in order to obtain specific information or clarify some of the findings of this study**. These experts were asked only about those findings that needed to be clarified, complemented or developed for a better comprehension. They were the following:

Table 1.6. Face-to-face interviews with independent experts from diverse fields

Name and position	Interview date and location
Runa Haukland *CEO of* Hamar Game Collective (HGC). Hamar, Hedmark, Norway	April 18, 2016 at HGC Hamar, Norway.
Simon McCallum *Associate Professor* at the Faculty of Information Technology and Electrical Engineering, NTNU Norwegian University of Science and Technology. Gjøvik, Norway	April 20, 2016 at the NTNU, Gjøvik, Norway.
Javier Celaya	May 29, 2017 at

CEO and founder of Dosdoce.com *Vice president of ARDE* (the Spanish Digital Magazines Association) and member of the Executive Board of the Digital Economy Association of Spain	Caixaforum, Barcelona
Simon Lee *CEO of* Peninsula *and director* of Canòdrom (the Creative Research Park of Barcelona)	May 30, 2017 at Caixaforum, Barcelona.
Daniela Tost *Head of the Computer Graphics Division and Specialist in 3D visualizations, serious games, gamifications and simulations at the* UPC (Technical University of Catalonia) *Director of* CREB (Biomedical Engineering Research Centre) UPC	April 19, 2018 at CREB UPC, Barcelona.
Juan Pérez *Head of European projects* CIT (Technology Centre) of UPC (Technical University of Catalonia)	April 26, 2018 at CIT UPC, Barcelona.

The methodology applied in the three sections is summarized in **Figure 1.3**.

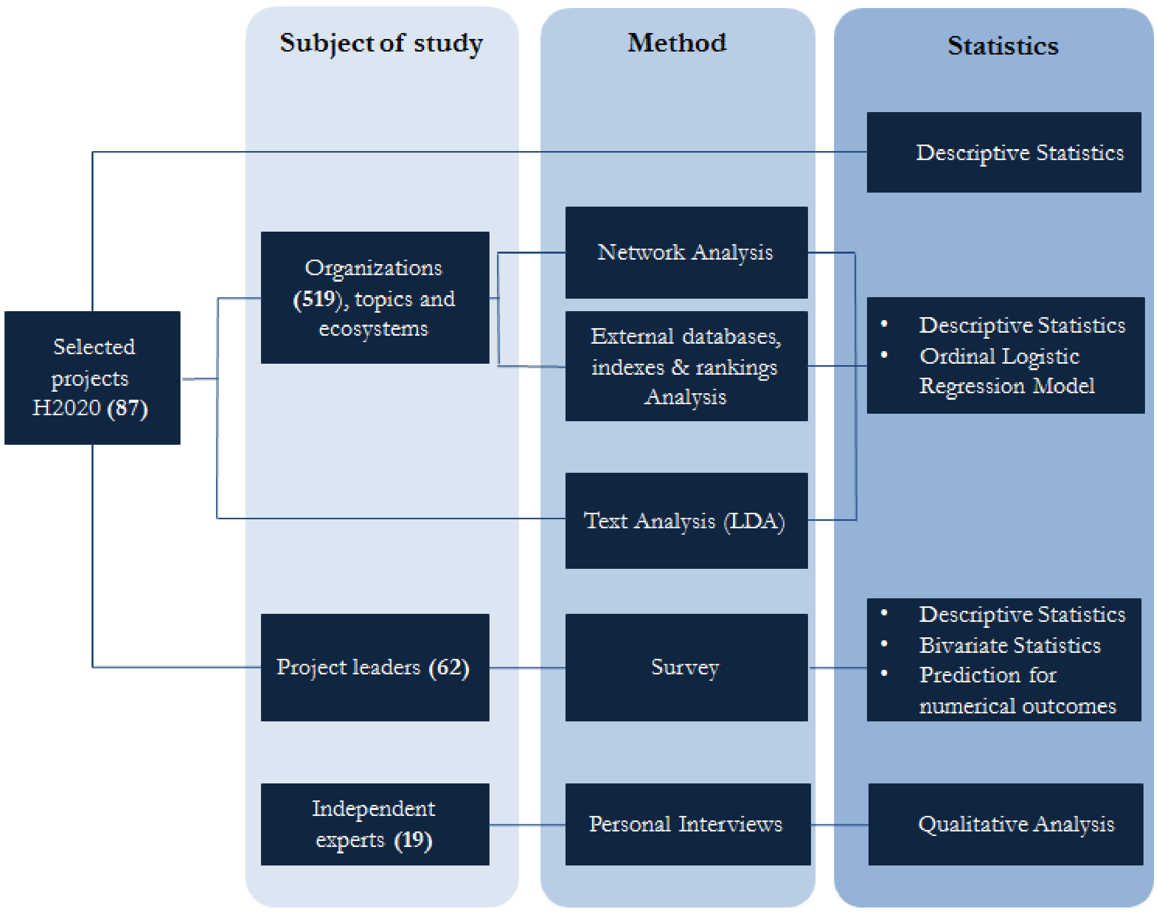


Figure 1.3. Summary of the methodology used in the empirical study

1.4.3. Analysis

1.4.3.1. Database

In the first place, an in-depth descriptive statistical analysis was performed for the entire sample of projects (87 projects with their 519 organizations and 597 observations) in order to get insights into the characteristics of the elements of analysis. Second, the subsequent focus on the organizations required the use of Lattice plot correlation, network graphs and text mining approaches to complement the previous descriptive statistical analysis. Finally, some variables required to be complemented by the analysis of external databases, indexes and rankings.

1.4.3.2. Survey

Firstly, a descriptive analysis was performed for the entire sample of collaborative projects' coordinators (74.1% response rate) in order to get information on the projects consortia. Later, I decided to select certain exogenous variables that influence directly in the development of other endogenous variables. So, I chose some key variables that firstly I crossed between them and then with the rest of variables, developing diverse bivariate statistical tests. These findings were complemented by statistics for predictions of numerical outcomes.

1.4.3.3. Personal Interviews

This qualitative analysis used the data obtained from several face-to-face interviews, all of them following a structured questionnaire. This information was written up into a report and a final chart, comparing the answers between the different interviewees who represent the Catalan video game ecosystem according to the Triple Helix Model. Complementarily, shorter interviews took place with additional independent experts to discuss or getting knowledge of some specific findings. Finally, all these data was used to complement and discuss some of the most relevant findings of this present study.

1.5 Overview of the chapters and their contributions

This dissertation pays close attention to the context in which innovation ecosystems unfold and its underlying innovation strategies and business model dynamics, which are reflected in the diversity of organizations, their contexts and their fields they are embedded in, studied across several chapters. Following is a brief overview of each of the chapters that form part of this thesis, including the key focus of the chapter and key contributions to the literature.

1.5.1. Open innovation practices and their boundary-crossing mechanisms

This chapter aims to help understanding the genesis of open innovation processes applied to the field of cultural organizations and how these are in constant evolution and transformation. Also, the chapter goes beyond showing how the cross-fertilization of knowledge and technology can be considered a disruptive innovation strategy. In addition, the presented theories connect with an interpretation that I formulate inspired by Bauman's liquid modernity that leads me to affirm that we are in front of the era of liquid technology.

Based on an analysis of extant literature and illustrated by specific case studies, the chapter analyses how the concept of innovation, which is of purely economic origin, has changed over time and up to the present day, progressing through different discourses, spaces and times. Its impact on Western economies has changed the way innovation is perceived: as an axis that has transversely penetrated our society up to the sphere of culture, a space that seeks its own process of adaptation and transformation. Additionally, best practices and case studies of cross-fertilization of knowledge and technologies are presented. Thus, I suggest that this framework provides a valuable guide to practitioners who wish to know, understand and develop generative and sustainable relationships with fringe stakeholders or other closer to their knowledge, field of work or value chain position. Likewise, I view cross-cultural bridge building as an important contributor to value creation in cross-sector collaborations, which has been absent in previous analysed works.

This chapter contributes in the debate over the term innovation and its evolution. Through certain positions, the emergence of innovation in the cultural sector is presented –making understandable as certain practices initially used by science and technology-based companies are transferred to the field of cultural industries. This analysis does not intend to be exhaustive, but rather through certain positions, I advance to define how innovation is implemented in culture, a space that is not exempt from tensions, contradictions and conflicting positions. Other related key concepts are presented, such as value generation and disruptive innovation in order to reach the concept of open innovation. Also, the chapter illustrates the importance of cross-fertilization of knowledge and technology, opening up new sub-spaces in the technical performance and functionality space and, by so doing, to create value for users. Furthermore, the complexity of innovation increases, while efficiency and consistency of the process decrease, but the cross-fertilization of knowledge and technologies is strategic for developing liquid technologies that will be applied in an increasingly liquid society.

1.5.2. The video game ecosystem: playful games, serious games and gamification

By considering video games one of the main elements of renewal and modernization of leisure forms in the last decades, this chapter yields a more comprehensive understanding of the constant evolution of the sector, incorporating the latest technological advances in the creation and distribution of video games in order to provide users with better gaming experiences, thereby obtaining substantial economic return. Also, the relationship between developers and players has evolved to a cooperation in which the player is the most important step of the value chain.

Based on an analysis of extant literature, revision of data and indicators (from the latest's trade publication, reports, market researchers, annuaries and official databases) and illustrated by specific case studies, the chapter seeks to identify and reflect on the factors critical to success in the industry of video games and new factors that may arise and contribute to the future success of this dynamic and constantly changing industry, including the analysis of two application fields developed by the video game ecosystem: the serious games and the gamification.

For the development of this research, I consider five specific objectives: firstly, mapping the value-chain and power relationships in the video game industry; secondly, identifying and discussing the appearance of new business models; thirdly, exploring the trends, challenges and opportunities opened by a new concept in the developer-consumer relationship, advancement of new technologies and the decision to exploit the Internet as a platform for games; fourth, identifying and analysing the specificity of the serious games and exploring the opportunities of the serious games industry; and fifthly, exploring the strategies and challenges of the gamification.

This research contributes to the gaming economy literature in three primary ways. First, the chapter defines the new scenario that provides a quasi-direct relationship of the development companies with the end users, avoiding the existing network of intermediation in the traditional value chain. This model facilitates the disintermediation in the process of editing the video game, reducing, or even eliminating the role of the publisher and increasing the relevance of developers. Second, the chapter analyses the business models focused on monetization, attending to new opportunities and challenges. Third, the research contributes to identify and analyse the opportunities (in terms of development and market) of the serious games and gamification, especially when they cross-fertilize knowledge and technologies from different fields.

1.5.3. Empirical study

Two characteristics found in the innovation ecosystems, the level of multidisciplinarity and the level of cross-fertilization of technologies, are deeply analysed in this chapter. One important benefit of multidisciplinarity relates to the nature of innovation, which often results from combining existing technologies or knowledge base (Ethiraj and Levinthal 2004). In this chapter, the aim is to further analyse a proposed innovation model so that the long-term success of cross-fertilized technologies including serious games and gamification could be achieved. The main idea is that, in an investment decision where available options may recombine and give birth to an innovative option (technology), some degree of diversity of parent options can lead to higher benefits than specialization (Zeppini and van der Bergh 2010). In a H2020 context, industry players and research institutions gain mutual benefit and learning from collaboration, which complements their internal research and development activities (Hanel and St-Pierre 2006; Kautt *et al* 2007;

Rothaermel and Ku 2008). In this chapter, the success of the global collaboration strategy is studied from two relevant perspectives for any innovation ecosystem: Knowledge-Technology and Management.

The **Knowledge and Technology perspective** takes into account the evolutionary economics literature that states that the long-term success of an emerging technology requires the sufficient creation of multidisciplinary knowledge and technology among its alternatives in the system (Van der Bergh 2008; Adler and Heckscher 2006; Van Rijnsoever *et al.* 2015). Having sufficient multidisciplinary knowledge and technology helps to prevent an early lock-in, facilitates recombinant innovation, increases resilience of a technology in case of unexpected circumstances, and allows market-growth (Dosi 1982; Adlet and Heckscher 2006; Negro *et al.* 2008; Paez-Aviles 2017). Besides, multidisciplinarity within projects enhances recombinant innovation (Baber *et al.* 1995; Rhoten 2004; Schmickl ant Kieser 2008; Fernández-Ribas and Shapira 2009), facilitating the possibility of new combinations and the cross-fertilization of technologies to increase the possibilities of transferring new outputs into the market.

The **Management perspective** is essential to complete successfully the process to overcome obstacles when generated outputs are transferred into the market, fulfilling the market needs. In terms of consumer demand, the technology matches a market when the technology performs a task that a consumer desires (Hellmand and Boks 2006). But the more technologies that are intended to be cross-fertilized, the more complex the process of technological transfer and commercialization is. This scenario leads me to think that the way this complex process is managed should not be based on conventional management strategies. In this regard, this section presents the analysis of the innovation management strategies that could boost the process of cross-fertilization of technologies including serious games and/or gamification. Innovation management strategies are indispensable in a convergent scenario (Almeida and Phene 2004; Maine *et al.* 2014) when the process gains complexity from managing different technologies and collaboration is becoming a key source of competitive advantage.

These perspectives are analysed with the information retrieved from an own database of 87 H2020 projects including serious games and/or gamification, 519 organizations and 597 observations. Later, in order to get insights mainly into the Innovation Management

Strategies, a project coordinators survey was conducted. This survey was addressed to the coordinators of the 62 collaborative projects including serious games and/or gamification technologies and funded by H2020. A total of 46 complete responses were received resulting in a 74.1 response rate. This response rate is extremely superior to those of e-mail surveys involving senior executives (Kriauciunas *et al.* 2011). Finally, some personal interviews were conducted with independent experts. The main objectives of these interviews are the following: (1) understanding the interests of the agents involved in the gaming ecosystem, (2) a better understanding of some relevant findings of the study, and (3) having elements for the subsequent analysis and discussion of the results. These face-to-face interviews are divided in two blocks: (1) with experts of the video game ecosystem and (2) with experts of diverse fields in order to obtain specific information or clarify some of the findings of this study.

The reasons for selecting this sample of EU-funded research projects are the following. Firstly, creating new multidisciplinary knowledge and technology usually takes place in innovation projects in which the more connected organizations are, the higher the degree of local clustering (Wasserman and Faust 1994). In the case of universities, research organizations and private companies, strategic partnerships designed to run for long time deliver greater and often unanticipated benefits to all parties through a virtuous circle of interactions (Edmonson 2012). Secondly, taking the demand side as a starting point, the European Commission[2] identified the most promising areas of innovation for the cross-fertilization of technologies that address clear industrial and market needs in a broad number of industrial sectors. Therefore, multidisciplinarity and cross-fertilization are clearly encouraged and evidenced in EU-funded projects.

From the knowledge and technology perspective, this research contributes to define the guidelines to policy makers, especially at the EU-level, for fostering the success of emerging technologies on the basis of their cross-fertilization and the creation of multidisciplinary knowledge. The degree of the multidisciplinarity of a project and a large knowledge base enhances recombinant innovation, increasing the possibilities of emerging and transferring the new technologies into the market. From the management perspective, findings could be used as a guideline for policy makers and project leaders that aim to

[2] https://ec.europa.eu/growth/sites/growth/files/docs/body/cross-cutting-kets-roadmap_en.pdf

create innovation on the basis of the cross-fertilization of knowledge and technologies. Managing innovation is essential to increase the creation of knowledge, to understand the competitive implications of partners' selection and to develop strategies or actions in order to influence the productivity, to develop collaborative strategies and fidelity actions for a better understanding of end user needs.

Considering this contribution, new scientific policies and strategies could be inspired by some of the results presented in this study to redefine, support and reward those collaborative projects that include the cross-fertilization of knowledge and technologies - including serious games and gamification. I not only provide the variables to understand the innovation management strategies in a particular moment in time but I also reflect on how they evolve over time and allow organizations to adapt to changing and evolving ecosystems. I also provide some insights to understand the factors that influence and the outputs derived from the cross-fertilization strategy. In fact, I consider the cross-fertilization of knowledge and technologies a strategy that, thanks to the research performed in this thesis, has shown what elements can be influenced to favour the process of innovation. So, this work contributes to a better understanding of the processes and ecosystems of innovation and thus, helps in reducing the Valley of Death gap between research and market.

CHAPTER 2

Open innovation practices and their boundary-crossing mechanisms

2.1. Abstract

This chapter aims to help in understanding the genesis of open innovation processes applied to the field of cultural organizations and how these are in constant evolution and transformation. The cultural experience will be one of the pillars of the many proposals that we find today, where the client or end user is not satisfied only with the enjoyment of culture and wants to intervene and be part of it. The more we empower the public or consumers, the more they can intervene in the processes of open innovation of any entity. The value chain shows how the value is being incorporated into every step of the process from research or development to the market. But organizations that follow the logic of value innovation release their resources and seek to identify new value sources to offer them to their customers; the success is achieved through a non-competitive approach what means an innovative vision in relation to business strategy. Interacting with other entities allow to gain greater wealth of knowledge and experiences that enrich their contribution to the company and may enable them to approach the solutions to new problems from new

perspectives. Besides co-creation, there are other common practices in implementing open innovation: crowdsourcing, expert networks, market innovations or "marketplaces", community building, monitoring information, living labs, beta labs or innovation jams. The chapter goes beyond showing how the cross-fertilization of knowledge and technology can be considered a disruptive innovation strategy. In addition, the presented theories connect with an interpretation inspired by Bauman's "liquid modernity" that leads me to affirm that we are in front of the era of "liquid technology".

2.2. Introduction

Given the growing disparity, multiplicity and frequency of use of the concept of innovation, this chapter has the aim of outlining and visualizing some ideas around this concept that will give us the keys to understand and apply innovation processes in organizations and cultural projects. At a time when we appeal to this term as a recurring solution to current problems, the cultural sector requires inspiration from success stories from other sectors to define strategies that can later be translated and adapted to each specific case. It is here that open innovation, which knows no sectorial, human or business barriers, has been gaining strength to become a priority for many organizations.

The present work analyses how the concept of innovation, which is of purely economic origin, has changed over time and up to the present day, progressing through different discourses, spaces and times. Its impact on Western economies has changed the way innovation is perceived: as an axis that has transversely penetrated our society up to the sphere of culture, a space that seeks its own process of adaptation and transformation.

This analysis also discusses some of the rhetoric used in the debate over the term innovation and its evolution. Through certain positions, the emergence of innovation in the cultural sector is presented. This analysis does not intend to be exhaustive, but rather through certain positions, I will advance to define the emergence of innovation in culture, a space that is not exempt from tensions, contradictions and conflicting positions. Other related key concepts are included, such as value generation and disruptive innovation in order to reach the concept of open innovation. Finally, it is introduced the term of innovation through cross-fertilization, analysing its meaning, origin and exploring its actual and potential applications. In addition, the presented theories connect with an interpretation inspired by Bauman's liquid modernity that leads me to affirm that we are in front of the era of liquid technology.

To achieve the goals of the research, the following activities have been conducted:

-**Literature Review**: The bibliographic section is thought to identify the state-of-the-art of the global innovative activity. Relevant data on research, development, trends and commercialization has been collected through an exhaustive literature review and a data base research. Additionally, the chapter introduces an extensive vision on innovation, showing the theoretical bases and even contrary and critical positions especially with the transfer to the market.

-**Case Study Analysis**: Some case studies have been used to illustrate specific examples including ideas and relevant practices presented in this chapter. The cases selected belong or are close to the cultural sector and help to understand different innovative processes at different stages, illustrating changes and opportunities that are taking place in this field.

-**Modelling the cross-fertilization of knowledge and technologies**: Bibliography and case studies have been used to illustrate how sectors cross knowledge and technologies to develop emergent technologies. Furthermore, Bauman's "liquid modernity" theory has been analysed to develop the idea of "liquid technology".

2.3. Innovation in the cultural sector: arguments for the debate

2.3.1. Innovation in the Cultural Sector

Reflecting on innovation in the cultural sector involves considering several issues related to the essential functions of culture and art. The debate about the role of innovation in culture remains open and it is difficult to provide an agreed response on how it is to be produced. Arguments from the Frankfurt School could enhance this debate. Two of its leading representatives, Max Horkheimer and Walter Benjamin, influenced by Marxism, observed that capitalism was increasingly invading the sphere of culture. Max Horkheimer and Theodor Adorno coined the concept of cultural industry in 1994. With this concept they predicted the end of aesthetic autonomy due to the triumph of market values over the cultural industry and its manipulation by political forces. They argued that real art should be free and independent. Meanwhile Benjamin (2003) argued that through "Mechanical Reproduction" artwork had undergone a profound transformation that could be recognized in its infinite and serial repetition.

Therefore, the discussion about the impact of economy on art remains open: it is necessary to answer whether the cultural industries generate consumer products characterized by the banality and the homogenization of tastes which restrict learning abilities and intellectual emancipation; or on the contrary, make the culture more accessible and democratic. From this point of view, the value of culture and art should be placed in its aesthetic value and its message rather than in its economic value.

George Yúdice enriched this discourse with his contribution in "*The Expediency of Culture: The Uses of Culture in a Global Era*" (Yúdice 2003). In it, he offers a new approach to the criticism of the commodification of culture from Adorno and Horkheimer. He claims that in the era of capitalism, culture has become a resource and no cultural activity can be conducted without funding; therefore, its utility must be demonstrated. This reflection begins a new era on the usefulness and values of culture. The concept of value will end by becoming an intrinsic part of the concept itself as is discussed below.

Yúdice has popularized the term "*culture as a resource*." He argues that culture becomes meaningless itself in order to become valued by the objectives that it is able to achieve. His analysis, focused on the UK, searches for practices of developing a creative culture designed to promote national economic growth. In this context, culture must justify its existence in productive or economic terms, implying a deep crisis in culture. Therefore it is necessary to know how culture contributes to national wealth by quantifying it in economic terms, and at the same time, knowing how it affects personal projects of the inhabitants of a country, without taking into account their personal enrichment. Yúdice affirms that "*without hard data (indicators) it is complex to justify the investment of a project. There are methodological difficulties in developing indicators for culture. The concept is built according to economic indicators that allow analysts to determine the health of the economy and predict the type of interventions that could strengthen it*" (2002: 30).

John Holden (2006) is critical of the value that politicians attach to culture, reducing it to an economic engine and instrument of cohesion, and losing sight of "the true meaning of culture in the lives of people and in the formation of their identities". It claims a global view of culture through ecology and not only as an economic phenomenon.

"Cultural ecology" has been used in anthropology since 1950 (Childe 1960, Steward 1955, White 1960) to refer to the study of human adaptation to social and physical environments. But the use of the term ecology in relation to the cultural sector is a more recent phenomenon. Two reports published almost simultaneously but without any contact between the authors (Holden 2004; McCarthy *et al.* 2005) use "ecology" as a metaphor and generalize the use of the expression.

Holden (2008) conceives cultural ecology as three large interactive spheres: public culture, popular culture and commercial culture. The first refers to the one intervened by the state, who also finances R&D in the creative ecosystem. But this kind of intervention, as argued by Crossick (2006), means that the way in which knowledge is generated within and for the creative industries means that priority is rarely given to people.

The second sphere is popular culture (homemade sector), the one in which the people who intervene do not receive a return for their work (although the institutions in which they work, such as museums or associations, can receive aid or sponsorship). The third, the commercial culture, is one that exists without public funding. The three spheres operate as a hybrid model in which there are no hierarchies and where culture is experienced as a social process, in constant evolution and with the capacity for regeneration.

Holden (2015) considers that there is culture in an ecosystem thanks to four main actors: the guards who look after and protect the culture of the past (museums, libraries, but also companies); the platforms that are the physical spaces like the cinemas, auditoriums, bars, and that they need the culture to live; the connectors, that is, the companies, the producers, those that try to make the system work; and finally, the nomads are the ones who can act as both guards and platforms.

David Throsby (2001) also argues that cultural value is biased by its economic connotations and must be freed from such a heavy burden. The economic value can be determined by the price that people are willing to pay for a certain good, while the cultural value can be defined from an anthropological perspective as "the set of attitudes, beliefs, habits, customs, values and practices that are shared or are common in a group". Cultural value can be deconstructed in its aesthetic, spiritual (or religious), social, historical, symbolic value and that of its authenticity. Each of these aspects contributes to a different facet of the global value that resides in an object, institution or experience.

Throsby seems to use the concept of cultural value as a way to achieve its ultimate goal: the concept of cultural capital. He defines the cultural capital as an asset that incorporates, maintains or provides cultural value that is added to the economic value that the asset possess. The cultural capital exists, both in tangible goods -museums, buildings, paintings, etc.- and in intangibles: the techniques, ideas, beliefs and customs of a society, which are also important for its economic development. The cultural capital of people is a basic element for their progress, offering symbols, traditions, ways and customs that can promote economic growth.

Guaranteeing cultural sustainability is, for Throsby, the rationale of the State's cultural policy. Given that cultural value is collective in nature, there is the danger that the market will fail in the adequate provision of a sustainable level of cultural capital. Therefore, the State must intervene in the market through cultural policy to ensure that cultural capital is maintained at a level that satisfies intertemporal justice in this matter.

Klamer (2003; 2004) joins Throsby (2001) in the vision that arts and culture give light to forms of value that cannot be captured solely through the lens of neoclassical economics. The "cultural value" cannot be expressed in the same units of measure of "economic value". In fact, the cultural value of an experience is lost if it is defined in economic terms.

According to Throsby and Klamer, there is no direct translation of cultural value into economic value, and besides, if it is done, it would be in many cases totally damaging to the conservation of the cultural good. This divergence between economic and cultural value has led some economists to apply the principles of "contingent valuation" to cultural goods. The contingent valuation, as it happens in the economy of the environment, has been adopted by the economy of the culture mainly because it is able to show the economic value of a good without having to resort to the usual means of valuation as the calculation of costs or the expected return, which always have to do with the maximization of economic benefits (Durán 2008).

Sara Selwood (2010) distinguishes cultural value from cultural impact, emphasizing that value has to do with worth and its importance, while impact has to do with the effect. In her study, she found it difficult to distinguish one from the other, considering that "value" and "impact" are linked in such a way that they can be considered two sides of the same coin. According to her, cultural impact should be understood as the impact of something in the culture, rather than the impact generated by the culture.

On the other hand, Jeremy Rifkin predicted that property will be less and less practical because products life cycles are increasingly being reduced by constant innovations in the market. For him, the current *hyper-capitalism* trades with access to cultural experiences. Culture thus becomes the ultimate goal of the economic value chain, ending with the transition from industrial production to cultural production. The most visible and powerful expression of this new cultural economy is global tourism: a form of cultural production that arises in economic life half a century ago and that later has become one of the most widespread cultural industries. Tourism is the commodification of the cultural experience (Rifkin *et al.* 2000). This cultural experience will be a mainstay of many current proposals, where the customer or end user wanted to be part of the culture and not just in contact with it.

For Charles Landry, it is necessary to highlight the power of our ideas to promote change, and for that a change of mind -activated by creativity- is necessary (2000: 5). "*Establishing innovative environments is a crucial challenge for creative cities* (2000: 15)." According to him, "*Creativity and innovation are always interconnected; creativity generates ideas which are the starting point, even though many of them could be unviable. Creativity is the prerequisite for developing innovation* (2000: 15)". Therefore, Landry shows the importance of creativity for the generation of ideas which could be applied in a business plan in order to see the impact they will have on society and market processes (Landry 2000).

As we wanted to show there is an interesting open debate about the role of culture and its value. From more Marxist positions, the end of aesthetic autonomy is denounced due to the triumph of the mercantile values of the cultural industry and its instrumentalization by the political powers (Benjamin 1936, Horkheimer and Adorno 1994). And for Yúdice, culture in contemporary capitalism has become a resource and therefore no cultural activity can be carried out without funding (Yúdice 2002). Further, Klamer (2003, 2004) and Throsby (2001) agree on the vision that arts and culture give light to forms of value that cannot be captured solely through the lens of neoclassical economics. For this reason, "cultural value" cannot be expressed in the same units of measure of "economic value" and they, together with other economists, will try to find new ways of measuring cultural value (Holden 2006, 2008; Selwood 2010). This value will be the one that will affect a large part of the innovation strategy of the institutions and / or companies, trying to modify the value chain that forms, shapes and finally distinguishes our product or service from the rest of the market offer.

The cultural experience will be one of the pillars of the many proposals that we find today, where the client or end user is not satisfied only with the enjoyment of culture and wants to intervene and be part of it. In the current ecosystem (Holden 2015), culture exists through the interaction of all the agents that interact, modify and provoke innovation within an institution and / or company with the objective of finally satisfying the needs of the consumer, the last agent of the value chain that is who should enjoy the culture. The more we empower the public or consumers, the more they can intervene in the processes of open innovation of any entity.

2.3.2. Origins of Innovation: The Schumpeterian Influence

The concept of innovation, which comes from the Latin term "innovare", is introduced seminally from an economic perspective by Joseph A. Schumpeter. His contribution is closely linked to two very present concepts in the contemporary economy: the figure of the entrepreneur and, on the other hand, the idea of credit.

This section analyses his arguments in relation to the innovation concept in two of his publications: "*The Theory of Economic Development*" (Schumpeter, 1934) and "*Capitalism, Socialism, Democracy*" (Schumpeter, 1983, 1942). Schumpeter argues that "*development is defined by the implementation of new combinations*" (1934: 66). He considers that innovation does not follow a single pattern and in *"The Theory of Economic Development"* (1934), Schumpeter proposed a list of various types of innovations:

- Introduction of a new product or a quantitative change in an existing product;
- New process of innovation in an industry;
- The opening of a new market;
- Development of new sources of supply for raw materials or other inputs;
- Changes in industrial organizations (European Commission 2005).

This means that innovation does not occur only in the product. It can also be manifested in many ways and in different facets.

Schumpeter also introduced the concepts of *investment* and *credit* to argue that the entrepreneur is the driving force in the process of innovation, but it is necessary that "he can convince the banks to provide him with the credit to finance the innovation" (1934: 69). The success of modern industry could not have been built without credit, because talent in economic life "rides on the success of its debts" (1934: 70), so the author sees very clearly "the established relationship between credit and innovation development" (1934: 70).

The importance of the concept of innovation in the Schumpeterian economic system and therefore in the contemporary economy is unquestionable. He states that innovation does not lead to direct profits, but these can be achieved if the innovations are properly exploited and managed (opening the door to contemporary management). According to the author "*new goods do not confer monopoly per se, even when used or produced by a single person. The product or old method has to compete with the products or old methods and new merchandise has to be introduced, this means that the demand curve must be established. (...) Thus, there may be an element of monopoly gained in that company's benefits, that are the prizes offered to the lucky innovator by the capitalist society*" (1950: 144). Therefore an innovation is "*a new combination of the means of production with access to the credit*" (1934: 74).

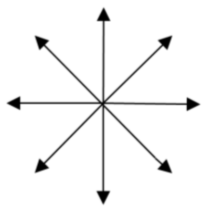
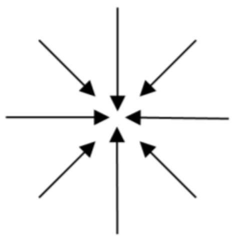
These new combinations of production factors generate inventions and innovations, which are key to economic growth and which are implemented by entrepreneurs. It is important to note that Schumpeter separated clearly the concept of inventions from that of innovation. He stated that making the invention and carrying out the corresponding innovation are two entirely different things. The social processes involved with producing inventions and innovations belong to different spheres with complex interrelationships and "*do not stand in any invariant relationship to each other*". Schumpeter has addressed three stages in the process of new technologies entering the market: invention, innovation, and adoption. Inventions represent the core idea or concept facilitating the new technology (Efrat 2014).

Schumpeter argues that there are three basic pillars for innovation: **investment, credit** and **entrepreneurs**. The goal is not limited to the production of innovations but also the creation of management models in order to ensure appropriate exploitation of them. But to ensure that these innovations are conducted and successfully managed, an economic agent committed to promote innovation is needed: the entrepreneur. It is noteworthy that key aspects of the current economic debate as well as the access to credit, investment needs and entrepreneurship promotion, were already described as strategic axes that determine the activity of institutions and cultural organizations of any economy.

At the industrial level, Schumpeter noted two new patterns of innovation that he classified as "**radical**" or "**incremental**". The first one shapes big changes, while the second denotes a continuous process of change. At a company level, Nelson and Winter (1982) and Kamien and Schwartz (1982) introduced the Schumpeter labels as *Schumpeter Mark I* and *Schumpeter Mark II* to synthetically characterize those theoretical models of innovative activities. The first label is also known as "**creative destruction**" where innovations are introduced by companies that did not innovate before: this is called "widening". Schumpeter Mark I industries are characterized by turbulent environments with relatively low entry barriers where innovations are mostly generated and developed by new "entrepreneurial" companies (**Table 1**).

Accordingly, technological competition among companies in Schumpeter Mark I industries assumes the "creative destruction" with successful innovating entrants replacing the incumbents. On the other hand, Schumpeter Mark II industries are characterized by stable environments with relatively high entry barriers in which innovations are generated and developed by large established companies. In Schumpeter Mark II industries, technological competition is related to a creative accumulation pattern where innovations are introduced by firms that have innovated before: this is called "deepening" (Breschi *et al.* 2000; Fontana *et al.* 2012). In Schumpeter Mark I, international technological specialization is associated with relatively higher degrees of asymmetries among innovators and innovative turbulence (as well as smaller company size), while in Schumpeter Mark II technological classes, international technological specialization is linked to the existence of a stable but competitive core of persistent innovators (Breschi *et al.* 2000). Marx (1887) and Schumpeter (1947) recognized that technology is what enables capitalism to constantly revolutionize itself, ensuring its vitality (Malerba 2002).

Table 2.1. Schumpeter`s patterns of innovation (Breschi *et al.* 2000; Schumpeter 1983)

Schumpeter Mark I	Widening 	***Large and highly turbulent population of innovators**:* High technological opportunities, low appropriability and low cumulativeness (at the firm level) conditions and a limited role of generic knowledge lead to low degrees of concentration of innovative activities with a relatively large number of innovators, high rates of entry and high instability in the hierarchy of innovators.
Schumpeter Mark II	Deepening 	***Concentrated and rather stable population of innovators***: Low opportunity conditions, high appropriability and high cumulativeness (at the firm level) conditions and a generic knowledge base lead to high degrees of concentration of innovative activities, low rates of entry and a remarkable stability in the hierarchy of innovators. However, also high opportunity conditions in conjunction with high appropriability conditions may be associated to a Schumpeter Mark II pattern.

Schumpeterian patterns of innovation have been identified in the rate of concentration of innovative activities among companies, the degree of stability in the hierarchy of innovative firms and technological entry and exit (i.e. the relevance of new innovators in an industry). According to an industry life cycle view, Schumpeter Mark I pattern of innovative activities may be transformed into a Schumpeter Mark II (Malerba 2002).

Technological innovation involves a technical preparation in material, financial but also in human resources (Claver *et al.* 1998). Thus, it is important to highlight the role of inventors and entrepreneurs in innovation. In this context, the social and economic theorist Richard Florida was also influenced by Schumpeter, as well as by Marx. He argued that the new system of capitalism is based on a synthesis of intellectual and physical labour: a melding of innovation and production (Florida and Kenney 1993). He labelled the talented human capital the "*creative class*". These workers are in knowledge-intensive jobs that involve the production of new ideas and products, or that engage in creative problem solving. But what ultimately makes a location attractive to industries are the clusters of talent that it has to hand. Talent is also an important factor in innovation. Knowledge workers not only improve existing means of production, they create new products that engender completely new markets. And what is crucial: "*talent attracts capital*" (Florida 2014).

Schumpeter's work continues to be revisited and discussed by other schools as we have seen, clearly demonstrating the validity of his speech and leading certain authors to affirm (Jessop 2002) that we live in a "state of Schumpeterian competition". Others like Nelson and Winter (1982) assimilate the Schumpeterian idea of innovation and believe that the results of the innovative process are not predictable and that the presence of uncertainty in the results does not contradict well-defined routines in organizations to support and direct their efforts. In this sense, innovation can even be a new combination of subroutines already used in the organization. The "routinization" of processes in the R&D department is positive for Nelson and Winter because it allows companies to make decisions against changes in the context (in this sense it is interesting to highlight the case of Cirque du Soleil that is presented later and where the creative process is clearly engineering); on the other hand, it is a negative element for Schumpeter due to the decrease in the importance of the entrepreneurial function and creative destruction.

Other authors such as Teece and Pisano (1994) incorporate the vision of dynamic capabilities as opposed to the static vision of capabilities that organizations have to reconfigure their assets, reacting swiftly and effectively to future changes. The dynamic capabilities approach is consistent with the Schumpeterian idea that the emergence of innovative products and processes arise from the new combination of knowledge (Yoguel 2013).

Schumpeter considers that the organizations constantly seek to create new combinations and the rival organizations try to develop or improve new skills. The strategic problem that arises in a company is the development of innovations difficult to imitate. According to this, the construction of capacities as well as the organizational changes is a key aspect. In the next sections we will see how these processes occur in the artistic and cultural field and how, through open innovation, solutions are offered to problems that hybridize and repeat in a similar way in different contexts.

2.3.3. Contemporary art as an open innovation metaphor

"Innovación en Cultura", developed by Yproductions (2009), is a critical approach to the genealogy and uses of the concept. From this, we can distinguish two processes of innovation in relation to their resources or support: when the creators introduce tools from other areas to provide leverage to its expressive potential; or in terms of their ideas or concepts, where the terms *innovation*, *transgression* and *developments* are often confused.

The first process includes a wide range of manifestations that include all possible approaches. Art has always experimented with other disciplines. However, from the second half of the twentieth century, this desire was normalized and became one of the main objectives of artistic production. These intersections between art, science and technology are an expanding field and show that the multidisciplinarity is increasingly present in many of the artistic and cultural projects that arise.

The second process involves innovation in terms of concepts or ideas legitimized by some aesthetic movements. According to Natalie Heinich, contemporary art is based on three levels: the transgression of boundaries produced by artists; the indifference and rejection of the public; and the strategies for recognition by institutions (López Anaya, 2007). Considering that this process culminates with a new trend or artistic movement, we could draw a parallel with the economic sphere and the way in which an innovative idea is being assimilated by the market.

Traditionally, art has always experimented with other disciplines. Marcel Duchamp shows an innovative product that was hosted by institutions and subsequently imitated as a first step within the European avant-garde: his ready-mades. The post-World War II European Informalism, through the material painting, begins to co-exist with foreign materials that were incorporated in the creations of this movement, adding new value that can be seen as a new reality. All these changes (holes, tears, cuts) contribute to a new view of the world, reflecting a heartbreaking reality that requires a new language because earlier narrative forms do not allow the expression of the pain of this new world. This new language that reflects a new need has an impact on the idea, the planning, the working methods and the final contemplation of the object, namely, to innovate throughout the process, in each of the stages of the development of a final product that will surprise the viewer.

This reflection on contemporary art helps to show how innovative processes have been implemented from the artistic field. The processes of social creativity can also be considered innovative, if by some means a product is brought to the market. Therefore, innovation is the economization of social creativity so that it can have an impact on the market, the last link in the value chain. Starting from this premise, we can talk about innovation in culture.

Today it is possible to see a convergence between the artistic and cultural innovation processes and those more typical of the business field. There is evidence that this convergence has always been present in the Anglo-Saxon context, but perhaps due to the current economic situation which is forcing us to rethink existing economic models, particularly (due to its dependence on public administration) in the field of culture management, this convergence is becoming more evident in the Latin world.

Pau Alsina argues that "*cultural innovation should be related to investment in research, rather than the processes that lead to a spectacle of culture. That is, investment in something that generates long-term benefits rather than short-term thinking* " This is one of the premises that many governments have avoided, seeking short term results because they can be viewed in the same legislature (YProductions, 2009).

It is indispensable to highlight the importance of knowledge transfer in any industry and centres of creation. This issue is under-developed in the cultural field. Common company areas of "business development", "technology transfer" or "valorization" still have little presence in the flowcharts of organizations from the cultural sector. In this sense, the initial problem has to do with the "recognition of artistic practice as a form of research”. Therefore, we must set certain standards, methodologies and procedures for the validation of cultural practices as research processes. Without these, knowledge transfer, the key element to open new markets for culture, is not possible. Therefore, it is not appropriate that research centres in the field of culture do not involve technology transfer to the business world.

These described strategies and practices are more present in the English-speaking world (in which market and culture are linked, from a business perspective). But we have to consider that the world is global, so results must not be distinguished only by a geographical point of view, but also by the ability to capture and incorporate the demands and needs of the customer. However, there are some kinds of products or services that cannot be governed only by mercantilist logic.

It is necessary to determine which aspects of culture should remain as the responsibility of the state and which ones can be tested for new ways of economizing. Obviously, this implies not embracing the laws of the free market, but rather understanding the different ways of understanding innovation in culture and considering what legal and fiscal frameworks are most desirable in each case, and also to consider what types of protection systems are necessary in order not to risk other values and uses of culture. For the business sector there are indisputable benefits in the cultural sphere outsourcing their research process. But on the other hand, we must ensure universal access to culture.

2.4. Value generation: key in defining innovation

An appropriate way to approach the term innovation is the view of Alfons Cornella (2009) who considers it "*a process consisting of three steps: idea generation, idea assessment, and finally results generated. Only when these three steps are accomplished can we talk about an innovation process*"[3].

Regarding the transference and adaptation of this concept to the cultural sector, Cornella (2009) argues that "*innovation outcomes do not need to be only economical; they can be measured in terms of use, improvement, satisfaction, troubleshooting, etc.* ". Cornella also argued that no one can talk about innovation without value, which includes having a general interest. In the cultural sector, the concept of value is related to satisfaction, optimism or enrichment, but not related to a selfish egoism of the artist (YProductions 2009). From this perspective, this term plays a key role in any innovation process. All cultural projects or initiatives should be considered based on their ability to generate value during different stages of the project, transferring any new idea to market and making progress through the value chain in order to obtain a clear and noticeable improvement at the end of the process. Therefore, we can say that innovation is the process of turning ideas into valuable ideas, generating with this a sustainable benefit for the organization (Gonzalez-Piñero *et al.* 2011)

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[3] http://www.historiadeldisseny.org/congres/pdf/47%20Diaz,%20M.%20Sonia,%20%20Garcia,%20Isabel%20M%20%20et%20%20Martinez,%20J.%20Gabriel%20BASTARD%20POP%20DESIGN,%20VISUAL%20REMIX%20AND%20MASHUP%20BY%20UN%20MUNDO%20FELIZ.pdf
[accessed May 21 2018].

2.4.1. The Value Chain

This concept from business management was first described and popularized by Michael Porter (1985: 36): "*Every company is composed of a set of activities performed to design, produce, deliver, bring to market and support the product. All these activities can be represented by a value"*. Porter used the "*value system*" to refer to the interconnection of value chains. This value system includes the value chains of suppliers (and also of their respective suppliers), the organization, distribution channels and customers (which at the same time will be extended to their customers, and so will spread to the chain).

Value streams were first introduced by Porter but later were explained more clearly by James Martin (1995: 66), who draws attention to many issues, models and methods to transform the vision of traditional enterprise into a more value-generating organization. Martin used the value flow (rather than the process) to define the integrative flow of the delivery activities for each customer (external or internal) (Martin 1995).

This type of exemplification shows how *the value* is being incorporated into every step of the process from research and development to the market. This gathering of value throughout the process allows the product or service to reach the market with an additional value.

A value chain is the breakdown of an organization in its strategically relevant activities in order to understand the behaviour of costs and existing differentiation pathways. The concept has been extended beyond individual organizations. The industry widely interacts synchronously with those local value chains to create a wider value chain, sometimes with a global scope. The new focus of many management strategists is related to capture of the value generated along the chain. By exploiting the upstream and downstream information flowing along the value chain, organizations can avoid intermediaries creating new business models. And this is the new challenge for many organizations in the cultural sector: trying to create value by leveraging existing resources and by seeking new ones to obtain the desired results.

Figure 2.1. Proposed value chain

Some basic steps in the value chain have been established (Gonzalez-Piñero *et al.* 2011):

A) Detection

As a first step it is necessary to know what technologies and results are in a more advanced state. We need to know the technological portfolio and proposals of our organization. We have to identify which technologies were developed under optimal conditions so that they could be transferable to the market (the ones that have succeeded the theoretical phase and could be available for application or implementation).

B) Selection

We should note that not all of our results satisfy commercial parameters to be exploited and thus, it is needed to sort them by their proximity to the market. We have to evaluate each result or technology and make the proof-of-concept. This assessment requires two aspects: one related to the marketing and business generation, and the other related to the quality of the outcome of our investigation.

C) Assessment

The business model of this new technology requires special attention to three areas that will define the impact of the results of our research on the market:

1) *Industrial Property:* It is important to know our R&D's degree of protection. We must analyse the state-of-the-art; recognise patentability opportunities, collisions with our R&D, patent families and new applications different from those originally intended.

2) *Market Survey:* sectors of interest, the advantages of our technology compared to other solutions on the market, industrial applications, time-to-market, competition, risks, prospects, etc.
3) *Legal aspects:* laws and regulations. The resulting prototype or service must be validated and follow the applicable legal regulations.

An evaluation of these three aspects provides enough information to define the strategy. If any of these areas of evaluation is negative, it may be necessary to pause, amend any weaknesses, and if those amendments are successful, proceed to the next stage.

D) Protection

Security aspects of our R&D are essential. First, we must know whether the result of our R&D is developed in collaboration with other partners to negotiate the rates of co-ownership. Second, it is necessary to take into account the different types of protection (patents, designs, software ...) or to consider the possibility of non-protection (trade secret). Finally, we must assess if the technology meets all the requirements for patentability: a) it must be possible to demonstrate the novelty, b) it should not be obvious and c) it must have an industrial use.

E) Exploration

The last stage of the value chain is to consider the exploitation of our R&D. Not all technologies can be exploited in the same way. There are different formulas: licensing the patent, creating a spin-off, or shared patent, among others. Once all these stages in the chain of value creation have been considered, we can explore how this linear model can be modified by new possibilities inspired by open innovation.

2.4.2. Value Innovation

The importance of value creation has also been studied by W. Chan Kim and Renée Mauborgne (2005) in *"The Blue Ocean Strategy"* through 150 strategic actions developed in 30 sectors over 100 years. Through this research, value innovation is conceived as an innovative vision in relation to business strategy: success is achieved through a non-competitive approach. The innovation value strategy is based on the metaphor of a blue ocean compared with a red one. The red ocean represents those organizations that compete in an existing market space. This ocean is highly explored and is characterized by a low differentiation normally based on the price. In this ocean, the fierce competition turns the water red. On the other hand, the innovation value strategy is in the blue ocean, where organizations that create new market spaces make competition irrelevant by creating and capturing new demand, aligning all activities of the organization with the goal of reducing costs while increasing the value of their products and services.

Innovation value strategies are not focused on competition. Rather, they search among all other competitive factors in the sector. The efforts and resources of the organization are focused on differentiating features, which can be clearly perceived by the consumer. Organizations that follow the logic of value of innovation release their resources and seek to identify new value sources to offer them to their customers.

The CNN television network, for example, decided not to compete with the networks in its race to hire famous presenters, but to generate specific quality content and become the reference for the news. Organizations that follow the logic of value innovation free their resources and dedicate them to identifying new sources of value and offering them to customers.

Kim and Mauborgne (2015) proposed a process that seeks to create value through innovations in four stages: (1) eliminating what is not valued, (2) reducing what is less valued, (3) increasing what is valued most and (4) creating what anyone else is offering. From to them, the concept of *user empowerment* (user force that influences each of the stages of the value chain of a product or service) clearly determines what gives real value to the customer, and therefore their opinion becomes essential when bringing new ideas to market.

In a world where knowledge is widely distributed, organizations cannot afford to rely solely on their own R&D and should rely on open innovation processes. The boundaries between an organization and its environment have become more permeable and collaborations between customers and companies are needed to develop new solutions (Chesbrough 2003).

Sticky information gives some a major cost advantage over others in the case of many innovation opportunities: the information required is shared by producers and consumers and is expensive to acquire, transfer and use (Von Hippel 1994; Lüthje *et al.* 2005). In this case, the producer offers customers "toolkits for user innovation" so that they can design customized products for them. One of the first industries to put emphasis on the empowerment of its customers was the video game industry, a sector that is at the forefront of the application of the "toolkits" method with which users build, modify and improve the video games in a certain version (Jeppesen and Molin 2003).

Blockbuster Inc., headquartered in Dallas-Texas was the movie and video games world's largest rental chain. The main reason for their disappearance was attributed to the appearance of another company, Netflix, rather than piracy. That new company innovated in the business model at that time by considering users' needs and by facilitating the task of renting movies for viewing at home. Netflix did not focus on competition. It based its strategy on knowing the needs and demands of potential customers. So they aligned this goal to their internal processes, making their competitor and market leader irrelevant.

Innovation opportunities appear in areas where nothing or almost nothing is available to the client, or when there is clear dissatisfaction with the current solution. The client does not often demand a specific solution, but shows their dissatisfaction. It is at those points where an organization that cares about its customers detects an opportunity to augment the process. What is regrettable is that there are still many organizations who disregard complaints and customer feedback. In the case of Blockbuster there was a key dissatisfaction among its customers: the penalties for delays in the delivery of movies and video games, which Netflix eliminated. In fact, Netflix has grown along the years making better the users' experience. According to Chris Jaffe, Netflix's vice president of product innovation, "my team can't make the decision (of evolving the product). We come up with the ideas, but what drives product decisions is our customers and what customers do and how they use the product" (O'Reilly 2016).

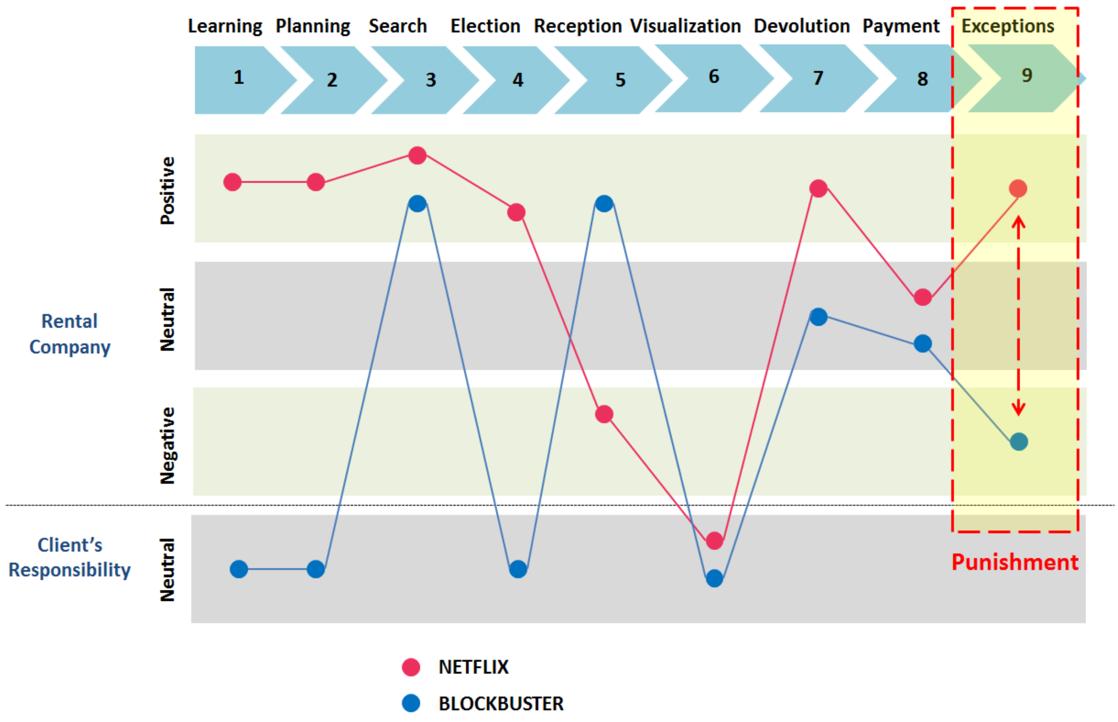

Figure 2.2. Customer journey for rent movies/ video games: Punishment (Adapted from Kim and Mauborgne 2005)

Netflix encouraged loyalty from new clients by providing them with a pioneer film election algorithm. The result was blocking their competition. This helped Netflix to fight against a process step -the viewing time- a moment that neither Netflix nor Blockbuster can control.

Netflix has a very active role in helping the client in the selection of the films that best suit their preferences. It has evolved and Netflix conducts a couple of hundred tests each year to personalize the product and offer products influenced by the kind of things a user has watched and the popularity of a particular title (O'Reilly 2016). Implementing technology in the process helps to increase customer satisfaction.

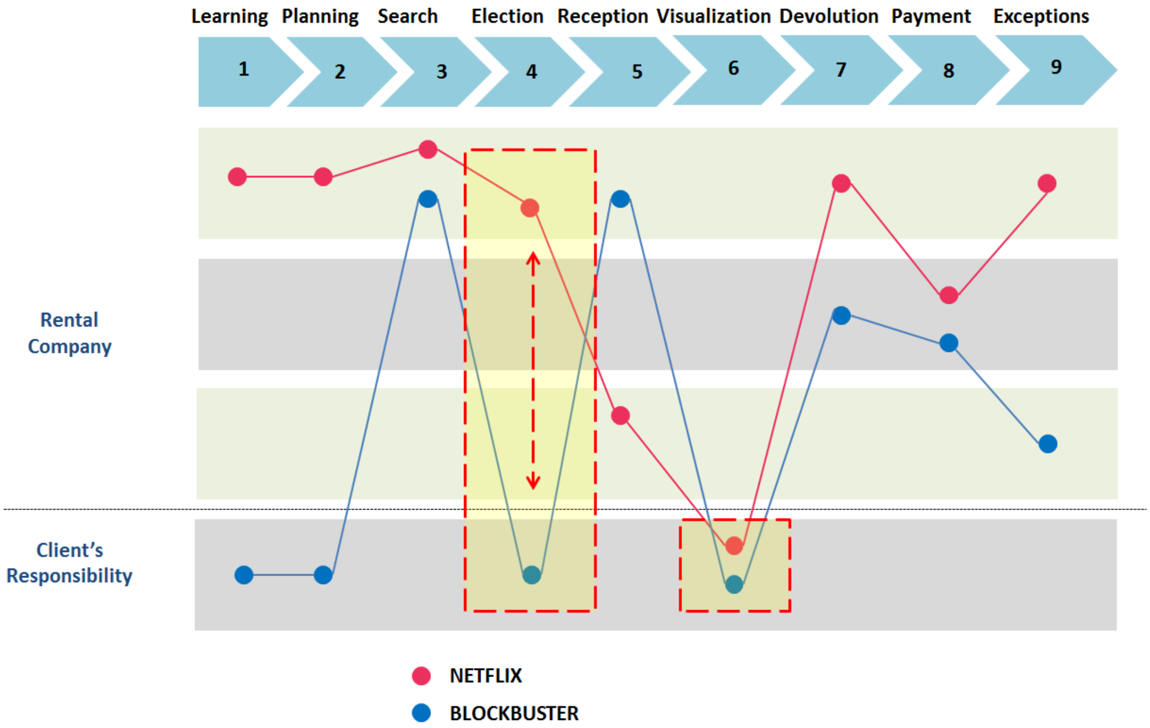

Figure 2.3. Customer journey for rent movies/ video games: Election and Visualization (Adapted from Kim and Mauborgne 2005)

The downside of the Netflix experience was the delay in receiving the film, but the program without penalties for delays made Netflix's customers return again and again, making the business model of this company a great success story. Nowadays, Netflix's streaming service is the most important service but DVD subscriptions still provide the company with a nice cushion of cash in the US. The company spends absolutely no money to promote its DVD service, but its millions of subscribers still allow it to rake in a 50% operating profit, which is a margin that any company would envy (Liedtke 2017).

Another example of the importance of value innovation is offered by Le Cirque du Soleil. This project sought to diverge from the classic and traditional circus. Their valorization strategy was based on exploiting new accepted aspects that they saw as an opportunity to innovate (**Figure 2.4**).

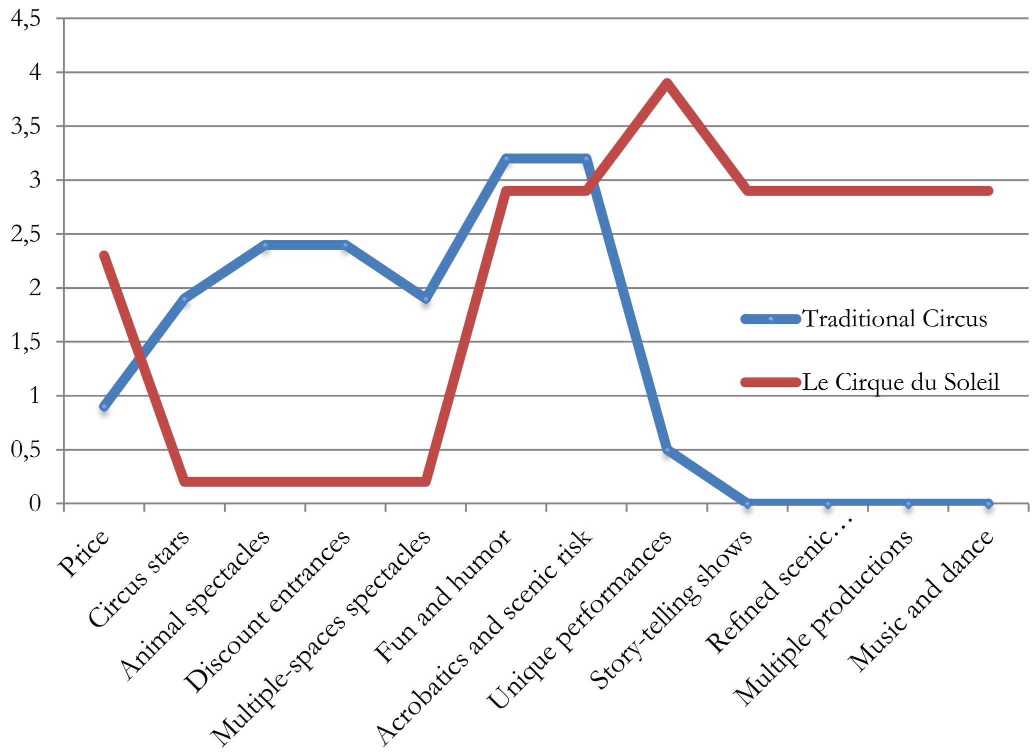

Figure 2.4. Le Cirque du Soleil's value innovation (Adapted from Kim and Mauborgne)

The circus industry was in crisis and began to have a marginal role in the performing arts. The model proposed by Le Cirque du Soleil created a new market space without competition contributing and enriching the anatomy of the city of Montréal (Cohendet *et al.* 2010). Instead of struggling with circuses having animals and renowned artists, they created a new concept incorporating more sophisticated theatre elements and other disciplines with a particular theme and an artistic atmosphere with a refined musical performance. In this regard, there were many engineers contributing to the design and development of all shows.

They overcame the boundaries of the circus and theatre industry, getting closer to a broad segment of consumers who previously had not considered attending a circus. It also increased the expectation of sophisticated leisure or entertainment, allowing them to increase the ticket price and target an entirely new adult audience. Hence, they created a new industry that provided innovative value to its customers and made the competition irrelevant. They assumed the importance of co-creation, understanding that collaboration – and openness- was not an option, promoting team diversity and defining a clear leadership (Simon 2015). In fact, they have created a culture that welcomes and encourages artistic tension and disruption through diversity. Also, to keep its creative brand fresh, Cirque du

Soleil believes that is critical to strive for collaboration beyond establishing strategic alliances with other companies or artists like Disney, Madonna, James Cameron and Desigual (Dan 2012).

Therefore, it is interesting to highlight how the examples cited have been able to position themselves in blue oceans, subsequently developing strategies to maintain that leadership position. The innovation processes have been so clearly defined in their structures that they are capable of launching new proposals to the market in order to continue being leaders in their sectors and in others in which they enter. Netflix has advanced in the production of its own content and thus can control the entire production and exhibition chain, CNN continues to stand out for its commitment to the news and Cirque du Soleil is a benchmark in the band of tickets making custom shows where they are hired

2.5. Disruptive versus incremental innovation

The term **Disruptive Innovation** (DI) was introduced by Clayton Christensen (1997) to differentiate from the term **Evolutionary** or **Incremental Innovation** (II). DI creates new needs or products and opens new markets (aligned with Kim and Mauborgne, we can say this is blue ocean). Usually this type of innovation takes into account the costs, and not only focuses innovation in the product, but also in the business model. An example are companies like iTunes or Spotify (Christensen 1997).

The incremental innovation has been a natural response to the entry of new competitors into the market. Established organizations search for a competitive advantage by progressively enhancing the value of their products through a process of evolutionary innovation of functions and uses, so that the market captures these improvements. It focuses on position in the market by improving the product itself. The problem is that this kind of innovation often increases the cost and a progressive decrease in the perception of the value by the customer. A clear example is the video games which are constantly improved (in terms of graphics, gameplay, etc.), updating and adding exclusives in each new version.

Radical innovation occurs when a product or service that reaches the market, is capable generating a category of its own. These are products and processes completely different from the existing ones; they are revolutionary changes in technology and represent turning points for existing practices. Incremental innovation occurs when a party is added (or removed, or combined, or subtracted, or supplanted) to a product or service. They are small changes and improvements that continuously contribute increased efficiency or customer satisfaction regarding products or processes. In one, the innovation starts from a conceptual base; in the other, on an absolutely new concept.

Both are absolutely essential in an organization. It is frequently seen that consolidated companies are more reluctant to take radical innovative actions because of "prestige", leaving radical or disruptive innovations to the entrepreneurs. Large companies, aware that their structures are large, slow and often do not favour creativity and the implementation of new ideas, have begun to approach the start-up[4] ecosystem.

In the case of Telefónica, the company has developed strategies to approach entrepreneurs and participate in their projects. Through Wayra[5], a network of accelerators with presence in 10 countries, selects the best technological start-ups in each country and accompany them for 10 months. Companies receive investment in exchange for future participation in the firms, business opportunities, visibility and networking.

One of the most notorious cases in 2016 was the purchase of the Ticketbis start-up by StubHub, a subsidiary of the US giant eBay. The disbursement of 165 million dollars allowed StubHub to acquire one of the leading companies worldwide in the sale of tickets between individuals for events (such as concerts or sports competitions). This type of acquisitions usually respond to access to a technology, an international expansion strategy or a brand image that would be very difficult to obtain from a large structure. According to one of the founders of Ticketbis, Jon Uriarte[6], the aim of this operation was to create the world leader in entertainment. To this end, SturHub, in addition to consolidating its international presence, intends to accelerate its business diversification; thus, besides the sale of tickets, they consider starting to distribute tickets directly (negotiating with promoters of events and concert organisers).

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[4] *A las grandes empresas les seduce el universo "start up",* Diario Expansión. Retrieved from: http://www.expansion.com/emprendedores.empleo/emprendedores/2016/08/01/579f5aac22601d00088b45de.html [accessed 27 May 2018].

[5] Wayra is Telefonica's accelerator of digital startups: http://wayra.co

[6] Ebay compra la "start up" española Ticketbis por 165 millones de dolares. Retrieved from: http://www.expansion.com/economia-digital/companias/2016/05/24/57443609e5fdeae5348b457a.html [accessed 27 May 2018].

As we have observed, the coexistence of the two types of innovation is often closed in many cases with the implementation of a "me too" process from large companies (with more budget and with a superior final result) or with a process of acquisition and incorporation of innovative companies or independent projects. These new strategies of open innovation mean that the company's laboratory can be anywhere in the world, but organizations must look for ways to detect the great opportunities that emerge outside the walls of their headquarters.

2.6. Closed innovation

Some aspects related to the model of open innovation as well as value generation have been already shown. However, it is important stopping in the predominant innovation model during almost the entire twentieth century: closed innovation.

According to Henry W. Chesbrough (2003), the premises of closed innovation are:

- Companies need to hire the best people if they want to have the best working team with them.
- It is necessary to internally research and develop if we are to bring to market new products and services. Research projects are managed exclusively with the knowledge and means from the organization itself.
- If we discover something, we have to be first in launching it to market.
- The company that first gets to market with an innovation is occupying a dominant position in it.
- An increased investment in R&D permits the discovery of more ideas, allowing us to dominate the market.
- We have to protect our intellectual property so that only we can benefit from it

Under these assumptions, projects could only begin within the organization and end on its own market. Companies invest in internal R&D as a form of protection and to obtain many revolutionary discoveries. Thus, organizations could bring to market new products and services that allow them to enter new market niches obtaining succulent benefits. From these benefits, a proportion was reinvested in R&D. They have created an ecosystem where new ranges of products and services for launching in the coming years were designed (Chesbrough, 2006).

Projects start as initial ideas (R&D), going forward along the value chain as they overcome the internal filters to reach consumers. This process is designed to remove false positives: projects that seem to be attractive at first but subsequently turn out to be disappointing. It was expected that survivor projects that had overcome a number of internal inspections, would have a greater chance of success in the market

This way of thinking includes examples such as the process of product testing by stages: the product development funnel, or the chain link model, found in many of the texts on R&D Management (Schonberger and Knod 1994)

In this internal process, ideas are examined and screened during the research process, and the surviving ideas come to market. This paradigm worked well throughout most of the twentieth century, and was predominant in the chemical and technological industry where significant results were achieved. However, this recipe did not work with the same efficiency in the subsequent years.

2.7. Open innovation

In a world where knowledge is widely distributed, organizations can not afford to rely entirely on their own research and should rely on open innovation processes. According to Chesbrough (2003: introduction) "*Open innovation is a paradigm that assumes that firms can and should use external as well as internal ideas, and internal and external paths to market, since companies seek to advance their technology*". The boundaries between an organization and its environment have become more permeable; innovations can be easily transferred inward and outward. The central idea of open innovation is that in a world of widely distributed knowledge, organizations cannot rely solely on their own research; instead they must buy or license processes or inventions (patents) from other companies.

Traditionally, companies have managed innovation in a closed form. Through historical and socio-economic changes, problems have arisen with this model:

- Collapse of the bulk of ideas: Research develops faster than technology; therefore many ideas were never developed. This generated complications in being competitive as technology came late to market causing frustration for researchers.

- Market Risk Capital: Initially small organizations and start-ups could not compete with big business innovation because of lack of capital. This situation changed with the emergence of investors. Thanks to venture capital, small organizations can produce new technology to develop further.

- Worker's Mobility: Dissatisfied researchers in large companies (because of the collapse of the bulk of ideas and their limited participation in the decision-making processes) caused the leakage of workers. Generally, these people create a new company with the aim of developing research based on the neglected ideas or seeking new applications of technology that had already shown its feasibility. Others were simply employed in a small company where their skills were more valued.

These damaging events created the necessity to change the manner of innovation management. Thus the open innovation model was born. Small changes such as collaboration between organizations and the business models based on innovation had greatly improved the performance and efficiency of many large organizations.

2.7.1. Open innovation: from technology-based companies to cultural industries

The idea of open innovation is based on the fact that "useful knowledge is high quality and widely distributed" (Chesbrough 2006: 9). This kind of innovation is not only applied for certain entities, but also for various institutions that continuously generate knowledge. This means that there is a trend of developing different forms of organization of innovation and new business models that use external and internal knowledge. Different forms of exploitation of outcomes to get them to the market provide value to the organization. Furthermore, this model allows academia to obtain internal and external knowledge.

Commercialization of transferred knowledge has become a priority from the point of view of open innovation. It is opposed from closed innovation policies which only prioritized innovation and not the marketing of the products. In fact, to talk about innovation, the invention's marketing strategy is necessary. Open innovation policies give importance to the business model rather than generating a new product or service (closed innovation).

Chesbrough (2003), a pioneer in the definition of open innovation models, states that the open innovation paradigm can be used by any company, institution or university regardless of their size or level of R&D&I. Obviously, neither the organizations nor the knowledge are homogeneous. This implies that the paths chosen for knowledge sharing and collaboration between partners are different, depending on the characteristics of each agent and if the framework for open innovation is maintained. In this context, the theory based on knowledge argues that industries and their agents differ in their dominant modes of knowledge (Asheim and Gertler 2005; Asheim 2007; Asheim *et al.* 2006)

As shown in **Figure 2.5**, open innovation process begins with the knowledge generated by the institution, externally acquired knowledge or both. It can be transferred to any other company or institution at any stage of the value chain (the process during which knowledge moves into the market or society) or be delivered directly to the market. Therefore, it is shown how an organization's knowledge can be absorbed by another for the development of new knowledge that will eventually be transferred to the market through a new company, a new institution or by the same company.

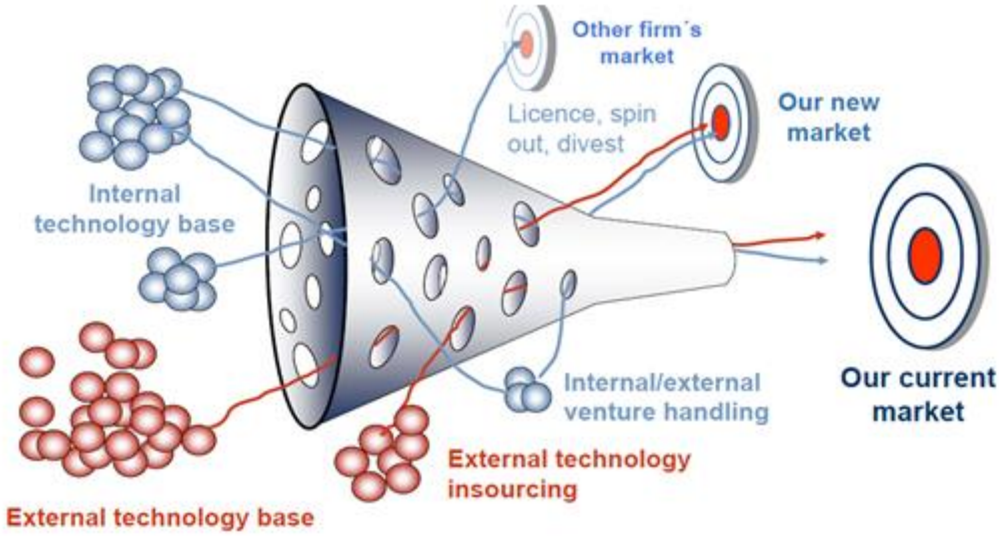

Figure 2.5. Open innovation process (Chesbrough 2004)

Companies or institutions based on analytical knowledge develop new knowledge by applying scientific laws. This type of knowledge, that seeks to understand the *why* of things, is hard coded, highly abstract and universal. Organizations with greater analytical knowledge usually have frequent links with the university and university graduated staff because of their research experience. Due to their high degree of codification they are less dependent on local social networks. By contrast, organizations based on synthetic knowledge apply or combine (in a new way) existing knowledge. This type of knowledge is defined as 'know-how'. This is partially encrypted, highly tacit and has more specific content. The links between academia and industry are relevant in companies with a synthetic knowledge domain, but especially in the field of applied knowledge. The staff usually develops skills through job training in vocational schools and/or universities.

Therefore, it is important to highlight the role of universities and other centres of knowledge generation in the open innovation processes. An increasing number of tools for producing R&D&I are being developed by university researchers. They are having an external social and economic impact. Most companies use a combination of different knowledge bases (Martin and Moodysson 2011; J Moodysson 2007), and the dominant knowledge base is what defines the competitive advantage of the company or institution. Therefore, different platforms offer technology supplies and demand services that are already used by some cultural industries.

In the previous section the open innovation model appears opposed to the closed innovation model, where the company or institution is owner of the knowledge and its strength is given by its ability to generate new R&D, giving him a dominant position. But the advent of new theories of open innovation in early 2000 which were implemented by some large corporations such as Xerox, Philips and Procter&Gamble, showed that the future roadmap will be very different. The starting point is the premise that good ideas are widely distributed. In the future, nobody will have the monopoly of applied knowledge. Furthermore, industrial innovation processes move in different directions and may not initially foresee the entire value chain because they can create new knowledge and market agents that modify our initial approaches.

Scientists, for example, prefer to publish their research findings through open science. This is also the case for companies that publish their internal research in scientific journals, motivated by the importance of forming ties to the larger scientific community in order to access basic knowledge. In this context, companies must be actively involved in the creation and dissemination of new knowledge. Therefore, they become more efficient learners and with a higher absorptive capacity. Companies have attempted to stave off a Schumpeterian destiny where incumbent companies are replaced by new entrants in the process of creative destruction (Hess and Rothaermel 2012).

Also, intellectual property is another aspect that needs to be managed differently in open innovation models. There is a need for access to the external IP (intellectual property) in order to drive our business model. And there is also the need to benefit other business models with our IP (we will not always use our knowledge but we can transfer it to others). Another aspect to consider is the fact that not all the best workers are in our organization. From this point of view, organizations began to be alert to new innovations and developments that occurred outside their offices and network in order to capture new innovations produced by other entities or outsiders.

Therefore, we could try to briefly define the open innovation ideology by contrasting it with the closed innovation model (Chesbrough 2003). It would be as follows:

• Not all the best people work for us. We need to work with brilliant people both inside and outside our company.

• External R&D can create substantial value; internal R&D is needed to claim some part of that value.

• It is not necessary that we generate research in order to profit from it.

• Building a better business model is preferable to being the first on the market.

• If we make the best use of internal and external ideas, we will succeed.

• We must take advantage of the use that others make from our intellectual property, and we must buy the intellectual property of others every time this creates an improvement on our own business model.

The application of open innovation strategies encourage the company-client *co-working* and the possibility of developing a more applied research based on the detection of new ideas and specific needs that can be brought to the market. The best ideas are no longer owned by any institution; it is important to have the ability to detect them because they are in many places. Furthermore, interacting with other entities allows to gain greater wealth of knowledge and experiences that enrich their contribution to the company and may enable them to approach the solutions to new problems from new perspectives.

An organization in a competitive market and open environment can succeed by learning more and better about the needs of their customers' innovations than the competitors do. The key is that an organization must also know their customers' value chain in order to help them to improve and become more competitive in each of the stages of the product or service transfer to the market. Social or collective intelligence is increasing in importance as opposed to individual knowledge and skill (Florida and Kenney 1993). Finally, having demonstrated how strategic open innovation is in science-based and technology-based companies, these practices must be transferred to the creative and cultural industries to redefine projects, connect better with their public and users and open co-development processes with all the agents along the value chain.

2.8. Open innovation on services

Manufacturing has continued to dominate innovation studies. The vast majority of innovation studies focus on technological innovation within manufacturing. The service-specific studies are in strict accordance with Schumpeter when they argue that innovation is much more than technological product and process innovation (Drejer 2004). As shown above, in a classical conception of business as a string of economic activities that add value to a product, the product is the implicit key throughout the process. The service appears only at the end of the diagram, having a unique role in facilitating the sale of the product, or maintaining its operation once acquired.

Thinking of the company as a service organization involves shifting attention from the product-oriented value chain and focussing on creating customer experience. Some of the concepts of open innovation are easily applied to innovation in services. In the open model there are two complementary types of opening:

> **Outside-in:** occurs when the organization predominantly uses external ideas and technologies in their business. In this context, openness means overcoming the “not invented here" syndrome and receiving external contributions with interest. An example of this type of innovation is offered by LEGO, allowing customers to create their own designs. Up until recently, companies were suspicious about innovation from the perspective of the customer, for fear of losing trade secrets or simply because they saw them as lacking the necessary expertise. But LEGO has increased the power of the spirit of open source.
>
> Mindstorms, the programmable kit related to robotics from LEGO, is a clear evidence of this opening model from the outside to the inside. After four years without any update from Mindstorms, and with rumours that LEGO could abandon the full product, the company decided to trust their loyal customers in the design of the new Mindstorms NXT. LEGO didn’t have any prototype developed. It was too early to use "beta testers" (those who are willing to try the product at a further stage of development), so LEGO Mindstorms needed a group of users (MUP: Mindstorm User Panel) to help them with the design. They had the complicity of four panellists (selected for their hobbies and previously demonstrated work at meetings and fairs of LEGO fans). These LEGO customers/regular users were also paid in a manner that was very satisfactory for both parties: they received some LEGO Mindstorms NXT and several prototypes. The company was positively valued at low cost.

The boldest aspect of the new LEGO Mindstorms was the decision to outsource their innovation to a group of citizens. LEGO expect to get a better product and also a closer relationship and trust in the client-company. It was clear to the LEGO Mindstorms NXT executives that the contributions of MUPers enabled them to obtain a better product. Inviting customers to innovate contributes to building better products, but opening the process also generates goodwill and helps to spread the message among fans. In the book *Democratizing Innovation*, the MIT professor Eric von Hippel (2005) said that "joy and learning are associated with membership in creative communities", driving people to generously share their time.

- **Inside-out**: this happens when the organization allows their own ideas, technologies or processes to be used by other organizations. In this case, *opening* means overcoming the "not sold here" syndrome, and welcoming external revenues. An example of this model is AMAZON.COM, which was associated with large retailers who wanted their websites to offer merchandise.

Service innovation requires changing the business model of product-oriented companies in relation to the following aspects: the value is in the business model; what was free before now is priced; relationship *vs.* transaction because co-creating with customers creates value.

This customer-company collaboration is needed to develop new solutions. From this point of view, the **user empowerment** (force from the end user) determines clearly what gives real value to the customer, and therefore his opinion must be taken into account. Their active participation throughout the process is also needed when launching new ideas to market. Therefore, the company works closely with their customers in order to develop new solutions by incorporating the client as an active part of the process. In this way, it is possible to affirm that the right way is to focus on the customer's value.

Service innovation requires a change of business model. Innovation in business models dates back to the fifteenth century, when Johannes Gutenberg was searching for applications for a mechanical printing device he had invented. However, the scale and speed in which innovative business models are changing the business landscape are unprecedented.

From an initial product orientation to a service orientation, the change is evident in the following aspects:

- From a client initial passivity to a client-company co-creation.
- From observing the business as a transaction, to contemplating it as a form of relationship.
- From a product rather than a service differentiation to a company that is distinguished by its services.
- From having the service at the end of the value chain to its becoming the priority throughout the value chain.
- From considering services less important in the strategy of the organization to being the principal element.

Innovation requires the ability to manage ambiguity and uncertainty in order to obtain a solid business model to ensure positioning and the future growth of the organization. Fred Collopy and Richard Boland (2004) describe the process of decision making as an attitude that assumes that it is easy to find alternatives and that the difficulty lies in choosing the right alternative for developing the strategy.

In addition, the tension between *scope economies* (customization) and *scale economies* (standardization) must be resolved. That is, our customers seek customized solutions for their needs and demands, but the organization also needs to approach the growing segmented consumer. This point of tension must be solved for the success of many organizations that are increasingly investing in learning more about their customers, making for an unforgettable consumer experience. Consumption and experience becomes even more important in the cultural sector.

This niche segmentation, following the targeting, leads to a greater specialization. The consumers demand services that best suit their needs and this requires organizations to offer more personalized services. This happens for example in music festivals, increasingly focusing on target groups that pay for experiences around music (psychobilly meetings, blue grass festivals, etc.). That is, the public does not seek only to hear a good band but an experience that goes far beyond this. That's where new possibilities open for organizations: extending that experience, making it more intense or proposing a complementary one.

Within organizations, it is important to highlight all those observational and recruiting processes they use in order to be nourished by the best internal and external ideas. It is recommended to constantly observe and pay attention to what is happening around, and which experiences are the most successful. That requires good comparative analysis (benchmarking) to obtain best practices from each experience. Once identified, it is necessary to include them in our project to strengthen it. And from there, we can innovate and improve. It becomes an advantage to imitate and incorporate outstanding practices that others have already implemented with some success (whether or not in our own sector). It's like having a cosmopolitan laboratory where new processes, products or services are being experimented with, but at very low cost to us. We must be alert to detect those interesting practices which open markets or modify them, which set new trends and change processes in order to introduce their improvements in a timely manner. In all these cases, reducing time-to-market from an idea in the value chain is one of the most important keys for the success of an organization.

Besides co-creation, there are other common practices for implementing open innovation. Some were born specifically in a particular sector but have spread across other fields, either as a simple inspiration or through copying the whole idea. Collaboration can also occur with partners, suppliers and even competitors. Some of these practices are:

- **Crowdsourcing**: outsource tasks to a large group of people, community or mass by competition. This practice excludes the usual financial barrier that prohibits most people from participating in these kind of projects, where satisfaction is generated through community work. The vast majority of crowdsourcers are anonymous.

- **Expert Networks**: creation and management of a network of "think tanks" for searching out and evaluating business opportunities, or contributing knowledge. These people collaborate regularly with the organization and provide a stable network of support for innovation.

- **Markets innovations or 'Marketplaces'**: access to space-webs where the supply of technological expertise is concentrated. These places enable ideas and technologies that other organizations do not know how to use to find a new home where they can be exploited.

- **Creating communities**: the organization that creates this space must listen, accept criticisms and participate with their users, obtaining various contributions to help with improving the organization. Besides, it is important that the organization implement a filtering system and work on the most important insights.

- **Information monitoring**: the Internet is an ongoing conversation, so it is crucial to be alert in order to know what is said about an organization or product, to detect possible inferences, and react.

- **Living Labs**: This concept was originated by the Professor William Mitchel MediaLab at the School of Architecture and City Planning of the MIT and was presented as a research methodology to test, validate, prototype and refine complex solutions in current evolving environments. First Living Labs were created as smart homes and their purpose was to capture the use and interactions of "invited" people who lived in them for days or weeks. This was accomplished through a set of sensors that allowed capture of the use made by the visitors with the technology that was available. Hence, the concept was reinvented and materialized in other environments, especially in information technology and communication. Subsequently, this application emerged in a wide variety of environments: automotive, industry, tourism, culture, etc.

  Common elements of the Living Lab concept are:

  - **Multi-Stakeholder**: when different stakeholders in the sector are involved in the process: universities, research centres, industry, governments and users.
  - **Multi-Context**: In contrast to classical validation processes which sought to isolate as far as possible the user-product context by creating a

"laboratory" experiment, a Living Lab captures the interrelationships between multiple contexts in an environment of current use.

  - **Feedback**: the access to information generated by the technology of Living Labs is continuous, enabling modification of what needs refining in a service or product development.
  - **Interaction:** between research centres, businesses, governments, users and other agents in a real environment. It seeks to create an environment where representatives of different interrelated actors can interact facilitating the transfer of knowledge between the research world and business.

- **Beta Labs**: a space with a high number of applications/prototypes in beta state available to be tested. They can be downloaded and used where the user wants. They bring knowledge to the organization about unexpected uses, implementation, improvement and preferences. For example, the Sports Tracker application from NOKIA, was designed for runners and cyclists that could benefit from the GPS incorporated in some Nokia models. This app showed unexpected uses in sports.

- **Innovation Jam**: It comes from the results of innovation clusters of IBM. All actors and stakeholders, receptors and interested people work together in these sessions. Employees, suppliers, customers and lead users share their thoughts about the future of the company and the direction it should take.

There are several examples of cultural organizations following the open innovation model and incorporating some of the practices presented. Different museums or think tanks are introducing R&D&I laboratories in their structure (the IRI -Institut de recherche et d'innovation of the Centre Pompidou in Paris- or the CCCBLAB -the laboratory of the Centre for Contemporary Culture of Barcelona) or an institution that gathers different associations of the artistic field such as Foment de les Arts Decoratives de Barcelona has created a specific centre of materials (Materfad).

The **centre Materfad** of the FAD (Fostering Arts and Design), self-denoted centre of materials of Barcelona, arises from a demand of the associates to know all the materials that can come to be used in any specific project and that better adjust to the characteristics of their projects. This has allowed that Materfad has elaborated a catalogue of materials and develops a continuous work of research and technological vigilance in the field of new materials, providing consulting and training services to its associates and to companies, professionals, universities and external technology centres. Its work of technological surveillance allows FAD to detect materials and technologies of a certain sector with potential to be applied in another, offering this knowledge to companies and professionals who use Materfad's consulting services.

Kobalt is an example of the latest business model revolutions of the music industry. In recent years, different artists such as Prince, Nick Cave, Travis, Dave Grohl, New Kids on the Block and the Pet Shop Boys have created their own record label and hired Kobalt. This is a marketing and distribution platform that allows them to retain 100% ownership of the master disc. Kobalt Music Group, which was born as an independent music label worldwide, launched a subsidiary in 2012: Kobalt Label Services (KLS).

KLS offers the next generation of services for artists and brands worldwide. They offer a complete solution to launch and commercialize discs while maintaining ownership of the work owned by record companies and artists. Established as an alternative brand model, KLS maximizes opportunities for customers and revenues of a wide range of digital retail, traditional physical retail, audio and video synchronization license, D2C and social media services. Customers benefit from the experience of Kobalt in multi-rights management, transparent accounting, advanced data analysis and experienced staff that coordinate and manage releases.

Their success reflects the consolidation and institutionalization of the model "do it by yourself". In this case the artists create their own label, which sometimes works more like a screen, bear the cost of recording their albums and then turn to companies like Kobalt to put them into circulation and promote them. There is no artistic interference in the record or excessive tariffs. Additionally, an absolute control of the income generated is obtained through the work of a powerful software. Sales benefits are clear and controllable. The group keeps the property in its work and is free to use it as they believe convenient. Kobalt's success is mainly due to two aspects: full ownership of the work and transparency.

2.9. Cross-fertilization of knowledge and technologies

Cross-fertilization (or cross-pollination) is defined as the recombination of previously separate concepts (Grodal and Thoma 2010). In the case of biology, this term makes reference to the combination of the genetic material of two plants when is combined, producing a genetically varied offspring of the parents. Cross-pollination requires external pollinating agents like water, wind and insects (Panawala 2017). The plant on the receiving end of this pollination is hardier and able to reproduce with greater variety. It meets environmental challenges more successfully because it's genetically diverse. In the same way, when organizations cross-pollinate knowledge and technologies make their businesses stronger, being able to weather the difficulties to be success in the market.

The intersection of knowledge fields yields a fertile breeding ground for new ideas (Fleming 2001; Fleming *et al.* 2007; von Hippel 1988). Aware of the importance of favouring these processes, some universities like Harvard in 2005 leaded the change for an innovation-stimulating, cross-disciplinary campus for science, engineering, medical and business schools (Fleming 2004). But although this cross-fertilization process can be stimulated within the organization (schools, campuses, headquarters, laboratories…), the challenge is crossing the boundaries to connect with external team members and develop new knowledge. There's a general acceptance that innovation is a source of competitive advantage and in-house R&D labs can't possibly create all the innovation necessary to maintain organizations' market position (Chesbrough 2003). According to Fleming (2004), the breakthroughs that do arise from multidisciplinary work, though extremely rare, are frequently of unusually high value— superior to the best innovations achieved by conventional approaches.

Creating and appropriating value from diversification in the technology base of products, through technology cross-fertilization, is not automatic; innovative management is needed for their realization. Hence, from a managerial or firm perspective, a crucial aspect is how companies create value for their customers and how companies appropriate economic value. Technology cross-fertilization does not inherently lead to improved customer or user value. Nor does increased user value inherently lead to increased value appropriated by the integrating firm. Thus, creating and appropriating value from diversifying the technology base of products clearly needs to be managed. The cross-fertilization may create a potential value for some users and the company's managers must envisage how the firm can appropriate it. The inherent value of a technology is latent until it is commercialized. In order to capture value from a technology investment the business design around the technology has to fit the circumstances of the technological or market opportunity.

The literature argues that the major driving forces of technology diversification are the opportunity to introduce new technologies into products by cross-fertilizing technologies, and the pressure to support a given product line to maintain its relevance (Granstrand *et al.* 1997). In so doing the literature emphasizes that products have to incorporate an increasing range of technologies (Pavitt 2001) obtained from scientific discoveries that generate innovations with commercial potential (Gambardella 1995; Klepper 2001; Murray 2002; Shane 2001, 2002). In fact, science could be considered a key factor that contributes to commercial production through knowledge and technology. In the post-industrial society the principal asset in productions has become knowledge and the ability to generate and integrate different knowledge sources within the organization (Machlup 1962; Powell and Snellman 2004; Rosenberg and Steinmueller 1988). Adding new technologies to the technology base of a particular product is associated with a search process in which new technologies are explored, and then integrated into the technology base, resulting in enhanced technical performance along the existing trajectory and/or new functionalities. This process is sometimes referred to as product related technology diversification (Granstrand 2001). Here, the search for new technologies is constrained by the need for them to cross-fertilize within the product, opening up new sub-spaces in the technical performance and functionality space. This is another type of economies of scope that is different from cost-related economies of scope resulting from resource sharing (Granstrand 1999).

Advances and breakthroughs in science and technologies open up opportunities for interdisciplinary combinations of different technologies (Granstrand 2001). Cross-fertilization occurs, in particular, with the use of so-called general purpose technologies (GPTs) (Torrisi and Granstrand 2004), which by definition are highly pervasive and cross most industry boundaries, being in many ways highly complementary to other technologies. GPTs act as enabling technologies by opening up new opportunities rather than offering complete product solutions (Bresnahan and Trajtenberg 1995).

Concepts involved in the commercialization of knowledge exist in three integrated but separate institutional environments: science, technology and commerce (Dasgupta and David 1994; Rosenberg 1990). In science researchers generate knowledge, which they disseminate through scientific articles, presentations at research conferences and their informal network of friends and colleagues. Some scientific concepts are translated into technological concepts in the form of technical drawings, documentation and patents. A fraction of these technological concepts are subsequently integrated into actual products; they are commercialized (Agrawal 2006).

Several studies have shown the importance of the business model for creating and appropriating value (Amit and Zott 2001; Chesbrough and Rosenbloom 2002; Magretta 2002; Markides and Charitou 2004; Morris *et al.* 2005) in rapidly changing ecosystems that force companies to adapt their strategies to the changing market demands (Casadesus *et al.* 2013; Teece 2010). Clearly the concept is a bit muddled, although the proposed conceptualizations do have a common denominator— to create and capture value. The literature on the business model, unlike the conventional strategy literature, has tried to include the creation of value for the user rather than merely addressing the appropriation of value. Therefore, the literature on business models goes beyond Teece's (1986) framework on how to appropriate value from innovation, which focuses on protecting an innovation in order to appropriate economic value, and not on value creation and value sharing (Moran and Ghoshal 1999; Jacobides *et al.* 2006), which to a large extent arise from its focus on competitive threats. The purpose with the cross-fertilization of knowledge and technology is to open up new sub-spaces in the technical performance and functionality space and, by so doing, to create value for users from the technical potential. However, it is a huge leap from firms' creation of value for their users to appropriation of economic value (Björkdahl 2009).

Studies of science and technology show that radical innovations spur the emergence of new fields (Basalla 1988). The existing research on cross-fertilization has focused either on cross-fertilization at the level of the individual, the team, or case studies of individual technologies (Fleming and Sorenson 2001; Hargadon and Sutton 1997; Nelson and Winter 1982; Schumpeter 1934). Schumpeter (1934) described the hallmark of entrepreneurship as recombining resources in novel ways. In Schumpeter's account the locus of cross-pollination is with the individual entrepreneur. Fleming (2001) shows how entrepreneurs, who recombine new elements, in general are less innovative, but the variance of cross-fertilized knowledge is much higher, which implies that individuals, who recombine concepts, create both influential breakthroughs and trivial inventions. Padgett (2001) also embodies this perspective as he views entrepreneurs as recombining logics in the environment in order to create new organizational forms. One of these ways to recombine ideas is the lateral thinking (de Bono 1967): a technique based on the assumption that any new concept, when it is considered by a person in light of his/her existing cultural mind-set, has the capability of self-connecting to existing concepts, even beyond the conscious control of the person.

The group as the unit of analysis has been emphasized by Hargadon and Sutton who demonstrated the condition under which teams are more likely to generate cross-fertilized results. Fleming (2004) shows that interdisciplinary teams produce more radical innovations than disciplinary based teams. Further, in the video-game industry Tschang (2007) finds that creativity in game design studios occurs through recombination of elements from prior games. Yet another line of research focuses on cross-fertilized within individual technologies by examining the knowledge flows that facilitated their creation (Brusoni *et al.* 2001; Stankiewicz 2000). Common across these research streams is an implicit assumption that novel concepts are cross-fertilized.

Furthermore, the literature on cross-fertilization has primarily been concerned with whether cross-fertilization yields innovative outcomes (Fleming 2001; Fleming *et al.* 2007; Hargadon and Sutton 1997; Hargadon 2003; Nelson and Winter 1982). But for cross-fertilized ideas to impact technology and economic growth they need to move from their locus of first use to other institutional arenas and new fields. Otherwise the cross-pollinated concepts might be innovative, but they will never gain widespread acceptance. Schumpeter's theory of entrepreneurship is, for example, based not only on the assumption that the entrepreneur recombines existing knowledge in the creation of novel concepts, but also that the novel concepts proliferate after cross-pollination has occurred (Schumpeter 1934).

Many efforts have been made to track the flow of knowledge between organizations and across institutional contexts (Powell et al. 1996; Powell and Snellman 2004; Sorenson et al. 2006). While studies and surveys have suggested that most inventions are patented, many scientific ideas still are not integrated into technologies (OECD 2007). There is, however, evidence that even though a scientific concept is translated into a technological possibility in the form of a patent it is not always commercialized (Mirowski and Sent 2002). Thus, still lack an understanding of how and why some concepts move between knowledge spaces, but others fail to proliferate (Aldrich 1999). Ideas that come from different organizations and fields, when cross-fertilize, can generate new knowledge and strategic alliances facilitate knowledge mobility (Mowery et al. 1996; Powell *et al.* 1996). Then, at a later stage, some of this previously generated knowledge will cross-fertilize (with new and existent knowledge) and will be used to develop a new technology. Finally, these new technologies will cross-fertilize with other new and existent technologies but only a short number of these technologies will be applied and commercialized. **Figure 2.6** summarizes this process of cross-fertilization of the value chain.

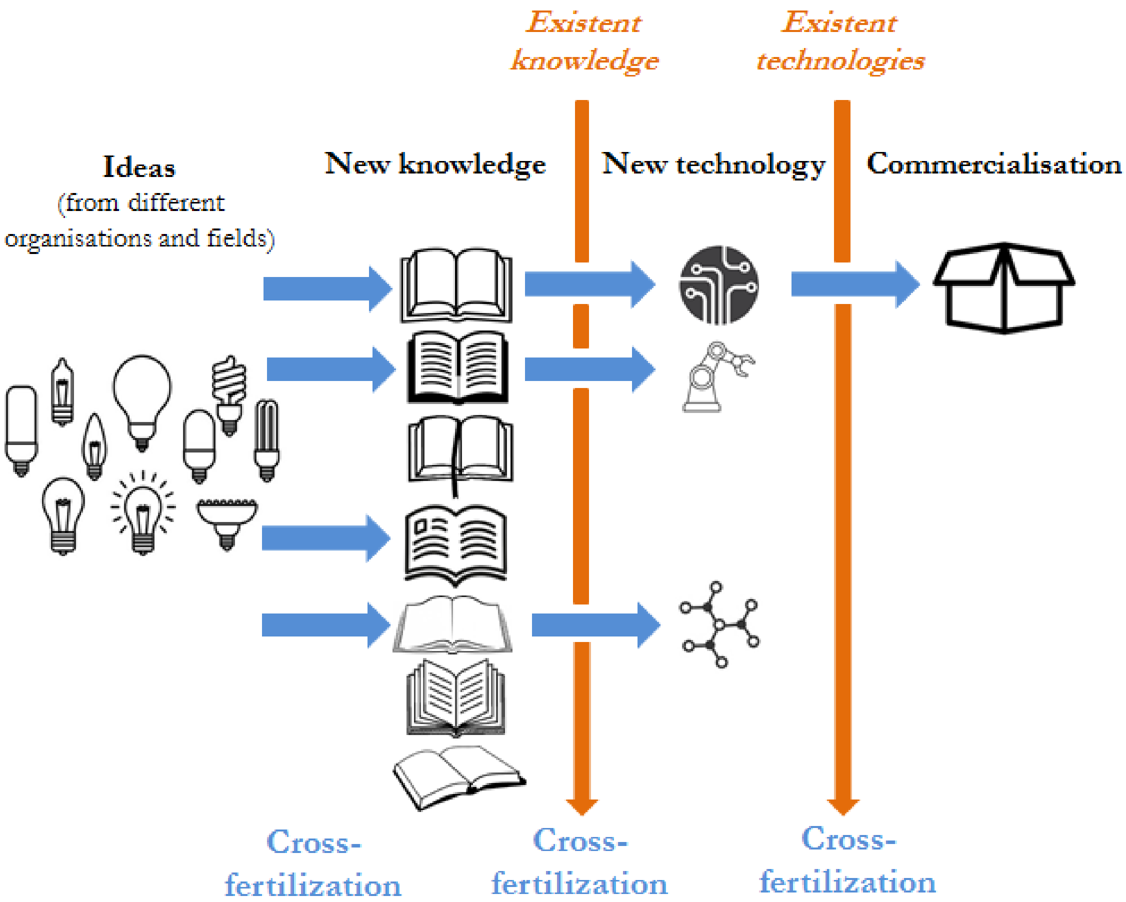

Figure 2.6. Cross-fertilization value chain

The literature often assumes that technological concepts and commercialization are identical phenomena, measured by whether a scientific concept is paralleled with a patent (Murray 2002). Technology is technical knowledge disclosed by inventors in patent documents. An invention needs to be novel and useful in order to be patented, and the public description of the invention enables lawful enforcement of its claims.

Finally and coming back to the previous concept of knowledge mobility, there is disagreement within the literature about how to best conceptualize and measure it. At the interorganizational level much research has emphasized the role of strategic alliances in facilitating knowledge mobility (Mowery *et al.* 1996; Powell *et al.* 1996). Other research has shown that knowledge complexity and the social distance between organizations interacts in predicting the flow of knowledge between organizations (Sorenson *et al.* 2006). According to Grodal and Thoma (2010) the mobility of scientific concepts into technology is aided when one or more of the authors are affiliated with industry. It has been debated which role scientists with industrial affiliation play in the translation of knowledge between science findings in scientific journals if the knowledge does not have commercial value (Bird *et al.* 1993). The argument behind this claim is that companies are reluctant to share any information that might provide their competitors with increased insight. Companies might thus choose to only publish information that is basic research, and thus far away from commercial possibilities (Grodal ant Thoma 2010). But attitudes about information protection are changing thanks to the open innovation perspective and the impossibility (and the big cost associated) of protecting technology that inspires new one.

2.10. Liquid Technology

Zygmunt Bauman advocates for the idea of "liquid modernity". His view emphasizes the fact of change within society and argues how change is occurring more and more rapidly in the contemporary world. He distinguishes between solidity and liquidity as the distinctive features of two eras: modernity and postmodernity, which becomes liquid modernity as it relates to contemporary existence.

Liquid modernity is Bauman's conception of how the world today denies the so-called solidity that it once struggled assiduously to create and maintain (Lee 2005). He addressed the liquefying power of modernity as being called upon to "replace the inherited set of deficient and defective solids with another set . . . which would make the world predictable and manageable". Yet, this power seemed to have generated "patterns and figurations which . . . were as stiff and indomitable as ever" and "whose turn to be liquefied has now come". This infinite progression of liquefaction provides the sense of impermanence that he described as "the new lightness and fluidity of the increasingly mobile, slippery, shifty, evasive and fugitive power" (Bauman 2000: 3, 5, 6, 14).

The idea of a solid end-point has fizzled out as the liquefying power of global capital is dissolving all the boundaries that once distinguished between different countries on the road to a solid modernity. This idea connects with the permeability of the boundaries between organizations and their environments; innovations can be easily transferred inward ant outward. Therefore, the central idea of open innovation is due to a world where knowledge is widely distributed and organizations cannot rely solely on their own research. Thus, ideas that come from different organizations and fields, when cross-fertilize, can generate new knowledge; later, this new knowledge (in contact with other external knowledge) will be used to develop new technologies. Obtaining these technologies (that later will cross-fertilize with new and existent technologies) follows a liquid process that let me talk about liquid technologies. Now technology mutates, transforms, continually reinvents itself and seeks new applications.

It is as though globalization created a borderless mass society (Lee 2002) in which technology crosses sectors, organizations and projects. Yet, islands of solidity still exist in this water-world of global capital because some companies still follow a closed innovation perspective –although not taking advantage of the use of external knowledge does not make sense nowadays. Today there is the growing conviction that change is the only permanence, and uncertainty the only certainty. A hundred years ago "to be modern" meant to chase "the final state of perfection" -- now it means an infinity of improvement, with no "final state" in sight and none desired (Bauman 2000: 82).

Technology changes constantly and it is the only permanence because the new ideas, the science push to generate new knowledge that will be transformed in new technology. There is "infinity of improvement" of this technology due to its liquidity. The technology advances like the water of a river in which tributaries contribute their water to the flow of the river, making it bigger, more powerful. At the end, there is the delta that represents the application of this technology in a whole sea, trying to find a commercial application. But the river never stops, because new knowledge (in contact with existent knowledge) is pushed to develop new technologies (in contact with existent technologies) to arrive again to the delta, in which a new technology will be applied and commercialized in the immensity of the sea or the ocean –a global and competitive environment.

Jacobsen and Marshman (2008) explain that we have moved from the stability, permanence, and heaviness of the "solid" modern era to the unstable, fleeting era of "liquid" modernity, where maximum impact, instant obsolescence and constant mobility are all important. Now reality is more transitory than permanent, immediate more than long term; and regards utility as prior to any other value. According to Bauman (1996: 18) the era of liquid modernity is centred on "avoiding fixation and keeping the options open". The idea of a life-long project is no longer desirable (Atkinson 2008); instead, a "flexible identity, a constant readiness to change and the ability to change at short notice and an absence of commitments" have become not only attractive options in the liquid modern society, but are apparent prerequisites for survival (Bauman 2004: 35).

Lee (2005) comments that social change is not just an intrinsic part of any society; it also produces a tendency towards the acceptation of new values underlying our conception of existence. The solid modernity of the past was once characterized by the attempt to make the world orderly and organised through the imposition of categories and definitions that were seen as equally solid and unchanging (Jacobsen and Marshman 2008). However, this new sense of liquefaction suggests that fixed categories have become ineffective, unable to reflect rapidly changing circumstances and social or cultural upheavals. This liquid society requires the use of a tool, technology, capable of adapting to the challenges and needs of a world in constant change and continuous acceleration.

All these changes also have affected values. "Transience has replaced durability at the top of the value table. What is valued today (by choice as much as by unchosen necessity) is the ability to be on the move, to travel light and at short notice. To be fixed is to be at fault. Power is measured by the speed with which responsibilities can be escaped. Who accelerates, wins; who stays put, loses." (Bauman and Tester 2001: 95). This ability to surf on the currents of the river is what is expected from technology. Changes are increasingly fast and a liquid technology, which brings together new and existing knowledge, is the only tool that can respond to the requirements and needs of users. Because now the user determines what has real value to him/her, and therefore their opinion becomes essential for the success of a product in the market. Users identify needs and companies have to solve them in a satisfying way for user's demands. So, this new liquidity of being has reduced the sense of durability and dissolves the bonds that reify our sense of security.

The trend towards flexible specialization, downsizing and subcontracting especially in the Western world accounts for the impression of an emerging liquid modernity. From this impression, work receives "a mainly aesthetic significance" (Bauman 2000: 139). In this environment of free-floating labour, production is no longer considered an important source of developmental values. Instead, production is reconfigured as a servant of consumption and the liquid technology has the guarantee to create new products or services, flowing continuously and generating enough water to move all the gear parts.

Bauman was right to give the characteristic of "liquid" to the time in which we live, because we no longer seek to stabilize ourselves in a specific place or time. We want to flow through the vortex of information that constitutes us and surrounds us. We change at the same pace as the conditions in which we live, and nobody knows what will happen next. Throughout this process technology accompanies us and responds to our needs and demands. It does so by adapting to any small change, even conditioning, winding, flowing and modifying the environment as no other element in the current world can do. For this reason, I defend the concept of liquid technology which flows, is deployed and even through intelligent algorithms responds to the most complex problems that require innovative and disruptive solutions. Liquid technology aims to continuously adjust the products and services portfolios of the companies to the changes described in the liquid society. The complexity of innovation increases, while efficiency and consistency of the process decrease, but the cross-fertilization of knowledge and technologies is strategic for developing liquid technologies that will be applied in our complex and liquid world.

2.11.Conclusions

This chapter aims to help in understanding the genesis of open innovation processes applied to the field of cultural organizations and how these are in constant evolution and transformation. Also, the chapter goes beyond showing how the cross-fertilization of knowledge and technology can be considered a disruptive innovation strategy. In addition, the presented theories connect with an interpretation that I formulate inspired by Bauman's liquid modernity that leads me to affirm that we are in front of the era of liquid technology.

The concept of innovation was introduced by Joseph A. Schumpeter, for whom innovation was "a new combination of the means of production with access to credit" (1934: 74). This new combination of production factors causes inventions and innovations that are key to economic growth and that will be implemented by entrepreneurs. That work introduced concepts such as investment, credit and entrepreneurs and focused not only on the production of innovations but also on the creation of managerial models to ensure proper operation of them.

From Schumpeter's contribution, it was shown how a part of the open debate on the impact of the art economy, including the contributions of the Frankfurt School (Adorno and Horkheimer 2007), was developed. Benjamin Yúdice (2003) has popularized the term "culture as a resource". He asserts that culture itself becomes meaningless unless it can be valued by what we get from the culture (contribution of culture to national wealth, quantifiable wealth in economic terms), as opposed to personal enrichment. Jeremy Rifkin goes further and criticizes the current "hyper-capitalist" access to cultural experiences. Thus, culture becomes the ultimate goal of the economic value chain, ending the transition from industrial production to cultural production. The chapter also includes and discusses the points of view of Holden, Throsby, Klamer or Landry.

Value creation is one of the key aspects in the definition of innovation. Value could be incorporated in each step of the value chain (screening, selection, evaluation, protection and exploitation) from the research and development to the market. The accumulation of value throughout the process is what makes the product or service reach the market with an additional value.

The importance of value creation has also been studied by Kim and Mauborgne (2005) in the *Blue Ocean Strategy*. They conceived innovation as an innovative vision related to business strategy: success with a non-competitive strategy. Through a metaphor, the red ocean represents organizations competing in existing market spaces (much more explored) with low differentiation, normally based on the price. However the strategy of innovation in value is the basis of the blue ocean metaphor. In this, organizations create new market spaces making the competition irrelevant by creating and capturing new demand, aligning all activities of the organization with the goal of reducing costs while increasing the value of their products and services (Kim and Mauborgne 2005).

The value of innovation strategies causes organizations to focus efforts and resources on differentiating features, enabling them to create differentiation that will be clearly perceived by the consumer. **User empowerment** enables us to clearly determine what the customer gives real value to and therefore his opinion becomes essential when launching new ideas to market. Often the client does not demand a specific solution but expresses his dissatisfaction at some stages of the process. It is at these points that an organization detects an opportunity to implement improvements in the process.

This chapter also analysed the distinction between **disruptive innovation** and **incremental innovation**. The first refers to creating new needs and products, and opening new markets. Usually it takes into account the issue of costs and innovation of the business model rather than focusing only on product innovation. On the other hand, **incremental innovation** is the response from well-established organizations to the progressive arrival of competitors. This response enhances the value of products through an evolutionary innovation process that is the improvement of functions and uses as a competitive advantage.

All these aspects have led us to introduce the concept of **open innovation**, which emerged in opposition to the concept of closed innovation. This last is a process of internal generation, where ideas are examined and screened during the research process and subsequently, the surviving ideas go to a development process and finally to market. This type of paradigm worked well throughout most of the twentieth century, but in a world where knowledge is widely distributed, organizations cannot afford to rely entirely on their own research and should rely on the **open innovation processes**.

Transferring knowledge to market is a priority in open innovation models. This is opposed to closed innovation policies that only prioritized innovation. Currently, innovation without marketing has no sense. In fact, to talk about innovation it is necessary for an invention to have a marketing strategy. Open innovation policies give much more importance to the business model, rather than to generating a new product or service.

Service in the cultural sector is where the concept of open innovation has evolved with greater force. Service innovation requires a change in the business model, and clients represent the basic part of the whole process. Now they can co-create and co-design; this is essential to the customers' relationship with the company. Services enable the company to be distinguished from competitors through the value chain, determining the success of the organization.

Considering the issues addressed in this chapter, cultural organizations must be able to distinguish themselves from competition. This means offering a new image that can gain a position in the changing environment. In this context, it is essential to take into account the creative component, as well as the strategies of co-innovation and co-creation. In the closed innovation concept, it was very difficult to envisage how a single organization could have a dominant position (a museum, a university or a research centre). We now know that any cultural initiative requires a good relational network, requires knowing where to acquire the knowledge, capture talent, redefine their commercial or public outreach strategy and renew constantly to enable adaptation to change.

Progressively, much more critical consumers will be seduced by those projects that know how to satisfy their needs and that provide an experience that places high value on their choice. LEGO Mindstorms business was the example analysed in this context. Their relationship with the customer was key to outsourcing innovation. Confidence in their customers was the bet that Lego took in order to get a better product, but which also enabled them to gain a trusting customer-company relationship.

Besides co-creation, there are other common practices in implementing open innovation. Some were born specifically for a particular sector but have spread across the remaining fields, either as a simple inspiration or by copying of the whole idea for other environment or sector. These are: **crowdsourcing, expert networks, market innovations or marketplaces, community building, monitoring information, living lab, the beta labs or the innovation jam.** All of them, analysed throughout the chapter, offer multiple formulas already tested with success. With them, we can develop co-creation processes with better-informed customers, users and all of those individuals involved in the value chain of any organization.

We must also consider interdisciplinary projects, which allow cultural proposals to take new directions, as shown by some of the initiatives reported. Not adapting to this changing environment of open innovation is a mistake that many organizations will pay for with their disappearance. Therefore, this chapter through the presentation of several cases of open innovation, aims to provide keys and inspiring examples for other projects that seek to be rethought to adapt to an environment in constant motion. Paraphrasing Charles Darwin (1859), adapting to change is the only way to survive.

Cross-fertilization (or cross-pollination) is defined as the recombination of previously separate concepts (Grodal and Thoma 2010). In the same way of biology, when organizations cross-pollinate knowledge and technologies make their businesses stronger, being able to weather the difficulties to be success in the market. The intersection of knowledge fields yields a fertile breeding ground for new ideas (Fleming 2001; Fleming *et al.* 2007; von Hippel 1988).

The literature argues that the major driving forces of technology diversification are the opportunity to introduce new technologies into products by crossfertilizing technologies, and the pressure to support a given product line to maintain its relevance (Granstrand *et al.* 1997). In so doing the literature emphasizes that products have to incorporate an increasing range of technologies (Pavitt 2001) obtained from scientific discoveries that generate innovations with commercial potential (Gambardella 1995; Klepper 2001; Murray 2002; Shane 2001, 2002). In fact, science could be considered a key factor that contributes to comercial production through knowledge and technology. Advances and breakthroughs in science and technologies open up opportunities for interdisciplinary combinations of different technologies (Granstrand 2001).

Concepts involved in the commercialization of knowledge exist in three integrated but separate institutional environments: science, technology and commerce (Dasgupta and David 1994; Rosenberg 1990). In science researchers generate knowledge, which they disseminate through scientific articles, presentations at research conferences and their informal network of friends and colleagues. Some scientific concepts are translated into technological concepts in the form of technical drawings, documentation and patents. A fraction of these technological concepts are subsequently integrated into actual products; later some of them are commercialized (Agrawal 2006).

The purpose with the cross-fertilization of knowledge and technology is to open up new sub-spaces in the technical performance and functionality space and, by so doing, to create value for users from the technical potential. However, it is a huge leap from firms' creation of value for their users to appropriation of economic value (Björkdahl 2009). Fleming (2004) shows that interdisciplinary teams produce more radical innovations than disciplinary based teams. Further, in the video-game industry Tschang (2007) finds that creativity in game design studios occurs through recombination of elements from prior games. Yet another line of research focuses on cross-fertilized within individual technologies by examining the knowledge flows that facilitated their creation (Brusoni *et al.* 2001; Stankiewicz 2000). Common across these research streams there is an implicit assumption that novel concepts are cross-fertilized.

Ideas that come from different organizations and fields, when cross-fertilize, can generate new knowledge and strategic alliances facilitate knowledge mobility (Mowery *et al.* 1996; Powell *et al.* 1996). Then, at a later stage, some of this previously generated knowledge will cross-fertilize (with new and existent knowledge) and will be used to develop a new technology. Finally, these new technologies will cross-fertilize with other new and existent technologies but only a short number of these technologies will be applied and commercialized.

According to Grodal and Thoma (2010) the mobility of scientific concepts into technology is aided when one or more of the authors are affiliated with industry. It has been debated which role scientists with industrial affiliation play in the translation of knowledge between science findings in scientific journals if the knowledge does not have commercial value (Bird *et al.* 1993). The argument behind this claim is that companies are reluctant to share any information that might provide their competitors with increased insight. Companies might thus choose to only publish information that is basic research, and thus far away from commercial possibilities (Grodal and Thoma 2010). But attitudes about information protection are changing thanks to the open innovation perspective and the impossibility (and the big cost associated) of protecting technology that inspires new one.

Liquid modernity is Bauman's conception of how the world today denies the so-called solidity that it once struggled assiduously to create and maintain (Lee 2005). Technology changes constantly and it is the only permanence because the new ideas and the science push to generate new knowledge that will be transformed in new technology. There is "infinity of improvement" of this technology due to its liquidity. The technology advances like the water of a river in which tributaries contribute their water to the flow of the river, making it bigger, more powerful. At the end, there is the delta that represents the application of this technology in a whole sea, trying to find a commercial application. But the river never stops, because new knowledge (in contact with existent knowledge) is pushed to develop new technologies (in contact with existent technologies) to arrive again to the delta, in which a new technology will be applied and commercialized in the immensity of the sea or the ocean –a global and competitive environment.

Changes also have affected values. "Transience has replaced durability at the top of the value table. What is valued today (by choice as much as by unchosen necessity) is the ability to be on the move, to travel light and at short notice. To be fixed is to be at fault. Power is measured by the speed with which responsibilities can be escaped. Who accelerates, wins; who stays put, loses." (Bauman and Tester 2001: 95). This ability to surf on the currents of the river is what is expected from technology. Changes are increasingly fast and a liquid technology, which brings together new and existing knowledge, is the only tool that can respond to the requirements and needs of users. So, this new liquidity of being has reduced the sense of durability and dissolves the bonds that reify our sense of security. Furthermore, the complexity of innovation increases, while efficiency and consistency of the process decrease, but the cross-fertilization of knowledge and technologies is strategic for developing liquid technologies that will be applied in our complex and liquid world.

CHAPTER 3
The video game ecosystem: playful games, serious games and gamification

3.1. Abstract

As the game industry continues to grow and expand its target market to nearly every person with access to an Internet connection, the capabilities needed to gain a competitive advantage are changing too. This chapter seeks to identify and reflect on the factors critical to success in the industry of video games and new factors that may arise and contribute to the future success of this dynamic and constantly changing industry. Starting from the analysis of the structure and dynamics of the value chain in the video games industry, this chapter discusses the most important changes that have taken place caused by the emergence of the Internet, in an attempt to redefine and understand the new rules and opportunities for companies and players. These last have empowered their role and companies may now understand better the needs and demands of their current and potential players. Business models of video games are constantly evolving to fully adapt to the needs and preferences of users in areas such as platforms (via the Web browser, mobile

applications, etc.), forms of payment (pay per download, subscription, payment for access, game extensions, etc.), or gaming devices (game consoles, computers, smartphones, tablets, etc.). In addition, the chapter analyses two of the applications developed by the video game industry: serious games and gamification. Both are promising in terms of research and development and the chapter analyses their benefits, business opportunities and market strategies.

3.2. Introduction

Video games have been one of the main elements in the constant line of renewal and modernization of leisure forms in the last half of the 20th century and the beginning of the 21st century. In recent years, there has been a transformation in the way people think about games. In the past, gaming was the domain of young males, and game studios devoted considerable resources to titles that appealed almost exclusively to this target group. Today, as development costs skyrocket and video game companies compete for the same customers, more studios are finding success in markets that traditionally have not been well served by the video game industry. Today's gamers include women, parents, and even senior citizens who enjoy playing games: whether arcade games or serious games, and currently women gamers outnumber men by a considerable margin.

In addition to their ludic importance, they have played a subtle role as a tool for social transformation and cross-fertilization with other fields. However, this aspect has been barely studied because, apparently, it has been an unintentional, collateral effect of the video game industry. In the last few years, this tendency has changed. The potential of video games as a tool has recently been glimpsed in fields distant from entertainment, and projects are being developed with the aim of including the game and its technology for transforming in a conscious, active, and direct way other more traditional sectors.

This chapter seeks to identify and reflect on the factors critical to success in the industry of video games and new factors that may arise and contribute to the future success of this dynamic and constantly changing industry, including the analysis of two application fields developed by the video game ecosystem: the serious games and the gamification. Starting from the analysis of the structure and dynamics of the value chain in the video games industry, I will discuss the most important changes have taken place caused by the emergence of the Internet, in an attempt to redefine and understand the new rules and opportunities for companies and players. These last have empowered their role and companies may now better understand the needs and demands of their current and potential players.

For the development of this research, I consider five specific objectives: firstly, mapping the value-chain and power relationships in the video game industry; secondly, identifying and discussing the appearance of new business models; thirdly, exploring the trends, challenges and opportunities opened by a new concept in the developer-consumer relationship, advancement of new technologies and the decision to exploit the Internet as a platform for games; fourth, identifying and analysing the specificity of the serious games and exploring the opportunities of the serious games industry; and fifthly, exploring the strategies and challenges of the gamification.

To achieve the goals of the research, the following activities have been conducted:

-**Literature Review**: The bibliographic section is thought to identify the state-of-the-art of the global innovative activity on video games. Relevant data on research, development, trends and commercialization has been collected through a literature review and a data base research.

For completing this thematic area, all stakeholders involved in the video games industry have been taken into account, as well as the collaborations, networks, and knowledge spillover between them. In this context, incubators and "indie" companies are key elements that have been included as the engine of this system. In addition, some interviews with stakeholders in the Spanish and Norwegian video game sector have been used to illustrate some key ideas.

For this purpose, I have reviewed data and indicators from the latest's trade publications, reports, market researchers, annuaries and official databases such as: Newzoo, DEV, ADESE, Swrve, Global collect and Marketsandmarkets. Data collection has been carried out in line with the proposed guidelines for collecting and interpreting technological innovation data established in the Oslo Manual (E. Commission 2005).

-**Case Study Analysis**: Some case studies have been used to illustrate specific examples of some of the ideas and practices presented in this chapter.

3.3. The video game: conceptual approach

The origin of video games can be placed in the 1950s, with the Noughts and Crosses game, developed by Alexander S. Douglas in 1952. The game was a computerized version of Tic Tac Toe and allowed a human player to play against a machine. Later in the same decade, another game was developed allowing two humans to compete against each other for the first time. It was a game of tennis, which today would be considered a true relic. The decade of the 70s represented the true emergence of video games, with the commercialization of Computer Space 1971 by Nolan Bushnell (Lago Moneo 2015).

3.3.1. Definition

There is no clear-cut definition of "video game" and it is common to refer to both the technological support devices (i.e., hardware, such as consoles) and the individual game itself (the software, the program) (Rodriguez 2002; Tejeiro and Pelgrino 2003). These inbuilt complexities make it in addition difficult to classify and define the different programmes, as to whether they are games or not.

Video game is a compound noun consisting of *video*, indicating that the output support or fundamental data is the image, and *game*, which gives the difficulty of discrimination but also its potential differential over other technologies.

3.3.2. Definition of game

After a literature review, two perspectives have been analysed further: the first one derived from humanistic theory, the second from mathematical theory. The first and most common in game theory is the humanistic definition provided by Huizinga (1938/ 2008) in his book "*Homo Ludens*" from 1938:

Formally, the game is a free action performed "what if" and is felt as lying outside of everyday life. It can completely absorb the player, without any material interest or advantage, and runs within a certain time and a certain space. It takes place in a specific order subject to rules and gives rise to associations which tend to surround themselves with mystery or disguise and stand out from the usual world (p. 27).

As opposed to this definition, and as a representative of the mathematical theory of games, Von Neumann and Morgenstern (1944) in their book "*Theory of Games and Economic Behaviour* "propose:

A game is simply the totality of rules that describe it. All forms in which it is used are understood to play (...). The moves are the chances that players have to choose among several alternatives under the rules of the game. (...). The specific alternative that is chosen in a given moment by a player will be defined as choice. (...). Finally, the rules should not be confused with the strategies of the players. (...) Each player chooses their strategies -the general principles governing their election (...) but the rules are absolute commands. If they are breached, then the game stops (p. 49).

3.3.3. Definition of video game

After the introduction to the concept of game, it is necessary to enlarge on the contributions from the new technologies and video games testing. There is still no unified definition or theory about the definition of game (Rodriguez 2002), therefore some of the definitions or characteristics that the main theorists in this field have considered fundamental are analysed. Some generic definitions of video game are:

- *Interactive animated images accompanied by an environmental sound and an interface* (Clais and Dubois 2011: 16).
- *All electronic games with an essentially playful objective played with the use of a computer, through diverse media* (Rodriguez 2002).

In these two definitions we found several important anchor points: the first is that every game has an interface, a way to communicate with the program and interact with it. The second important concept may seem banal; it is the idea that video games are computer programs that have invaded various media.

Darley and Levis proposed a more complete and closer definition, describing the game as:

- *It is an enveloping activity with a specific goal, in a micro-world controlled by relatively simple and clear norms* (Darley 2000: 164).
- *A game consists of a computing environment on a screen whose rules have been previously programmed* (Levis 1997: 27).

Concerning definitions, it is important to highlight three characteristics: first, video games are guided by specific objectives, -whether they are more or less explicit or imposed; second, they are structured with simple and clear rules; third, video games are enveloping activities, an idea that links with the definition of Huizinga regarding the absorption of the player.

Finally, a very interesting definition is the one proposed by Chris Crawford (1982), with reference to programming and game design:

Video games [unlike simulations] are artistic representations of a phenomenon (...). The designer simplifies this phenomenon deliberately to focus the player's attention on those important factors (...). The games create a fantastic representation, not a scientific model (p. 8).

Crawford has two central ideas of video games: the first is the manipulation of the player's attention by the developer of the video games in order to make a relevant determined situation. The second is disregard for the realism of the situation.

3.4. The global video games market at a glance

According to the latest quarterly update of Global Games Market Report (Newzoo, April 2016) gamers worldwide will generate a total of $99.6 billion in revenues in 2016, up 8.5% compared to 2015. For the first time, mobile gaming will take a larger market share than PC gaming with a quota of $36.9 billion, up 21.3% globally.

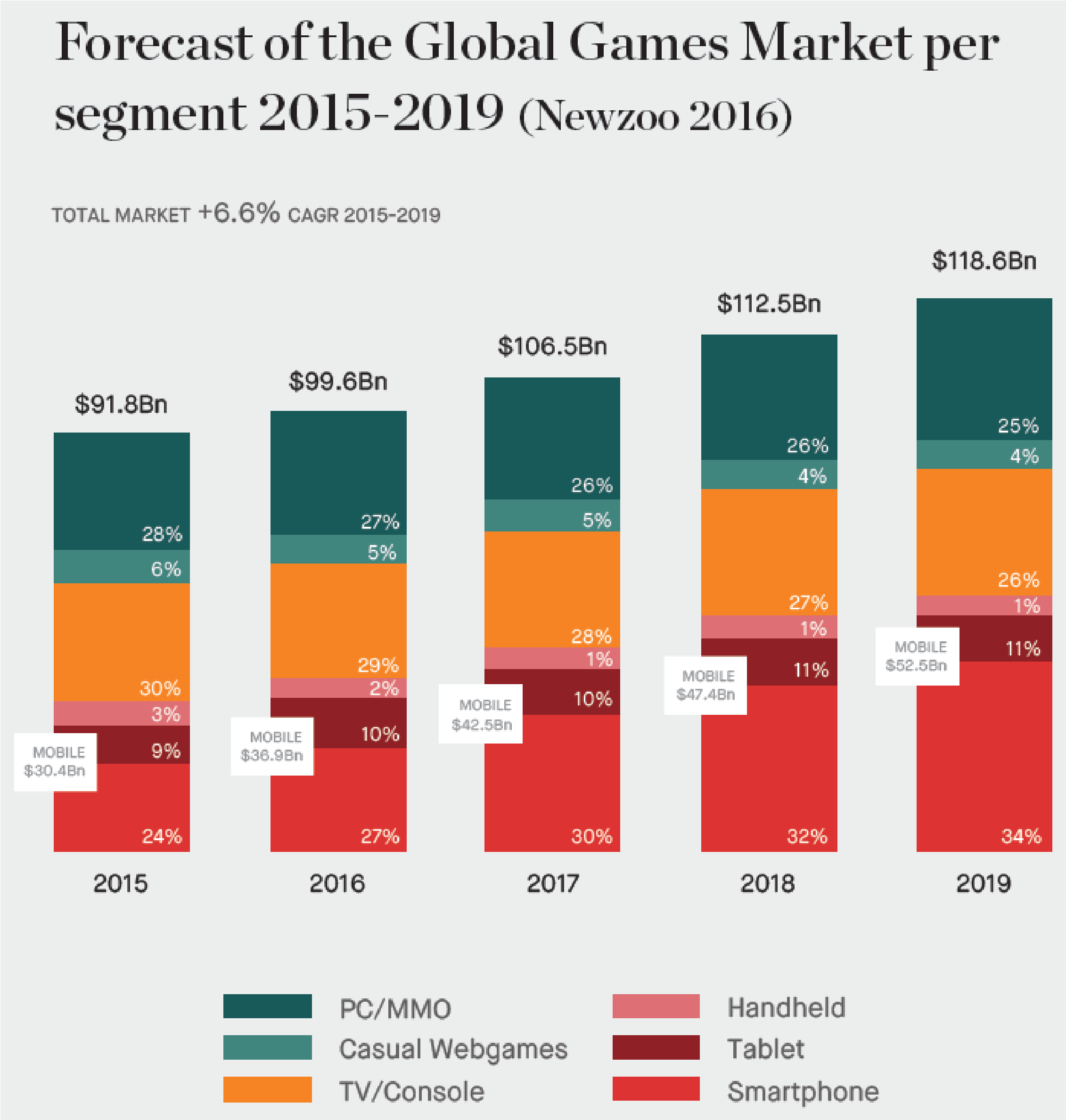

Figure 3.1. Forecast of the global games market per segment 2015-2019 (Based on Newzoo 2016)

The Global Games Market per Region shows how Asia-Pacific (APAC) reaches $46.6 billion this year, or 47% of total global game revenues. This growth represents a 10.7% year-on-year (YoY) increase. China alone accounts for half of APAC's revenues, reaching $24.4 billion this year to cement its place as the largest games market in the world, ahead of the US's anticipated market size of $23.5 billion. China's PC market is showing signs of slowing growth, with a 4% increase compared to the previous 16% as the success of "core" mobile titles is starting to cannibalize PC game spending. However, the mobile segment in China is growing even faster than estimated and will reach $10 billion this year, up 41% from $7.1 billion in 2015. China will remain the largest games market for the foreseeable future, growing to $28.9 billion by 2019.

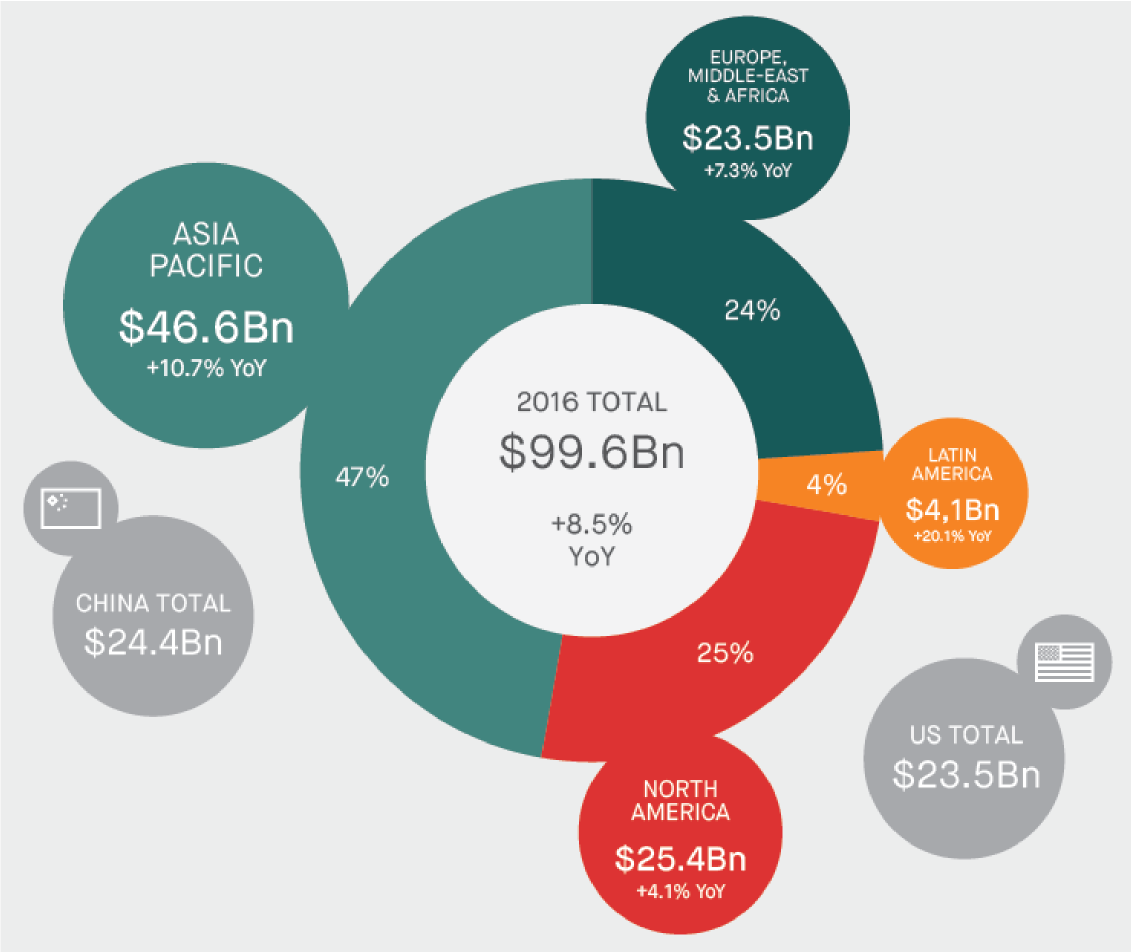

Figure 3.2. 2016 Global games market per region with year-on-year growth rates (Based on Newzoo 2016)

North America is the second largest region with estimated revenues of $25.4 billion in 2016, a year-on-year growth rate of 4.1%. This growth is mainly driven by the mobile segment. Console revenues remain stable as the segment moves toward digital and continuous monetization. Western Europe will see a slightly higher growth rate of +4.4% which can be mainly attributed to the fact that the region has seen slower adoption of mobile gaming to date. Eastern Europe, meanwhile, will even grow a bit more, from the past year's crisis, with a 7.3% year-to-year growth rate.

Latin America is the smallest of the four major markets with just $4.1 billion in revenues in 2016, but it is also growing the quickest, up 20.1% year-on-year (YoY). Mobile games will generate $1.4 billion, up significantly from $900 million last year. Brazil and Mexico combined will contribute over 70% of total gaming revenues in the region (Global Collect 2014). Other market research reports have mentioned far higher revenues for this part of the world but, despite a huge mobile gaming audience of more than 190 million consumers, spending has remained low (Newzoo 2016).

The big moneymaker in absolute dollar terms is PC-based gaming, with revenues of almost $32 billion. A high percentage of the turnover derives from (mid)core PC/MMO games, while casual web game revenues continue to decline. This is followed closely by the *Entertainment Screen* (TV/Console) which will grow to $29.0 billion. The fastest growing segment is clearly *Personal Screen*, or smartphones, with a YoY growth rate of 23.7% and which by 2018 will take the lead globally. The top 10 games in the segment represent nearly a quarter of total revenue. The *Floating Screen* (tablets & handheld consoles) remains the least important gaming screen, with revenues of $11.6 billion, as handheld revenues are expected to plummet another 24% this year.

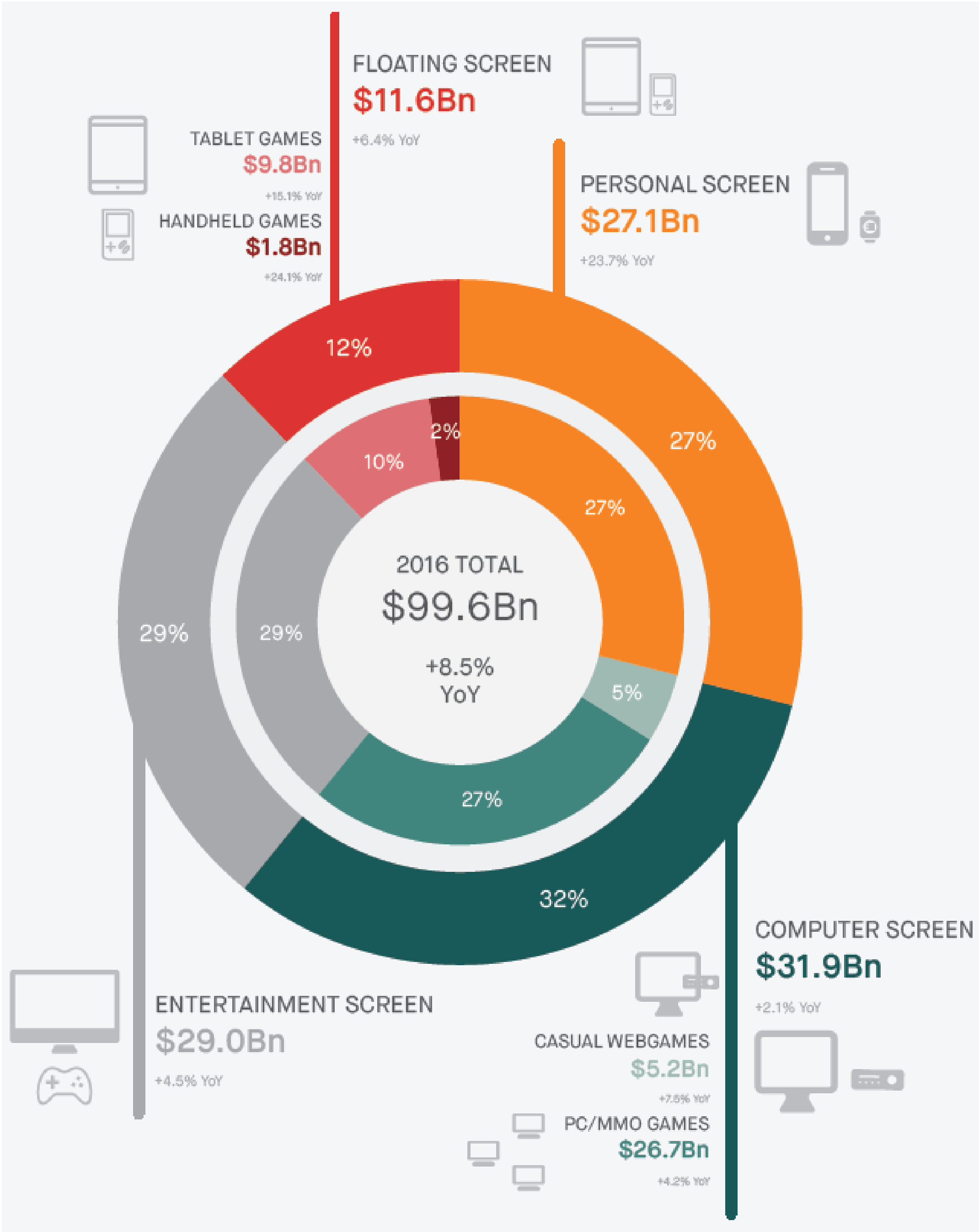

Figure 3.3. 2016 Global games market per screen and segment with year-on-year growth rates (Based on Newzoo 2016)

3.5. The Value Chain of the Video Game Industry

3.5.1. The traditional Value Chain: a close innovation approach

Value chain analysis, which represents analysis of an organization or industry that uses value-creating activities, is a useful way to understand influence of key players during video game development process (Dess *et al.* 2010).

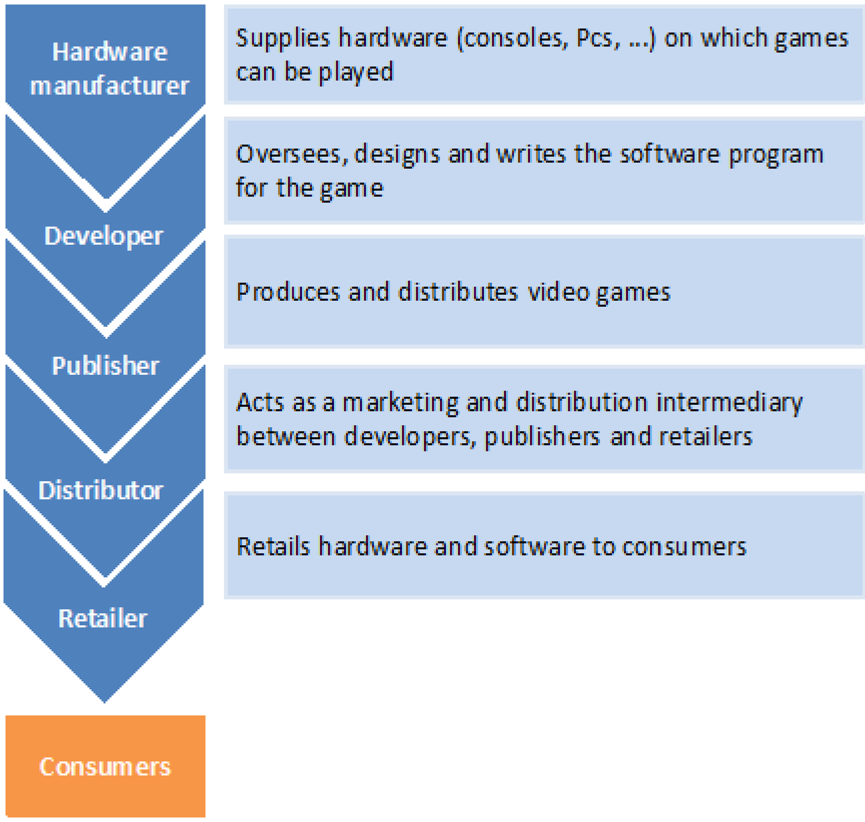

Figure 3.4. Traditional video gaming value chain (Based on Newzoo 2016)

From a closed innovation perspective, the figure above illustrates 5 critical industry players that put value in the development of video games. Every step adds value to the final product and incomes are distributed among agents according to preset percentages. Hardware manufacturers can best be described as console, gaming platform manufacturing companies, which produce hardware components and devices to process video games: PCs, gaming consoles, tablets, handhelds and smart phones. Nintendo, Sony and Microsoft are the top hardware manufacturing companies for video game platforms.

Developers are key players in this value chain analysis. They are the ones that develop software to make players able to play video games with specific devices as indicated above. Software developers do not always work in video game publisher companies. They might own different software developer companies that might sell software licenses or develop software for video game publishers. The development cycle of the video game starts with design, research, implementation, testing and lastly mastering.

Video game publishers are software marketing companies that pay commissions (licensing fees) for rights to publish video games or contract and sub-hire developers to produce video games for them. Afterwards they market the game titles and distribute them to retailers and end-consumers. As with book publishers, video game publishers are responsible for their product manufacturing, distribution and marketing.

According to Neely-Cohen (2014) "publishers could collaborate with indie game developers," much like a comic book writer collaborates with an artist, and that "literary magazines and libraries could sponsor gamejams," increasing accessibility and inclusivity by providing their unique writing resources and beta readers to game writers. Some book publishers are already dipping their toes into the depths of the music industry, creating soundtracks for books. A logical next step could be that video games become a medium for book publishing, exemplified by the publishing company Madefire[7]. In the case of the novel *Echo of the Boom* (2014) by Neely-Cohen, six independent video game developers made experimental games inspired by the text[8]. The use of other platforms to tell a story is known as transmedia, which refers to when a brand reaches out beyond one media.

Distributors adopt an intermediary role between publishers and retailers. Most publishing companies own their special distribution networks to move their products to retailers, where end consumers can buy video games.

Retailers deal with selling video games to end consumers. However, the latest trend in the computing industry, which is digital distribution of video game licenses directly to consumers, has a negative influence on physical sellers in the sector (Business Insights, 2009).

As seen, the value chain is a concept of critical analysis which let us understand the important role of players in the video games industry. Also, hardware manufacturers, video game publishers and developers seem to be key players in the industry, adding value on the software in order to turn it into a successful video game.

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[7] Madefire works with a team of legendary and cutting-ege storytellers to bring its Motion Books to life: www.madefire.com

[8] www.echooftheboom.com

An essential aspect in the traditional value chain is the video games funding and investment. Production of video games for console and PC is characterized by high initial development costs, which are generally assumed by publishers. In the case of vertical integration, the publisher and developer are part of the same company, and it is the company which finances all processes. When there has been no vertical integration publishers are responsible for financing the development of the game, thereby obtaining commercialization rights and a high percentage of sales.

Distribution and retail sale to the end user is done through specialized agents that sell the game in exchange for a fee based on the sales. Furthermore, we cannot forget the important role played by the technology providers that facilitate both developers and publishers development environments, hosting, game engines, graphics software and animation, etc., all essential elements for creating video games.

3.5.2. The impact of Internet: redefining the Value Chain

The progressive shift to online gaming has introduced new methods of distribution and has begun to reorganize the functions and dynamics of interaction between actors in each of the different levels of the value chain.

One of the levels and functions most affected by the emergence of the Internet are the retailers and their logistic distribution function. This process is no longer relevant in the online gaming segment, due to the fact that the "digital goods" are produced and distributed on the network at marginal costs approaching zero.

As stated in the Libro Blanco del Desarrollo Español de los Videojuegos (DEV 2014), online digital distribution is affecting the operational structure, causing a convergence between the functions of the distributor and the retailer with the editor or publisher. Much of the main activity involving distributors and retailers tends to disappear, since the distribution of content on physical media is replaced by its direct distribution via the Internet. The publisher, in many cases, distributes video games directly without the need for a dealer acting as an intermediary between the publisher and retailer. This first emerging disintermediation process negates the role of the dealer.

Publishers may also choose to distribute games through Internet service providers (ISPs) or via device manufacturers. ISPs and device manufacturers act as content aggregators and provide game markets (app stores) for the distribution of games, which facilitate the promotion and localization of new video games for users while attracting advertising, an additional source of income. The increasing importance of Internet service providers and device manufacturers resulted in a process often called "re- intermediation": ISPs and device manufacturers take the role previously held by distributors. In this new scenario, access to an unlimited global market for distribution of video games through ISPs or device manufacturers provides a quasi-direct relationship for the development companies with end users, avoiding the existing network of intermediation in the traditional value chain. This has favoured the emergence of new business models diverging from traditional ones such as free to play (F2P), commercialization of virtual goods, games financed by advertising, etc., all based on a continuous and direct relationship with the user.

Figure 3.5 provides an overview of the changes described. These disruptive trends, coupled with technological advances, have transformed the video gaming landscape. The battle lines are drawn between console manufacturers and publishers. Hardware manufacturers are moving on to more advanced models such as sensors and motion controls, while depending on the type of game (e.g. massive online games –MMO[9]) the publisher can act as a distributor of the video game and as a potential seller of games edited with other agents, such as ISPs, mobile operators or handset manufacturers, for commercialization through their own app stores.

[9] MMO and MMOG: Massively Multiplayer Online Game.

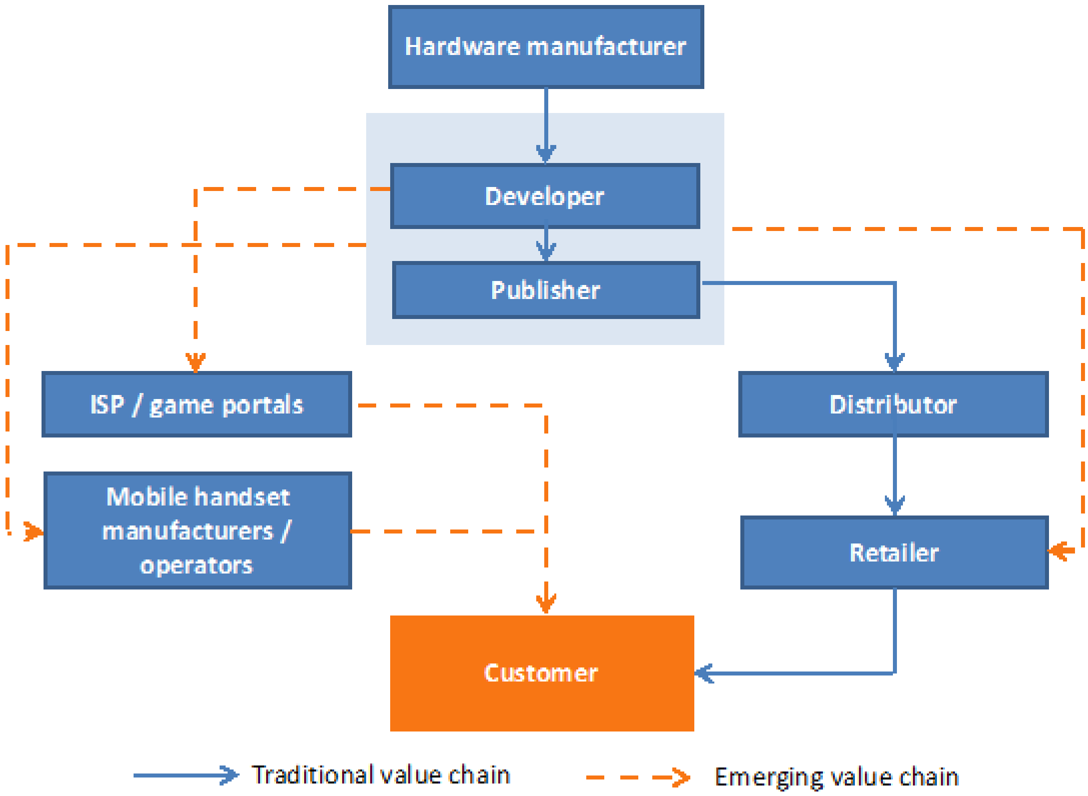

Figure 3.5. The emerging video gaming value chain (Based on Business Insights 2009)

These changes in the commercialization of online games, in comparison with the traditional value chain, not only affect the interactions between the various stakeholders in the process of value creation, but also the type and number of stakeholders involved.

Primarily technology providers have an essential role in the new value chain. Particularly the role of middleware provision is gaining importance; middleware is commonly known as engines that facilitate development environments for creating video games, as well as hosting providers who provide storage and processing of huge data traffic generated by online games. The access of thousands of users via the Internet is a technological challenge for developers of online games, who require the solutions provided by these providers.

Secondly, today's online games enhance the role of certain actors, such as localization professionals and team motivators. Localization professionals, who were already part of the traditional value chain, are taking an important role reinforced by the internationalization of the games thanks to the Internet. Thus, these professionals are not only mere translators but, on the contrary, the localization task becomes a process of adapting a product to the needs and demands of the potential gamers and the target culture. Therefore, localization professionals work with different skilled profiles such as graphic designers, programmers, editors, linguists, sound technicians, etc. In addition, depending on the size of the publisher company, these professionals may be inside the structure of the publisher or outsourced.

On the other hand, the team motivator also acquires a significant role because nowadays players from around the world form "clans" in which they study the games. They train and play together for many hours a week to form virtual communities. These communities are defined as places on the Internet where users interact and communicate about related topics. To prevent these communities from dissociating from the game or communication between players being reduced and dying away, the community motivator has to direct, encourage, motivate and facilitate interactions between users with the game on which the community has been created. An additional important function is the management and administration of the community.

Online payment methods also have a special relevance in the new scenario. At present there are various forms of online payment such as electronic purses (Moneybookers, Google wallet), credit cards and debit cards (VISA, MasterCard), bank transfer payment, prepaid cards (Ukash, paysafecard), payments by reference, peer-to-peer payments (Twyp, Bizum, Venmo, Pay Pal, Android Pay, Samsung Pay, Apple Pay), electronic banking and other solutions. These services are used by agents who act as distributors of online video games (the developers, publishers or app stores) to charge end users a fee.

Clearly, developers and end users have benefitted the most by the Internet disintermediation. Developers access to greater opportunities for commercializing their games, with new multiple alternatives (e.g. portals games, app stores, own distribution platforms, etc.). On the other hand, end users have been increased significantly in number by the supply of games available with various business models that fit to their specific demands: monthly subscriptions, pay to play, free games accepting advertising, free to play (F2P), etc.

Free to play (F2P) refers to video games that give players access to a significant portion of their content without paying (Weidemann 2009). There are several kinds of free-to-play games, but the most common is based on the freemium business model. For freemium games, users are granted access to a fully functional game, but must pay microtransactions to access additional content. Free-to-play games are the opposite of pay to play, in which payment is required before using a service for the first time.

Free to play games were first popularly used in early massively multiplayer online (MMO) games targeted towards casual gamers, before finding wider adoption. Various forms of F2P games include: browser-based games including the Massively Multiplayer Online Games (MMOGs), client-based MMOGs, social network-based games (eg, using Facebook) or casual games (Runge 2014).

These new strategies for business generation have introduced new concepts such as DLC[10] (Downloadable content) which refers to the extra content for a video game we download from the internet, either distributed by the game's official publisher or a third party content producer. This content enhances or completes the video game's features. Total Annihilation[11], released on September 1997, was the first modern game featuring DLC offering additional free new units, maps, and scenarios.

The inspiration of this practice comes from the serialization by the film studios in the 80s and the 90s when the digital game industry discovered that the code of the game could be re-used by creating new content on top of the existing engine –a possibility harnessed by game fans through the use of game mods[12] (alteration of content from a video game in order to make it operate in a manner different from its original version). Short for modification, mods were created pro bono and shared by fans on the Internet. The gaming industry soon discovered the tendency to extend games this way on the part of the audience, and thus the commercial expansion pack was born. Limited to the PC gaming culture, these add-on packages came in many shapes and sizes, and were distributed both through physical and digital distribution channels. Due to their small size and subsequently faster development cycle, expansion packs made serializing games an increasingly fast-paced affair (Nieborg 2006). This practice of "branche serialization" can be seen as the starting point for the modern DLC strategies of exhausting intellectual properties through as many franchise instalments as possible (ibid).

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[10] DLC also is read as Downloadable add-on content.
[11] https://en.wikipedia.org/wiki/Total_Annihilation [Retrieved May 2 2018].
[12] https://en.wikipedia.org/wiki/Mod_(video_gaming) [Retrieved May 4 2018].

Unlike in the earlier economies of scale[13], it has now become profitable to develop and publish game content that costs only around 1-10€. Designing smaller games and add-on content has had many benefits: due to small investment, companies can take more risks and try out things, and the game content can be both attuned to wider spectrum of demographies and be better personalised for individual players (Sotamaa *et al.* 2011). DLC has also allowed more flexibility with "branched serialisation" than ever before.

Game design on most platforms can now take for granted the possibility of patching, updating, and changing games when needed. This is also increasingly often expected by the audience, as the most celebrated applications seem to be those which constantly improve the experience they are offering with a stream of new content. According to Stenros and Sotamaa (2009), "business-wise the objective behind the flow of upgrades and add-ons is not only to create some additional revenue but perhaps even more importantly to create a long-term service relationship with the customer". Moving away from single expansion packs towards distribution of content how and where ever, it is this service mentality that clearly is the next logical step in the evolution of franchising and serialisation.

DLC is responsible for driving players' engagement in many games and can be free, paid or a mix of both. Also, it is very useful for the acquisition and monetization, but more importantly, for the retention of users in social games. Greater game longevity can be achieved with a constant stream of DLC releases that help players get a sense of continuing support for the game. It keeps player interest alive thus reducing the drop out. Plus, it can make players who stopped playing come back and check the new content for the game (Hamari 2011).

As Ed Fries (2014)[14] -the former vice president of game publishing at Microsoft- said, "we've gone from a situation where we dream up a game, we spend three years making it, we put it in a box, we put it out in stores, we hope it sells, to a situation that's incredibly

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[13] Economies of scale arise because of the inverse relationship between the quantity produced and per-unit fixed costs; i.e. the greater the quantity of a good produced, the lower the per-unit fixed cost because these costs are spread out over a larger number of goods. More information at: http://www.investopedia.com/terms/e/economiesofscale.asp#ixzz4XGVz3nwr [Retrieved May 21 2016]
[14] http://www.geekwire.com/2011/experiments-video-game-economics-valves-gabe-newell/ [Retrieved May 21 2016].

more fluid and dynamic, where we're constantly modifying the game with the participation of the customers themselves". This thought synthesizes the importance of the player in the co-design and co-development process of a video game.

There is a general movement to use the creative potential of consumers (Von Hippel 2001, 2002). The idea that the user can be considered as an innovative resource refers to community sourcing in open innovation literature (Linder *et al.* 2003; Chesbrough 2003). A traditional way of involving players' participation is in the development of the game before marketing. For example, while developing the gameplay, companies like Activision Blizzard[15] share the game with its fans in the testing phase via open and closed betas. This soft launching enables debugging and balancing the game for the fans. It is also a means of motivating fans to participate in the hard launching of the game (Davidovici-Nora 2009).

Activision Blizzard acquired King in early 2015[16]. Combining their revenues, this newly created entity is the third biggest public company by game revenues in the world in 2015 (6.7 billions). This company uses for innovation purposes small computer programs that enhance the interface of the game. They are called add-ons. Contrary to physical product design by the online consumers' community, World of Warcraft (WoW) players' contributions fit their individual needs perfectly. Indeed, the advantage of digital innovations designed for digital use is that both innovators and users can immediately test them and can modify them consequently. Outsourcing innovation to players is also a mean to hyper differentiate the game at lower costs while maximizing the potential sources of innovation. Activision Blizzard develops the gameplay and invests at minimal level to develop the interface (Davidovici-Nora 2009). The benefit is that the product is tailored to the individual needs of the consumer (Von Hippel 2001; Thomke and Von Hippel 2002; Von Hippel and Katz 2002). This approach enables deeper understanding of customers' behaviours, to identify upcoming trends and to reduce the failure rate of new extensions.

Adaptation in an industry with constant change requires an evolution in the way major studios currently think and operate. It requires re-thinking content and developer

[15] www.activisionblizzard.com
[16] https://techcrunch.com/2016/02/23/activision-blizzard-closes-its-5-9b-acquisition-of-king-makers-of-candy-crush/

relationships, creating captivating gamer experiences, delivering content where gamers want it, and innovating both business model and franchise intellectual property. According to the role of the companies along the value chain, Kelly (2014) classifies them as:

-Portfolio Management Companies: those who look more like portfolio management companies, as they continue to regularly acquire new IP and manage a broad assortment of brands that target various gamer groups. It requires a strict ownership of future creative decisions and branding.

-Content Provider: those who bring together content creators within a single distribution channel that work together to achieve economies of scale, but maintain individual control of branding and creative license. The content creator owns the IP and the content provider makes a margin on the consumer transaction. Distributors can leverage their strong capabilities in delivering content to the gamer.

-Consumer Product Company: they own the value chain from conception to distribution. The focus of these companies is to maintain complete ownership of the brand and its extensions into new product categories.

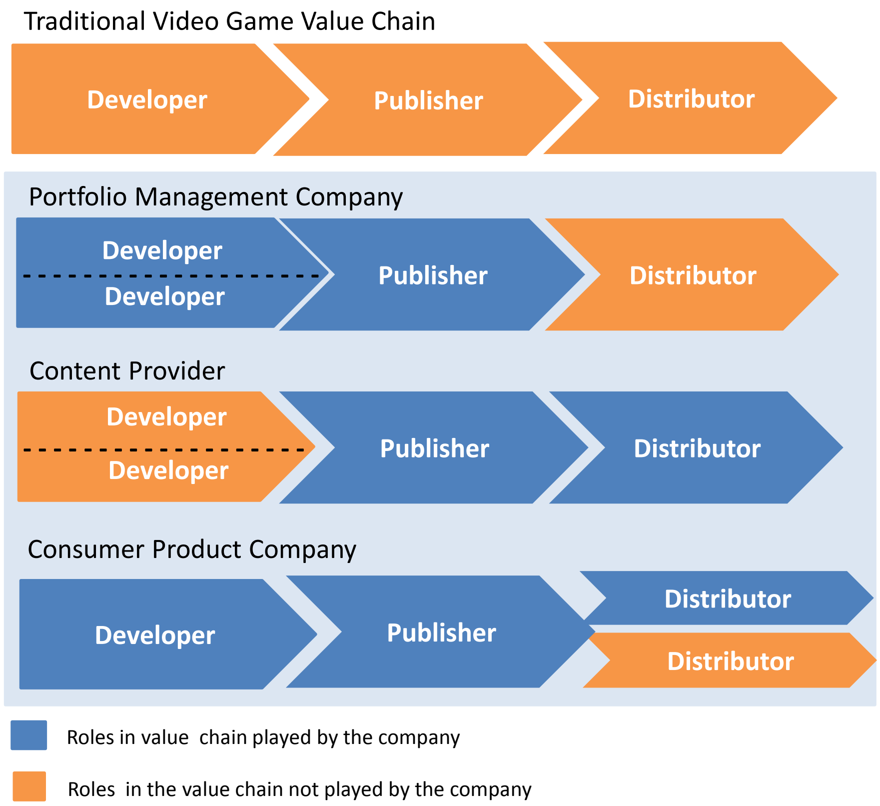

Figure 3.6. The evolution of the video games industry value chain (Based on Kelly *et al.* 2004)

3.6. Business models: monetizing video games

Business models for commercialising video games are constantly evolving to fully adapt to the needs and preferences of users in areas such as: platforms (via the Web browser, mobile applications, etc.), forms of payment (pay per download, subscription, payment for access, game extensions, etc.), or gaming devices (game consoles, computers, smartphones, tablets, etc.).

Monetization is crucial because it is the factor that turns the production of the game a project sustainable over time, capitalizing the effort in design, development, marketing and distribution of the video game. Currently, different business models are being applied, often combined to suit different user profiles of the same game. These business models are the following[17]:

[17] http://weirdlogicgames.blogspot.com.es/2013/04/importancia-de-la-monetizacion-y-los.html

-Pay to Play: this is the more traditional model, in which the game is purchased physically or by paying for its download.

-Free to play (F2P) and freemium: This model gives the user a free version of the game, with the ability to purchase upgrades or new features through micro payments (In-App purchases).

-Advertising: the game includes advertising for which the developer/owner of the game gets revenue. There are different alternatives:

> **-In Game Advertising**: games contain advertising such as messages or products of a certain brand.
>
> **-Around-Game Advertising**: publicity surrounds the game, and may appear before or after playing, very common in online games.
>
> **-Advergaming**: a brand is specifically promoted throughout the game (work for hire), because it is itself funding the development of the game.

3.6.1. Pay to Play

This is the most common distribution and sales system for physical games. As with the purchase of any product, consumers simply pay at the store (physical or online) to buy the game. This model is used in the traditional distribution. But it has also been used in the online video game download, for both PC and mobile games. Through the app stores for mobile devices or specific portals (like Steam[18]) users download games on their mobile devices (smartphones and tablets) and computers, either for a fee or for free.

If a game company decides to stick to the traditional model, it is imperative to justify the higher price point with more than just the cost to provide the experience. Game companies can demonstrate value with differentiated game mechanics or an increased number of

[18] http://store.steampowered.com

gameplay hours. Upping the replay factor with new gameplay modes (such as online multiplayer) and multi-branched storylines can help justify a premium sticker price. If the experience is unique, highly valued by gamers, and "worth the price" it can still be successful in the traditional model (Kelly *et al.* 2014). Titanfall[19], which was released exclusively on Xbox One, had more than 900,000 copies sold within a week of its release on March 11, 2014[20]. The traditional model may not be growing, but the model is still viable for the mega studios that can support it. But from an open innovation perspective, large studios that use the traditional outright purchase model are adopting elements of other business models to extend their revenue, trying to extend the life of existing games and extract additional revenues from these high value gamers who are open to paying for additional content above the initial sticker price.

3.6.2. Free-to-play (F2P) and freemium

This is another model initially developed by the gaming industry. The F2P model has its roots in the dot-com boom where companies discovered that the most valuable asset in the Internet era was an audience and the biggest audiences were attracted by free services. The engagement of these audiences could be turned into profits through advertising and upselling to premium services.

However, F2P really became popular alongside the explosive uptake of the social networks and mobile devices that put games-capable platforms into the lives of over a billion people of different backgrounds, ages and genders. In addition, the openness of these platforms allowed developers previously locked out of the video games industry by platform and retail gatekeepers a route to the market (Luton 2013)

Using this model, the player can have access online to the game for free and only pays if he agrees to new features, improved extensions or to purchase virtual goods that help advancement in the game play. In-app purchases refer to a form of monetization that has become widely used in social games, consisting in exchanging real money for currency that

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[19] https://www.titanfall.com
[20] http://www.fool.com/investing/general/2014/03/27/xbox-ones-titanfall-and-ps4s-infamous-second-son-t.aspx

can be used in-game for buying experience points or other objects. In the free part of the game advertising may also be used as a source of income. The concept of this model is based on the existence of a large user base that plays for free. A small percentage paying small amounts periodically for virtual goods is enough for ensuring the profitability of the game -this percentage varies between 5% or 7% of F2P players (Luton 2013).

This 5 percent is even considered a good conversion rate –the percentage of people moving from non-paying to paying. This means that 95 percent of players do not spend anything. Although these non-payers do not contribute financially, they do add value to the game.

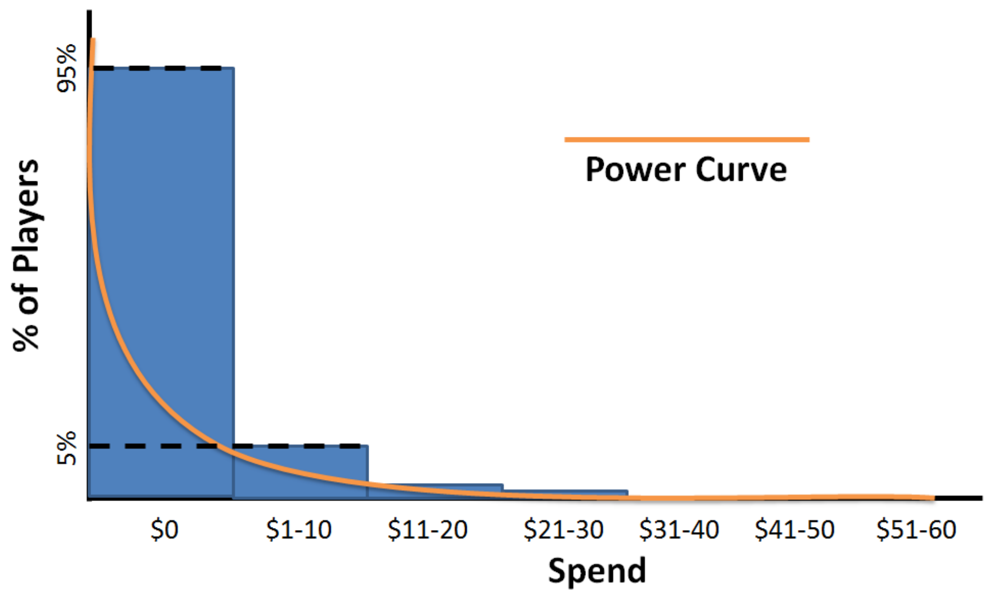

Figure 3.7. Spend vs. players power law curve (Based on Luton 2013)

F2P has an inherent quality that makes the model work: consumable purchases. These allow players to buy a resource that can be depleted and repurchased repeatedly. Therefore, the key is to reach a critical mass of users to obtain an optimum number of paying users.

The Monetization Report 2016 by Swrve, a company that manages users of several successful free-to-play games, shows that less than 1.5% of players are actually paying any money at all. Therefore, we have a huge base of 98.5% of the players who never makes any micro-transaction. Nevertheless, there is a much more important fact: half of mobile games money comes from 0.15% of players. Those spending the biggest sums in-game have earned the nickname of whales (a term re-purposed from the casino-industry [21]). Meanwhile, those with lower spends are known as minnows. Thus, the value of certain types of players, and having tools to identify them becomes paramount.

However, why does a player pay in a free-to-play video game? There are different motivations:

1. Time: There are players who have more money than time and others who have more time than money. So, players with less time are willing to pay to speed up the gaming experience.

2. Personalization: The visual differentiation is very common and used for Asian audiences. They have no impact on the gameplay but may be a reason why a player engages with the free-to-play (Luban 2011).

3. Content: It is paid for extra content that adds hours to the gaming experience - extra chapters, missions, levels or any additional supplement to the original game

4. Gameplay options: Free-to-play provides an opportunity to diversify gaming options, the range of choice, and offer different game experiences. Options that can be offered could be different game modes, different characters, levels of difficulty and any option that will enhance replayability by providing new experiences. It is usually combined with motivation content.

5. Grants and benefits: It is necessary to pay to get extra help to match the level of a player with average skill to make progress in-game. For example, when buying a power-up[22] to facilitate the achievement of a level in Candy Crush Saga[23]. In addition, the premium objects are included. They allow for leveling up directly or access to important advantages. They are a way to earn income at the expense of

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[21] http://www.cnbc.com/2015/08/03/the-shocking-truth-about-mobile-gaming.html
[22] Power-up: a bonus which a player can collect and which gives their character an advantage such as more strength or firepower.
[23] https://king.com/es/play/candycrush

favouring players who pay. Such a practice means that the game will be distorted, converting a free-to-play game into what has been called "pay-to-win" because players who are willing to pay for special items or downloadable content may be able to gain a significant advantage over those playing for free.

A common suggestion for avoiding what critics of such games call "pay-to-win" (p2w) is that payments should only be used to broaden the experience without affecting gameplay. Some suggest finding a balance between a game that encourages players to pay for extra content that enhances the game without making the free version feel limited by comparison (Delucci *et al.* 2013). In response to concerns about players using payments to gain an advantage in game, titles such as World of Tanks and the next World of Warplanes and World of Warships (all by Wargaming[24]) have explicitly committed to not giving paying players any advantages over their non-paying peers. The strategy is called "free-to-win" by the company, which first started testing it in 2012. The core basis of "free-to-win" is to remove all payable options that could be viewed as giving a player an advantage in battle. Now, revenues come from sales of non-advantageous content, such as premium vehicles, personalization options and the like. This free-to-win strategy has been applied to all the last, current and future Wargaming titles and the move is in part meant to make Wargaming a bigger player in the burgeoning eSports arena -they currently have a Wargaming.net League[25] (Graft 2013; Pitcher 2013).

In single player games, another of the critics concern with "pay-to-win" is the tendency for free games to constantly request that the player buy extra content. Payment may be required in order to survive or continue in the game, annoying or distracting the player from the experience (Meer 2009).

3.6.3. Advertising

In video games, advertising is undergoing a process of constant innovation, in which there co-exist different trends for integration. Some trends include the screening of advertising before the game begins (**around game advertising**),

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[24] www.wargaming.net
[25] http://eu.wgleague.net

the insertion of advertising in mobile applications (banner ads), or even the distribution of video games developed specifically for advertising brands, products or public or private initiatives (**advergaming**). This last model is used by companies who want publicity, developing a game as part of their advertising strategy because it is less intrusive than traditional advertising and offers a high viral impact.

Finally, **in-game advertising** (IGA) involves the insertion of an actual ad in the game, which adds more realism and increases efficiency of the advertising action. The earliest known IGA was the 1978 computer game Adventureland [26], which inserted a self-promotional advertisement for its next game, Pirate Adventure[27]. IGA anticipated to grow to $7.2 billion by 2016 (Tassi 2011)

This clear interest of companies in IGA also attracted the interest of several academic researchers to understand how effective IGA is, and trying to quantify this effectiveness through some studies. Yang *et al.* (2015) found some types of recognition were low among college students, although players did retain word fragments in sports games. Grace and Coyle (2011) went beyond this, saying that 35% of players could recall advertised brands in a controlled study of car racing games. Lee and Faber (2007) found that the primary factors for player-retention of IGA are location of brand messages in the game, game involvement, and prior game playing experience.

As I have shown, monetization is one of the key aspects for game companies. Experimentation with pricing models and dynamic pricing changes allows game companies to better understand the elasticity of their product, and adjust quickly to changes in demand. The next chart summarizes the most important strategies followed by companies for the distribution of video games:

[26] https://boardgamegeek.com/boardgame/183231/adventure-land
[27] https://en.wikipedia.org/wiki/Pirate_Adventure

Distribution method of games	Physical Distribution	Digital Distribution	Subscription-based services	Free-to-play (F2P) + Micropayments
Upfront cost of the game	**$20-$60** Not including downloadable content	**$0.99-$4.99** Depending on marketplace platform	**Varies** Depending on game service	**Free** Not including micro-transactions
Primary challenge	Insufficient stock (not when downloadable)	Marketplace crash / Downtime	Server crash / Downtime / Attrition	Conversion
Responsible party	Retailer / Supply chain	Marketplace host	Cloud service provider	Cloud service provider
Financial impact	Deferred revenue / Lost sales	Deferred revenue / Lost sales	Refunds / credits to win back customers	Inability to generate revenue-loss is permanent
Owner of risk	**Gamer** High upfront cost without a trial	**Developer** Revenue share with marketplace	**Publisher / Developer** Attrition of customers over time	**Publisher / Developer** Conversion rate of customers from free to paid

Figure 3.8. Game industry monetization models (Based on Kelly *et al.* 2014)

3.7. Future Growth Trends

The most important change the video game industry is experiencing is the advancement of new technologies, the decision to exploit the Internet as a platform for games and additionally the redefinition of the developer-consumer relationship. According to the information presented in the previous sections, six key trends and challenges in the development have been highlighted:

3.7.1. More screens and connected ecosystem

Only seven years ago, gamers played mainly on two screens: the TV and the PC. That number has since doubled giving room for more time and ultimately money to be spent on gaming. Gamers will still spread their budget across all screens putting pressure on individual game revenues.

In order to combat the noise and multi-tasking, games need to be able to transcend the individual device and connect across an ecosystem of connected devices. A seamlessly connected ecosystem has the ability to captivate users on every screen, blocking out competing leisure activities (Kelly *et al.* 2014).

Being able to deliver a connected experience requires a strong understanding of consumer behaviour to inform the design of companion experiences, as well as thoughtful engineering and cloud hosting capabilities to enable cross-platform integration, all of which are relatively new to the traditional studio.

Cloud gaming is a game mode that allows the user interfacing online via streaming on your PC or mobile device while the game is running on the developer´s server and is transmitted directly to devices with access to the server through the client application installed (Game as a Service). This allows access to games without powerful devices because the user devices' processing capacity has no importance from a technical perspective, as the game company's server is the system that runs the game with all the processing needs required.

Furthermore, the booming market for mobile devices like smartphones and tablets has intensified the battle of the consoles between the major brands (Sony, Microsoft and Nintendo), in a race to create an attractive secondary device game for players.

3.7.2. Free Games, Apps and Unique Personalized Experiences

Consumers have become used to the idea of trying a game before they decide to spend money. The days of low quality free games have passed as in-game spending business models have proven successful. A deeper knowledge of the "whales" (preferences and consumption habits) is required for a better personalization of the game experience. Additional value can be obtained driving customer value as a differentiating characteristic of the game and using the data derived from personalization. Game companies that can enhance their data analytics capabilities will be able to glean new insights to inform future content and distribution decisions, and drive additional revenues – the most important component of personalization is getting buy-in from the gamer, who is more willing to share their information if he/she can see the value and potential benefits of doing so (Kelly *et al.* 2014). The challenge for game companies is getting the balance between the science of data-driven decision making, and other core aspects of game design.

Furthermore, F2P games have lower barriers to entry which drive growth in successful content produced by indie game developers. Worldwide mobile gaming is growing rapidly which brings an influx of independent developers effectively lowering costs of development. This is an opportunity for countries with an emerging and dynamic game scene such as Norway where some indie developers have already tasted mainstream success –DirtyBit's FunRun[28] games have scored 65 million downloads. The studio Krillbite[29] raised $248,000 for "Among the Sleep" on Kickstarter. In the case of Norway part of the gaming industry's success can be attributed to the Norwegian Film Institute, facilitating a budget which let the studios focus more on the creative process (Stafford 2015); but this facility in obtaining the necessary resources for the game development could mean that the overall strategy is not adequately market oriented.

Hamar Game Collective[30] is an interesting and inspiring initiative to create a sustainable games industry on the regional level. They have helped developers to solve some of these challenges by creating an environment where the companies can grow and share, learn and work (Thorsen 2015). After three years of work, Hamar Game Collective passed from three to eight companies demonstrating that by pushing the local talent they can act as incubator for companies aiming to reach for a share of the market. However, big players are taking notice of how low development costs and a cult-like following can draw large loyal communities. For example, in 2014 Microsoft purchased Mojang AB[31], maker of "Minecraft[32]", for $2.5 billion in an effort to capture a larger audience for its smaller form factor devices (Ovide and Rusli 2014). Some voices as Salim Ismail (2016) consider that disruptive innovation no longer takes place in large companies.

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[28] http://www.dirtybit.com/
[29] http://www.krillbite.com/
[30] http://www.hamargamecollective.com/
[31] https://mojang.com/
[32] https://minecraft.net

According to App Annie (2016) mobile consultancy, consumers spent 41100 million dollars on apps in 2015 through digital stores such as Google Play and the App Store. Although video games in 2015 represent 41% of global downloads of apps, all together accounted for 85% of overall spending, about 34800 million dollars. This figure will double by 2020, reaching 74.6 billion dollars, 74% of 101100 million of global spending expected for that year. Also, App Annie's report analyses the average estimated time to maturity for new games, which dropped 60% from 2014 to 2015 –from almost 30 weeks to just over 17. Compared to just three years prior, this is a remarkably slim window in which to generate downloads. For games released in 2012, average time to reach maturity was over 10 times longer than it was for those released in 2015.

This naturally impacts marketing and monetization strategies as publishers seek high visibility and engagement upon release. Furthermore, it has significant ramifications for the portfolio management, with most publishers requiring more frequent releases to maintain the momentum that may have been sustained by a single title in previous years. Meanwhile, as mobile game revenue grows, it is also becoming less concentrated among the top publishers. Even as the biggest names in mobile gaming draw attention with multi-million-dollar ad campaigns and high-profile releases, the concentration of revenue in the mobile gaming market has been trending toward less concentration at the top (App Annie 2015).

Capabilities	Description	Benefits	Challenges
Gamer Segmentation	Break down entire user base according different criteria: demography, gameplay patterns, new targets, culture...	· Inform future game design and development · Refine features and content to tailor to segments	· Data ownership · Privacy · Centralize acces of gamer records and analysis
Pricing and Targeted Offers	· Develop pricing strategies based on user segments · Implement dynamic pricing and offers for specific user / segments	· Quickly adjust prices to maintain competitiveness · Increase propensity to buy based on offer / promotions	· Perceived price discrimination · Requires pricing control · Recommendation engine costs and maintenance
Next-Best Action Marketing	· Achieve better insights into the lifecycle of a customer · Understand progression of purchases for users	· Anticipate customer needs to provide timely offers · Improve more personalized recommendations	· Requires long lead time to achieve enough data to track trends
Churn Analytics	· Identify pre-cursor behaviors to attrition of users · Track success of win-back strategies	· Anticipate user churn before it occurs · Improve success of win-back strategies	· Time-to-insight can be lengthy

Figure 3.9. The benefits from hyper-personalization
(Based on from Kelly *et al.* 2014)

3.7.3. Business Model Balancing Act

New Business models require continuous balancing between value for the consumer and profit for the developer and/or publisher. Monetization of the game should keep free gamers happy and provide room for spending by the "whales". According to Swrve (2016), over 11% of revenue was delivered by only 1% of purchases (those over 50%), mostly because in many games there were no purchases at that level. There are always some customers who want to buy in at higher levels, and that needs to be supported.

It is currently possible to test multiple configurations and layouts in game stores and establish what works. Even more powerful is the ability to learn from user's preferences and format the store accordingly –such as by showing more expensive bundles to players who have already purchased.

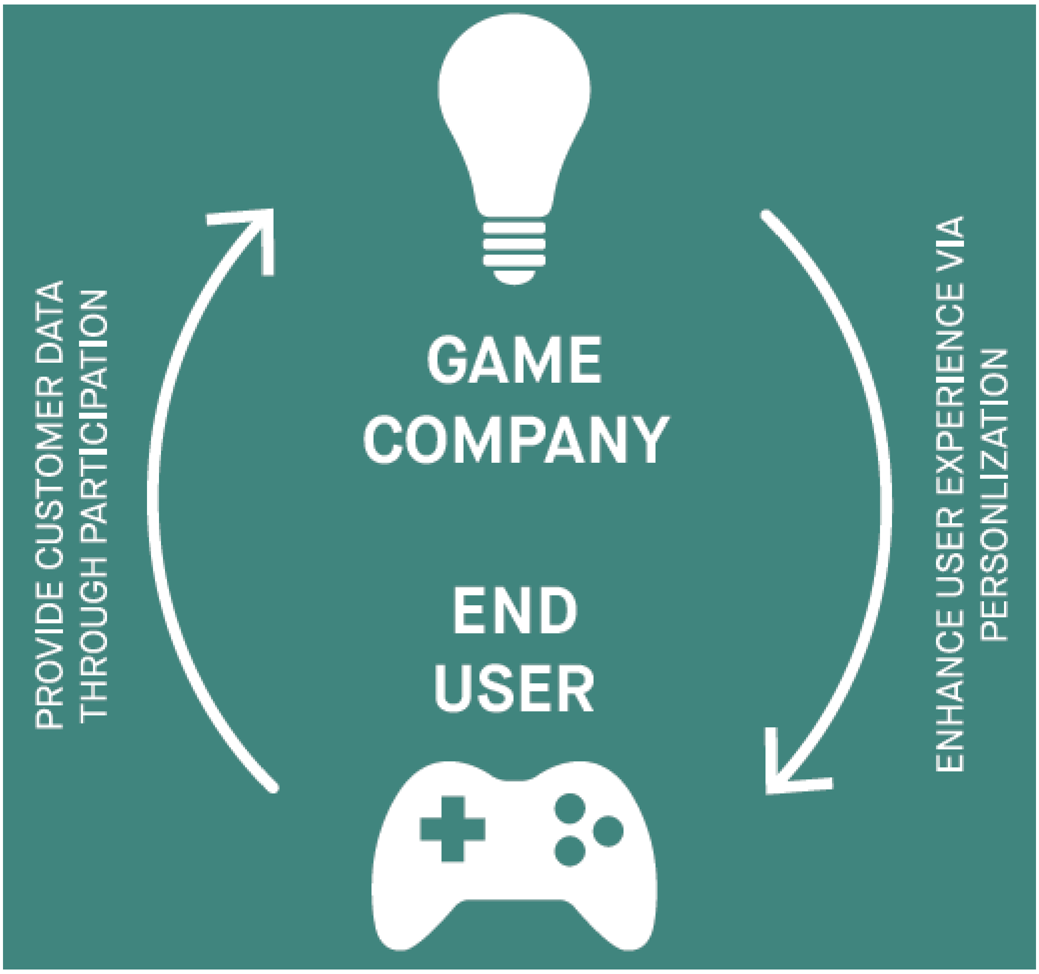

Figure 3.10. Personalization and data sharing cycle (Based on Kelly *et al.* 2014)

3.7.4. Digital distribution

As monetization now takes place within the game at a moment the consumer chooses, publishers and developers are even more incentivized to keep their gamer engaged as long as possible. Video content and eSports are increasingly becoming part of this strategy. Running games as a service requires a different organizational structure than selling (boxed) products. Distribution has become more of a portfolio management function than a single decision: pricing control, level of customer interaction, and ownership of gamer-related data are important variables in determining channel strategy.

The new value chain offers the opportunity to the company to define how it creates the relationship with the gamer. The company can create its own direct-to-consumer relationship, and decide whether it is better to invest the effort to build a new channel or to leverage already established channels with proven reach. Obviously, owning a direct-to-consumer channel means having a complete control over the data analytics, pricing, marketing and management of customer relationships. However, the purchasing process needs to be frictionless and simple and it requires strong capabilities in managing a cloud-based commerce platform and efficient customer relationship management. According to Fries (2011)[33], "it's not just that we have digital distribution to our customers. It's that we have this incredible two-way connection that we've never had before with our customers".

3.7.5. Global Market Place

The games market is now a truly global playground. Online connectivity in general and mobile devices specifically allow companies to localize and launch games anywhere on the planet. To secure growth, emerging markets should be a part of any game company's strategy. Some governments have defined strategic programs to help their companies to penetrate in these new markets. Recently the Norwegian Ministry of Culture, Innovation Norway and the Norwegian Film Institute together launched the Games Go Global initiative - a new export programme for Norwegian computer game companies to help facilitate their games reaching its audience (Norwegian Film Institute 2016).

Companies need to create game portfolios that reduce overall risk and improve success rates for games in development. Game analytics and live experimentation can improve a game's understanding of its consumers, and how they relate to content. Innovation can come through development of a completely new story or in the form of new gamer mechanics. Developing a new story with new characters can invigorate a game company's existing core base, gain new fans and re-acquire those that might have fallen off an existing franchise (Kelly *et al.* 2014).

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[33] Bishop T., 2011. *How Valve experiments with the economics of video games*, Geek Wire: http://www.geekwire.com/2011/experiments-video-game-economics-valves-gabe-newell/

Additionally, selecting where and how to promote a game plays a critical role in determining its success. Content creators must leverage platforms like Twitch[34] to highlight the new stories and demonstrate new game mechanics to enable game discovery and start the flywheel of gamers generating their own clips to share with others.

3.7.6. The game as more than a game

There are new applications for the technology and methodology developed by the video game industry. Some of these opportunities are:

-**Serious games**. Those games used for purposes other than entertainment and applied in various fields such as education, defence, medicine, health, job security or culture. This is a model of collaboration between the video game industry and other sectors, whose synergies are estimated to reach $5,448.82 Million by 2020, at a CAGR[35] of 16.38% between 2015 and 2020 (Marketandmarkets.com 2015).

-**Immersive experiences**. Devices that enable virtual and augmented reality gaming experiences, like Oculus[36], are nearing broad commercial release, leaving the door wide open for new game content specifically for these devices. Initiatives like Google's Project Tango[37] are encouraging experiences similar to virtual reality by enhancing the real world surrounding the gamer.

-**Gamification**. This is the application of typical elements of game playing to other areas of activity[38]. This idea comes from trying to use the intrinsic motivator potential seen in video games in non-game contexts in attempts to improve user engagement, organizational productivity, and interactions with customers, among others. Currently we can find three groups of gamification projects: marketing, training and improving working efficiency (DEV 2014).

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[34] Twitch is the world's leading video platform and community for gamers: https://www.twitch.tv/
[35] CAGR: Compound anual growth rate
[36] https://www.oculus.com
[37] https://get.google.com/tango
[38] https://en.wikipedia.org/wiki/Gamification

-**Interaction with other fields**. Film and television companies make their content more interactive as AMC has with The Walking Dead[39] and HBO has with Game of Thrones[40] and game companies can no longer only look at each other as the competition. Other non-traditional gaming companies like Amazon are realizing the value in original content and are further raising the competitive stakes. The idea of multi-channel story telling is just beginning; pioneers like Disney and Amazon are tying media assets across comics, movies, games and a range of physical items. However, future advances may open up for the possibility of a multi-platform product in which the current differences between a movie and a game will not exist. The narrative will continue in new formats or at the confluence of some formats we already know.

3.8. Serious Games

According to Wolf and Crookall (1998), "the modern era of simulation/gaming began in the late 1950s" and it emerged through a combination of "war-gaming" practices, and new educational theories that prioritised active participation – such as experiential learning (Kolb 2014). Indeed, these same theories of experiential learning are apparent in contemporary serious games approaches (Susi *et al.* 2007; Crookall 2010; Connolly 2012). But a historical precedence is suggested by Wolf and Crookall in war-games formerly introduced in the 17th and 18th century – discounting war-themed "parlour games" chess and chaturanga[41] (Wolfe and Crookall 1998).

Serious games as understood today are built on the rise of digital technologies. Clark C Abt (1987) is often credited with coining the modern definition of "serious games" (Ritterfeld 2009; Djaouti *et al.* 2011) that frame them as games designed for a purpose beyond entertaining:

[39] http://www.amc.com/shows/the-walking-dead
[40] http://www.hbo.com/game-of-thrones
[41] Chaturanga is an ancient Indian strategy game which is commonly theorized to be the common ancestor of the board games. Retrieved from: https://en.wikipedia.org/wiki/Chaturanga [accessed May 15 2018]

"Games may be played seriously or casually. We are concerned with "Serious Games" in the sense that these games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement. This does not mean that serious games are not, or should not be, entertaining." (Abt 1987)

3.8.1. Definition

This term is nowadays established but existing definitions are frequently a derivative or slight re-interpretation of "games that have a purpose beyond entertainment" (Goffman 1976; Djaouti *et al.* 2011). According to Corti (2006: 1) game-based learning/serious games *is all about leveraging the power of computer games to captivate and engage end-users for a specific purpose, such as to develop new knowledge and skills*.

In Zyda's (2005: 26) more formal definition, entertainment is explicitly brought up as an ingredient:

A serious game is a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives.

When comparing serious games with just computer games, Zyda argues that serious games have more than just story, art, and software. It is the addition of pedagogy (activities that educate or instruct, thereby imparting knowledge or skill) that makes games serious. However, he also stresses that pedagogy must be subordinated to story and that the entertainment component comes first.

A problem with the term "serious game" itself is that there appears to be a contradiction between its constituents; the terms "serious" and "game" may seem to be mutually exclusive. The first constituent, "serious", is according to Gershon *et al.* (2006) intended to reflect the purpose of the game, why it was created, and has no bearing on the content of the game itself. Regarding the second constituent, already Wittgenstein (1953) showed that there are difficulties in defining the concept of a game. There simply are no necessary and sufficient conditions. In Michael and Chen (2006: 19) games are described as:

...a voluntary activity, obviously separate from real life, creating an imaginary world that may or may not have any relation to real life and that absorbs the player's full attention. Games are played out within a specific time and place, are played according to established rules, and create social groups out of their players.

Still others consider fun the prime factor in games and education and, according to Prensky (2001), games should be fun first and then should encourage learning. Michael and Chen (2006) argue, with regard to serious games, that the main point is to get players to learn something, and, if possible, have fun doing it. According to them, serious games are defined as:

games that do not have entertainment, enjoyment, or fun as their primary purpose (2006: 21).

3.8.2. Entertainment vs. Serious Games

An adequate question to ask is how serious games differ from entertainment (playful) games. Michael and Chen (2006) discuss the issue from a design and development perspective; contrary to many markets for entertainment games, the hardware used in many of the markets for serious games is years old and therefore less than optimal. The serious games market is also more likely to possess a wide variety of hardware and operating systems. Furthermore, this market includes not only experienced gamers, but also possible first-time players and the games must therefore be even more accessible (Wilkinson 2016).

The main strength of the casual game sector apart from being one the fastest growing markets in the gaming industry is that it reaches to a wide demography. Gamers generally want the richest gaming experience but serious gamers put more emphasis on the model or simulation used to solve a problem. Further, for serious gamers the most important elements of learning are in focus and the assumptions necessary for making a correct workable simulation –otherwise the simulation will teach the wrong skills. Entertainment games, on the other hand, allow players to focus on the fun parts and to use a number of techniques (random numbers, time compression, etc.) for simplifying the simulation processes. Michael and Chen (2006) argue that in serious games it may be important to rethink the use of such simplifying techniques. For example, serious games should respond more to the conscious decisions made by players than to chance, and therefore randomness may be inappropriate.

In the case of communication, it tends to be perfect in entertainment games (there are not delays and misunderstandings in the game dynamics), whereas some serious training applications should rather reflect that communication seldom is perfect. The development process of a serious game is not identical to the one for the entertainment games. In serious games, there are one or more specialists from an application area involved. For instance, a health game needs medical and health-related competence right from the beginning. One or more of the application area specialists may provide an application-specific game behaviour. For example, a didactic expert might introduce didactic elements into the game.

Figure 3.11 shows a framework for the development of serious games. In the centre, game design methods, concepts and principles are used in analogy to the development and design of entertainment games. These elements are combined with further domain-relevant methods, concepts and technologies supported by further information and communication technologies (IT) as well as domain-specific methodologies and technologies with regard to the characterizing goal of the serious games. Typical ICT technologies include mechanisms of artificial intelligence (AI) for the planning, automated generation and intelligent behaviour of virtual characters, aspects of human-computer interaction (HCI), usability features, usage of game controllers and I/O devices, multimedia aspects (computer graphics, audio, etc.) as well as sensor technology to retrieve and monitor context information. Domain-specific methodologies include aspects such as psychosocial, didactic, and pedagogic concepts (Göbel and Gutjahr 2010). These concepts give a new value to the game, passing to have the dimension of a serious game; the outer ring of the figure shows some of the most relevant areas of application of serious games.

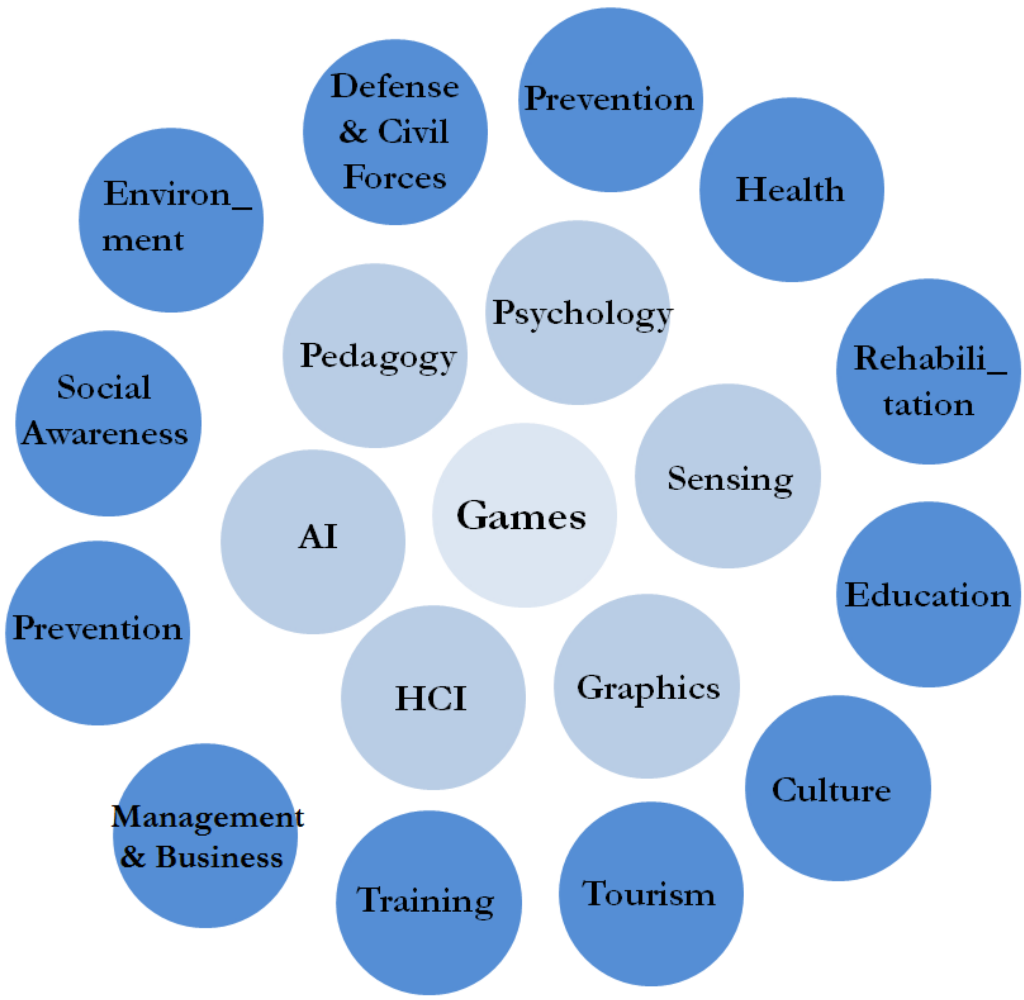

Figure 3.11. Game design combined with technologies and disciplines are applied in a broad range of fields

From the point of view of the user, an entertainment game tends to be developed for everyone (Arnab *et al.* 2013); the differences among the players' demographics and the different interests of groups suggest opportunities for the developers of a number of niche markets. Georgiva *et al.* (20015) shows how publishers tend to be specialized in specific targets: the main audience of Big Fish Games and GameHouse are females aged 18-35 and 55-64 (Alexa 2012a, 2012b); on the other hand, Funkitron attracts mainly males between 18 and 34 years. But Zynga also attracts more females at the age between 18 and 24. This diversification among the players' demographics and the different interests of these groups suggest opportunities for the developers for a number of niche markets.

In contrast, the market for serious games can be described as predominantly Business to Business (B2B) in which the games are developed for schools, institutions, governments or companies that can provide the necessary funding. Although not as widespread, serious games titles within the Business to Customer (B2C) market exist and they are targeted at various customer groups (Alvarez and Michaud 2008). They typically address to much smaller and more targeted audience compared to entertainment games.

One of the most important requirements for good games is to fit as closely as possible to the characteristics of the player in order to be both attractive and effective. This means that the game should be *adaptive* and *adaptable* to the personal characteristics of the player as well as to the requirements for reaching the characterizing goal (Dörner *et al.* 2016). There are many options to ensure adaptability –from designing one's own avatar to choosing an appropriate game level. On the other hand, adaptivity means that the game adapts itself more or less automatically to the specific situation. There are also many options for adaptivity, for example, presenting easier or more difficult tasks, providing support (e.g. hints to the solution), or witching of relevant aspects like emotional or cognitive state of the player or emerging difficulties is required. Kickmeier-Rust *et al.* (2011) introduced the concepts of micro and macro adaptation. Micro adaptation is a specific fine tuning whereas macro adaptation comprises traditional techniques such as adaptive presentation, navigation, curriculum sequencing, and problem solving support based on static learner characteristics. These concepts connect with the term of *personalization* which means that games can be tailored to the individual characteristics of the playing person (Dörner *et al.* 2016). The game can be either adapted by and external person like the player, teacher, or therapist (*adaptability*) or adapt itself based on in-game assessment (*adaptivity*).

Game flow is an experience during gaming characterized by exclusive concentration on the game, feeling control over the game, being immersed in the game, facing clear goals and getting immediate and consistent feedback (Sweetser and Wyeth 2005). It occurs when there is an appropriate fit of task difficulty and player skills. But in the case of serious games is the concept of dual flow what is characteristic and unique. The appropriate balance of task difficulty and skill level ensures that the double mission of serious games is accomplished: being both effective and attractive.

Finally, there is a big question related to serious games: data protection. With respect to legal issues, on the one side detailed user profile information –such as the knowledge background of a learning subject, or a user's health status- will help to configure appropriate game-based learning and training environments (e.g. a personalized cardiotraining program with specific duration, intensity, and frequency according to the user's health status). On the other side, that kind of personalized information in principle might lead to misuse, too. It is always the question of who gets what information and what happens with it (Dörner *et al.* 2016). For instance, in the field of healthcare and ambient assisted living, it is not clear who has to be aware of the health status of an elderly person: Doctors, therapists, caregivers, the family, health insurance companies. For that, appropriate data protection mechanisms are essential and it is currently an unanswered question.

The following table (**3.1**) summarizes the differences discussed throughout this section:

Table 3.1. Main differences between entertainment (playful) and serious games

Areas	Serious Games	Entertainment Games
Target group	Specific target groups	Wide audience
Task vs. rich experience	Problem solving in focus	Rich experiences preferred
Focus	Important elements of learning	To have fun
Simulations	Assumptions necessary for workable simulations	Simplified simulation processes
Communication	Communication is often perfect	Should reflect natural communication (i.e. non-perfect)
User's segmentation	Games developed for specific clients	Everyone
Development	Developers + Involvement of specialists of the application areas	Developers
Personalization	Game must be *adaptive* and *adaptable* to the personal characteristics of the player	Personalization recommended
Game flow	Dual flow compulsory	Game flow recommended
Data protection	Key issue and it is not currently solved	It matters but it is not a key issue

3.8.3. Characteristics and Challenges

Despite the increasing interest in serious games (Cheng *et al.* 2015; Riedel *et al.* 2015), the deployment of serious games is still low. In the industry, companies appear not completely convinced of the benefits of serious games for corporate training, possibly due to a risk-averse attitude towards new technologies (Azadegan *et al.* 2012), or due to the perception that using such tools can be costly (Batko 2016).

Serious games design is challenging because the principles of learning and gameplay are different and frequently conflicting (Arnab *et al.* 2015). The term serious game itself evokes this conflict, since, by definition, play is a voluntary and unproductive activity that brings joy and amusement (Huizinga 1949; Caillois 1961); thus, trying to combine seriousness with play brings not only technical, but especially conceptual concerns.

Serious games exist in a balance between learning and entertainment objectives. Consequently, learning is not the only relevant aspect in serious game assessment. The extent to which a game can engage and motivate the learner is also important, especially because engagement is positively associated with learning outcomes (Carini *et al.* 2006).

Technically, game development is also a daunting task, for which there is little guidance from the software architectural and development aspects (Scacchi and Cooper 2015). Although there are many libraries and game engines for commercial game development, this environment is very heterogeneous and can present challenges in deciding how to best combine components and sub-system architectures (Scacchi and Cooper 2015).

A particular challenge is linking pedagogical practices to concrete gaming aspects that can realize those practices (Arnab *et al.* 2015). Communication between the multidisciplinary teams that are involved in the design and development of serious games can also be problematic, due to a lack of common vocabularies that facilitate cooperation (Marne *et al.* 2012).

Furthermore, due to their specific learning requirements, serious games are typically conceived as one-of-a-kind products, fully tailored to the clients' requirements. As a consequence, these games have low reusability of the final product and of its components

(Stanescu *et al.* 2014). Coupled with high production costs and challenging and time-consuming production processes, it is not difficult to understand why adoption is still low.

The benefits of the use of serious games are considered to increase various skills but this potential is threaten by the lack of evidence. According to Squire and Steinkuehler (2005: 34) "we actually know relatively little about the consequences of game play on the cognition of those who play them". What we do know is that games, simulated environments and systems, etc., allow learners to experience situations that are impossible in the real world for reasons of safety, cost, time, etc. (Corti 2006; Squire and Jenkins 2003). In fact, serious games in a diversity of fields need more evidence, especially health games. A platform like Smart Aging[42], a platform for the assessment of cognitive functions based on the serious game technology (Pazzi *et al.* 2014; Tost *et al.* 2014, 2015, Bottiroli S *et al.* 2017) has been adapted and revised following pilot testing in clinical institutions. These kinds of studies are basic to demonstrate the real clinical relevance of these platform/serious games in order to implement them as an effective tool for cognitive rehabilitation.

Analyses have been conducted over the years, consistently showing that games promote learning (Szczurek 1982; Randel *et al.* 1992; in van Eck 2006). At the same time, it seems difficult to draw any firm conclusions from studies on computer and video games due to conflicting outcomes (Mitchell and Savill-Smith 2004) although the positive impacts detected support the development of a number of different skills: analytical and spatial skills, psychomotor skills, visual selective attention (Mitchell and Savill-Smith 2004); mental rotation (De Lisi and Wolford 2002); improvement of attention behaviour of children (Navarro *et al.* 2003); or increased social skills such as collaboration, negotiation, and shared decision-making (Rieber 1996; Mitchell and Savill-Smith 2004; ELSPA 2006).

In the case of Serious Games in education, there must be a manner of objectively establishing a student's progress within the context of the given objectives of the game

[42] Smart Aging is a platform based on serious games technology consisting in various games in 3D real life tasks developed to assess global cognition and specific cognitive mechanisms, such as episodic and prospective memory, attention, and executive functions, being those more impaired in dementia. The platform was developed by CREB UPC (Barcelona, Spain), Conzorzio di Bioingegneria e Informatica Medica (Pavia, Italy), University of Pavia, Mondino National Neurological Institute (Pavia, Italy) and UOC Neurologia A Azienda Ospedaliera Univesitaria Integrata (Verona, Italy).

(Loh 2012; Bellotti *et al.* 2013). For this reason, performing summative assessment in serious games occupies an important role in research on game-based learning. It gives us tools to review games, evaluate their effectiveness and eventually improve them, particularly when aggregating results from groups of students to extract an assessment of the serious games itself (and not of the learner).

3.8.4. Fields of application

Damien Djaouti *et al.* (2011) identified 953 Serious Games in the period 1980-2002. Moreover, of these 953 Serious Games 'ancestors' 65.8% could be categorised as educational (Djaouti *et al.* 2011). From 2002 through to 2010 there was a marked increase in the total number of serious games however, the proportion of educational games dropped to 25.7%. This reduction of the proportion of educational Serious Games was of course the result of an increased diversity of purpose in the emergent field of serious games.

Here then, we have a dramatic shift in the field of serious games as the diversity of their application grew. For instance, as identified in Djaouti *et al.*'s work (2011) between 2002 and 2010, 30.7 % of the Serious Games developed were designed for advertising. Indeed, following 2002 the newly founded Serious Games Initiative[43] had a role in developing the application of serious games in social activism, and healthcare. In 2004 the first Games for Change[44] conference was held and thus a formalised network of non-profits and experts emerged to explore the potential of serious games for tackling social issues (Klimmt 2009). In this same year the Games for Health conference was also first held to explore the potential of Serious Games in healthcare (Howell 2005).

A basic concept of a serious game is its characterizing goal. This goal characterizes the serious game and can be used to classify serious games in to several categories. The

[43] The Serious Games Initiative (SGI) was founded by the Wilson Centre (US's key non-partisan policy forum for tackling global issues through independent research and open dialogue to inform actionable ideas for the policy community) with one goal: to use games to engage the broader public in policy discourse. Under the umbrella of the Science and Technology Innovation Program, SGI is using games as a dynamic technology to communicate cutting edge research at the Wilson Centre and beyond.

[44] Games for change is a moviment and community of practice dedicated to using digital games for social change.

characterizing goal can pertain to the following competence or skill domains: cognitive and perceptual; emotional and volitional; sensory-motor; personal; social; and media (Wiemeyer and Kliem 2012; Wiemeyer and Hardy 2013). Also, serious games can be classified according to the area of application.

Serious games can also be classified by application area. According to the Serious Game Classification System provided by Ludoscience (2014) or the serious games directory provided by the Serious Games Association (2014), among the most common serious games categories are corporate games for training and simulation purposes, educational games, health games, and advergames (Dörner *et al.* 2016). Further categories include social awareness games, games for architecture and planning, and games for tourism and cultural heritage. Training and simulation represent a large application area for serious games that is also commercially relevant. Due to increasing demands on the health system, health games have become increasingly popular. These games address several health-related aspects such as nutrition, physical activity or rehabilitation (Anguera *et al.* 2013; Tárrega *et al.* 2015; Argenton *et al.* 2016; Fleming *et al.* 2016). But games could be applied to any field: security awareness, museology, politics, NGOs…

3.8.5. Market Opportunities and Business Models

According to *The 2017-2022 Global Game-based Learning Market* (Adkins 2017), the five-year compound annual growth rate (CAGR) for serious games on the planet is 20.2% and revenues will be more than double to $8.1 billion by 2022, up from the $3.2 billion reached in 2017. The world regions with the highest growth rate are leaded by Africa (54.4%), followed by Easter Europe and Latin America at 37.3% and 35.1%, respectively.

Also, Adkins' report (2017) analyses the countries with highest revenues for serious games in 2017 which are China, the US, and India, respectively. In the 2017 market, China was the largest buyer of serious games having overtaken the US in 2014, but market conditions have changed (dramatically) for the worse in that country due to newly imposed restrictive regulations on game development. Most of these current games are learning games. According to Adkin (2017), learning games designed for early childhood education have a robust growth rate of 21.6% and global revenues will nearly triple by 2022. They are the top revenue opportunity for serious game developers throughout the forecast period. Some specific global trends creating a high demand for early childhood learning games are the following: games for children with special needs; inexpensive robot tutors that play learning games with young children; brain trainers for kids; coding games; the addition of art games in an expanded genre called STEAM (science, technology, engineering, art, and math); childhood learning games based on social and emotional learning (SEL) pedagogies; and the augmented and virtual reality games designed for young children.

Compared to business models and value chains in the entertainment sector, the typical scenario in serious games is slightly different because domain experts enter on the stage and bring in another dimension –the serious part. Typically, serious games production is initiated either by a customer –such a company aiming to introduce game-based learning and training (rather than an idea of a game developer or game publisher serving the anticipated needs and interests of the gamers' community)- or represents a byproduct of collaborative research projects in form of a proof of concept for new technical achievements in (mostly technology-driven) research initiatives (Göbel *et al.* 2016).

Games for children with special needs are gaining traction and developers can command higher prices for the products. In fact, customers typically initiate and finance serious game development (i.e., contract game developers for customized solutions and distribute the game for free for training purposes among company employees, or among school-age children in educational settings). Only few examples exist where consumers (players) directly purchase a game but investors are increasingly interested by the revenues' growth rate of these personalized games.

Funding schemes and distribution models of serious games are quite different from entertainment ones: serious game projects are typically not produced for the mass market, but for individual customers. Further, additional stakeholders such as the actual customer and subject-matter experts –such as educators, medical doctors or therapists- are involved in the development process. But although serious games distribution is commonly much targeted and not as widespread, marketing will play a crucial role for the distribution of games. Reviews on video game sites, different contents, updated screenshots of the game, or even press releases on the company's website can be very beneficial for word-of-mouth marketing (Mayo 2010). Distributing serious games via gaming portals can vastly increase reach and popularity of the game if the portal has already garnered enough traffic (Mayo 2010).

A major drawback in the serious games market is that (so far) most serious game productions have small development budgets (which are one to two dimensions lower compared to entertainment titles), coupled with wrong expectations of customers: there is generally a discrepancy between expected quality –compared to successful entertainment productions- and low budgets –compared to existing (Dörner *et al.* 2016). Also, in schools, barriers to adoption include not only negative perceptions towards the educational value of games but also the difficulty of providing good enough games to keep students interested (Egenfeldt-Nielsen 2006; Rice 2007).

The market for serious games can be described as predominantly Business to Business (B2B) market in which the games are developed for schools, companies, governments or any institution that can provide the necessary funding. Although not as widespread, serious games titles within the Business to Customer (B2C) market exist and they are targeted at various customer groups (Álvarez and Michaud 2008). For example Wolfquest, a game about ecology and the live of wolves, was designed for children at the age 9 and above. However, the core audience consists of wolf enthusiasts. Serious games can also be designed for niche markets such as games for children with extremely low or high achievements (Mayo 2010). Games that can be integrated into their learning process and help them receive more practical experience can significantly increase in popularity (Robertson and Miller 2009). Serious games are designed also for older users, aged 55 and above, as for example HappyNeuron (by SBT), designed to stimulate player's memory and brain (Álvarez and Michaud 2008).

One possible way for a serious games market breakthrough would be certified serious games with significant evaluation studies that prove benefits to a potential customer. For instance, certified health games subsidised by the health industry might provide necessary development budgets. This could encourage game developers to both investigate the serious market and develop high-quality, entertaining, customized health games –both convincing customers in terms of its proposed effects and affordability (Dörner *et al.* 2016).

The freemium model could be beneficial for serious games companies not only as a monetization technique but also to explore the preferences of their potential users. This will allow developers to target more precisely their audience and focus on its community to create games for this community. Such models would be appropriate for serious games similar to casual games such as Farm Ville, Castle Ville or Astro Garden– games providing a virtual environment where users can play together as “neighbours” and enhance their game skills through quests and sharing their knowledge whit their groups of “neighbours” (Georgieva *et al.* 2015). But not only the freemium business model would have to be adapted for serious games, the most likely simplest route for mainstream developers will be adapting existing titles to non-leisure uses. As there are no specialized design and communication tools in this area -with most of the evaluation of a game’s chance of success coming from experience- creating new titles from scratch will likely be beyond many developers in the short- to medium term (Dörner *et al.* 2016).

Nevertheless, serious games –either in the form of contractual work or as a part of collaborative research projects with even smaller development subjects- provide a good opportunity for developer studios to cross-finance their own technology development or to bridge time between big(ger) entertainment productions eventually popping up due to unforeseen events, such as problems with a (bankrupted) publisher –unfortunately not that unrealistic in the fast-moving gaming industry (Dörner *et al.* 2016).

3.9. Gamification

Gamification — applying the mechanics of gaming to non-game activities to change people’s behaviour — is an important and powerful strategy for influencing and motivating groups of people. The business community is starting to realize the power it has to improve customer engagement, build loyalty, and motivate employees and partners to perform at high levels. And the concept has the potential to solve a variety of problems outside the business world as well, in areas such as: health, education, public policy, tourism, sustainability, personal development –and the list keeps growing.

Nick Pelling in 2002 introduced the term gamification while designing a game-like user interface for commercial electronic devices (ATMs, vending machines, mobile phones). He created a game like fun to the transaction, infusing gamification into a physical device but at that time was not interested in making use of it in the Internet. Thus the idea faded into the dark until its inception into Internet.

Three years later, 2005, Rajat Paharia founded Bunchball, a platform designed to boost engagement on websites by adding a layer of game mechanics. In 2007, Kevan Davis developed Chore Wars, a site designed to incentivize the act of doing chores by turning it into a game. But the Gamification became popular after the success of the Foursquare application, which contained game elements in non-game contexts (Deterding *et al.* 2011). This app allowing users to search for and discover new places was launch a year before (2009). The idea was letting users collect badges and other achievements. BigDoor was launched the same year and started providing gamified customer-loyalty solutions.

Foursquare and Starbucks, the world's biggest coffee chain, started to award their customers with points and badges when they checked in via the application after buying a coffee. There is no real-world profit from this but this enabled Starbucks to engage people to visit more in their stores. Also, Nike did a gamified application called Nike+ in 2008. Users could capture distance, pace, and calories burned via the application and follow their progress. Users could also get rewards, challenge other users and communicate with them (Bunchball Inc. 2010).

In 2012 Gartner Inc. (2012) estimated that the gamification was on the rise of popularity. They stated that more than 70 % of global 2000 organizations were having at least one gamified application and more than 50 percent of organizations would gamify their innovation processes (Gartner Inc. 2012). In fact, the global gamification market will grow from USD 1.65 Billion in 2015 to USD 11.10 Billion by 2020, at a CAGR of 46.3% (Marketsandmarkets 2015).

But the real origin of non-digital gamification, according to McCormick (2013) is situated in 1910 when Kellogg's cereals offered its first "premium", the Funny Jungleland Moving-Pictures book, free with every two boxes. Two years later, Crack Jack started putting prizes, from stickers to baseball cards, in its boxes of caramel-coated corn snacks. At this moment the concept of gamification was yet to be born, but its primary building block -fun- was motivating millions of consumers.

3.9.1. Definitions

Before presenting and analysing some of the most relevant definitions of gamification, a revision of Marczewki's diagram (2013) facilitates the comprehension of the big differences between the key terms analysed in this chapter: video games, serious games and gamification. He bases the distinction between of these concepts in the presence or not of four elements related to games: game thinking, game elements, gameplay and fun. **Figure 3.12** shows these connections:

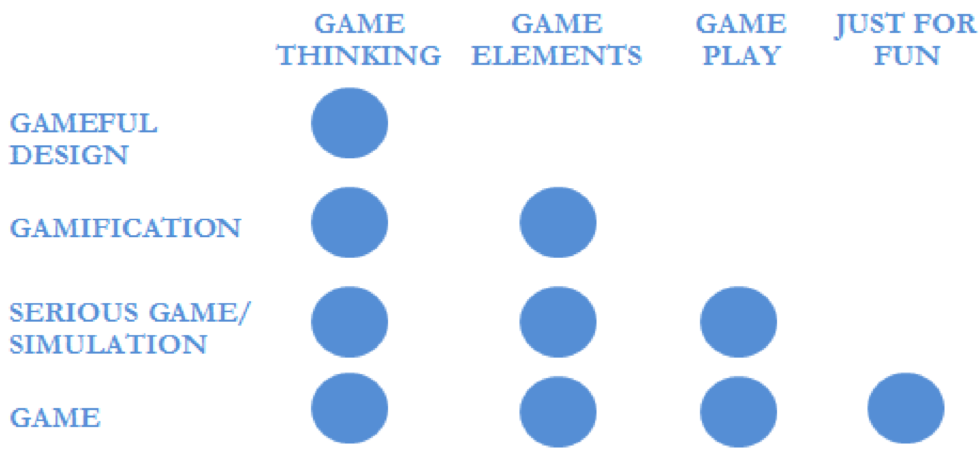

Figure 3.12. Differences in terms: game, serious game, gamification and gameful design (Marczewki 2013)

In Marczewski's diagram Kim (2012) added an extra category. Kim considers that there is a clear distinction between games and social games because this fifth category (social games) implies a strong connection between players.

There have been many attempts to successfully define Gamification. This section shows those more commonly accepted and opens a debate between these definitions. Zichermann and Cunningham (2011) define the concept of gamification as follows:

Gamification is the process of game-thinking and game mechanics to engage users and solve problems.

This definition focuses on the purpose of gamification and emphasizes its goal, that is, user engagement and problem solving. However, this definition does not seem to help in distinguishing gamification from games, particularly the same genre called "alternate reality game" (ARG). What differentiates an ARG from other types of video game is that ARG players make their moves in the real world, not in from of a computer or a video game console screen, and interact directly with other players in the game. The widely accepted definition by Deterding *et al.* (2011) tries to give a more concise understanding of the concept:

Gamification is the use of game design elements characteristic for games in non-game contexts, which is differentiated from playful design and a full-fledged game.

By specifying the context to which game design elements are applied, this definition makes a clearer distinction between games (including ARGs) and gamification. The nature of the problem that gamification tries to solve is not fictional but real. In order for something to count as gamification rather than a game, its goal must be solving a real-world problem. Deterding concludes that gamification relates to games, not "play". **Figure 3.13** shows that serious games and gamification are in different ends of the game spectrum. When gamification uses only some of the game elements it can be located into the "parts" side. When more and more game elements are added to it, it starts moving on the spectrum towards "whole" side and eventually becoming a game itself (Deterding *et al.* 2011.)

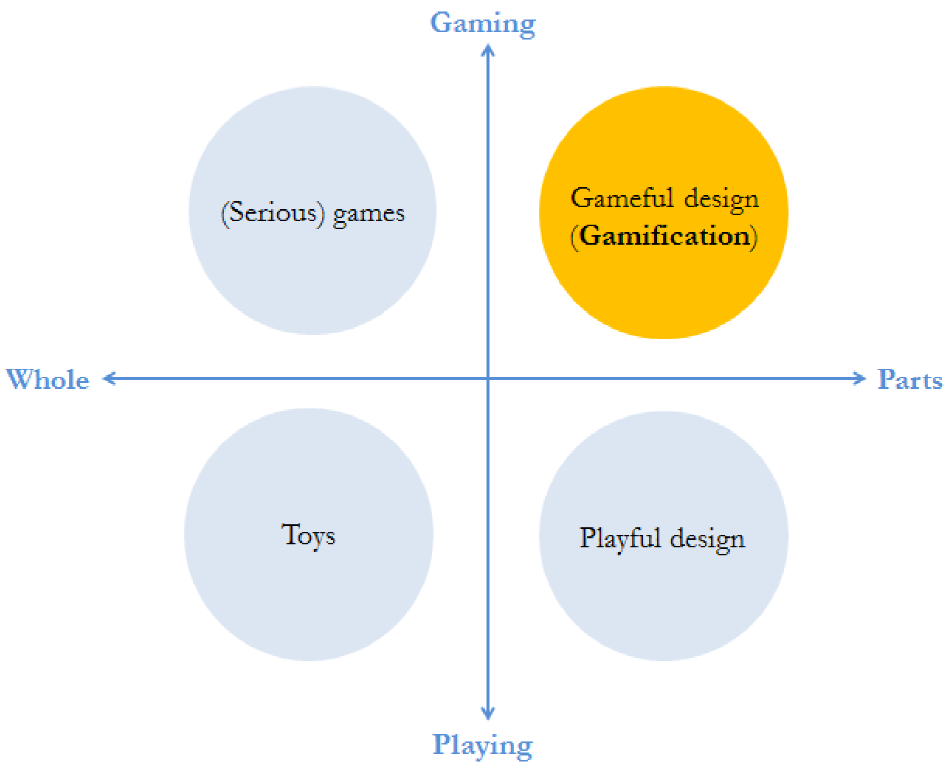

Figure 3.13. Gamification between game and play, whole and parts (Based on Deterding *et al.* 2011).

From the perspective of the game designer, gamified applications are built with the intention of a system that includes elements from games, not a full "game proper", but from the user's perspective, such gamified systems can then be enacted and experienced as "games proper", gameful, playful, or otherwise. Marczewski (2013) provides a helpful distinction of gamification from gameful design and serious games. According to him, gamification is distinguished from games in that it lacks gameplay and is different from playful design in that gamification possesses game elements while playful design does not. And according to Huotari and Hamari (2012) the gamefulness emerges from the psychological consequences with derive from using the gamified system:

Gamification is a process of providing affordances for gameful experiences which support the customers' overall value creation.

But not all game researchers agree on this distinction between playful design and gamification and between gamification and games. Kapp (2012) defines gamification in the context of learning and instruction much more broadly as follows:

Gamification (or learning and instruction) is the delivery of content –for a purpose other than pure entertainment- using game-based thinking and mechanics.

This definition requires only a purpose other than pure entertainment as the defining characteristic of gamification. In Kapp's view, the creation of an educational game does not establish a clear distinction between gamification and serious game. But people can always use one development for both purposes. This may be why Gartner's redefinition of gamification includes the phrase "experience design". Gartner Study rephrased its definition of gamification "to avoid market confusion, inflated expectations and implementations failures" (Burke 2014) as follows:

Gamification is the use of game mechanics and experience design to digitally engage and motivate people to achieve their goals.

Therefore, the key elements of this definition are: game mechanics, experience design, method to digitally engage (rather than personally engage, meaning that players interact with computers, smartphones…), motivating people and enabling players to achieve their goals. Others like Dominguez *et al.* go a step further and limit gamification to the domain of software application:

Gamification could be more narrowly defined as incorporating game elements into a non-gaming software application to increase user experience and engagement.

While there is a close relationship between gamification and software application, limiting gamification to the digital realm or software application is overly restrictive. As Deterding *et al.* (2011) argue, games and game design are themselves transmedial categories, and media convergence and ubiquitous computing are increasingly blurring the distinction between digital and non-digital. This is a legitimate argument against restricting gamification to the digital realm only. Kilian Jornet, considered the best world ultra-runner, tells that after running more than 24 hours, he tries to gamify the race: imagining that he is attacked by Indians and has to dodge their arrows, trying not to step on small elves, etc. (Sanchis 2011). Therefore, gamification can take any form and what is really important is that gamification does engage and help people to achieve their real-life goals using appropriate gaming elements and dynamics.

3.9.2. Designing gamification: target groups and user types

Gamification is currently being utilized for the purpose of improving user engagement and instruction. But the goals of many gamification projects do not appear to have been clearly set out before the projects began. This is probably due to the fact that gamification is still seen as a relatively new and experimental strategy. Nevertheless, considering various outcomes from a gamification project in advance and determining which outcome should be given the highest priority can greatly facilitate the evaluation and improvement process of a gamification project. Setting a clear goal for a gamification project makes it much easier to design the project and to evaluate it after it is run.

Once the goal is clear, it has to be considered at whom the gamification is directed and what the characteristics of the target group are. And inside the target group, another thing to consider is the user type. Bartle (1996) classified players in the MUD (Multi-User

Dungeon)[45] games into four types: achievers, explorers, socialisers, and killers. He described the four types as follows:

- "Achievers regard points-gathering and rising in levels as their main goal."
- "Explorers delight when the game reveals its internal machinations. … They try progressively esoteric actions in wild, out-of-the-way places, looking for interesting features … and figuring out how things work."
- "Socialisers are interested in people, and what they have to say. The game is merely a backdrop, a common ground where things happen to players. Inter-player relationships are important: empathising with people, sympathising, joking, entertaining, listening; even merely observing people play can be rewarding-seeing them grow as individuals, maturing over time."
- "Killers get their kicks from imposing themselves on [and causing distress to] others".

People in different user types prefer one type of game to another. Bartle's player types have served as a general framework for other game researchers and a guideline for game designers even though they are specific to MUD-type games (Wohn and Lee 2013). Marczewski (2013) modifies Bartle's player types to fit the context of gamification as follows:

- player (motivated by extrinsic rewards)
- socialiser (motivated by relatedness)
- free spirit (motivated by autonomy)
- achiever (motivated by mastery)
- philanthropist (motivated by purpose)

The main difference between Bartle's player types and Marczewski's gamification user types is that the later accommodates the fact that unlike games whose players always want to play, gamification will have two different types of people: those who are willing to play

[45] MUD (Multi-User Dungeon) is an adventure game played through real-time interaction with other players in a virtual world described only in text.

for extrinsic rewards and those who are not. Obviously, these user types are theoretical abstractions, but they provide a useful guide in understanding how motivations are involved in gamification. That is why that gamification that focuses on, for example, personal mastery and achievement would have little appeal to types of users such as "socialiser" and "philanthropist"; on the contrary, players or achievers will be more engaged. The "free spirit" type will be drawn to game mechanics such as the detailed customization of avatars, space, and journey-type quests where many discoveries can be made and a lot of detours are available.

In the context of education, it is clear the potential of gamification as a pedagogical tool beyond mere engagement. Van Eck (2006) argued that not all games will be equally effective at all levels of learning and that it is critical understanding how different types of games work and how game taxonomies align with learning taxonomies. For example, card games will be best for promoting the ability to match concepts, manipulate numbers, and recognize patterns; arcade-style games are likely to be best at promoting speed of response, automaticity, and visual processing; adventure games are likely to be best for promoting hypothesis testing and problem solving. This means that there is a need for matching specific learning goals with the adequate type of gaming elements or games.

Kapp (2012) proposes seven types of knowledge, along with gamification elements and examples for each type (**Table 3.2**), trying to respond to Van Ecks's (2014, 2017) work. These gamification elements are closer to a type of game or a gaming activity but in the context of education Kapp's classification is useful in investigating further how to best apply gamification to learning and instruction.

Table 3.2. Types of knowledge, gamification elements and examples (Based on Kapp 2006).

Types of knowledge	Gamification elements	Examples
Declarative Knowledge	Stories/narrative, sorting, matching, replayability	*Trivia, Hangman, Drag and Drop*
Conceptual Knowledge	Matching and sorting, Experiencing the concept	*Whack a Mole, You Bet!*
Rules-Based Knowledge	Experience consequences	*Board games, Simulated work tasks*
Procedural Knowledge	Software challenges, Practice	*Data Miner, Software scenarios*
Soft Skills	Social Simulator	*Leadership simulation*
Affective Knowledge	Immersion, Providing success, Encouragement from celebrity-type figures	*Dafur is Dying*
Psychomotor Domain	Demonstration, Haptic devices	*Virtual Surgery Simulator*

Yu-Kai Chou (2014) saw that almost every game is fun because it appeals to certain core drives within people that motivate us towards certain activities. He also noticed that different types of game techniques push us forward differently: some in an inspiring and empowering way, while some in a manipulative and obsessive manner. So, he tried to find what differentiates one type of motivation to another and classified them in the eight Core Drives for human motivation (epic meaning and calling; development and accomplishment; empowerment of creativity and feedback; ownership and possession; social influence and relatedness; scarcity and impatience; unpredictability and curiosity; loss and avoidance). A good gamified system doesn't need to have all of the Core Drives, but it does need to do really well with the ones it does implement (Chou 2014).

Gamification aesthetics are less directly tied to the learning content and experience the gamification tries to deliver. For this reason, any game aesthetics than can serve the purpose of delivering the given learning content can be chosen, whether it is narrative, challenge, discovery or fantasy (Bohyun 2015). On the other hand, coming up with compelling game dynamics and supporting them with appropriate game mechanics is much more challenging and that is why designers must go one step further and should ultimately create a playful and fun experience from those game mechanics and dynamics.

3.9.3. Motivation strategies

Since the goal of gamification is always something other than gameplay itself, it seems to assume that what motivate people to engage in any gamified application is almost always extrinsic. But it seems that people are also capable of enjoying the gamified experience for its own sake regardless of the designer's intention. So, it is possible that intrinsic and extrinsic motivation coexist independently for the same activity (Bohyun 2015). A good example is the Bottle Bank Arcade[46] machine. The goal that the designers had in mind was to encourage people in a funny way to collect and recycle more bottles. But that does not prevent anyone from playing the Bottle Bank Arcade game for its own sake. The same person may be extrinsically motivated to collect and recycle more bottles, so that she can play the Bottle Arcade game, and at the same time also intrinsically motivated to do so because she wants to protect the environment. In fact, during the same period the nearby conventional bottle banks were used twice.

It is also relevant to emphasize that the more closely the goal of gamification aligns with the goal of a player, the more successful the gamification will be. This strategy also minimizes the potential negative effect of gamification on intrinsic motivation because in such a case players already are intrinsically motivated to a degree to perform the activity. They may need just a little extra push to actually do the work. Also, the rewards attached to gamification must be appropriate to the context and do not pose the risk of distorting the intended context (Bohyun 2015).

The theory of flow by Csikszentmihalyi is found in almost all of the discussions of game design and gamification (Charles *et al.* 2011; Deterding *et al.* 2011; Groh 2012; Herzig *et al.* 2012; McGonigal 2011; Werbach and Hunter 2012; Zichermann and Cunningham 2011). Flow is the "satisfying, exhilarating feeling of creative accomplishment and heightened functioning" (Csikszentmihalyi 2000: xiii.). He believed that flow is lacking in everyday life

[46] http://lemon2020.com/2013/11/08/bottle-bank-arcade-machine-many-of-us-return-our/

but is found in an overwhelming abundance in games and gamelike activities (McGonigal 2011). According to Csikszentmihalyi, this state is often found between anxiety and boredom. If a task is too easy, then the user will be bored and not occupied by it. If a task is too difficult, then the user will become anxious and demotivated. Therefore, game designers, educators, and any other person designing a system to motivate its users must consider the user's skill and challenge level, and slowly increase the challenge level as the user gains experience in order to maintain the state of flow (El-Khuffash 2013; Perttula *et al*. 2017)

Despite the concept of flow, most gamification systems rely on extrinsic motivators as discussed above. It follows the behaviourist model of thinking that considers that a reward or punishment, if applied consistently, will condition people towards certain actions and reinforce certain behaviours (Werbach and Hunter 2012). But the problem is that extrinsic reward, when offered incorrectly, can result in demotivation. Children motivated to read by stars or money may stop reading when the rewards are withdrawn or lose interest in these extrinsic motivations. These rewards become expected, and instead of learning to read for the joy of reading, reading becomes a chore to gain these rewards (Werbach and Hunter 2012). Children who were paid to draw enjoy the act of drawing less than they did before (Zichermann 2011).

On the contrary, the cognitivist theory of Self-Determination (SDT) believes that humans are pro-active and have a strong internal desire for growth, but that external environment must support them (Deci and Ryan 1985) in their needs: competence (ability to accomplish external feats), relatedness (desire for interactions and social connectedness) and autonomy (freedom over your own choices and values). As seen, some aspects of SDT are aligned with Csikszentmihalyi's theory of flow.

When people feel that gamification attempts to manipulate their behaviour, they will inevitably object to and disengage from it. Even verbal rewards that were shown to enhance intrinsic motivation had and undermining effect when they were given with a controlling interpersonal style (Deci *et al,* 2001). Therefore, people's autonomy must be respected in any attempt to engage people and influence their behaviour. Gamification has its limits but it should not detract from its value. Designers must apply gamification wisely, thoughtfully, and selectively with a clear goal; a thorough understanding of the target audience, the nature of the target activity, and the gamified learning contents; an appropriate and effective rewards for the intended context.

3.10. Conclusions

Co-creation is a form of continuous dynamic customization and undoubtedly, innovation is one of the hallmarks of the video game industry. The trends described show the constant evolution of the sector, incorporating the latest technological advances in the creation and distribution of video games in order to provide users with better gaming experiences, thereby obtaining substantial economic returns. Also, the relationship between developers and players has evolved to a cooperation in which the player is the most important step of the value chain.

The traditional gaming value chain has been eroded by the new methods of distribution and has begun to reorganize the functions and dynamics of interaction between actors in each of the different levels of the value chain. From a linear traditional value chain, hardware manufacturers, developers and publishers seemed to be the key players in the industry. They were influential and capable of defining trends in the market due to their critical role in the industry.

But the emergence of the Internet changed the rules and one of the groups most affected was the retailers and their logistical distribution function. Publishers may also choose to distribute games through the ISP[47] or via device manufacturers, accessing a global market without limits on the distribution. This new scenario provides a quasi-direct relationship of the development companies with the end users, avoiding the existing network of intermediation in the traditional value chain. This model facilitates the disintermediation in the process of editing the video game, reducing, or even eliminating the role of the publisher and increasing the relevance of developers.

Developers and end users have benefitted most from the Internet's disintermediation. Developers' access to new multiple alternatives for commercializing their games and to the

[47] ISP: Internet Service Providers

players has been increased significantly by the supply of games available with various business models that fit to their specific demands. Consumers have an active role in the gaming value chain because the companies outsource, hyper-differentiating the game at lower costs while maximizing the potential sources of innovation.

Business models are focused on monetization, the factor that makes the game a project sustainable over time, capitalizing on the effort made along the value chain until the game goes into the market. I have identified three main strategies for monetization: Pay to Play, Free to play or freemium and Advertising. The first one is used in traditional distribution but is also used in the online video game download.

Free to play is based on the existence of a large user base that play for free and only a small percentage paying small amounts periodically for virtual goods –this percentage is around 5%. On the Internet the most valuable asset is the audience and the biggest audiences were attracted by free services. There are always some players (whales) who have different motivations for paying in a F2P game. And for the companies there is a challenge: increasing the percentage of players they can turn into payers spending real money in the game. The third monetization strategy is Advertising, with different trends such as around game advertising, advergaming and in-game advertising.

This chapter also includes some challenges, opportunities and trends based on the important change that the game industry is experiencing: the advancement of new technologies, the decision to exploit the Internet as a platform for games and the redefinition of the developer-consumer relationship. These six challenges identified emphasize different aspects such as: more screens and connected ecosystem (the game has to transcend the individual device and connect across an ecosystem of connected devices); free games, apps and Unique Personalized Experiences (trying to get the balance between the science of data-driven decision making and other core aspects of game design); Business Model Balancing Act (new business models require a continuous balance between value for the consumer and profit for the developer and/or publisher); digital distribution (the new value chain offers the opportunity to the company to define how it creates the relationship with the gamer); global market place (there is a truly global playground in which game analytics and live experimentation can improve a game's understanding of consumers, and how they relate to content); and the game as more than a game (new opportunities for the technology and methodology developed by the video game industry: serious games, immersive experience, gamification, interaction with other fields,…)

The trends described above show us a sector in constant evolution, concerned to know better the end user and incorporate him/her in the development process, incorporating the latest technological advances in the creation and distribution, cross-fertilizing with other fields to provide users with better gaming experiences, thereby obtaining significant economic returns. This innovative character of the field generates new relationships that push companies to determine the best approach for managing direct-to-consumer relationships, troubleshooting gamer issues, reducing gamer churn and preventing loss of gamer engagement.

The digital end points, the lower barriers to entry for low-cost alternatives, and the need to innovate and join the group of disruptors are more critical than ever. This innovative character as described throughout this chapter makes the game one of the most competitive and attractive investment sectors, with an audience that grows from year to year in non-existing percentages in any other sector.

The chapter also deeply analyses two of the applications presented in section **3.7.6** and developed by the video game industry: serious games and gamification. The term serious game is nowadays established but existing definitions are frequently a derivative or slight re-interpretation of "games that have a purpose beyond entertainment" (Goffman 1976; Djaourti *et al.* 2011). In fact, section **3.8.2** answers to the question about how serious games differ from entertainment (or playful) games. These main differences, organised by areas and applied to serious games are the following: target group (SG are addressed to specific target groups); task *vs.* experience (SG is focused in problem solving), focus (important elements of learning), simulations (assumptions necessary for workable simulations), communication (should reflect natural communication), user's segmentation (games developed for specific clients), development (made by developers and the involvement of specialists of the application areas), personalization (the game must be adaptive and adaptable to the personal characteristics of the player), game flow (dual flow compulsory) and data protection (key issue and it is not currently solved).

The benefits of the use of serious games are considered to increase various skills but this potential is threaten by the lack of evidence. According to Squire and Steinkuehler (2005: 34) “we actually know relatively little about the consequences of game play on the cognition of those who play them”. What we do know is that games, simulated environments and systems, etc., allow learners to experience situations that are impossible in the real world for reasons of safety, cost, time, etc. (Corti 2006; Squire and Jenkins 2003). In fact, serious games in a diversity of fields need more evidence, especially health games. In the case of Serious Games in education, there must be a manner of objectively establishing a student’s progress within the context of the given objectives of the game (Loh 2012; Bellotti *et al.* 2013). For this reason, performing summative assessment in serious games occupies an important role in research on game-based learning. It gives us tools to review games, evaluate their effectiveness and eventually improve them, particularly when aggregating results from groups of students to extract an assessment of the serious games itself (and not of the learner). But games could be applied to any field: security awareness, museology, politics, NGOs…

Compared to business models and value chains in the entertainment sector, the typical scenario in serious games is slightly different because domain experts enter on the stage and bring in another dimension –the serious part. The freemium model could be beneficial for serious games companies not only as a monetization technique but also to explore the preferences of their potential users. This will allow developers to target more precisely their audience and focus on its community to create games for this community. Such models would be appropriate for serious games similar to casual games such as FarmVille, CastleVille or Astro Garden– games providing a virtual environment where users can play together as “neighbours” and enhance their game skills through quests and sharing their knowledge whit their groups of “neighbours” (Georgieva *et al.* 2015). But not only the freemium business model would have to be adapted for serious games, the most likely simplest route for mainstream developers will be adapting existing titles to non-leisure uses. As there are no specialized design and communication tools in this area -with most of the evaluation of a game’s chance of success coming from experience- creating new titles from scratch will likely be beyond many developers in the short- to medium term (Dörner *et al.* 2016).

In sum, the serious games market is promising in terms of research and development; however, it also represents a scattered industry with a variety of application areas and characteristics. As of today, there is no serious games market breakthrough. Reasons for these grand challenges have been presented along the section **3.9** and include socio-economic aspects (development costs, quality, cost-benefit ratio), legal aspects (data protection and privacy), and a number of research and technical development related issues. Issues in the latter category range from effective game creation to adaptive control and adaptation mechanisms –along with evaluation aspects to prove the effects and benefits of serious games.

Nevertheless, serious games –either in the form of contractual work or as a part of collaborative research projects with even smaller development subjects- provide a good opportunity for developer studios to cross-finance their own technology development or to bridge time between big(ger) entertainment productions eventually popping up due to unforeseen events, such as problems with a (bankrupted) publisher –unfortunately not that unrealistic in the fast-moving gaming industry (Dörner *et al.* 2016).

Gamification — applying the mechanics of gaming to non-game activities to change people's behaviour — is an important and powerful strategy for influencing and motivating groups of people. The business community is starting to realize the power it has to improve customer engagement, build loyalty, and motivate employees and partners to perform at high levels. And the concept has the potential to solve a variety of problems outside the business world as well, in areas such as: health, education, public policy, tourism, sustainability, personal development –and the list continues to grow.

Once the goal is clear, it has to be considered at whom the gamification is directed and what the characteristics of the target group are. And inside the target group, another thing to consider is the user type. Bartle (1996) classified players in the MUD (Multi-User Dungeon)[48] games into four types: achievers, explorers, socialisers, and killers. Marczewski (2013) modifies Bartle's player types to fit the context of gamification as follows: player

[48] MUD (Multi-User Dungeon) is an adventure game played through real-time interaction with other players in a virtual world described only in text.

(motivated by extrinsic rewards), socialiser (motivated by relatedness), free spirit (motivated by autonomy), achiever (motivated by mastery), and philanthropist (motivated by purpose). The main difference between Bartle's player types and Marczewski's gamification user types is that the later accommodates the fact that unlike games whose players always want to play, gamification will have two different types of people: those who are willing to play for extrinsic rewards and those who are not.

Since the goal of gamification is always something other than gameplay itself, it seems to assume that what motivate people to engage in any gamified application is almost always extrinsic. But it seems that people are also capable of enjoying the gamified experience for its own sake regardless of the designer's intention. So, it is possible that intrinsic and extrinsic motivation coexist independently for the same activity (Bohyun 2015). A good example is the Bottle Bank Arcade[49] machine explained in the section **3.10**. It is also relevant to emphasize that the more closely the goal of gamification aligns with the goal of a player, the more successful the gamification will be. This strategy also minimizes the potential negative effect of gamification on intrinsic motivation because in such a case players already are intrinsically motivated to a degree to perform the activity. They may need just a little extra push to actually do the work. Also, the rewards attached to gamification must be appropriate to the context and do not pose the risk of distorting the intended context (Bohyun 2015).

When people feel that gamification attempts to manipulate their behaviour, they will inevitably object to and disengage from it. Even verbal rewards that were shown to enhance intrinsic motivation had and undermining effect when they were given with a controlling interpersonal style (Deci *et al.* 2001). Therefore, people's autonomy must be respected in any attempt to engage people and influence their behaviour. Gamification has its limits but it should not detract from its value. Designers must apply gamification wisely, thoughtfully, and selectively with a clear goal; a thorough understanding of the target audience, the nature of the target activity, and the gamified learning contents; an appropriate and effective rewards for the intended context.

[49] http://lemon2020.com/2013/11/08/bottle-bank-arcade-machine-many-of-us-return-our/

CHAPTER 4
Empirical Study

4.1. Abstract

Two characteristics found in the innovation ecosystems, the level of multidisciplinarity and the level of cross-fertilization of technologies, are deeply analysed in the empirical study. The chapter is studied from two perspectives that are relevant for any innovation ecosystem: Knowledge-Technology and Management. These perspectives are analysed with the information retrieved from an own database of 87 H2020 projects including serious games and/or gamification, 519 organizations and 597 observations. Later, in order to get insights into the Innovation Management Strategies, a project coordinators survey was conducted. **The Knowledge-Technology perspective** presents how creating adequate multidisciplinary knowledge and technology is fundamental to ensuring the long-term success of an emerging technology including serious games and/or gamification, and how important is the research and innovation that takes place in the practitioners' communities. **The Management perspective** presents the analysis of the innovation management strategies that boost the cross-fertilization of technologies that include serious games and/or gamification. These strategies were analysed by considering literature on innovation and network theories, absorptive capacity and dynamic capabilities. Some personal interviews were conducted with independent experts to understand and have elements for the analysis and discussion of the previous results. Findings suggest that the multidisciplinarity of a project is highly influenced by the creation of knowledge and

technology. Furthermore, the management strategies boosting high levels of cross-fertilization of knowledge and technologies -including serious games and/or gamification- are principally market and customer-oriented strategies. Practical and methodological contributions from this study could enrich innovation literature from the point of view of technological and management approaches.

4.2. Introduction

When organizations decide on investment in technological innovation, they implicitly or explicitly make choices about diversity of options, strategies or technologies. Such choices should ideally consider the benefits and costs associated with multidisciplinarity and arrive at an optimal trade-off. One important benefit of multidisciplinarity relates to the nature of innovation, which often results from combining existing technologies or knowledge base (Ethiraj and Levinthal 2004). In this chapter, the aim is to further analyse a proposed innovation model so that the long-term success of cross-fertilized technologies including serious games and gamification could be achieved. The main idea is that, in an investment decision where available options may recombine and give birth to an innovative option (technology), some degree of diversity of parent options can lead to higher benefits than specialization (Zeppini and van der Bergh 2010). This problem is relevant to both private and public organizations.

Two characteristics found in the innovation ecosystems, the level of multidisciplinarity and the level of cross-fertilization of knowledge and technologies, are deeply analysed in this empirical study. In a H2020 context, industry players and research institutions gain mutual benefit and learning from collaboration, which complements their internal research and development activities (Hanel and St-Pierre 2006; Kautt *et al* 2007; Rothaermel and Ku 2008). In this chapter, the success of the global collaboration strategy is studied from two relevant perspectives for any innovation ecosystem: Knowledge-Technology and Management.

The **Knowledge and Technology perspective** takes into account the evolutionary economics literature that states that the long-term success of an emerging technology requires the sufficient creation of multidisciplinary knowledge and technology among its alternatives in the system (Van der Bergh 2008; Adler and Heckscher 2006; Van Rijnsoever *et al.* 2015). Having sufficient multidisciplinary knowledge and technology helps to prevent an early lock-in, facilitates recombinant innovation, increases resilience of a technology in case of unexpected circumstances, and allows market-growth (Dosi 1982; Adlet and Heckscher 2006; Negro *et al.* 2008; Paez-Aviles 2017). Besides, multidisciplinarity within projects enhances recombinant innovation (Baber *et al.* 1995; Rhoten 2004; Schmickl and Kieser 2008; Fernández-Ribas and Shapira 2009), facilitating the possibility of new combinations and the cross-fertilization of technologies to increase the possibilities of transfering new outputs into the market.

The **Management perspective** is essential to complete successfully the process to overcome obstacles when generated outputs are transferred into the market, fulfilling the market needs. In terms of consumer demand, the technology matches a market when the technology performs a task that a consumer desires (Hellmand and Boks 2006). But the more technologies that are intended to be cross-fertilized, the more complex the process of technological transfer and commercialization is. This scenario leads us to think that the way this complex process is managed should not be based on conventional management strategies. In this regard, this section presents the analysis of the innovation management strategies that could boost the process of cross-fertilization of technologies including serious games and/or gamification. Innovation management strategies are indispensable in a convergent scenario (Almeida and Phene 2004; Maine *et al.* 2014) when the process gains complexity from managing different technologies and collaboration is becoming a key source of competitive advantage.

For both analyses, the funded H2020 projects that include serious games and/or gamification were selected as the element of study. Specifically, the reasons for selecting this sample were the following. Firstly, creating new multidisciplinary knowledge and technology usually takes place in innovation projects in which the more connected organizations are, the higher the degree of local clustering (Wasserman and Faust 1994). In the case of universities, research organizations and private companies, strategic partnerships designed to run for long time deliver greater and often unanticipated benefits to all parties through a virtuous circle of interactions (Edmonson 2012). Secondly, taking the demand side as a starting point, the European Commission[50] identified the most promising areas of innovation for the cross-fertilization of technologies that address clear industrial and market needs in a broad number of industrial sectors. Therefore, multidisciplinarity and cross-fertilization are clearly encouraged and evidenced in EU-funded projects.

4.3. Research Questions

This thesis seeks to get insights about the innovation and technology challenges in the cross-fertilization of technologies when serious games or gamification are included, from basic research through technological commercialization, exploring the specificities of capabilities required to get a successful technology transfer process.

The research focus of this work takes into account public funding, focusing on the relations inside the innovation ecosystems and how collaborative consortia add value along the value chain. Following up on these motivations, the general question this dissertation aims to answer to complement the burgeoning research in this area is:

How is the process of cross-fertilization of technologies in H2020 projects including gamification and/or serious games?

As cross-fertilization of technologies is a highly complex phenomenon, this research has focused on de-structuring the phenomenon into four research questions addressed in two specific perspectives: Knowledge-Technology and Management. These research questions I ask in chapter 4 are the following:

RQ1. Is there a high degree of Multidisciplinary Knowledge and Technology in projects including Serious Games and/or Gamification?

RQ2. Is importing ideas from broad networks in projects including Serious Games and/or Gamification an indispensable innovation management strategy to increase the creation of knowledge, processes or services for being transferred to the market and fulfilling market

[50] https://ec.europa.eu/growth/sites/growth/files/docs/body/cross-cutting-kets-roadmap_en.pdf

needs?

RQ3. Is creating a collaborative environment in projects including Serious Games and/or Gamification an indispensable innovation management strategy to increase the creation of knowledge in order to obtain or improve products, processes or services ready for being transferred to the market and fulfilling market needs?

RQ4. Is the technology-market matching in projects including Serious Games and/or Gamification an indispensable innovation management strategy to increase the creation of knowledge in order to obtain or improve products, processes or services ready for being transferred to the market and fulfilling market needs?

4.4. Two perspectives of the study: Knowledge-Technology and Management

The Japanese concept of *ba* can be thought of as a shared space for emerging relationships. This space can be physical, virtual, mental, or any combination of them. But what differentiates *ba* from ordinary human interaction is the concept of knowledge creation, providing a platform for advancing individual and/or collective knowledge (Nonaka 1998). This shared space that serves as a foundation for knowledge creation is an appropriate metaphor about what a H2020 collaborative project consortium is.

A research project's consortium could support organizations' business goals. These organizations consider a variety of strategic benefits, in particular, assessing how collaboration could achieve continuous innovation and thus create persistent competitive advantage. There is a need to increase capacity for carrying out open-ended and non-linear problem solving involving a wide participation of people in knowledge-rich environments. The combination of newness and often asymmetric dispersion of knowledge suggests that relevant knowledge will most likely reside in networks of organizations, rather than in individual members of a technology innovation system (Powell *et al.* 1996).

Innovative organizations achieve new products or increase product differentiation in two ways: first, by leveraging a partner's superior capabilities (i.e. know-how that the firm did not possess internally); and second, by accessing a partner's contextual knowledge (knowledge that the partner possessed by virtue of its local position) (MacCormack *et al.*

2007). In a H2020 context, industry players and research institutions gain mutual benefit and learning from collaboration, which complements their internal research and development activities (Hanel and St-Pierre 2006; Kautt *et al.* 207; Rothaermel and Ku 2008). These benefits comprise the "3C's" of a global collaboration strategy for creating value at any type of organization (see **Figure 4.1**).

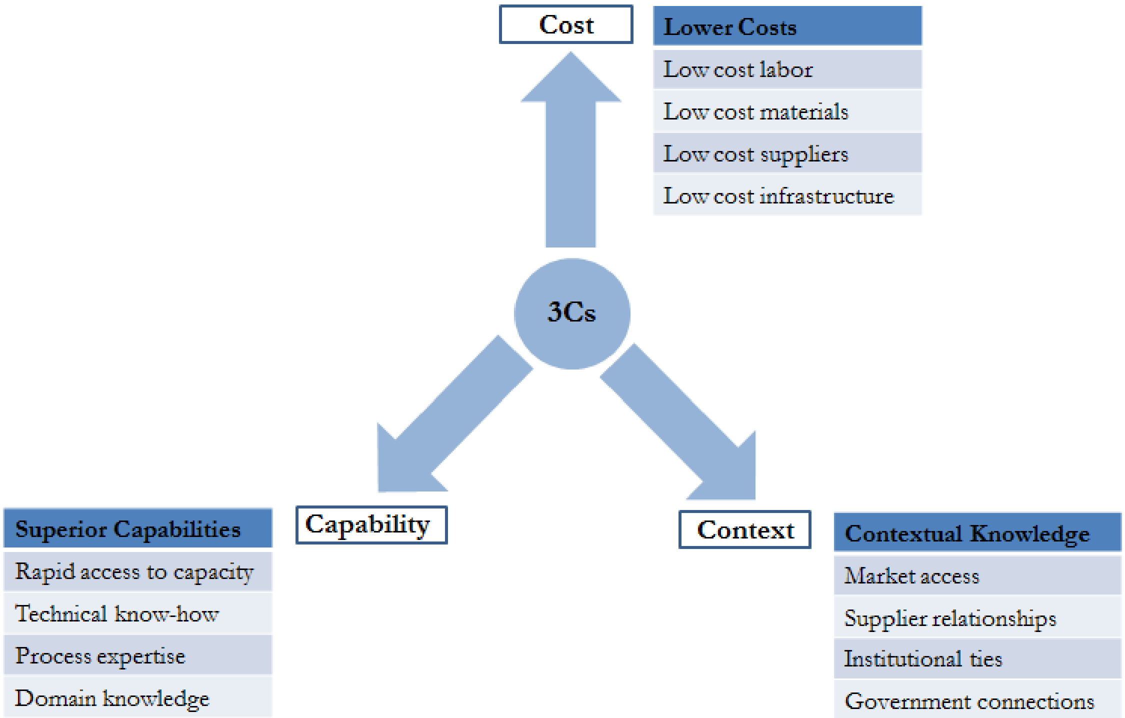

Figure 4.1. The benefits from the 3C's of a global collaboration strategy (Based on MarcCormack *et al.* 2007)

In this chapter, the success of the global collaboration strategy is studied from two perspectives that are relevant for any innovation ecosystem: Knowledge-Technology and Management.

4.4.1. Knowledge and Technology perspective

Consortium research addresses the issue of getting access to and exchanging knowledge from the practitioners' community. It supports the development of artifacts and is characterized by close cooperation between the university and its partners in all stages of the design-oriented research process, practical validation of research results with partner companies, and a focus on the practical benefits of the research, with all research activities being funded by the consortium partners (Otto and Österle 2010). But ecosystem in which research is taking place and the roles of the actors within this ecosystem are under change. Today, research and innovation are taking place in the practitioners' community (Starkey and Madan 2001; Søraa *et al.* 2017). In order to be able to accomplish innovation, all these companies are using resources that are much larger and more powerful than the resources traditionally available in academic research institutions.

Funding instruments can be used as a tool for policy makers to influence in organizations and in their level of technological diversity (Adler and Heckscher 2005; Edquist and Hommen 1999) and thus to secure the long-term viability of technology. Also, the use of specific technologies is encouraged to be recombined with others creating new applications or developing new uses to existent technologies. From an innovation perspective, concepts as serious gaming or gamification are an example. The creation and persistence of knowledge and technological multidisciplinarity depends on learning from their neighbourhood and network externalities. There is little empirical evidence about the characteristics of innovation projects that influence multidisciplinarity. Van Rijnsoever *et al* (2015) demonstrated that diversity created by an innovation project is related to the network position and organization composition of a project. Adding to insights from innovation systems (Edquist 1997), Van Rijnsoever *et al.* (2015) argue that it is also important to consider the structure of the network to make a technology successful in the long term.

The international multidisciplinarity of collaborative research projects should be beneficial to technological diversity creation, but they did not test this implication empirically. From this knowledge and technology perspective, these current approaches are extended by the study of the influence of the characteristics of EU-funded serious games and gamification related projects on the creation of multidisciplinarity. Additional novel variables that have a plausible influence on diversity creation are included.

Furthermore, to understand technological multidisciplinarity, a deep analysis of the content of the documents is needed. An approach is to look at the network of citations of the documents (Rafols and Meyer 2010). A different one is using pre-existing categories like patent classes to measure diversity (Rafols and Meyer 2010; Jonard and Yfldizoglu 1998). Yet, these approaches are mainly applicable to patent, Web of Science categories or publication data, and not to H2020 projects. Hence, to study multidisciplinarity, topic modelling was applied (Leydesdorff *et al.* 2014) as a novel approach to categorize the most relevant topics and thematic areas that are described in 87 projects including 519 organizations. The method allows calculating multidisciplinarity in an efficient manner (Paez-Aviles 2017).

The change in knowledge and technological diversity caused by a project was related to the independent variables mentioned above and results have shown that the largest contribution to diversity comes from the multidisciplinary nature of a project and the knowledge base of the organizations in a project. Moreover, the obtained results largely confirm the results by Van Rijnsoever *et al.* (2005) and Paez-Aviles (2017). These results aim to open the reflection as how policy makers can use public subsidies to influence the level of diversity in a technological field.

4.4.2. Management perspective

The importance of having mechanisms for systematic management of innovation has been widely recognized and investigated (Burns and Stalker 1961; Parker 1982; Kanter 1983; Leonard-Barton 1992; Christensen 1997). Chiesa *et al.* (1996) developed an innovation audit model which tests a set of organizational innovation management good practices, in order to determine the firm's innovation capabilities. This model is based in the exploration of "key" innovation processes (new concept generation, new product development, process redefinition, technology acquisition) plus other "support" activities (leadership and culture, resource allocation, organizational systems). Other models of functional analysis were proposed by Yam *et al.* (2004) and Heinz *et al.* (2006).

Technological diversity leads to opportunity creation (Pisano 2006; Subramanian and Soh 2010) and there is enormous potential for innovation from the confluence of technologies (Sharp *et al.* 2011). Maine *et al.* (2014) go a step forward and explore how the convergence of technologies can lead to the creation of radical innovation and subsequently the emergence of new industries. According to Maine *et al.* (2014) there are three central innovation management strategies in this convergence: i) *to import ideas from broad networks*, ii) *to create environments for deep collaboration* and iii) *technology-market-matching*. The first strategy refers to the search and synthesis of concepts of ideas that could be taken up from networks with different technology streams. The second strategy involves the dynamic collaborative flow of knowledge between R&D groups. Finally, these two strategies need to be complemented by considering market needs, which is the third strategy (Paez-Aviles 2017).

The present study is based on the three aforementioned strategies, considering also other aspects related to network theories, absorptive capacity and dynamic capabilities' literature. The aim is to obtain an expanded vision of these three strategies and the possible influence they could have on the cross-fertilization of technologies including gamification and serious games. To that end, a survey addressed to all the project coordinators of H2020 projects including gamifications or serious games technologies was answered by the 74% of the sample. It was focused on the strategies defined by Maine *et al.* (2014) in order to get insights about the level of applicability of these technologies and their organizations, the level of cross-fertilizations in their projects, and their innovation management strategies.

Answers were statistically treated by using the program for Statistical Analysis in Social Science (SPSS). With the aim of explaining in more detail some findings, additional interviews were conducted to independent experts from the Triple Helix model of the video game ecosystem. The answers of these personal interviews were qualitatively analysed and used to discuss some of the study's outcomes.

4.5. Theoretical background and research hypothesis

4.5.1. Knowledge and Technology perspective

Collaboration with fringe stakeholders has been advocated as a means to achieve creative destruction and innovation beneficial to both business and society (Gardetti 2007; Gupta and Westney 2003; Hart and Sharma 2004; Tennyson 2003). The idea, supported by innovation studies (von Hippel 1998; Chesbrough 2003) is that the knowledge essential to disruptive innovations is located outside the boundary of the organization and its most powerful stakeholders. Furthermore, diversity increases the chances of making recombinant innovations, and hence of further developing a technology. And diversity gives more knowledge and technology alternatives, providing flexibility (Frenken and Nuvolari 2004; Stirling 2007).

Based on these considerations, the following variables and hypothesis are formulated to answer the first research question (**RQ1**): multidisciplinarity, knowledge base, organizations (number and diversity), clustering and innovation intensity. These six aspects are analysed as follows:

- **Degree of multidisciplinarity**

The concept of discipline has been subject to much debate and there is a growing recognition that new approaches and different types of expertise are needed to face new challenges. According to Choi (2006) multidisciplinarity draws on knowledge from different disciplines but stays within their boundaries, meanwhile inter-disciplinarity refers to the interaction between disciplines into a coordinated and coherent whole. In the context of this research, the definition from Rafols and Meyer (2010) is considered. These authors define multidisciplinarity as the spanning of a diversity of knowledge areas, which could be disciplines, technological fields or industrial sectors (Rafols and Meyer 2010). Many other scholars have analysed multidisciplinary projects from the perspective of collaboration between team members (Teasley and Wolinski 2001; Chin *et al.* 2002; Cummings 2005; Rijnsoever and Hessels 2011), or on the skills required to manage these types of projects (Konig *et al.* 2013; Dewulf *et al.* 2007). Páez-Aviléz and Van Rijnsoever (2017) attempted to analyse the diversity of topics within a project to calculate the degree of multidisciplinarity. But no other research has been focused on the degree of multidisciplinarity of projects and how this contributes to knowledge and technological diversity.

There are good reasons to suspect such a relation. A multidisciplinary environment favours a greater diversity of idea generation and promotes creativity (Alvers *et al.* 2007). Knowledge processes becomes intense and knowledge creation frequent (Lofsten and Lindelof 2005; Seufert *et al.* 1999; Freel 2000). These cooperative environments have been found to contribute to better exploitation of limited research capacities (Roper and Brookes 1999; OECD 1999) and to the development of valuable and more radical ideas and solutions adjusted to the increasing complexity of problems. Therefore, they are more effective in the pursuit of creativity, innovation and product development than monodisciplinary and monosectoral environments (Hargadon 2003).

Multidisciplinarity within projects enhances recombinant innovation (Baber *et al.* 1995; Rhoten 2004; Schmickl and Kieser 2008; Fernández-Ribas and Shapira 2009), increasing the possibilities of emerging and transferring into the market new technologies (Paez-Aviles *et al.* 2017). It is thus expect that the degree of multidisciplinarity of a project has a positive effect on the creation of multidisciplinary knowledge and technology. This leads to the first hypothesis:

Hypothesis 1*: The degree of multidisciplinarity of a project is positively associated with the creation of multidisciplinary knowledge and technology.*

- **Knowledge base**

The most common definition for knowledge is a justified true belief (Chisholm 1982): 'I know something, if I believe it, if I have evidence that it is true, and if it is true'. This concept is one of the key resources that foster innovation (Grant and Baden-Fuller 1995), process that rely on the own knowledge-base (internal knowledge) or on knowledge outside the firm (external knowledge). But knowledge generation and knowledge creation is the "capability of a company as a whole to create new knowledge, disseminate it throughout the organization, and embody it in products, services and systems" (Nonaka and Takeuchi 1995).

Historically, research institutions have been perceived as a source of new ideas and industry offered a natural route, to maximising the use of these ideas. However, many companies are developing open innovation approaches to R&D, combining in-house and external resources, and aiming to maximize economic value from their intellectual property, even when it is not directly linked to their core business. Generating R&D alliances between different type of organizations is crucial for developing strategies to create new knowledge and creating the conditions for successful knowledge transfer (European Comission 2007).

Organizations complement their internal activities to seek for external knowledge with the assistance of a broader group of external sources of technological knowledge and involve them in long-term relationships to perform functions beyond simple information retrieval and dissemination (Becker and Gassmann 2006; Benassi and Di Minin 2009; Sawhney *et al.* 2003; Steward and Hyysalo 2008). Specially, consultancies exploit existing specialist solutions to come up with new managerial approaches to bridge the gap between technological opportunities and user needs (Bessant and Rush 1995; Hargadon and Sutton 1997). This diversity of knowledge generation and partners in H2020 consortia is also associated with the technological diversity (Lazear 2004; Lettl *et al.* 2009).

Prior knowledge also strengthens the absorptive capacity of organizations by increasing "the prospect that incoming information will relate to what is already known" (Cohen ant Levinthal 1990). Hence, a large knowledge base enhances the ability of an organization to make novel combinations. Moreover, a larger prior knowledge base demonstrates that organizations have the experience and routines needed to combine knowledge (Kogut and Zander 1992; Paez-Aviles 2017). This effect is even stronger if the joint knowledge base of all project partners is larger, as it further increases the chances of making novel combinations. This reasoning leads to the following hypothesis:

Hypothesis 2*: The size of the joint knowledge base of organizations within a project is positively associated with the creation of multidisciplinary knowledge and technology.*

- **Number of organizations**

Number of organizations refers to "*the size of the project consortium in terms of distinct actors*" (Rijnsoever *et al.* 2015: 1097). Dailey (1978) stated that a larger team size decreases team cohesiveness and collaborative problem solving. That is why more collaboration between companies and universities alone is not enough and there is a need to deploy the subsidy smartly, for example, by rewarding consortia that operate independently of each other. Parties have a certain expertise that they make repeated use of. This does not lead to new types of projects and solutions even though that is usually the aim of the innovation policy of the European Comission. Van Rijnsoever (2015) therefore thinks that when it takes subsidy decisions, the government should also consider whether applicants are involved in any other collaborative programmes.

Having said that, a common position in literature considers that larger project teams provide a larger chance of recombining different types of knowledge, expertise and ideas, and thus innovation (Powell *et al.* 1996; Ruef 2002). Yet, few studies explicitly study the influence of the number of organizations involved on the creation of technological diversity. In this context, evidence suggests that there is a negative association between the number of project partners and the creation of technological diversity (Rijnsoever *et al.* 2015). The argument is that intense collaborations could result in conformity of norms and conventions producing less novelty (Tatikonda and Rosenthal 2000). Keeping this in mind the following hypothesis is proposed:

Hypothesis 3: *The number of organizations in a project has a positive association with the creation of multidisciplinary knowledge and technology.*

- **Diversity of organizations**

More and more organizations have made it their economic goal to create new ideas, new technologies, and new content (Florida 2002b). As these innovations are diffused throughout society, their effects are often seen as life changing (Roberts 1988). Innovation projects commonly involve different organization types that come from different institutional spheres (Hsu *et al.* 2011). Universities, research institutions and industry have been collaborating for over a century, but the rise of a global knowledge economy has intensified the need for strategic partnerships that go beyond the traditional funding of discrete research projects. The most productive collaborations are strategic and long-term. They are built around a shared research vision, establishing deep professional ties, trust and shared benefits that work to bridge the sharp cultural divide between academia and industry (Edmonson 2012).

This study distinguishes the organization types previously described in section **1.4.1. Sample Selection**. Pandza *et al.* (2011) demonstrated that usually, the inter-institutional collaboration is taking place between private industry and public research organizations (Pandza *et al.* 2011). Juanola *et al.* (2012) also showed that the development of new devices requires the interaction between multiple organizations. Their diversity in the workforce, or the combination of various cultural and demographic categories, can increase creativity, innovativeness, performance, and the quality of work (Cox *et al.* 1991; Florida 2002; Herring 2009; Hubbard 2004; Page 2007). Meanwhile, other studies found that diversity harm cohesiveness in groups, hinders the establishment of trust among members, causes conflicts, and leads to both poor performance and low quality of work (Allen and Eby 2003; Dimitrova and Kok 2010; Jackson *et al.* 2003, Jackson *et al.* 2004; Kirkmand *et al.* 2001; Li *et al.* 2005; Mathieu *et al.* 2008; Olson *et al.* 2008b). But referring diversity as a form of social capital, social network analysts argue that diverse ties bring in more resources for network members (Erickson 2003; Lin 1999, 2001; Lin *et al.* 2009).

Every organization brings to the project unique knowledge and skills that can be recombined to form novel concepts and designs (Mo 2016), creating more technological multidisciplinarity and diversity (Rijnsoever *et al.* 2015). Following the arguments, a positive relation between organization's diversity and knowledge and multidisciplinary technology creation is stated:

Hypothesis 4: *The diversity of organizations in a project has a positive association with the creation of multidisciplinary knowledge and technology.*

- **Degree of clustering**

As organizations can participate in multiple projects, a network emerges in which projects are nodes and organizations are ties between the nodes (Paez-Aviles *et al.* 2017). Ties function as a form of social capital that can connect people with diverse resources embedded in their social networks (Erickson 2003; Lin 1999, 2001; Lin and Erickson 2008). Clustering is a property of a local network structure which refers to the likelihood that two organizations that are connected to a third organization are also connected to one another (Kaiser 2008; Eslami *et al.* 2013). The more they are connected, the higher the degree of local clustering (Wasserman and Faust 1994).

In the case of universities, research organizations and private companies, strategic partnerships designed to run for five to ten years deliver greater and often unanticipated benefits to all parties through a virtuous circle of interactions. Above all, long-term alliances build the vital human capital needed to make the industry-university collaborations work. It is the human ties, understanding and trust on both sides of the partnership that count most. Over time, a well-managed partnership produces a growing number of professors and graduate students, who can think and act across the cultural divide, connect with the key research interests of a company and work harmoniously to define big and common strategic goals (Edmonson 2012).

The cluster of individuals that share a similar set of skills and expertise has been dubbed a "community of practice" (Wenger 1998) or a "network of practice" (Brown and Duguid 2001). Such fluid groups are important to the circulation of ideas. Saxenian (1994) argues that informal knowledge sharing, widely institutionalized as a professional practice in Silicon Valley, is one of the crucial factors contributing to its fertile innovative climate. Cohen and Fields (1999) stress that professional ties in Silicon Valley are forged in complex collaborations between entrepreneurs, scientists, firms, and associations, focused on the pursuit of innovation and its commercialization. This collaborative process generates and refines the intangible raw material of technical change (Fagerberg *et al.* 2005).

There is an open debate about the degree and the effect of clustering on innovation. On the one hand, clustered networks are argued to be dense local neighbourhoods where organizations trust each other, shared norms emerge, information is verified or diffused (Powell *et al.* 1996; Ahuja 2000; Schilling and Phelps 2007), and novel combinations are being made (Uzzi and Spiro 2005). However, too much clustering can have negative effects on innovation. Excessive cognitive resemblance may limit innovation opportunities, since there would be little left to learn (Boschma 2005; Nooteboom 1999). Rather, to access the cognitive diversity that is required for innovation, organizations may have to venture further afield (de Jong *et al.* 2010).

Many of the ties are redundant, yet costly to maintain (Burt 2004). Also, sharing the same information sources also means that knowledge becomes more homogenous. Moreover, the shared norms can hamper creativity (Paez-Aviles *et al.* 2017). The opposite of clustering is that there are structural holes in a network (Burt 2004). Structural holes occur when two organizations that are connected to a focal partner are not connected to each other (Burt 2001, 2004). This means that the focal partner has access to two different sources of information, which allows for making novel combinations (Burt 2004) that add more to multidisciplinary technology (Rijnsoever *et al.* 2015). Hence, it is hypothesized:

***Hypothesis 5**: The degree of clustering around a project is negatively associated with the creation of multidisciplinary knowledge and technology.*

- **Innovation Intensity**

Innovation is considered vital for its contribution to business performance, and the literature consistently associates it positively with performance. This linkage between innovation and its impact on performance was validated by Han, Kim and Srivastava (2005). Higher innovation possessed by a firm causes higher organizational performance in the market competition (Subramanian *et al.* 1996). Considering the operational complexity of a service firm, the intensity of innovation is generally manifested in the form of product modification (Verhees *et al.* 2004). The firm requires diverse resources inputs and combinative capabilities (Kogut et al. 1992). In the light of the growth of a firm, its ability of innovation will generate a competitive edge and business growth in the market (Romano 1990). Thus, an organization's innovation has become important for it to increase growth of development and value creation (Wolff *et al.* 2006).

Innovation in any organization is related with organizational learning (Cohen *et al.* 1990; Tsai *et al.* 1998). The more emphatically knowledge is learned and absorbed, the higher the performance an organization can achieve through the capability of innovation (Lane *et al.* 1998). Also, the more dynamic or complex the environment, the greater the compulsion to innovate and the more innovative organizations are likely to be. The pressure to innovate on organizations is great and, hence, the intensity of innovation is one of the decisive factors for making them competitive (Chen *et al.* 2008).

Universities and research institutions have a key role in the generation of knowledge but the cultural divide between universities and industry still runs deep. It acts as a brake on effective collaboration with the business world although this cultural divide can be overcome, but it requires strong university leadership, faculties who understand business, and incentives and structures for academics to bridge that gap (Edmonson 2012).

According to the theory of regional innovation systems (Cooke 2001), it has been shown that higher concentration of talents in a region helps to connect and exchange knowledge resulting in enhanced innovations (Boshma 2005; Kakko and Inkinen 2009). However, knowledge is bound to a geographical location, and the content of knowledge bases varies geographically (Boschma *et al.* 2014; Frenken and Hoekman 2014). Therefore the further the distance between organizations, the more likely it is that their knowledge bases differ. Hence, it is hypothesized:

***Hypothesis 6**: The innovation intensity in a project is positively associated with the creation of multidisciplinary knowledge and technology.*

4.5.2. Management perspective

Managing innovation is essential to increase the creation of knowledge in order to obtain or improve products, processes or services. This process is successful only when those generated outputs could overcome obstacles to being transferred to the market and fulfilling market needs. It forces managers to understand the competitive implications of partners' selection and to develop strategies or actions in order to influence the productivity and impact of their scientists and product development teams. These strategies are even more indispensable in a convergent scenario when the process gains complexity from managing different technologies (Paez-Aviles 2017) and collaboration is becoming an important source of competitive advantage.

Maine *et al.* (2014) have shown that there are three central innovation management strategies in this convergence: i) *to import ideas from broad networks*, ii) *to* c*reate environments for deep collaboration* and iii) *technology-market-matching*. The first strategy refers to the search and synthesis of concepts or ideas that could be taken up from networks with different technology streams. The second strategy involves the dynamic collaborative flow of knowledge between R&D groups. Finally, these two strategies need to be complemented by considering market needs, which is the third strategy. These strategies are analysed in this study taking into account wider perspectives and are described hereafter

4.5.2.1. Importing ideas from broad networks

Competing effectively in knowledge-rich and rapidly changing environments requires developing strategic alliances with multiple actors for taking advantage of technological and market ideas from broad networks. It refers to getting concepts or ideas from networks with different technology streams (Allen *et al.* 1980; Brown and Utterback 1985; Lee *et al.* 2001; Chesbrough 2006; Maine *et al.* 2014). In this study, this innovation management strategy is analysed from different points of view: knowledge and technological distance, knowledge and technological effort, access to external information and participation of end users.

- **Knowledge and Technological distance**

Innovation can be viewed as a process of searching and combining knowledge across different technology fields. The variety of technology fields together constitutes the "technology space", in which the fields may have different distances between each other (Teece *et al.* 1994; Breschi *et al.* 2003; Kay *et al.* 2014). It could also be viewed as a dimension of the embeddedness of an organization in a network that might affect the flow of knowledge and how much an organization could learn or integrate new information from its network (Wenger 1998; Gilsing *et al.* 22008; Kim *et al.* 2015). In this context, technological distance could be related to the absorptive capacity[51] of organizations since the level of novelty of the shared knowledge can vary according to this distance (Nooteboom *et al.* 2007).

Organizations utilize external collaborations to stay abreast in rapidly developing technological fields (Cohen *et al.* 1990; Powell *et al.* 1996). Technological proximity (Jaffe 1986; Leydesdorff *et al.* 2014) facilitates mutual understanding and trust and the benefits of recombining information across different technological domains increase when the distance between those domains decreases (Llerena and Meyer-Krahmer 2003). However, when the distance is too short, knowledge could be overlapped and little could be shared, reducing the level of novelty produced (Gilsing *et al.* 2008). If the opposite occurs with a large technological distance, communication problems could emerge (Jeong and Lee 2015),

[51] Absorptive capacity is defined as the ability to recognize the value of new knowledge, assimilate, and apply it to commercial ends [461]–[463].

especially when the technological knowledge is tacit or "sticky" (von Hippel 2005). In this case, transferring knowledge and information could be more difficult and costly, hampering the assimilation of ideas from the network and therefore negatively affecting the absorptive capacity of organizations (Nooteboom 1999; Paez-Aviles 2017).

Combining new knowledge from different technology sources generally reflects large technological distances, promoting higher innovation novelty and this has a positive effect in novelty creation (Rosenkopf and Nerkar 2001; Ahuja and Lampert 2001; Cassiman *et al.* 2005; Laursen and Salter 2006). On the other hand, drawing upon familiar technological elements can reduce search costs as well as the variability of outcomes (Rosenkopf and Almeida 2003; Carlile 2004; Taylor and Greeve 2006).

Technological distance could also be associated with radical and incremental innovations. Diverse technologies have been found in radical innovations while the opposite occurs in incremental innovations (Wuyts *et al.* 2005). In this regard, there are two positions in the literature. One says that technological distance and innovation is an inverted u-shaped relationship (Wuyts *et al.* 2005; Cloodt *et al.* 2006; Nooteboom *et al.* 2007; Gilsig *et al.* 2008). The other position states that radical innovations and technological distances are more of a linear relationship (Phelps 2009; Quintana-García and Benavides-Velasco 2011). In this study the author is inclined to think that serious games and gamification act as a thread stitching different technologies and giving rise to mainly radical innovations -although incremental also takes place in some projects. He thinks that this process is being boosted when there are larger technological distances within the broad network (Paez-Aviles 2017). Therefore the knowledge that is imported from the network is more heterogeneous rather than homogeneous. Hence, the following hypothesis is advanced:

***Hypothesis** 7: Cross-fertilization of knowledge and technologies is being boosted when there are larger knowledge and technological distances in the network.*

- **Knowledge and Technological effort**

Collaborative networks provide access to more diverse sources of information, ideas and technologies and, in turn, these linkages increase the rate of innovation of organizations (Teece 1992; Powell and Grodal 2005; Castellani and Zanfei 2006). Expanding international networks is a fundamental vehicle for the adaptation and improvement of technology according to local demand (Mansfield *et al.* 1979; Lall 1979), for the monitoring of technology development carried out elsewhere (Florida 1997), and for the absorption of locally available knowledge (Almeida 1996; Cantwell and Noonan 2002).

Technological effort could be related to the amount of resources invested in R&D activities and the acquisition of technological capabilities (Rieg and Alves Filho 2003; Lopes and Judice 2011). Ahuja (2000b) and Stuart (2000), for example, demonstrate that firms with many prior patents are more likely to form alliances that firms lacking patents, suggesting a recursive process of innovation and growth in which collaborative ties play a central role. Other perspectives suggest that technological effort is the use of technological knowledge along with further resources to create, assimilate or adapt technology (Dahlman and Westphal 1981).

Srivastava *et al.* (2015) state that organizations who make strong technological efforts have an increased motivation to search, evaluate and apply that external knowledge or those ideas. To this end, they need to pool the skills of specialized participants to help the overall flow of information and resources in the network (Smith 2006). However, there is a reduced technological effort when organizations are more concerned about protecting their knowledge resources, through fear of losing their control over valuable technological competencies (Rieg and Alves Filho 2003). These opposed dimensions operate and influence the level at which an organization could benefit from the network (Dahlman and Westpal 1981; Rieg and Alver Filho 2003).

Based on the above, it is argued that when there are different technologies involved in the process of developing a product, it is difficult for an organization to be specialised in all of them. The consequence is that organizations tend to search for that specialization in external sources, resulting in stronger technological efforts (Paez-Aviles 2017). This reasoning leads to the following hypotheses:

Hypothesis 8*: Cross-fertilization of technologies is being boosted when organizations make stronger knowledge and technological efforts to import the ideas from the network.*

- **Acces to external information**

Organizations can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology (Chesbrough 2003). Open Innovation deals with the exploitation and exploration of the knowledge existing outside the boundaries of the organization itself (Calanstrone *et al.* 2007). The ability to interact with their ecosystem has an impact on an organization's performance (Ritter and Gemünden 2004). Moreover it has been shown that an open prioritization as a strategy for importing knowledge could accelerate the commercialization end (Gassmann 2010).

Most of the innovation active organizations cannot rely solely on internal sourcing but also require knowledge from beyond their boundaries when going through the innovation process. In fact, the benefits of opening up the innovation process to external knowledge flows ("open-market" innovation) is a critical new source of competitive advantage (Rigby *et al.* 2002). Having access to external information could be a determinant for belonging to a broad network. Based on this, the following hypothesis is formulated:

Hypothesis 9*: Cross-fertilization of knowledge and technologies is being boosted when organizations consider important to have access to external information.*

- **Participation of end users**

There is a general movement to use the creative potential of consumers (Von Hippel 2001, 2002). The idea that the user can be considered as an innovative resource refers to community sourcing in open innovation literature (Linder *et al.* 2003; Chesbrough 2003). Outsourcing a portion of the innovation task to customers can be an effective approach for speeding up the development of products better suited to customer needs (Thomke *et al.* 2002; Von Hippel *et al.* 2002; Von Hippel 2001) by allowing a better understanding of customers' behaviours, identifying upcoming trends and reducing the failure rate of new products or services.

Customer innovation makes sense when the market demands more customised products and supplying this raises costs which are difficult to pass on to customers, when the firm needs many iterations before the product is fine tuned and, lastly the firm's manufacturing function can be easily adjusted to received impulses from the customers (Thomke and von Hippel 2002). Therefore, value generation is possible by co-creating with the current and potential users of these products or services. In the video game industry, a traditional way of involving players' participation is in the development of the game before marketing. For example, while developing the gameplay, many companies share the game with its fans in the testing phase via open and closed betas. This soft launching enables debugging and balancing the game for the fans. It is also a means of motivating fans to participate in the hard launching of the game (Davidovici-Nora 2009).

In fact, for fulfilling the expectations and needs of consumers the process of creation cannot be carried out in isolation (Lusch *et al.* 2007; Vargo *et al.* 2008; Grönroos 2008). Therefore, the following is hypothesised:

***Hypothesis 10**: Cross-fertilization of knowledge and technologies is being boosted when end users participate in the innovation process at different stages of the value chain.*

4.5.2.2. Creating a collaborative environment

The European H2020 strategy sets the target of "improving the conditions for innovation, research and development"[52], in particular with the aim of increasing combined public and private investment in R&D to 3% of GDP by 2020[53] (between 2013 and 2015 this percentage of GDP in the EU stagnated at 2.03%). But interactive learning among European organizations is crucial for innovation process. A third of the EU's innovative enterprises were engaged in some form of co-operation with other enterprises or institutions during the period 2012-2014[54]. Indeed, between 62% and 97% of all product innovations are achieved in collaborations between innovating firms and other organizations (Orstavik 1998; Smith 2006; Edquist *et al.* 2010; Paez-Aviles 2017).

High quality multidisciplinary cooperation often resulted from heterogeneous backgrounds (Jason 2000) and effective communication and interactions (Nigel and Anita 1995). This team-based collaboration foster cross-functional activities, creates innovative value, often

[52] European Council conclusions 17 une 2010, EUCO 13/10, Brussels, 2010: ec.europa.eu/eu2020/pdf/council_conclusion_17_june_en.pdf
[53] European Comission, Taking stock of the Europe 2020 strategy for Smart, sustainable and inclusive growth, COM(2014) 130 final, Brussels, 2014 (p. 12): eur-lex-europa.eu/legal-content/EN/ALL/?uri=CELEX:52014DC0130
[54] Europe 2020 indicators – R&D and innovation: c.europa.eu/eurostat/statistics-explained/index.php/Europe_2020_indicators_-_R%26D_and_innovation

leads to new ways of working (Ashkenas 2012) and has an impact on the survival of the organizations (Bansemir 2013; Segers 2013). In addition to increasing innovation, collaboration increases employee energy, creativity, productivity, information diffusion, ideas, skills and resource sharing and inter-organizational learning (Eisenhardt and Schoonhoven 1996; Sarkar *et al.* 2001). But, when the relationship is poorly coordinated, collaborating with other organizations could be a drawback (Smith 2006).

In this context, the creation of a collaborative environment is analysed from different points of view in this study: previous collaborative experience, knowledge intensity, types of collaboration network and cultural diversity. These four aspects are analysed as following:

- **Having previous collaborative experience**

A corollary of the internationalisation of business and commerce is the increased fragmentation of value chains due to outsourcing and collaborative networks for the design and delivery of goods (Economist Intelligence Unit 2007; De Meyer 2009). It means that organizations collaborate with others to complete their needs or to increase collaborations along the value chain, especially in radical innovations (OECD 2014; Vom Stein *et al.* 2015).

Innovation—defined here as the application of knowledge in a novel way, primarily for economic benefit—is becoming increasingly important to help organizations become more productive and innovative. Developing an innovative environment and a complex tacit knowledge could become more explicit as partners develop a wider bandwidth of communications. If the partnership gains in maturity and time, sharing information becomes more subtle (Simonin 1999). In addition, when collaboration emerges from the beginning of the value chain, technology is jointly transferred from research to market in a timely manner (Meister *et al.* 2013; Juanola-Feliu *et al.* 2012; Paez-Aviles *et al.* 2015). The straightforward argument is that in the cross-fertilization of technologies, where knowledge is complex and technologies are different, organizations tend to collaborate from the beginning of the process, therefore:

***Hypothesis 11**: Cross-fertilization of knowledge and technologies is being boosted when organizations have had previous collaborations at early stages of the value chain.*

- **Knowledge intensity**

Knowledge-intensive activities (KIAs) [55] rely on the performance of scientific and technological R&D and the exploitation of its outcomes, which requires a highly skilled labour force and capital investments. If performed successfully, they result in increased domestic and foreign competitiveness for knowledge-based goods, which is often associated with high-tech specialisation and a greater economic openness. Strong performance in all these aspects creates a mutually reinforcing dynamic that is a sustained source of growth.

The knowledge intensity can be considered as a distinctive characteristic of the organization, a particular sector or the whole country perceived as a complex technical-economical-social system (Mildeová 2005), and therefore should be modelled and monitored. Chan (2009: 161) argues that 'knowledge intensity increases with the rising complexity of business processes'. Moreover, Andreeva and Kianto (2011) prove its influence on the organizational innovation performance.

The Innovation Union Competitiveness report (2014) highlights the relevance of skilled and highly educated labour into the knowledge economy. In view of 2020 it is crucial to increase the knowledge-intensity of countries' labour force, and in particular to increase the share of researchers in the business sector. In particular, there were an estimated 738 thousand doctoral students in the EU-28 in 2014 and women accounted for slightly less than half (an estimated 46 %) of doctoral students in the EU-28 in 2014[56].

The absence of data on doctorate holders employed in the business sector, leads to the identification of employment in knowledge-intensive activities as a measurable indicator of

[55] An activity is classified as knowledge intensive if tertiary educated persons employed represent more than 33% of the total employment in that activity (http://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an8.pdf)
[56] EUROSTAT February 2017: http://ec.europa.eu/eurostat/statistics explained/index.php/R_%26_D_personnel

driving innovation. By using econometric models it is identified that the production of new PhD holders has a strong effect on employment in knowledge-intensive activities (Romera *et al.* 2014). Therefore, doctoral graduates are key players for research and innovation, as well as to manage successfully that risk, so there is a crucial link between employability of PhD holders and opportunities for innovation. While the most innovative countries improve their performance, others have shown a lack of progress (Benito *et al.* 2013). In order to boost their innovation performance, countries and more specifically its organizations need to concentrate their efforts in the employability of doctorate holders, specifically, in the private sector. Therefore the following is hypothesised:

Hypothesis 12*: Cross-fertilization of knowledge and technologies is being boosted the greater the number of doctors in the collaborating organizations is.*

- **Types of collaboration network**

Many studies indicate that the positions of firms in interorganizational networks influence firm behaviour and outcomes (e.g., Powell *et al.* 1996; Walker *et al.* 1997). Actors can build relationships with multiple disconnected clusters and use these connections to obtain information and control advantages over others (Burt 1992). But collaboration networks could take a number of forms according to different criteria. Powell and Grodal (2006) for example, differentiate the type of networks according to the characteristic of the authority the network has, therefore the network can be hierarchical (being monitored by a central authority), or heterarchical, where there is a strong self-organization with diffuse authority (Powell and Grodal 2006).

Interfirm collaborative linkages are associated with two distinct kinds of network benefits. Firstly, they can provide the benefit of resource sharing, allowing firms to combine knowledge, skills, and physical assets. Secondly, collaborative linkages can provide access to knowledge spillovers, serving as information conduits through which news of technical break-throughs, new insights to problems, or failed approaches (Ahuja 2000).

Networks can also be classified based on the level of formality or informality. Informal relationships are characterized by a high level of trustworthiness and could significantly contribute to the innovativeness of projects (Tsai and Ghoshal 1998; Powell and Grodal

2006). Individuals in this kind of network are unbounded and ungoverned organic structures (Mintzber 1989). On the other hand, formal social networks are prescribed by management and usually directed by strategies or missions to be accomplished (Chandler 1962).

The different varieties of research collaboration could also be defined by funding instruments; therefore their dimensions have significant policy and strategy implications (Vonortas and Okamura 2013). In some case, these collaboration networks are driven under government requirements that promote the need for such interactions and exchanges (Lane 2005). These partnerships are formal collaborations, usually formed between industry and universities (Stiglitz and Wallsten 1999; Poyago-Theotoky *et al.* 2002), especially where high technology is involved (Powell and Grodal 2006). Taking this into consideration, it is expected that a formal network organizational structure is more related to this H2020 funding initiative, rather than informal ones. Therefore:

Hypothesis 13*: Cross-fertilization of knowledge and technologies is being boosted when the type of collaborative structure tends to be formal.*

- **Cultural diversity: Language, Size of the cities and Gender**

The impact of cultural diversity on innovation and creativity has long been an issue of debate in management and economics. According to the results obtained by Ozman and Erdil (2008), cultural diversity is a "double-edged sword" (Milliken *et al.* 2003) which can have a positive or negative impact on innovation. Positive effects are related with increased synergies and spillovers which arise from the association of different viewpoints, and increased opportunities for knowledge recombination. The positive impact of cultural diversity on innovation has been shown in regional contexts (Gossling and Rutten 2007; Niebuhr 2009; Bonet and Négrier 2011) and on creativity in entrepreneurial teams (Bouncken, 2004). Negative effects are related mostly to communication problems and problems which arise in conflict resolution.

Ozman and Erdil (2008) consider cultural attributes as drivers of networks. In return, these emergent networks shape learning and innovation in the system. This approach is particularly suitable for cultural diversity, since the relation between networks and cultural context requires a bottom-up approach in which the formation of networks, and the cultural context is intermingled, and in which they coevolve. The two more relevant attempts to classificate the cultural diversity (Fearon 2003; Alesiana *et al.* 2003) include in their different analysis the linguistic fractionalization with the ethnic and the religious one.

Languages mediate our experiences, our intellectual and cultural environments, our modes of encounter with human groups, our value systems, social codes and sense of belonging, both collectively and personally (UNESCO 2009). From the perspective of cultural diversity, linguistic diversity reflects the creative adaptation of human groups to their changing physical and social environments. In this sense, languages are not just a means of communication but represent the very fabric of cultural expressions, the carriers of identity, values and worldviews (Rivière *et al.* 2019)

English is frequently the lingua franca among native and non-native speakers of European projects but at the same time many problems arise in language-diverse teams. Native English speakers, "tend to dominate group discussion ignoring that the differences in ability to speak English create an unequal playing field" (Schneider and Barsoux 1997; Vonortas and Okamura 2013). Other authors have also drawn attention to the emotional solidarity, observing that in an international environment, "creativity and innovation occur through a healthy interaction of perspectives", and that "embracing and enjoying differences facilitates the interaction and camaraderie of the team" (Schweiger *et al.* 2003; Paez-Aviles *et al.* 2015). These cross-border international teams have become a concern of paramount importance in management and language diversity is increasingly recognized as a valuable resource (Henderson 2005).

Large cities have always exhibited diversity. They have been market places and have attracted flows of diverse people who have stimulated cities to become centres for the arts, for creativity and for innovation (Eraydin *et al.* 2010). The evidence in support of a 'diversity dividend' in terms of creativity (Florida 2002; Anderson *et al.* 2005), innovation (Niebuhr 2010; Özgen *et al.* 2011; Hauge 2014), and productivity (Ottaviano and Peri 2006; Südekum *et al.* 2009; Trax *et al.* 2012) has mounted over the last decade. Large, creative cities are increasingly viewed as motors of economic change (Chapain *et al.* 2010; Cohendet *et al.* 2010; Rodríguez-Pose and Hardy 2015) and there is good evidence that economic diversity in cities helps support long-term economic growth (Glaeser *et al.* 1992; Duranton and Puga 2001).

Urban-level features support positive effects of diversity: a more diverse urban population may drive the development of new goods and services (Leadbeater 2008), and a diverse urban environment may help attract a 'creative class' of skilled, liberally-minded employees (Florida 2002). Also, more cosmopolitan urban populations may also raise demand for new hybridised goods and services, triggering Jacobian knowledge spillovers across sectors (Mazzolari and Neumark 2009; Lee and Nathan 2011).

Gender, while men's and women's access to science in schools and universities has improved immeasurably in Europe, the same cannot be said for women's access to scientific careers. Women account today for almost 60% of university degrees in Europe, and they achieve excellent grades, better on average than their male counterparts (Sánchez de Madariaga *et al.* 2012). However, their presence at the top of scientific and academic careers is scarce. Only one in five professors is female across the European Union's 28 states, despite making up 47% of PhD graduates[57]; and the proportion of female leaders is slightly higher at 20%[58]. Women's skills, knowledge and qualifications are grossly underused in the labour market and also, the number of women in decision making positions throughout the science and technology system is lower (Sánchez de Madariaga *et al.* 2012).

An analysis by sex shows that men accounted for 67 %[59] of the EU-28's workforce of researchers in 2014. Women accounted for at least half of the total number of researchers in 2014 in Bulgaria, Lithuania and Latvia (where their share peaked at 52 %), while the share of women in the total number of researchers was also close to parity in Croatia[60]. The gender gap in terms of the number of researchers was largest in the Netherlands and France where at least three quarters of all researchers were men.

Therefore, when organizations create teams with different viewpoints, foster the knowledge recombination, establish a common lingua franca and give more visibility to

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57 She Figures Report (2015). European Comission.
58 Women in Science (2017). UNESCO Institute for Statistics.
59 EUROSTAT Statistics (2017). European Comission.
60 EUROSTAT Statistics (2017). European Comission: Share of female researchers by sectors of performance (http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=rd_p_femres&lang=en)

women, it is an opportunity for cross-fertilizing knowledge and technologies. Hence, it is hypothesized:

Hypothesis 14*: The cultural diversity is positively associated with the creation of knowledge and multidisciplinary technology.*

4.5.2.3. Technology-market matching

The commercialization of a new technology involves some kind of coupling or linking between a technology and markets (Balachandra *et al.* 2004; Coombs *et al.* 2001). A technology matches a market, in terms of consumer demand, if the technology performs a task that a consumer desires (Hellmand and Boks 2006). The success of a new product or technology is strongly related to this match (Cooper and Kleinschmidt 1986; Utterback 1994) and high technology firms are challenged to identify market applications and consumer demand as well as understand consumer desires whilst markets emerge and their technology matures (Hellman and Boks 2006).

Following up on this idea, Maine *et al.* (2014) asserts that there are two aspects of the technology-market matching strategy: the recognition of promising opportunities to exploit and the prioritization through resource allocation. The first one emphasizes that any new product should address market needs and understands customer's availability for a technology. Meanwhile, the second aspect is more aligned with market orientation involving an in-depth understanding of customer requirements and demands. In this context, the technology-market matching is analysed from different perspectives: market orientation, customer prioritization and experience in higher TRLs. These three aspects are examined as following:

- **Market orientation**

A business that increases its market orientation will improve its market performance (Levitt 1960; Kotler 1984; Kotler *et al.* 1987; Webster 1988). There is considerable agreement that, in general, a market orientation is a culture in which all employees are committed to the continuous creation of superior value for customers (Narver and Slater 1990; Deshpande *et al.* 1993; Day 1994). Based on this value, the central principle of market orientation is that every person in the Organization understands that each and every individual and function can, and must, continuosly contribute skills and knowledge to creating superior value for customers (Slater *et al.* 1998)

A market orientation contains three major behavioral components: "customer orientation"— the continuous understanding of the needs of both the current and potential target customers and the use of that knowledge for creating customer value; "competitor orientation"—the continuous understanding of the capabilities and strategies of the principal current and potential alternative satisfiers of the target customers and the use of such knowledge in creating superior customer value; and "interfunctional coordination"—the coordination of all functions in the business in utilizing customer and other market information to create superior value for customers (Narver and Slater 1990).

Findings suggest that a market orientation is positively related to business performance in all types of markets (e.g. Slater and Narver 1994). This process is particularly important since most firms have to take critical market application decisions based on explicit knowledge of customer needs and market demands, which are difficult to identify (Hellman and Boks 2006). It has been shown that market orientation improves organizational and product performances (Atuahene-Gima 1995).

In addition, the European paradox defines the phenomenon of having good higher education systems, good research infrastructure and results but failing to translate this into marketable innovations (Andreasen 1995; Maassen *et al.* 2007: 265). The H2020 will help to address the European Paradox, fostering projects with innovative, market-oriented solutions closer to commercialization. According to these arguments, it is expected that the cross-fertilization of Serious Games and Gamification related projects is developed in market-oriented innovation projects. Thus:

Hypothesis 15: *Cross-fertilization of knowledge and technologies is being boosted when there is a market-oriented process.*

- ***Customer prioritization***

Customer orientation makes reference to the continuous understanding of the needs of both the current and potential target customers and the use of that knowledge for creating superior value for them (Narver and Slater 1990). In order to increase customer value and response, firms may either lower customers' perceived costs in relation to benefits or increase customers' perceived benefits in relation to costs (Zeithaml 1988). But the critical success factor is related to the in-depth understanding of customer requirements and demands (Friar ant Balachandra 1999; Hellman ant Boks 2006). Prioritizing customers facilitates adoption and implementation of new innovations (Boon *et al.* 2011). These asseverations led to consideration of the crucial role of user involvement in the innovation process (Von Hippel 1976; Barki ant Hartwick 1989, 1994; Gales ant Mansour-Cole 1995; Kujala 2003; Lettl 2007).

Nevertheless, Christensen (1997) and Hoeffler (2003) argued that focusing on customers could impede radical innovations due to the fact that customer feedback could be irrelevant (Christensen 1997; Hoeffler 2003). But also customers are rarely able to explicitly state their requirements and tend to resist radical solutions which often require changes in their behaviour (Sandberg 2008; van den Hende and Schoormans 2012). The anticipation seems to be particularly important in recognizing latent needs (de Heer *et al.* 2002; Slater and Narver 1998) and therefore, it is difficult to assimilate customers' needs during the development of radical innovations (Sandberg 2008), especially at early phases of technology commercialization (Löfsten ant Lindelöf 2002). Due to this fact, and considering the above-mentioned concerns of H2020, it is hypothesized that organizations involved in cross-fertilization of technologies could be more conscious of customers by prioritizing their needs.

Hypothesis 16: *Cross-fertilization of knowledge and technologies is being boosted when customer needs are being prioritized.*

- ***Experience in higher TRLs***

Technology Readiness Levels (TRLs) are a type of measurement system used to evaluate the maturity level of an evolving technology. Each technology project is evaluated against the parameters for each technology level and is then assigned a TRL rating based on the projects progress. This NASA TRL Metric created by Stan Sadin (Sadin *et al.* 1989; Leete *et al.* 2015; Bakke 2015) was introduced in Horizon2020 mainly for at least two reasons. Firstly, to help to limit the scope of the more generic topics introduced by the

Commission. Secondly, setting the direction by making clear how far you are from the final goal (TRL9).

Sauser *et al.* (2006) propose a framework of system readiness level[61] (SRL) based on a technology readiness level (TRL) and an integration readiness level[62] (IRL), which is designed to complement the challenge that TRL only speaks about the technology itself, and not how it may technically integrate into a new or existing system. Regardless of a single technology's maturity, it is doomed to fail if it cannot interface with the systems in its environment (Baines 2004), and as interconnectivity becomes more and more, this ability to integrate becomes more crucial (Solberg *et al.* 2016).

Paun (2011, 2012) has developed a readiness framework based on illustrating the gap, or asymmetry, between technology push, strongly attributed to TRL, and market pull, which he attributes to a demand readiness level (DRL). The purpose of DRL is to measure the level of market pull corresponding to the level of technology push (Solberg Hjorth *et al.* 2016). In this context, the criterion for matching the technology to a market is not only concerned with the intensity of market research but also with the organizations' experience in these related activities (Howells 1997).

In view of the above and considering that cross-fertilization of technologies is being fostered at higher TRLs to incentivize the scalability of products, it is expected that organizations involved in this process have already participated in previous activities in the context of pilot production and product demonstration. This reasoning leads to the following hypotheses:

***Hypothesis 17**: Cross-fertilization of knowledge and technologies is being boosted when organizations have experience in higher levels of technological maturity.*

A summary of the research questions, hypothesis and its measurement variables is presented in **Table 4.1**.

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[61] System Readiness Level (SRL) is a concept that incorporates the current TRL scale, and introduce the concept of an Integration readiness level (IRL) to dynamically calculate a SRL index (Sauser et al. 2006).
[62] Integration Readiness Level (IRL) is a concept to help understand the maturity of integrating one System to another (Eder et al. 2017).

Table 4.1. Research questions, hypotheses and variables

Research Question	Variables	Hypothesis
RQ1. Is there a high degree of Multidisciplinary Knowledge and Technology in projects including Serious Games and/or Gamification?	**V1. Degree of multidisciplinarity**	H1. The degree of multidisciplinarity of a project is positively associated with the creation of multidisciplinary knowledge and technology.
	V2. Knowledge base	H2. The size of the joint knowledge base of organizations within a project is positively associated with the creation of multidisciplinary knowledge and technology.
	V3. Number of organizations	H3. The number of organizations in a project has a positive association with the creation of multidisciplinary knowledge and technology.
	V4. Diversity of organizations	H4. The diversity of organizations in a project has a positive association with the creation of multidisciplinary knowledge and technology.
	V5. Degree of clustering	H5. The degree of clustering around a project is negatively associated with the creation of multidisciplinary knowledge and technology
	V6. Innovation Intensity	H6. The innovation intensity in a project is positively associated with the creation of multidisciplinary knowledge and technology.
RQ2. Is importing ideas from broad networks in projects including Serious Games and/or Gamification an indispensable innovation management strategy to increase the creation of knowledge in order to obtain or improve products, processes or services ready for being transferred to the market and fulfilling market	**V7. Knowledge and Technological distance**	H7. Cross-fertilization of knowledge and technologies is being boosted when there are larger knowledge and technological distances in the network.
	V8. Technological effort	H8. Cross-fertilization of technologies is being boosted when organizations make stronger knowledge and technological efforts to import the ideas from the network.

needs?	**V9. Acces to external information**	H9. Cross-fertilization of knowledge and technologies is being boosted when organizations consider important to have access to external information.
	V10. Participation of end users	H10. Cross-fertilization of knowledge and technologies is being boosted when end users participate in the innovation process at different stages of the value chain.
RQ3. Is creating a collaborative environment in projects including Serious Games and/or Gamification an indispensable innovation management strategy to increase the creation of knowledge in order to obtain or improve products, processes or services ready for being transferred to the market and fulfilling market needs?	**V11. Having previous collaborative experience**	H11. Cross-fertilization of knowledge and technologies is being boosted when organizations have had previous collaborations at early stages of the value chain.
	V12. Knowledge intensity	H12. Cross-fertilization of knowledge and technologies is being boosted the greater the number of doctors in the collaborating organizations is.
	V13. Types of collaboration network	H13. Cross-fertilization of knowledge and technologies is being boosted when the type of collaborative structure tends to be formal.
	V14. Cultural diversity	H14 The cultural diversity is positively associated with the creation of knowledge and multidisciplinary technology.
RQ4. Is the technology-market matching in projects including Serious Games and/or Gamification an indispensable innovation management strategy to increase the creation of knowledge in order to obtain or improve products, processes or services ready for being transferred to the market and fulfilling market needs?	**V15. Market orientation**	H15. Cross-fertilization of knowledge and technologies is being boosted when there is a market-oriented process.
	V16. Customer prioritization	H16. Cross-fertilization of knowledge and technologies is being boosted when customer needs are being prioritized.
	V17. Experience in higher TRLs	H17. Cross-fertilization of knowledge and technologies is being boosted when organizations have experience in higher levels of technological maturity.

4.6. Variable measurements

The variables previously introduced were measured on the basis of several categorical indicators, which are explained in this section and summarized in **Table 4.2**. A code of asterisks shows the source of the measured indicator: one asterisk (information retrieved from the projects data base), two asterisks (information retrieved from the survey) and three asterisks (information retrieved from external data bases). In the case of the information retrieved from the survey (**), the code "(q*number*)" informs about the question number of the survey (annex 1).

Table 4.2. Variables, indicators, sources and measurement scales

RQ	Variables	Indicator	Source	Measurement scales
RQ1	**V1. Degree of multidisciplinarity**	I1.1. Number of topics (colorimetric map) I1.2. Thematic areas I1.3. Number of projects coordinated by country and main thematic area	* * *	Multiplicity of topics Wide range of thematic areas Multiplicity of projects coordinated by country and main thematic area
	V2. Knowledge base	I2.1. Type of organizations I2.2. Percentage of projects coordinated by HEC and REC I2.3. Correlation between type of organizations and thematic areas I2.4 Universities in the 2017 European Universities Rank (QS) I2.5 Research Centres in the 2017 European Ranking Web of Research Centres.	* * * *** ***	Diversity of types of organizations High number of HEC and REC coordinating projects Percentage of knowledge provider institutions per thematic area Number of universities in top positions Number of research centres in top positions
	V3. Number of organizations	I3.1. Average number of organizations per project	*	Important number of organizations in a research collaborative project
	V4. Diversity of organizations	I4.1. Diversity of typology of organizations per project I4.2. Correlation between type of organizations and thematic areas	* *	Multiplicity of types of organizations Percentage of knowledge provider institutions per thematic area
	V5. Degree of clustering	I5.1. Number of connections.	*	Clustering map. The more they are connected, the higher the degree of local clustering.

		I5.2. Number of projects with a high percentage of organizations in local clusters.	*	Percentage superior to 50%
	V6. Innovation Intensity	I6.1. Average of Global Innovation Index by project consortium	***	High average score
RQ2	**V7. Knowledge and Technological distance**	I7.1. Process of communication or agreement (q0010)	**	□ Very easy. □ There were some misunderstandings finally easily solved. □ There were problems only with some partners. □ There were problems with most of the partners.
		I7.2. Decision making/ problem solving (q0011)	**	□ As a collective decision □ Through a board/coordinator □ Vertical bilateral □ Only in consensus meetings □ Only in informal meetings □ Other
		I7.3. Perceived technological knowledge from their network (q0012)	**	□ Very similar □ Quite similar □ Quite different □ Very different
		I7.4. Level of involvement of Serious Games and/or Gamification in the project (q0014)	**	□ Very important □ Important □ Moderate □ Weak □ Unnecessary
		I7.5. Degree of complementarity of organizations	**	Statistical correlation between type of organization and the job title or position
	V8. Technological effort	I8.1. Openness in knowledge sharing (number of HES and REC)	*	Total percentage of knowledge producing institutions
		I8.2. Perceived technological knowledge from their network (q012)	**	□ Very similar □ Quite similar □ Quite different □ Very different
		I8.3. Invested time in knowledge sharing (q0015)	**	□ None □ Less than 4 hours □ Between 4-8 hours □ Between 8-12 hours □ More than 12 hours
	V9. Access to external information	I9.1. Perceived benefits from the network (q0021)	**	□ Access to new markets □ To gain competitive advantage in the market □ Access to economic resources □ Access to knowledge □ To speed up innovation process □ Reduce market risk □ Other specific reasons

	V10. Participation of end users	I10.1. Organizations of end users (OTH)	*	Number of end-users organizations (directly or indirectly -OTH)
		I10.2. End users involved in the development (q0016)	**	□ Yes, as a partner of the consortium □ Yes, they are represented by one/ or more of the partners □ Yes, through outsourcing (directly contracted by one/ or more of the partners) □ No
		I10.3. Stage in which the collaboration started –when they are involved in the development (q0017)	**	□ Idea generation (TRL 0) □ Basic research (TRL 1) □ Technology formulation (TRL 2) □ Applied research (TRL 3) □ Small scale prototype (TRL 4) □ Large scale prototype (TRL 5) □ Prototype system verified (TRL 6) □ Pilot system verified (TRL 7) □ Commercial design (TRL 8) □ Full commercial application (TRL 9)
		I10.4. End users involved in the product demonstration activities (q0026)	**	□ No □ Yes
RQ3	**V11. Having previous collaborative experience**	I11.1. Previous collaboration with same partners (q0019)	**	□ All of them □ Most of them □ Few of them □ None of them
		I11.2. Stage in which the collaboration started –when there is a previous collaboration with same the partners (q0020)	**	□ Idea generation (TRL 0) □ Basic research (TRL 1) □ Technology formulation (TRL 2) □ Applied research (TRL 3) □ Small scale prototype (TRL 4) □ Large scale prototype (TRL 5) □ Prototype system verified (TRL 6) □ Pilot system verified (TRL 7) □ Commercial design (TRL 8) □ Full commercial application (TRL 9)
	V12. Knowledge intensity	I12.1. Percentage of PhDs in the project (q0013)	**	□ None □ < 10% □ 10-30% □ 30-50% □ >50%
	V13. Types of collaboration network	I13.1. Partnerships with universities/ research institutions and industry. (presence of HES, REC and PRC in a project)	*	Number of partnerships between universities/research institutions and industry
		I13.2. People involved in the scientific/technical/managerial activities as coordinator (q004)	**	□ Less than 5 people □ Between 5 – 10 people □ Between 10 – 15 people □ More than 20 people
		I13.3. Main reasons to collaborate (q0021)	**	□ Access to new markets □ To gain competitive advantage in the market

				□ Access to economic resources □ Access to knowledge/ technological resources □ Financial risk sharing □ To speed up innovation process □ Other specific reasons
	V14. Cultural diversity	I14.1. Language/s of the countries	*	Number of languages spoken by the members of the consortium
		I14.2. Size of the cities	*	Number of partners from large cities
		I14.3. Gender of project coordinators (q01)	**	Number of women coordinating projects
RQ4	**V15. Market orientation**	I15.1. Partners cover all the value chain (q0023)	**	□ Mostly □ No
		I15.2. Importance of market research (q0024)	**	□ Very Important □ Quite important □ Not important
		I15.3. Driver of the product demonstration/pilot production (q0025)	**	□ Market reasons (e.g. competitive pressure, customer requirements, estimated market potentials, etc.) □ Information on research activities (e.g. originating from universities, research & technology organizations, universities, customers, competitors, etc.) □ Access to public subsidies (e.g. tax refunds, investment support) □ Market regulation activities (e.g. industrial policy, standardization activities, market deregulation, other environmental, or social legislation) □ Other
	V16. Customer prioritization	I16.1. End users involved in the development (q0016)	**	□ Yes, as a partner of the consortium □ Yes, they are represented by one/ or more of the partners □ Yes, through outsourcing (directly contracted by one/ or more of the partners) □ No
		I16.2. End users involved in the product demonstration activities (q0026)	**	□ No □ Yes
	V17. Experience in higher TRLs	I17.1. TRL starting point (q007)	**	□ Idea generation (TRL 0) □ Basic research (TRL 1) □ Technology formulation (TRL 2) □ Applied research (TRL 3) □ Small scale prototype (TRL 4) □ Large scale prototype (TRL 5) □ Prototype system verified (TRL 6) □ Pilot system verified (TRL 7) □ Commercial design (TRL 8) □ Full commercial application (TRL 9)

		I17.2. Expected final TRL (q008)	**	□ Idea generation (TRL 0) □ Basic research (TRL 1) □ Technology formulation (TRL 2) □ Applied research (TRL 3) □ Small scale prototype (TRL 4) □ Large scale prototype (TRL 5) □ Prototype system verified (TRL 6) □ Pilot system verified (TRL 7) □ Commercial design (TRL 8) □ Full commercial application (TRL 9)
		I17.3. Previous collaboration with same partners (q0019)	**	□ All of them □ Most of them □ Few of them □ None of them
		I17.4. The stage in which the collaboration started –when there is a previous collaboration with the same partners (q0020)	**	□ Idea generation (TRL 0) □ Basic research (TRL 1) □ Technology formulation (TRL 2) □ Applied research (TRL 3) □ Small scale prototype (TRL 4) □ Large scale prototype (TRL 5) □ Prototype system verified (TRL 6) □ Pilot system verified (TRL 7) □ Commercial design (TRL 8) □ Full commercial application (TRL 9)

Source:
* Database analysis
** Survey analysis
***Other external sources

4.6.1. Knowledge and Technology perspective

- **V1. Degree of multidisciplinarity**

There is an increasing emphasis in teamwork that involves multiple disciplines (Nolan 1995; Barr *et al.* 1999; Wilson and Pirrie 2000; Tres *et al.* 2000). It is generally assumed that efforts to involve more than one disciplines are valuables and beneficial (Whitfield 2004; Evely *et al.* 2010). A multiple disciplinary approach is emphasized in H2020 and breeds diversity.

To analyse the creation of multidisciplinarity, the first step was to find all the technological alternatives present in the system of projects. In the case of publications and patents this is often done by looking at citation patterns or pre-existing categories (Boschma 2005; Rafols and Meyer 2010; Zhang *et al.* 2016). Yet these measures are not applicable to the selected project data, as only the abstracts were accessible. Hence, topic modelling techniques were used. Topic Models represent a set of probabilistic variable models used to evaluate the semantic structure of documents based on a hierarchical Bayesian method (Leydesdorff *et al.* 2014; Yegros-Yegros *et al.* 2015) which can be used to identify topics among documents. The different technological alternatives are based on semantic clusters, which are usually identified as "topics". Therefore, topics are a set of words that represent a theme. For example, the words "video game", "player" and "serious game" can be classified in one topic because these words are related to each other. The distribution of topics is the relation that links words in a vocabulary and their occurrence in documents (mixture of topics). In this study, documents are the abstracts of each project.

For the first indicator (**I1.1**), it is considered the use of VOSviewer (Van Eck and Waltman 2010, 2014), a software tool for constructing and visualizing bibliometric networks. Two visualizations provided by VOSviewer play an important role. The first visualization shows the clusters in a clustering solution and the citation relation between these clusters. The second visualization uses a so-called term map to indicate the topics that are covered by a cluster. This visualization shows the most important terms occurring in the publications belonging to a cluster and the co-occurrence relations between these terms (van Eck and Waltman 2017). Therefore, it was argued that the more multiplicity of topics, the bigger degree of multidisciplinarity.

The second indicator (**I1.2**) for this variable is based on the wide range of the projects' thematic areas. It is analysed in two ways: firstly, by descriptive analysis and secondly, in order to visualize the distribution of topics per project, by a level plot graph developed by using the lattice package in R (Steyvers and Griffiths 2006). In this case the figure obtained shows the LDA graph, where the x axis shows the countries and the y axis the 10 groups of topics analysed in the whole system of projects. The distribution of each topic in each project is defined by the intensity of colours: more intense blue colours show few topics distributed in a project (so the colour is concentrated only in one point), while red colours show a distribution of more than one topic in a project. To confirm the validity of the result, it has been verified the groups of topics created.

Finally, a third indicator (**I1.3**) considers the multiplicity of projects coordinated by country and the main thematic area. The way in which the different thematic areas are coordinated by teams from different countries shows us the importance of coordination. It may need to be thought of as a much more inclusive process, being accomplished when developing and enacting strategies, which aim to pull together everything needed to carry out project tasks (Fujimura 1987). Therefore, the greater diversity of coordinators and the thematic fields of the projects, the greater the multidisciplinarity of the project.

- **V2. Knowledge base**

The need for sharing knowledge between research institutions and industry has become a need to maximize the use of knowledge. Many companies are developing open innovation approaches to R&D, combining in-house and external resources, and aiming to maximize economic value from their intellectual property, treating public research as a strategic resource. So, knowledge is the starting point and when it is curated and put in the right hands it has the power to bring about high value to change to society.

According to the European Patent Office (EPO)[63] the patent applications at the EPO office remained high in 2016: 159,353. The top technology fields were leaded by medical technology (12,264 patent applications), followed by digital communication (10,915), computer technology (10657), electrical machinery/energy (10,293) and transport (8,402). Furthermore, applications for patent protection were leaded by large enterprises (66%), SMEs (28%) and universities and public research (6%). It shows how nowadays knowledge is not only property of universities or research institutions but they have a key role opening new research fields. Based on that, the first indicator (**I2.1**) contemplates how important is that different types of organizations collaborate in the same project.

Universities are a source of new products that can be channelled through private organizations to the market. The impact of their collaboration depends on the company size (Okamuro 2007). In general, SMEs can benefit more from R&D collaboration with universities rather than larger firms because large companies are less willing to share their

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[63] EPO Annual Report 2016: https://www.epo.org/about-us/annual-reports-statistics/annual-report/2016.html

economic knowledge with smaller rivals and have preference to collaborate with other large firms in order to maximize the internalization of spillovers (Röller *et al* 2007). These innovations co-developed with universities and private companies have equal chances of commercial exploitation as those that are introduced by private-private collaborations. In fact, 70% of innovations with high potential are co-developed with universities (Pesole and Nepelski 2016). This key role of universities helps us to define the second indicator (**I2.2**): the bigger the percentage of HECs and RECs (knowledge producing institutions), the greater knowledge base in the project.

In this context, it is also relevant to know if the knowledge provider institutions have the same weight in each thematic field. The intensity of projects in each field shows the demand and supply side of that innovation to deliver a valuable product to market. That is why the third indicator (**I2.3**) pretends to know if percentages of organizations are similar or different in each thematic area.

In order to go deeper in the role of universities, the fourth indicator (**I2.4**) measures the number of universities included in the QS World University Rankings, in particular the 2017 European Universities Rank. It is the only international ranking to have received the International Ranking Expert Group (IREG)[64] approval and its methodology[65] is as follows (**Figure 4.2**):

Indicator	Weighting	Elaboration
Academic peer review	40%	Based on an internal global academic survey
Faculty/Student ratio	20%	A measurement of teaching commitment
Citations per faculty	20%	A measurement of research impact
Employer reputation	10%	Based on a survey on graduate employers
International student ratio	5%	A measurement of the diversity of the student community
International staff ratio	5%	A measurement of the diversity of the academic staff

Figure 4.2. Methodology of QS World University Rankings

[64] IREG Ranking Audit. IREG Observatory on Academic Ranking and Excellence. International Expert Group (IREG) [Retrieved 14 September 2017]
[65] QS World University Rankings: Methodology: https://www.topuniversities.com/qs-world-university-rankings/methodology?page=1 [Retrieved 23 February 2018]

Finally, in order to have a whole view of the knowledge producing institutions, this fourth indicator is accompanied by another fifth (**I2.5**) to measure the research centres according to the European Ranking Web of Research Centres 2017. This methodology has as the unit of analysis the institutional domain, so only universities and research centres with an independent web domain are considered. If an institution has more than one main domain, two or more entries are used with the different addresses.

Therefore, specific information about the most relevant universities and research centres in H2020 projects will give more details about the kind of institutions that integrate the project consortia. Also a third ranking, the 2016 European Research Ranking, is used to complement those previous findings. The indicators **I2.4** and **I2.5** complement qualitatively the **I2.2**, more focused on the number of HEC and HES.

- **V3. Number of organizations**

There is a high number of organizations in H2020 projects creating value together. A common position in literature considers that larger project teams provide a larger chance of recombining different types of knowledge, expertise and ideas, and thus innovation (Powell *et al.* 1996; Ruef 2002). That is why this indicator (**I3.1**) gives importance to the average number of organizations per project. It makes the realistic assumption that reaching an extra level of this variable results in a decrease of the diversity creation because of the need of shared agreements between partners.

- **V4. Diversity of organizations**

Applied research conducted in universities and workplaces generally demonstrates a positive association between diversity and various learning outcomes (Holoien 2013). Ignoring these differences in teams and organizations may inhibit information system's implementations in global settings and increase the risk of project failure (Harris and Davison 2002). Cultural diversity is very important to organizations that have adopted global strategies (Adler 1997). In this context, the first indicator (**I4.1**) contemplates the diversity of types of organizations per project.

The second indicator (**I4.2**) for this variable contemplates the relation between the types of organizations and the thematic areas per project. So, it could be obtained information about preferences of organizations for some specific fields.

- **V5. Degree of clustering**

Clusters are described as networks of interdependent firms, knowledge producing institutions, technology providing firms, bridging institutions and customers, linked in a value creating production chain (Jones 2002). In this study the degree of clustering was obtained by calculating the local clustering coefficient (CC) of a project (Kaiser 2008). The CC is a quantitative way to study the structure of a network (Vavrek 2011). It represents the probability that two random neighbours of an organization from a project are connected. It measures the extent of interconnectivity between the neighbours (Bengisu and Nekhili 2006) and is represented as:

$$CC_i = \frac{2Li}{Di\,(Di-1)}$$

Where *I* is the focal project or node, D_i is the number of other neighbour projects that have an organization in common with *I*, and L_i is the number of links that connect the neighbour projects D_i, if they are connected.

Van Rijnsoever *et al.* (2015) indicate the need to distinguish projects that are not connected to other projects (isolates) from projects that are connected, but whose neighbours are unconnected, since both receive a value of 0. Hence, an extra dummy variable for isolates was created. The number of organizations is also correlated by definition on the clustering coefficient. This is because clustering is conditional on having at least two ties. To separate the effects of isolates and number of ties, both of them were regressed on the clustering coefficient. The residuals of this regression are from an unconfounded measure for clustering, and this was used as an independent variable in the models.

A graph visualization and analysis tool Gephi has been used. The network is made of two components: a list of the actors (organizations) composing the network, and a list of the relations (the interactions between actors). As part of a mathematical object, actors will then be called vertices (*nodes*), and relations will be denoted as tiles (*edges*). From the results of this analysis, the first indicator (**V5.1**) considers that the more organizations are connected, the higher degree of clustering.

A cluster enhances productivity not only through the acquisition and assembly of input but also through facilitating complementarities between the activities of cluster participants. A geographically proximate cluster of independent and informally linked firms and institutions represents a robust organizational form in the continuum between markets and hierarchies (Porter 2000). The second indicator (**V5.2**) for this variable is based on the importance of local clusters. So, in order to evaluate the variable I will consider the number of projects with a high percentage of organizations in local clusters; due to the non-existence of literature I propose a percentage superior to 50%.

- **V6. Innovation intensity**

According to Pesolel and Nepelski study (2016), projects tend to focus on technology-related steps over business-related ones. Some examples illustrate these ideas: a 65% of the projects that plan to commercialise their innovations either created, or plan to create, a prototype. In contrast, only 39% of projects have carried out or plan to carry out a market study. And writing a business plan is on the agenda on only 36% of projects that plan innovation commercialization. Hence, in order to increase the chances of successful commercialization of an innovative output, projects must take into account more than the technological aspects and introduce business-related elements into their organizations' activities.

The Global Innovation Index (GII)[66] aims to capture the multi-dimensional factors of innovation and measure them. It provides a database of detailed metrics for economies, which in 2017 encompasses 127 economies, representing 92.5% of the world's population and 97.6% of global GDP. The GII relies on two sub-indices- the Innovation Input Sub-Index and the Innovation Output Sub-index-each built around key pillars (**Figure 4.3**).

[66] The Global Innovation Index 2017 (GII) is co-published by Cornell University, INSEAD, and the World Intellectual Properpty Organization (WIPO, an agency of the United Nations)

Five input pillars capture elements of the national economy that enable innovative activities: (1) Institutions, (2) Human capital and research, (3) Infrastructure, (4) Market sophistication, and (5) Business sophistication. Two output pillars capture actual evidence of innovation outputs: (6) Knowledge and technology outputs and (7) Creative outputs. Each pillar is divided into sub-pillars and each sub-pillar is composed of individual indicators (a total of 81 in 2017). Sub-pillar scores are calculated as the weighted average of individual indicators; pillar scores are calculated as the weighted average of sub-pillar scores.

Four measures are then calculated:

- Innovation Input Sub-Index: is the simple average of the first five pillar scores.
- Innovation Output Sub-Index is the simple average of the last two pillar scores.
- The overall GII score is the simple average of the Input and Output Sub-Indices.
- The Innovation Efficiency Ratio is the ratio of the Output Sub-Index over the Input Sub-Index.

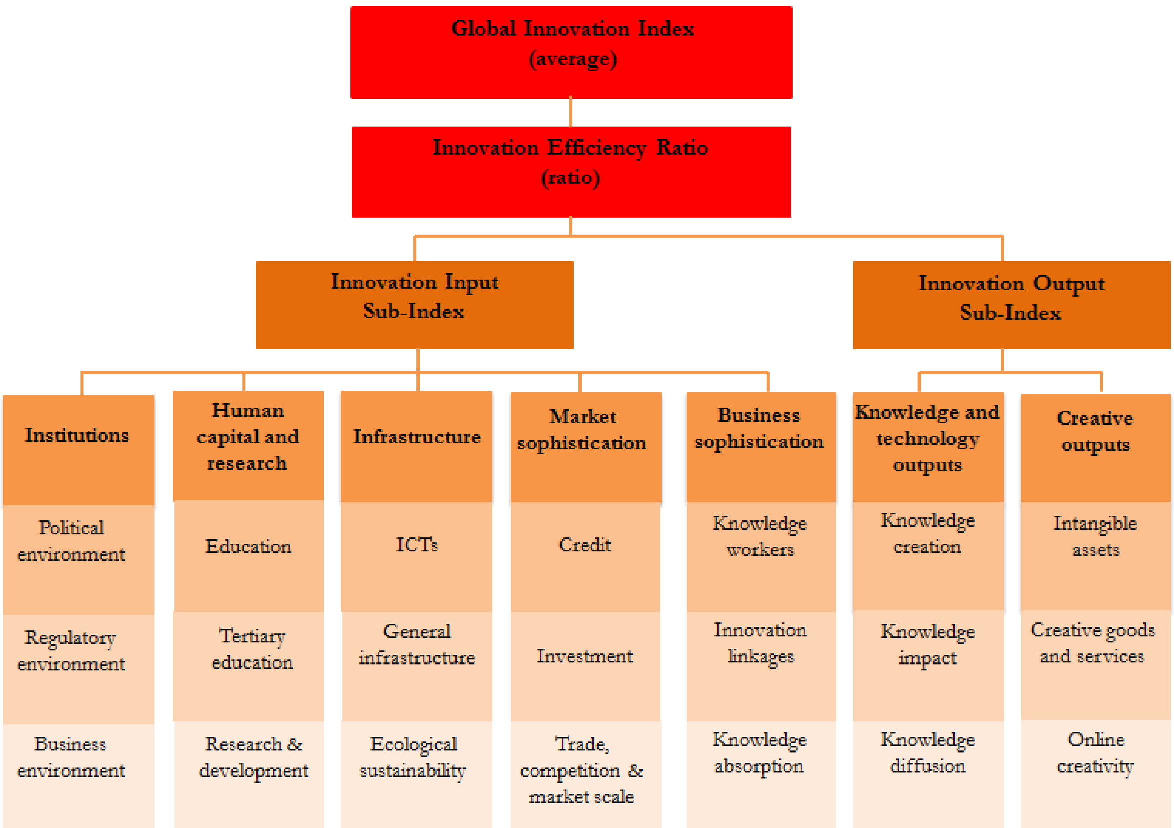

Figure 4.3. Calculation Methodology of the Global Innovation Index

According to the GII detailed calculation methodology, the indicator (**I6.1**) aims to establish a value for a hypothetic average organization. This score is obtained by giving the IGG value that corresponds to each organization (depending on its country) and then calculating the participations of each organization. The higher the average score is, the higher the innovation intensity is.

4.6.2. Management perspective

- **V7. Knowledge and Technological distance**

Several methods could be used to measure technological distance. The majority of them use patent data (Arundel ant Kabla 1998; Enkel ant Gassmann 2010; Bar ant Leiponen 2012; Vom Stein *et al* 2015; Bowen and Jianxi 2017). In the context of this study, the intention was to know the managerial strategies; therefore, a "perceived" technological distance was considered in order to know the organization's strategies when belonging to a network. Therefore, technological distance here is measured as the perceived difference between one organizations' technological knowledge compared with the technological knowledge from the partners in its network. This is the third indicator (**I7.3**) for this variable. If the perceived technological knowledge is very different, technological distances are considered to be larger, and where the opposite is the case, the distance is considered to be shorter.

For the first (**I7.1**) and second (**I7.2**) indicator, it was considered that technological distance could be evaluated according to the perceived difficulty in the process of communication, agreement, decision making or problem solving between the partners in the network (Gilsing *et al.* 2008; Von Hippel 2005; Jeong and Lee 2015). Therefore, it was argued that with greater technological distances, this process could be perceived as difficult, and that with shorter distances the opposite is likely to be true.

The fourth indicator (**I7.4**) is the level of involvement of Serious Games and/or Gamification in the project. Including the essence of games –fun, play, transparency, design and challenge- and applying it to real-world objectives rather than pure entertainment (Palmer *et al.* 2012; Terlutter and Capella 2013), gamification helps to reduce distance between partners and their knowledge and technology. So, the argument is that the more important gamification and/or serious games are in the project, the distance is considered shorter.

Complementarity offers an approach to explaining patterns of organizational practices. The theory of complementarities predicts that these practices will tend to cluster and an organization with one of the practices is more likely to have the others as well (Brynjolfsson and Milgrom 2012). More complementarity between organizations makes shorter the knowledge and technological distance. In this regard, the fifth indicator (**I7.5**) is measured according to the complementarity of organizations and the knowledge field.

- **V8. Technological effort**

The technological effort of each organization can be measured by the amount of resources an organization invests in R&D and acquisition of technological capabilities (Rieg and Alves Filho 2003; Magri *et al.* 2011). By knowledge production we mean the cluster of related activities in the university and research institutions that has to do with producing new knowledge (Cloete and Bunting 2011). In this regard, the first indicator (**I8.1**) is based in the openness of knowledge sharing and is measured by the total percentage of knowledge producing institutions (HEC and HES) in H2020 projects.

The second indicator (**I8.2**) for this variable is based on the fact that stronger technological efforts could be related to sharing internal knowledge, rather than to protecting internal knowledge (Vanhaverbeke and Cloodt 2006). Technological effort could also be associated with the benefit that organizations perceive as coming from their network. It has been shown that organizations that perceived unequal benefits from their network tended to strive to obtain these benefits from the knowledge present in their network (Vanhaverbeke and Cloodt 2006; Paez-Aviles 2017). In this context, the second indicator for this variable could be: the more equal perception of benefits from the alliance network, the bigger technological effort can be done.

In addition, having stronger technological efforts could involve expending more time in knowledge sharing (Adams *et al.* 2006). In this regard, the argument for the third indicator

(**I8.3**) is that organizations with stronger technological efforts expend more hours in data and knowledge sharing.

- **V9. Acces to external information**

This indicator (**I9.1**) for this variable is measured by considering that having access to external information could be an important reason to belong to a network. In this case, the indicator proposed is based on the argument that having access to competitors reflects the commitment and capacity of each partner to learn and absorb the other's skills, this being an important reason to belong to a collaborative network (Laursen and Salter 2006, 2014). This idea is supported with the open innovation theory, by affirming that collaborating with competitors is associated with external search strategies, which are sources of innovation (Granovetter 1985; Kale *et al.* 2002; Soh 2003).

- **V10. Participation of end users**

An organization satisfying and fulfilling customers' expectations, at the same time, generates wealth for organizations. Hence we have two perspectives of value (Martinez 2003): internal value where value is considered as wealth (stakeholder perspective) and external value (costumer perspective) in which value means satisfaction. In fact, the customer engagement is not considered just as the voice of the customer as an input to create and test de products, the customer is considered as a partner in the innovation process (Sawhney *et al.* 2005; Parida *et al.* 2012). Therefore, the involvement of end users along the value chain is evaluated through four indicators: the first indicator (**I10.1**) shows the number of end-users organizations participating in a project; the second indicator (**I10.2**) evaluates the level of involvement of end users in the development stages; and the fourth indicator (**I10.4**) shows the involvement of end users in the product demonstration activities. Additionally, the second indicator (I10.2) is complemented by the third one (**I10.3**) in order to identify in depth at which stage of the value chain the collaboration started with the end users.

- **V11. Having previous collaborative experience**

Extant literature finds that prior alliance management experience (Spekman and MacAvoy 1998; Anand and Khanna 2000; Kale *et al.* 2002) and the alignment of partners' missions, strategies, and values (Austin 2000; Murphy and Arenas 2011; SEKN 2004) improve the probability of successful outcomes through alliances. Also, evidence from the survey to provide quantitative evidence on more disruptive technologies (Key Enabling Technologies[67]) showed that 77% of the respondents usually cooperate with stakeholders in joint projects at different stages along the value-chain (Meister *et al.* 2013).

Based on these data, the first indicator (**I11.1**) for this variable considers that having a good collaborative experience in previous alliances, gives organizations relational capabilities that foster the development of superior competences (Mooi and Sarstedt 2011) and the effective selection of future alliance partners (Rogers 2003). Therefore, having previous collaboration experience could be an influencing factor for cross-fertilization (Paez-Aviles 2017). Furthermore, the second indicator (**I11.2**) shows at which stage of the value-chain started the previous collaboration.

- **V12. Knowledge intensity**

Knowledge creation represents an inherent part of the innovation process. It is more about creating a novel idea, while innovation is the successful implementation and commercialization of the novel idea (Freeman 1982; Woodman *et al.* 1993; Garcia and Galantone 2002; Andreeva 2009). The common approach for investigating the knowledge intensity in a research field is to measure the educational level of the organization. In this respect, William Starbuck (1992: 719) suggests to define knowledge-intensive organizations by one third of personal with expert status, i.e. with a formal education an experience comparable with a doctoral degree. Hence, the degree of knowledge intensity shall be identified by the amount of employees with a formal academic degree. That is why the high number of PhDs in the projects (59% of the organizations have more than 30% of PhD employees) corroborates the existence of knowledge intensity (**I12.1**).

- **V13. Types of collaboration network**

[67] Key enabling Technologies are a group of six technologies: micro and nanoelectronics, nanotechnology, industrial biotechnology, advanced materials, photonics, and advanced manufacturing technologies.

There is a thin line between a researcher engaged in collaborative research and one engaged in an interactive innovation process. The majority of collaborative researchers primarily see themselves as knowledge brokers, who support landscape development and governance by producing and recombining knowledge (van Paassen *et al.* 2011). The idea of knowledge brokerage involves exploiting the preconditions for innovation that reside within a larger social structure by bridging multiple domains, learning about the resources within those domains, linking the people and their knowledge to new situations, and building networks and institutional routines around the innovations that emerge from the process (Hargadon 2002). Usually research institutes currently experiment this "first level brokerage". It is difficult to find research institutions who are involved in second level or systemic brokerage and this role is taken by other type of organizations. Therefore, the first indicator (**I13.1**) considers that a bigger number of partnerships between universities/research institutions and industry could be influencing the level of cross-fertilization.

The second indicator (**I13.2**) is based on the fact that organizations coordinating a H2020 project involve a team in both R&D and managerial activities. Therefore the importance that the organization coordinating the project gives a professional support to the partners of the consortium could be influencing the level of cross-fertilization.

The third one (**I13.3**) makes reference to the main reasons to collaborate. There are several reasons why the level of research collaboration has increased in the last decades but some specific reasons could be (Sylvan and Martin 1997): (1) the escalating costs of conducting fundamental science at the research frontier, (2) the substantial fall in the cost of travel and communication, (3) advances depend crucially on interactions with other scientists, (4) increasing need for specialization within certain scientific fields, (5) growing importance of interdisciplinary fields, (6) several political factors. Therefore, it is argued that different reasons to collaborate require different kind of partners in the consortia.

- **V14. Cultural diversity: Language, Size of the cities and Genre**

Last decade many studies in diversity focused on the assumption that unity in the group, in terms of acting and thinking as one collective, is the final and ideal form of collaboration

(Marks *et al.* 2002; Salas and Cannon-Bowers 2000; Mohammed and Ringseis 2001). But new evidence (Star 1989; Star and Griesemer 1989) provided new evidence that professionals can collaborate successfully even if they represent and maintain to function in separate socio-cultural worlds. These processes of boundary crossing (Akkerman and Bakker 2011; Konkola *et al.* 2007; Macpherson and Jones 2008) show that professional groups are diverse in diverse ways, and are often faced with multiple boundaries at once. Furthermore, heterogeneous teams are more likely to develop creative ideas compared to homogenous teams (Egan 2005). Therefore, I propose three indicators to analyse from different perspectives the variable to conceptualize unity and diversity in the project teams.

The first indicator (**I14.1**) makes reference to the main spoken language in each state. There is a diversity of languages in some of the analysed states (Spain, Belgium, France…) but I have chosen the most used language in each state and the European Commission. In this context, the first indicator for this variable is that the more languages spoken by the members of the consortium, the more diverse the team is.

Large, creative cities are increasingly viewed as motors of economic change (Chapain *et al.* 2010; Cohendet *et al.* 2010) and some industries, like the creative ones, are considered as eminently urban and associated to big cities (Curried-Halkett and Stolarick 2013). The creative industries are generally viewed as dependent on the density of specialized workers, suppliers, and customers offered by cities (Lazzeretti *et al.* 2008; Chapain and Comunian 2010). Therefore, the bigger the number of partners from large cities, the more diverse the team is (**I14.2**).

Finally, the indicator completing the cultural diversity variable is gender. Analyses have demonstrated[68] that the lack of women in higher decision-making positions is not a problem that will be resolved over time. Woolley *et al.* (2010) found specifically that the proportion of women on a team increases team performance. Additionally, empirical research has found that women scientists tend to express not just stronger skills for working in cross-disciplinary teams, but also greater interest in integrating across fields and approaches and be committed to connecting their research with societal concerns (Rhoten

[68] Empfehlungen zur Chancengleichheit von Wissenschaftlerinnen und Wiessenschaftlern. Wissenschaftsrat 2007: 13-14.

and Pfirman 2007). Therefore, the more women coordinating projects, the more diverse teams are (**I14.3**).

- **V15. Market orientation**

Market orientation is a business culture in which all employees are committed to the continuous creation of superior value for customers. The creation of value takes place along the value chain, from research to market. That is why the first indicator (**I15.1**) is related to knowing if partners cover all the value chain.

The second indicator (**I15.2**) for this variable contemplates market research activities, considered to be important in the phase of pilot studies (Abdi 2007). These activities enable us to understand how markets work (Husson *et al.* 2010) as well as the customers' inputs regarding product features and preferences (Luo *et al.* 2007; Savescu 2014)). In addition, these activities are important when decisions need to be taken in terms of accessibility and acceptability of customers (Le *et al.* 2008). Therefore, in order to evaluate this variable the interviewees were asked about the importance of market research in the development of the project.

In the survey by Meister *et al.* (2013), more than 90% of the interviewed organizations answered that market reasons are one of the most important triggers of pilot production activities (Mintzberg 1989). In this context the third indicator (**I15.3**) is related to knowing if market reasons are the principal driver of product demonstration or pilot production for organizations.

- **V16. Customer prioritization**

To measure the level of customer, two indicators were considered. Technology match requires, on the one hand, a better understanding of customer demands, and on the other hands, that the technology's operational performance is suitable for the end customer (Savescu 2014). A user-driven innovation puts the customer in a centric position but a company needs the skills to determine the profoundness of user generated ideas, to differentiate between normal (lead) users and the set of users who are able to foster radical innovation, and has the absorptive capacity to exploit disruptive inputs (Cohen and

Levinthal 1990). Thus, the first indicator shows if organizations have involved the end users in the development of the project (**I16.1**).

The second indicator (**I16.2**) is based on the requirement of product design for matching product functionality to customer needs. Also, it is necessary understanding customer needs to ensure product success, validating and proving technology functions, attributes and performance (Zhao *et al.* 2003; Majava *et al.* 2014). The resulting scenario in this sense will be marketable products or licensable intellectual property (Zhao *et al.* 2003, Savescu 2014). Therefore, for this indicator the aim is to know if end users are involved in the product demonstration activities.

- **V17. Experience en higher TRLs**

The TRL scale has among other been considered a picture of the remaining technical risk of a project. It is a method of estimating technology maturity of a product, with high TRL associated to products closer to market. Experience on higher levels of technology maturity is measured based on four indicators. The first indicator (**I17.1**) is the TRL starting point of the project and the second one (**I17.2**) is the expected final TRL.

In order to match technology to customer needs, experience with operation in practice is important (Hellman 2006). Moss Kanter (1994) talks about the collaborative advantage in which partners collaborate (creating new value together) rather than mere exchange (getting something back for what you put in). Partners value the skills each brings to the alliance. Furthermore, these alliances are living systems that evolve progressively in their possibilities. Beyond the immediate reasons they have for entering into a relationship, the connection offers the parties an option on the future, opening new doors and unforeseen opportunities. According to this argument, previous collaboration with same partners demonstrates they share values, confidence and aims; and it could be a good measure of experience in higher TRLs (**I17.3**). Furthermore, this indicator is complemented by the stage in which the collaboration started (**I17.4**).

4.7. Results

4.7.1. Knowledge and Technology

The information retrieved from the selected projects was used to create a database including the 87 projects with their 519 organizations and 597 observations, detailing any characteristic. Clearing, filtering and detection of errors took months of work to obtain the final database. The network of organizations and their connections between projects is presented in **Figure 4.4**. This high degree of connections let me support **Indicator 5.1**.

The **Indicator 5.2** of clustering is based on the importance of local clusters. So, in order to evaluate the variable I considered the number of projects with a high percentage of organizations in local clusters; due to the non-existence of literature I proposed a percentage superior to the 50%. After the analysis of local clusters, findings suggested an important presence of local clusters what supports this second indicator.

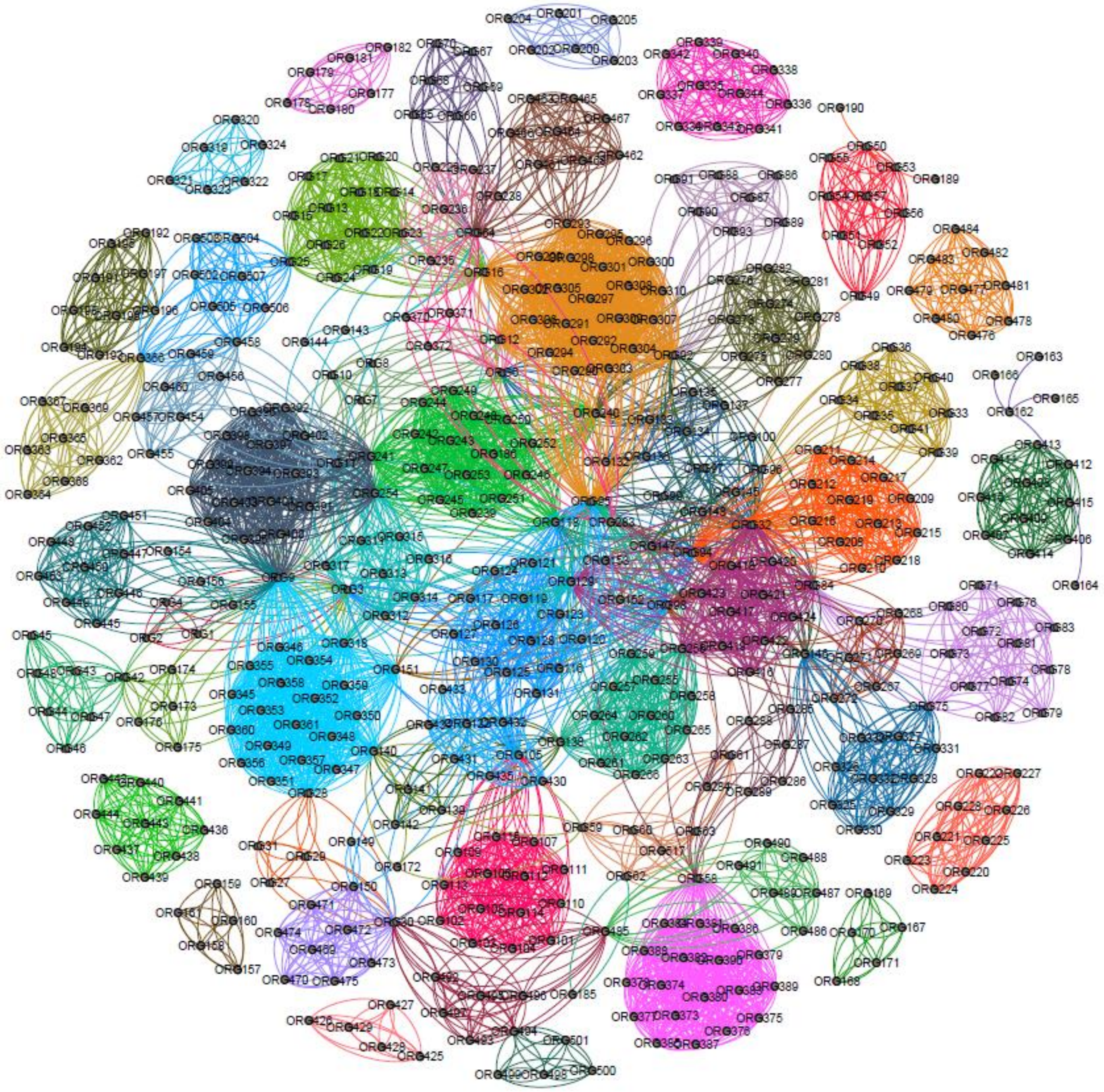

Figure 4.4. Network of the 519 organizations and their connections within projects.

From the set of projects, it was found that there were 40 participant countries (**Figure 4.5**), including 36 Member State Countries of the European Union and their overseas departments, and 4 Non-Member States: Canada, Colombia, Japan and Uruguay. In this sample, the country with the greatest number of organizations was Spain (with 77 organizations), followed by the United Kingdom (65) and Italy (62). On the contrary, the countries with fewer organizations were Belarus, Bosnia and Herzegovina, Croatia, Iceland, Latvia, Ukraine, Lithuania, Colombia, Canada, Japan and Uruguay (with one project each).

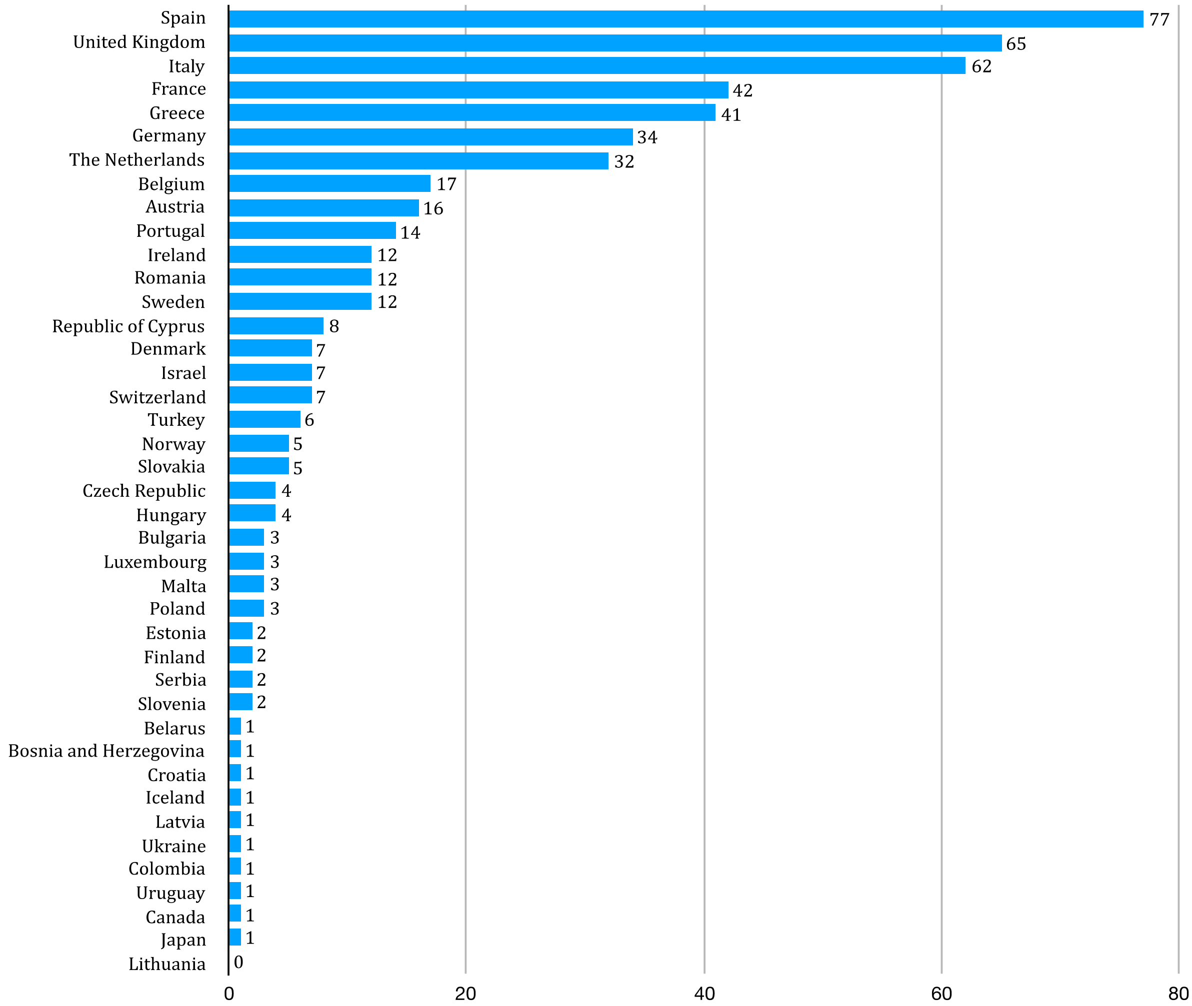

Figure 4.5. Number of organizations per country

In terms of participations in projects per country (**Table 4.3)**, Spain leads again the ranking with 95 projects, followed by the United Kingdom (73) and Italy (66). But it is Greece, with 53 participations in consortia, who occupies the fourth position followed by Germany (44 projects) and France (43). It means that France with 42 different organizations and Germany with 34 participate in a similar number of projects.

Table 4.3. Number of organizations and participations in projects per country

Countries	Organizations	Participations	Participations/ Organizations
Austria	16	19	1,19
Belarus	1	1	1,00
Belgium	17	19	1,12
Bosnia and Herzegovina	1	1	1,00
Bulgaria	3	3	1,00
Croatia	1	1	1,00
Republic of Cyprus	8	8	1,00
Czech Republic	4	4	1,00
Denmark	7	7	1,00
Estonia	2	2	1,00
Finland	2	3	1,50
France	42	43	1,02
Germany	34	44	1,29
Greece	41	53	1,29
Hungary	4	4	1,00
Iceland	1	1	1,00
Ireland	12	12	1,00
Israel	7	7	1,00
Italy	62	66	1,06
Latvia	1	1	1,00
Lithuania	0	0	0,00
Luxembourg	3	3	1,00
Norway	5	9	1,80
Malta	3	4	1,33
The Netherlands	32	39	1,22
Poland	3	3	1,00
Portugal	14	16	1,14
Romania	12	13	1,08
Serbia	2	2	1,00
Slovakia	5	6	1,20
Slovenia	2	2	1,00
Spain	77	95	1,23
Sweden	12	14	1,17
Switzerland	7	7	1,00
Ukraine	1	1	1,00
United Kingdom	65	74	1,14
Turkey	6	6	1,00
Colombia	1	1	1,00
Uruguay	1	1	1,00
Canada	1	1	1,00
Japan	1	1	1,00
TOTAL	**519**	**597**	**1,15**

The connections between countries are represented in the cluster map of the total system of projects (**Figure 4.6**). Nodes are the countries and lines (edges) are partnerships. The thickness of the line represents the number of partnerships: thicker lines present a greater number of partnerships between countries; and the thinner the lines, the less collaboration. As shown, countries that participate in more collaborative consortia are Spain, United Kingdom, Italy, France, Greece, Germany and The Netherlands. Visually, three countries' circles can be clearly identified in **Figure 4.6**.

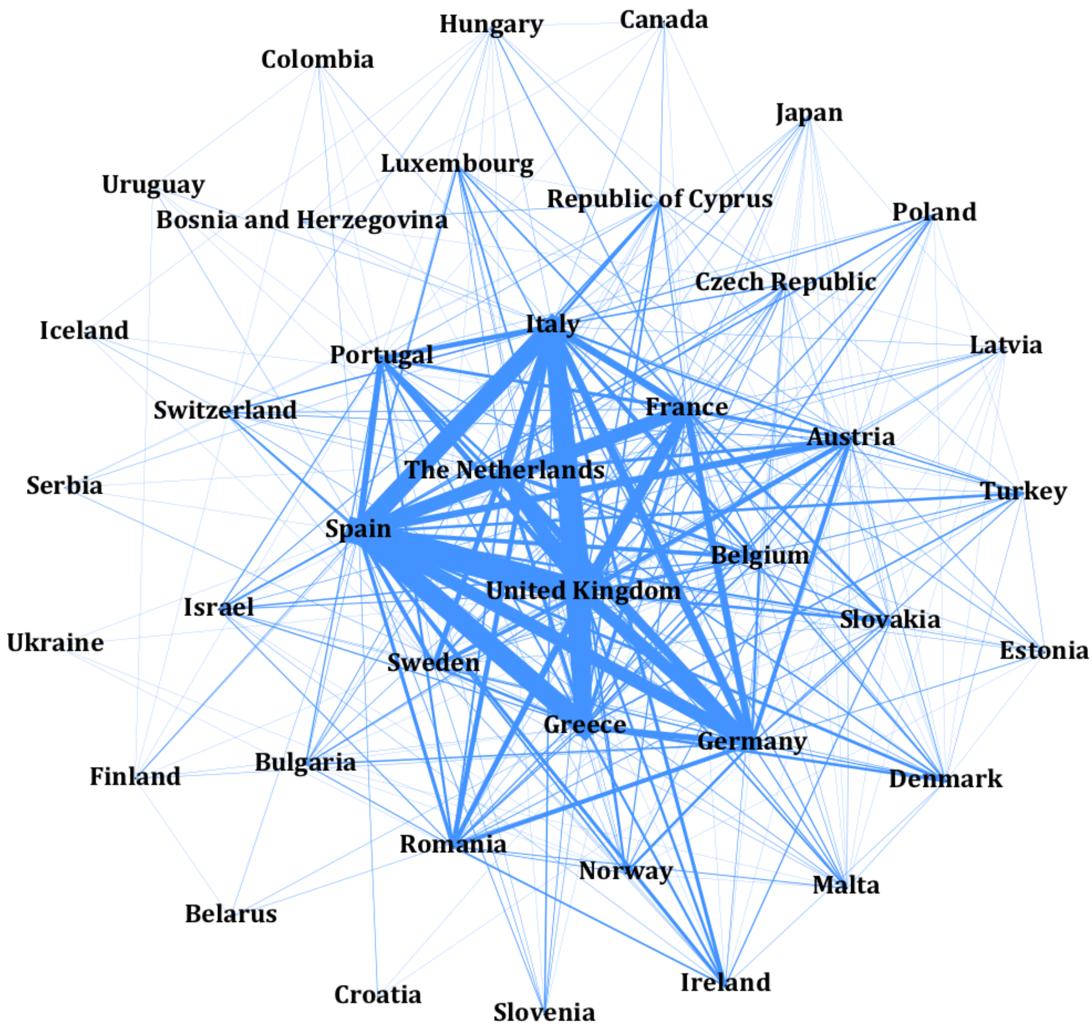

Figure 4.6. Number of countries in the system of projects

The majority of participant organizations are PRC (42%), followed by HES (29%) and REC (14%). The sample also shows a lower participation of PUB (8%) and OTH (7%), as shown in the **Figure 4.7**. Having into account that in many cases the existence of HES and REC depends on the organizational knowledge system of each country (Martynenko and Menshykov 2017), the sum of both variables have a percentage (43%) very well balanced with the number of companies. To mention an example about how the creation of knowledge producing institutions (HES and REC) depends on the states internal affairs, the Norwegian University of Science and Technology (NTNU), organization that participates in two projects, is the result of a merger in 1966 between the Norwegian Institute of Technology and the University in Trondheim (Trueman *et al.* 2014). This diversity of types of organizations and the relevant number of HES and REC support **Indicator 2.1**.

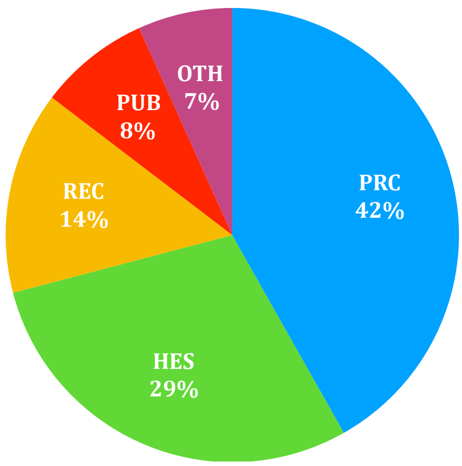

Figure 4.7. Number of organizations per type

When we cross the type of organization with the type of project -according to whether they are collaborative (H), individual (I) or European Research Council (ERC)-, we observe that the individual projects are clearly developed by PRC and the ERC by HES.

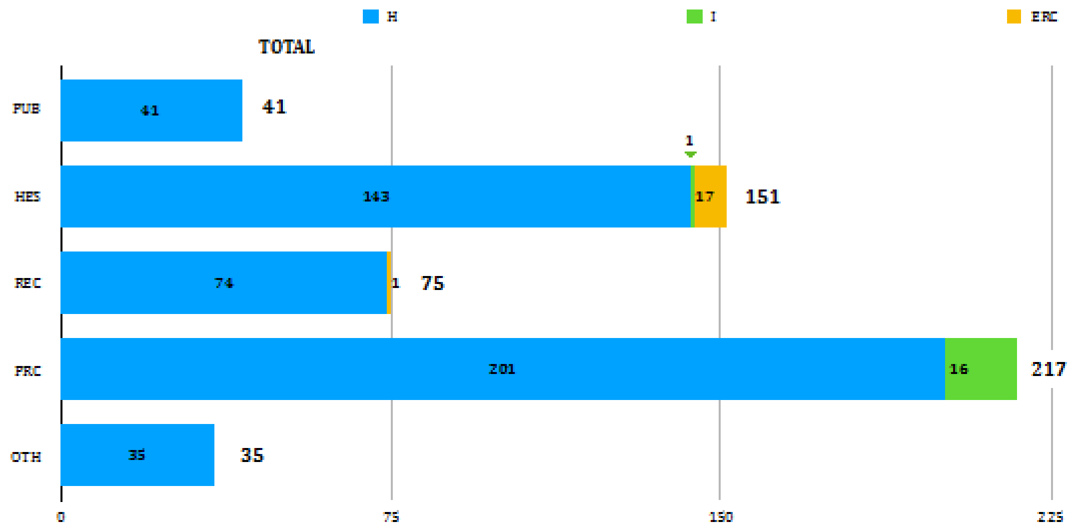

Figure 4.8. Number of organizations per type of call

In order to explore the diversity of typology or organizations per project, I calculated the number of organizations per type (**Figure 4.8**; **Table 4.4**) and the projects in which they participate (**Figure 4.8; Table 4.4**). After this, I determined the average of each type of organization based on the total number of projects (although only 62 of the 87 are collaborative projects). So, I determined that there are 2.66 private companies participating in each project while the number of HES is 2.15 and REC 1.11. A PUB participates in the 0.53 of projects and OTH in 0.41. This information helps me to support the existence of a multiplicity of types of organizations per project (supporting the **Indicator 4.1)** and a high percentage of knowledge producing institutions (supporting the **Indicator 8.1**).

Table 4.4. Number of participations in projects per type of organization

	Organizations		**Participations**		**Org/Total projects**	**Participations/ Total projects**
	N	*%*	**N**	*%*	**N**	**N**
PUB	41	*8%*	46	*8%*	0,47	0,53
HES	151	*29%*	187	*31%*	1,74	2,15
REC	75	*14%*	97	*16%*	0,86	1,11
PRC	217	*42%*	231	*39%*	2,49	2,66
OTH	35	*7%*	36	*6%*	0,40	0,41
TOTAL	**519**	*100%*	**597**	*100%*	5,97	6,86

Total projects: 87

In order to identify the existence of end-users organizations, I have analysed all the results marked as OTH. The conclusion is that the 95% of organizations (considered as OTH) are promoted by official institutions. It means that the end users are misrepresented or not represented directly by themselves (through associations, foundations…). In this case the **Indicator 10.1** is not supported.

The creation of value takes place along the value chain, from research to market. That is why the collaboration between knowledge producing institutions and private companies is needed. After analysing the percentage of partnerships between HES/REC and PRC in the 62 collaborative projects, it achieves the 98.34%. It means that the **Indicator 13.1** is fully supported because a bigger number of partnerships between HES/REC and PRC could be influencing the level of cross-fertilization.

A common position in literature considers that larger project teams provide a larger chance of recombining different types of knowledge, expertise and ideas, and thus innovation (Powell *et al.* 1996; Ruef 2002). According to this, I have calculated the average of partners in the 62 collaborative projects. The result is that there are 9.2 partners per project, a very high number when I reviewed the recommendations[69] of different bodies of the European Union. Specifically, it is recommended per project at least two mutually independent legal entities established in two different countries and a reasonable number of associated partners to avoid administrative difficulties. The number of partners will depend on each programme and on each partner organization's added value to the proposal. Each partner organization should therefore demonstrate a real and active role in the project[70]. According to the average of partners per collaborative projects, this finding fully supports **Indicator 3.1** because there are a relevant number of organizations in the collaborative projects.

Figure 4.9 shows the distribution of the different types of organizations per participant country. The percentage of companies is higher in almost all countries with the notable

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[69] http://ec.europa.eu/chafea/documents/news/training_presentation/04_How_to_find_project_partners.pdf [Last retrieved April 26, 2018]
[70] https://ec.europa.eu/research/participants/portal/desktop/en/support/faqs/faq-8345.html[Last retrieved April 24, 2018]

exception of United Kingdom where the number of HES is superior. Also, the number of OTH in The Netherlands is far superior to any other country in relative terms (22%).

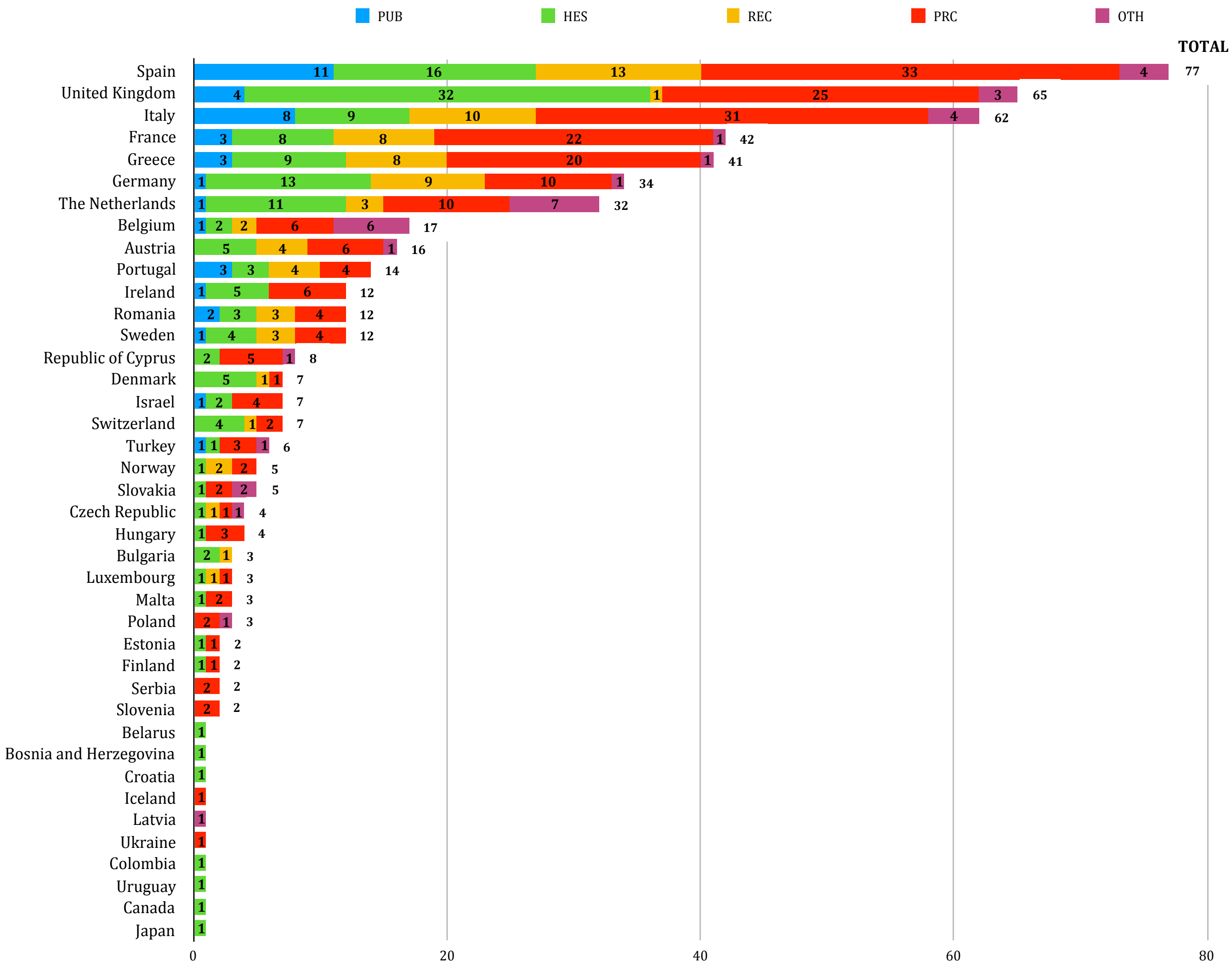

Figure 4.9. Number of projects per type of organization and country

The participation in projects is bigger than the number of organizations. In fact, there are 519 organizations but have been registered a total of 597 participations in projects. It means that some organizations participate in more than one project; in this regard, the ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS that participates in seven projects stands out, followed by FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V. with six and NUROGAMES with five.

As shown in **Figure 4.10**, it is striking that France is backing two positions compared to the previous graph (**Figure 4.9**). The 42 French organizations participate in 43 projects (one company per project) while on the other hand 41 Greek organizations participate in 66 projects or 34 German organizations are involved in 44.

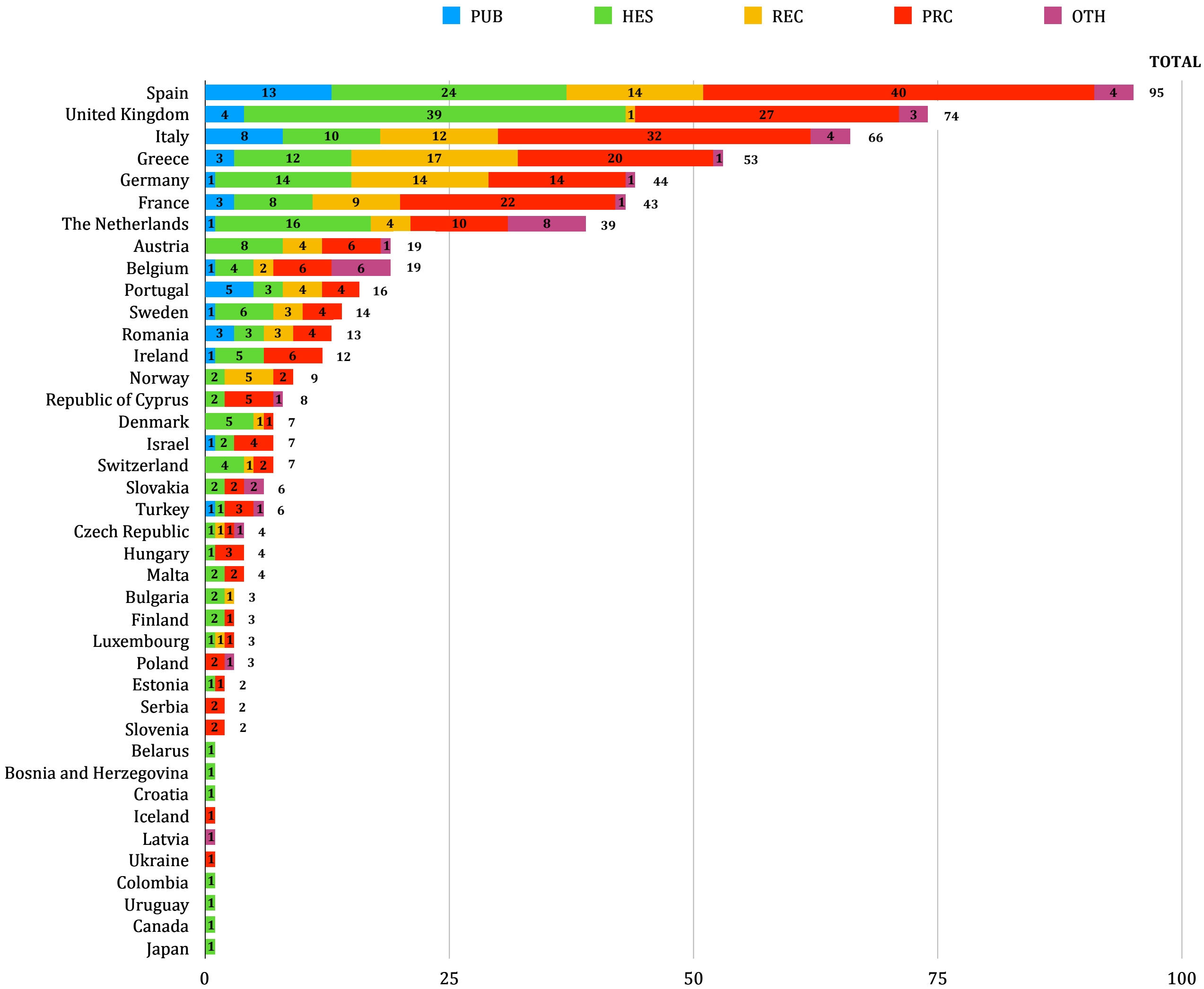

Figure 4.10. Number of participations per type of organization and country

The analysed database has a wide range of projects from different fields that I have grouped by the thematic areas shown in **Figure 4.11**. This wide range of thematic areas is leaded by the health and the education areas, each of them with 18 projects. Projects in the energy field are 12, followed by 10 in Environment & Climate Action and 9 in Social Sciences & Humanities. The next are the fields of Security and ICT with 6 respectively.

Finally, Transport (3), Video games Technology (2) and other diverse fields like Chemistry (1), Mathematics (1) and Sport (1) close the list. This result confirms the multidisciplinarity of fields, fully supporting the **Indicator 1.2**.

Regarding to the high number of projects in the areas of education and health, it is very relevant that the six interviewees from video game companies[71] (Creatiulab, Ravalmatic, Òmada, Abylight, Incubio and Ubisoft) chose education as the sector that can benefit more from the experience of the serious game. The second chosen was the health field by four of the interviewees.

In the case of universities[72], the three responsables of the video game studies at the Universitat Politècnica de Catalunya, ENTI-Universitat de Barcelona and Universitat de Vic chose education twice (health one). And from the government[73] sphere, the four interviewees chose education and only one person health. Therefore, 12 of the 13 (92%) experts chose health as one of the sectors than can benefit more from the serious games. The second field according to the answers was health, chose in the 50% of cases and the rest of answers are very diverse. Therefore, there is an alignment between the high number of projects in these areas and the opinion of the interviewed experts.

Complementarily, Juan Pérez[74] considers that the main applications of serious games include education and simulation/training. "The health domain has a prominent position

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[71] The interviewees were: Mr. Andreu Taberner (CEO of Creatiulab; www.creatiulab.com), Mr. Javi Sanz (Art director and CEO of Ravalmatic; www.ravalmatic.com); Ms. Inma Chapín (CEO of Omada; www.omada.es); Ms. Eva Gaspar (CEO of Abylight and president PAD –Professional Associated Developers-; www.abylight.com); Mr. Pere Torrents (Co-director of GAMEBCN and Marketing Manager of Incubio; www.gamebcn.com); Ms. Maria Teresa Cordón (Managing director of Barcelona Studio of UBISOFT; www.ubisoft.com).

[72] The interviewees were: Mr. Jesús Alonso (Manager of the following Masters: Video Game Design and Programming, Digital Art and Animation, Mobile Business & Apps Design at UPC School of Professional and Executive Development; www.talent.upc.edu); Mr. Òscar G Pañella (Academic Director of ENTI the Video game School and CEO of Cookie Box; www.enti.cat); Mr. Sergi Grau (dean of the Science and Technology Faculty of Universitat de Vic; www.uvic.cat).

[73] The interviewees were: Ms. Marisol López (Digital Manager at ICEC –Institut Català de les Empreses Culturals-; www.icec.gencat.cat); Ms. Montse Basora (COO of Entrepreneurship; Barcelona Activa; www.barcelonactiva.cat); Ms. Ana Majó (Director of Strategic Sectors and Innovation at Barcelona City Council; www.barcelona.cat); Ms. Itziar Blasco (Head of mStartup Barcelona of Barcelona Activa; www.barcelonactiva.cat).

[74] Juan Pérez is Head of European projects at CIT (Technology Centre) of UPC (Technical University of Catalonia)

due to several factors. Bad decisions/interventions in the medical area might lead to severe injuries or even death, so it seems logical to invest substantial resources in training tools and approaches. Additionally, serious games can be used not only by health professionals (surgery training, decision-making, etc.), but also by other stakeholders such as patients or care givers for applications such as changing habits, increasing motivation or improving adherence to the treatment".

Dani Tost[75] also puts the emphasis on the potential number of users because the cost of the production is very high and needs to be amortized. Related to the fields, she considers that the use of conventional games to motivate students is a classic of pedagogy and the serious games follow the same approach. In health, serious games began to be applied mainly in rehabilitation because this field requires new formulas to make more attractive a repetitive and very little motivating activity.

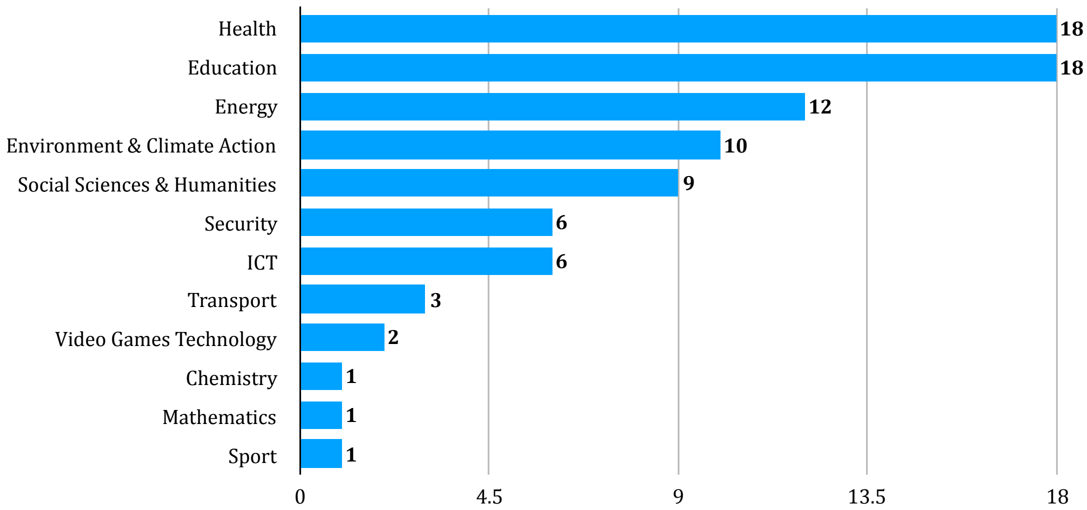


Figure 4.11. Number of projects per main thematic area

The following **Figures (4.12.a** and **4.12.b**) show the number of projects per main thematic area and country. Specifically, the **Figure 4.12.a** plots out the correlation matrix between countries and thematic areas, representing the correlation coefficients using the library

[75] Dani Tost is Head of the Computer Graphics Division and Specialist in 3D visualizations, serious games, gamifications and simulations at the UPC (Technical University of Catalonia); also, she is the director of CREB (Biomedical Engineering Research Centre) UPC

lattice[76]. The colour level is proportional to the value of the observations: pure blue corresponds to the highest value of number of projects. On the other hand, the **Table 4.5** shows the similar information but in a statistical descriptive way.

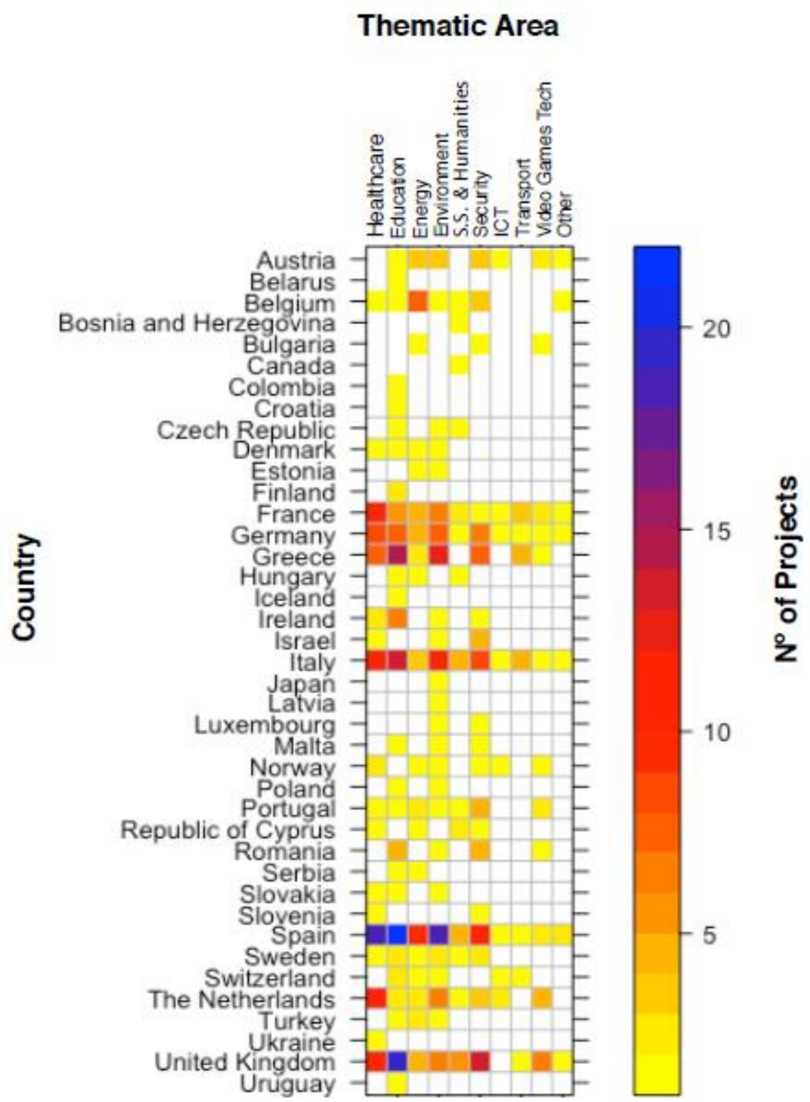


Figure 4.12.a. Number of projects per main thematic area and country using the library lattice

[76] The lattice package, written by Deepyan Sarkar, attempts to improve on base *R* graphics by providing better defaults and the ability to easily display multivariate relationships. In particular, the package supports the creation of *trellis graphs* - graphs that display a variable or the relationship between variables, conditioned on one or more other variables.

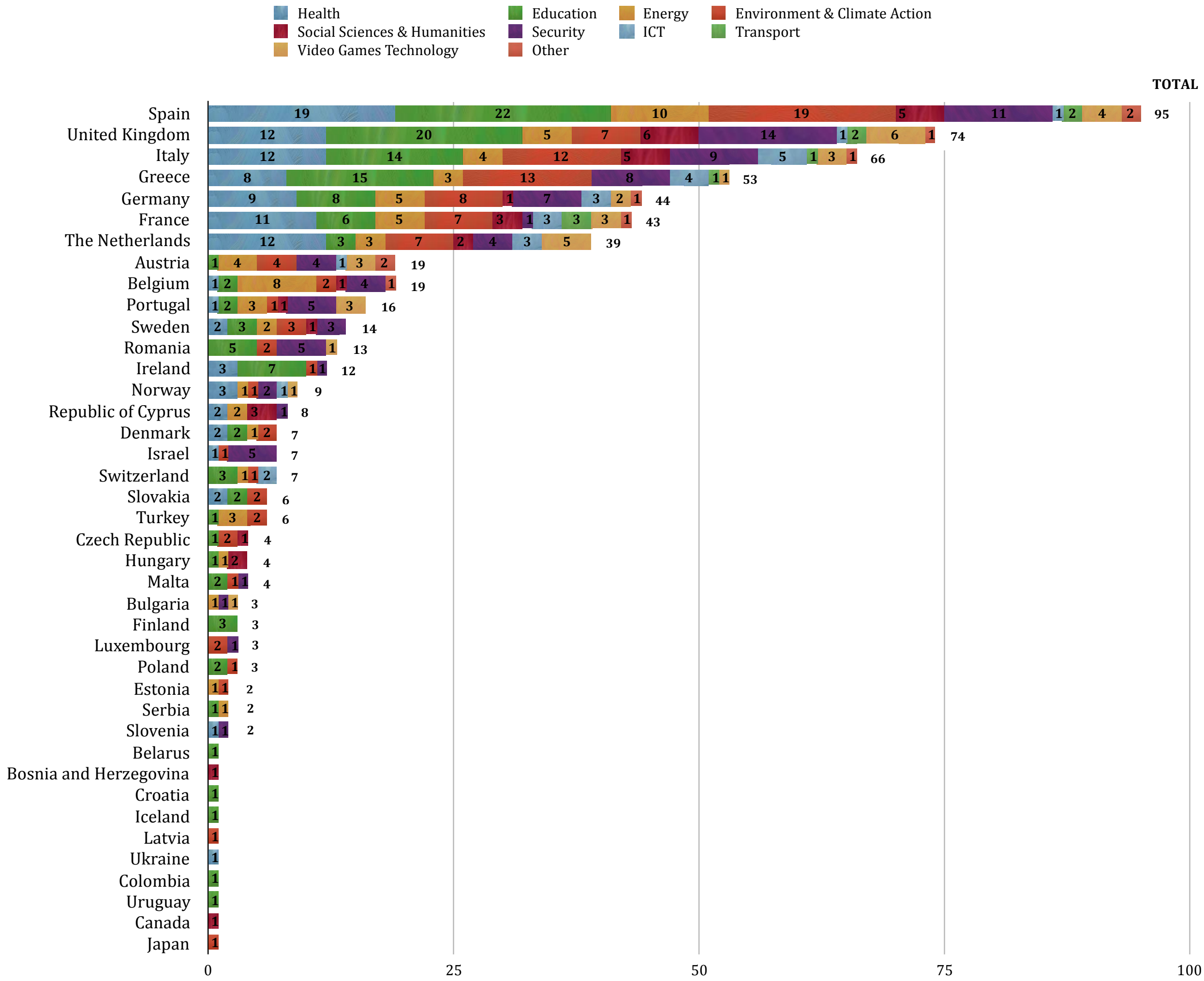


Figure 4.12.b. Number of projects per main thematic area and country

The **Table 4.5** shows how HES and REC leads the participation in all the fields with the exception of the projects in Energy (PRC 48%) and equals those in ICT (50%). It evidences that the base and applied knowledge provided by universities and research centres could be a key element to define and accelerate the projects. This relevance of knowledge providing institutions in almost all the fields is interpreted as a full support to **Indicator 2.3**. Furthermore, the high number of private companies let me say that there is a well-balanced representation of PRC and knowledge providing institutions fully supporting **Indicator 4.2**.

Table 4.5. Number of participations in projects per main thematic area and type of organization

	Health		Education		Energy		Environment & Climate Action		Social Sciences & Humanities		Security		ICT		Transport		Video Games Technology		Other		TOTAL	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
PUB	4	*4%*	4	*3%*	1	*2%*	13	*13%*	1	*3%*	21	*24%*	0	*0%*	0	*0%*	2	*6%*	0	*0%*	*46*	8%
HES	29	*28%*	53	*40%*	14	*22%*	**23**	*22%*	**16**	*48%*	**19**	*22%*	**10**	*42%*	**4**	*44%*	**13**	*39%*	**6**	*67%*	*187*	31%
REC	21	*21%*	12	*9%*	13	*20%*	22	*21%*	4	*12%*	15	*17%*	2	*8%*	2	*22%*	6	*18%*	0	*0%*	*97*	16%
PRC	39	*38%*	56	*43%*	31	*48%*	37	*36%*	11	*33%*	29	*33%*	12	*50%*	3	*33%*	10	*30%*	3	*33%*	*231*	39%
OTH	9	*9%*	6	*5%*	5	*8%*	9	*9%*	1	*3%*	4	*5%*	0	*0%*	0	*0%*	2	*6%*	0	*0%*	*36*	6%
	102	*100%*	**131**	*100%*	**64**	*100%*	**104**	*100%*	**33**	*100%*	**88**	*100%*	**24**	*100%*	**9**	*100%*	**33**	*100%*	**9**	*100%*	***597***	100%

Given the leading role of Spanish organizations in number and participations, I explored in more detailed the Spanish case but I have only included some brief information. **Figure 4.13** shows the number of Spanish organizations per type and province. In the case of the first two positions of the ranking some differences catch my attention. Madrid (with 17 organizations) has a 59% of PRC meanwhile the number of organizations in other categories is considerably below. On the contrary, Barcelona (with 15 organizations) has a fewer number of PRC (27%) but in relative terms the number of organizations of other categories is higher. In opposition to Madrid, the presence of different types of organizations in Barcelona province is more balanced.

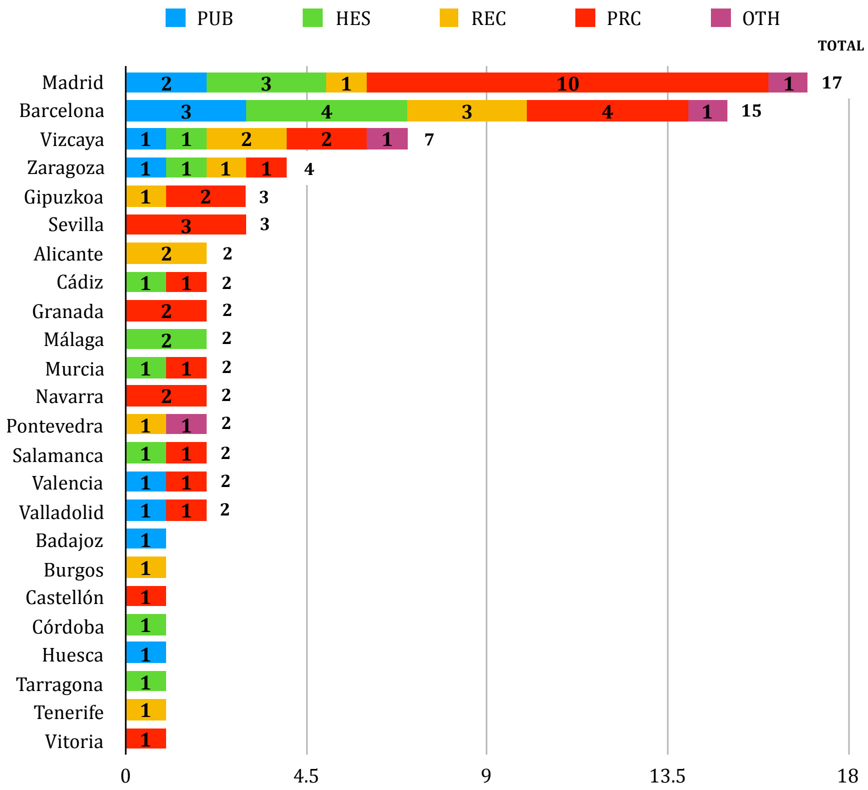


Figure 4.13. Number of Spanish organizations per type and province

In the case of Spain, the participation in projects is also bigger than the number of organizations. In fact, there are 77 organizations but have been registered a total of 95 participations in projects (**Figure 4.14**). It means that some organizations participate in more than one project; in this regard, the Universidad Politécnica de Madrid participates in four projects; followed with three projects by Universidad Complutense, Inmark Europa, Atos Spain and Ministerio del Interior (from Madrid), the Universitat Politècnica de Catalunya (from Barcelona) and Brainstorm Multimedia (Valencia). This last company is the only one that participates from Valencia. As reflected in the analysis, there is a significant number of organizations from Madrid that participate in three projects achieving a total participation of 29 projects.

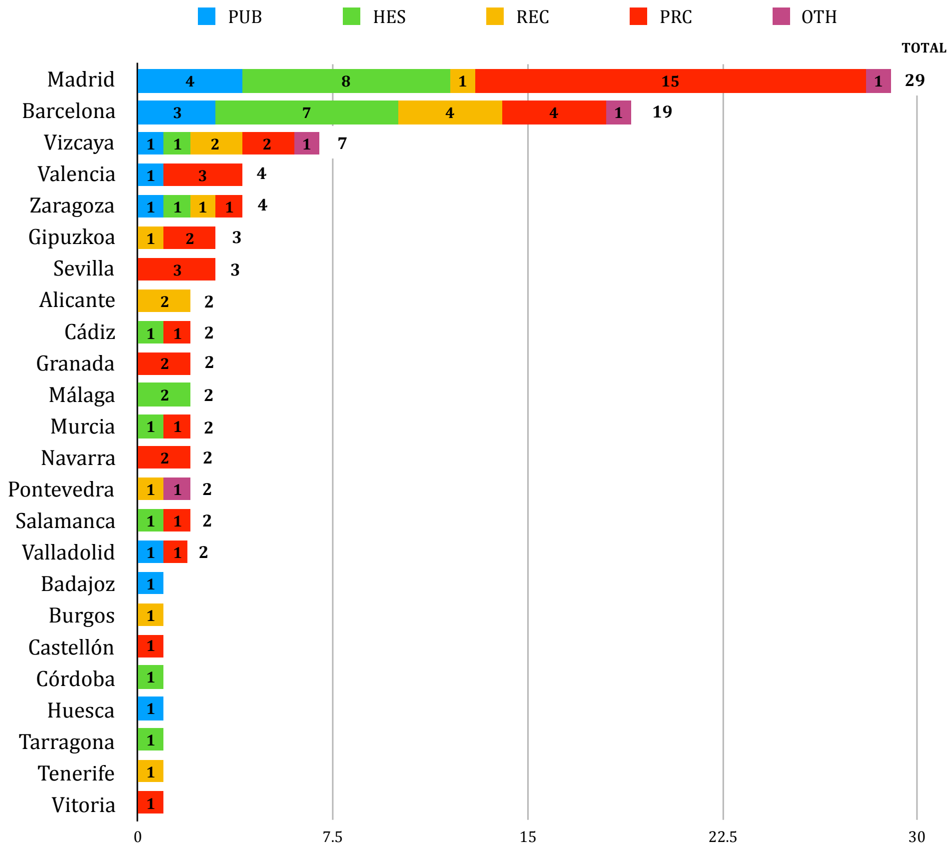


Figure 4.14. Number of Spanish participations per type and province

In terms of thematic areas, it is relevant the participation from Madrid in 9 projects in the education field (**Figure 4.15**). These projects are followed by 7 in the field of Environment & Climate Action and 5 of Security. On the side of Barcelona, there are 6 projects in the area of Environment & Climate Action and 5 in the Health field -Catalonia concentrates the 47.05% of Spanish pharmaceutical production and 36.6% of Spanish pharmaceutical exports[77].

[77] http://catalonia.com/trade-with-catalonia/life-sciences.jsp [Last retrieved April 22, 2018]

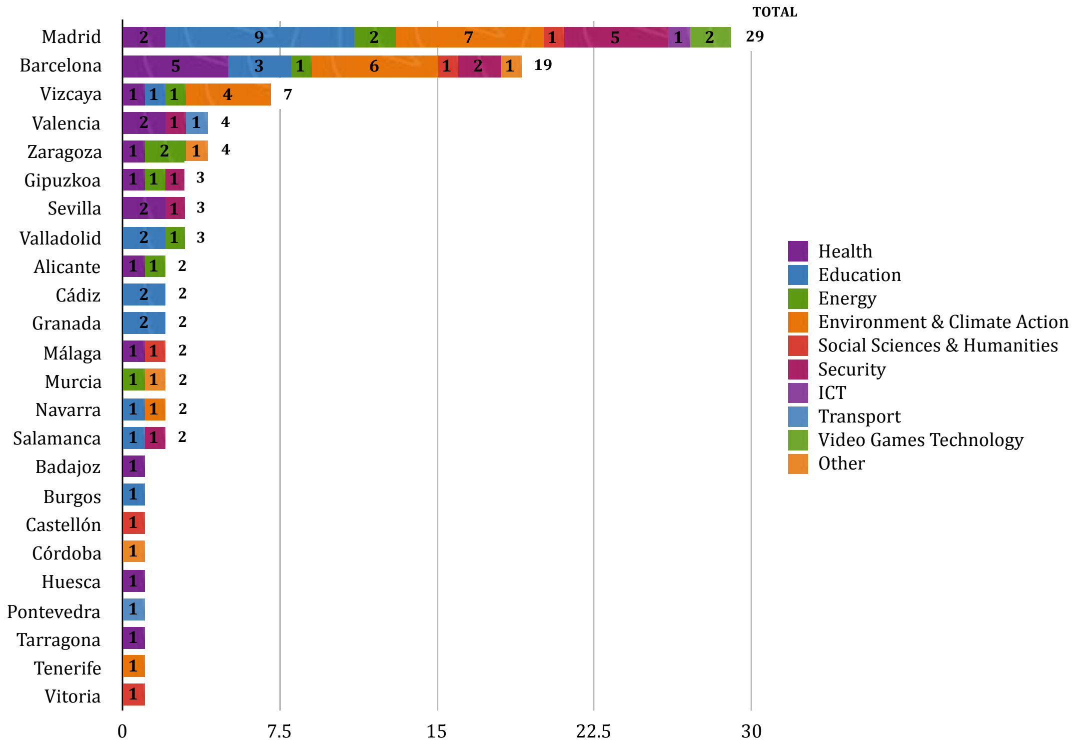


Figure 4.15. Number of projects per main thematic area and province in Spain

Additionally, I have analysed the ranking 2018 of European universities[78] (developed by QS World University Rankings) in order to identify how many of the first 100 universities participate in H2020 projects that include Serious Games and/or Gamification. The results show that there are 15 organizations in the top 100 participating in at least one project although the total number of participations is 21. It would have been interesting to know the number of projects presented to the calls in order to know if they applied for grants and had not success -but this information has not been obtained and neither is it published by the universities.

After comprehending the relevance of the universities participating in those projects according to one of the most relevant university rankings, I wanted to know what would happen when research centres are considered. Analysing the ranking 2017 of European

[78] https://www.topuniversities.com/university-rankings/world-university-rankings/2018 [Last retrieved April 2, 2018]

Research Centres[79] (by Webometrics) I found that only 5 research centres are in the list of the top European Research Centres. All of them have one project with the exception of Fraunhofer Gesellschaft that participates in 6. Maybe the expertise field of the rest of research centres is not close to the projects including serious games and gamification technologies but it is an issue to consider.

Finally, in order to compare the information obtained with the rest of H2020 projects, I used the 2016 European Research Ranking[80]. This ranking is based on the freely and publicly available data on European research projects that takes information from CORDIS database. So, I could identify if the organizations participating in projects including Serious Games and Gamification differ from those participating in other typology of projects. The result is that 57 organizations (HEC and REC) were included in the top 100 of the 2016 European Research Ranking, participating in a total of 85 projects. Therefore, when I compare the number of knowledge producing institutions in these calls with the rest of H2020 calls, these HEC and REC are very well positioned. This ranking criterion requires a minimum of 5 projects per year to calculate the rank of an individual institution and represents the sum of all grants allocated to projects this institution has participated in. After all this analysis, these results are interpreted as full support for **Indicator 2.4 and 2.5** because in independent rankings HEC and REC are not too relevant but when comparing them with the rest of institutions in other H2020 calls, the data demonstrate how relevant they are. A summary of the information discussed is shown in **Table 4.6.**

Table 4.6. Presence of Knowledge producing institutions in the European rankings

Item	**Categories**	**2018 European Universities** (QS World University Rankings)	**2017 European Research Centres** (Ranking Web of Research Centres)	**2016 European Research Ranking**
Organizations	HEC	15		49
	REC		5	7
Projects	HEC	21		69
	REC		10	16

[79] http://research.webometrics.info/en/Europe [Last retrieved April 2, 2018]
[80] http://www.researchranking.org/index.php?action=ranking [Last retrieved April 2, 2018]

In addition, a text exploratory analysis was done ir order to visualize the word trends using the *VOSviewer* software. This tool is used for constructing and visualizing bibliometric networks. The following figure shows the density visualization of the content of the system of projects based on the density of words. Each point in the map has a colour that depends on the density of words at that point. The larger the number of words in the neighbourhood of a point and the higher the weights of the neighbouring words, the closer the colour of the point is to red. Conversely, the smaller the number of items in the neighbourhood of a point and the lower the weights of the neighbouring words, the closer the colour of the point is blue. Following the approach of this thesis, an analysis was done for visualizing trends in H2020 projects including serious games and gamification. In this regard, two graphs were created to illustrate the map of terms from different perspectives: a density visualization map (**Figure 4.16**) and a network visualization map (**Figure 4.17**). As can be appreciated, words showing more density in the text are: "device", "serious gaming", "digital game", "energy consumption", "energy efficiency", "science", "school", "caregiver" among others. These findings give a general vision about what are the projects mainly focusing on and the discourses that can be found in the system of projects. This multiplicity of topics is interpreted as a full support for **Indicator 1.1**.

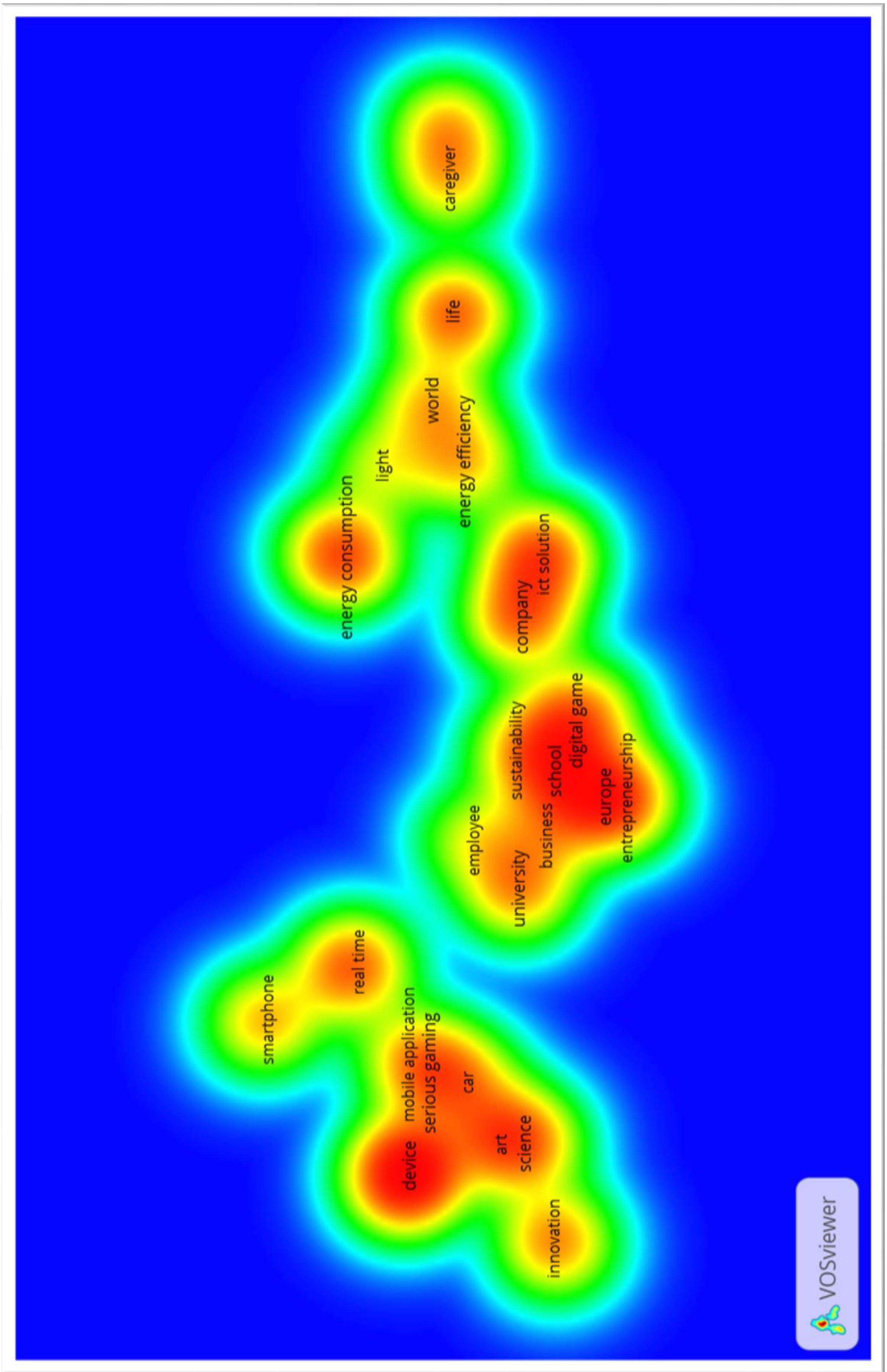


Figure 4.16. Density visualization map of terms

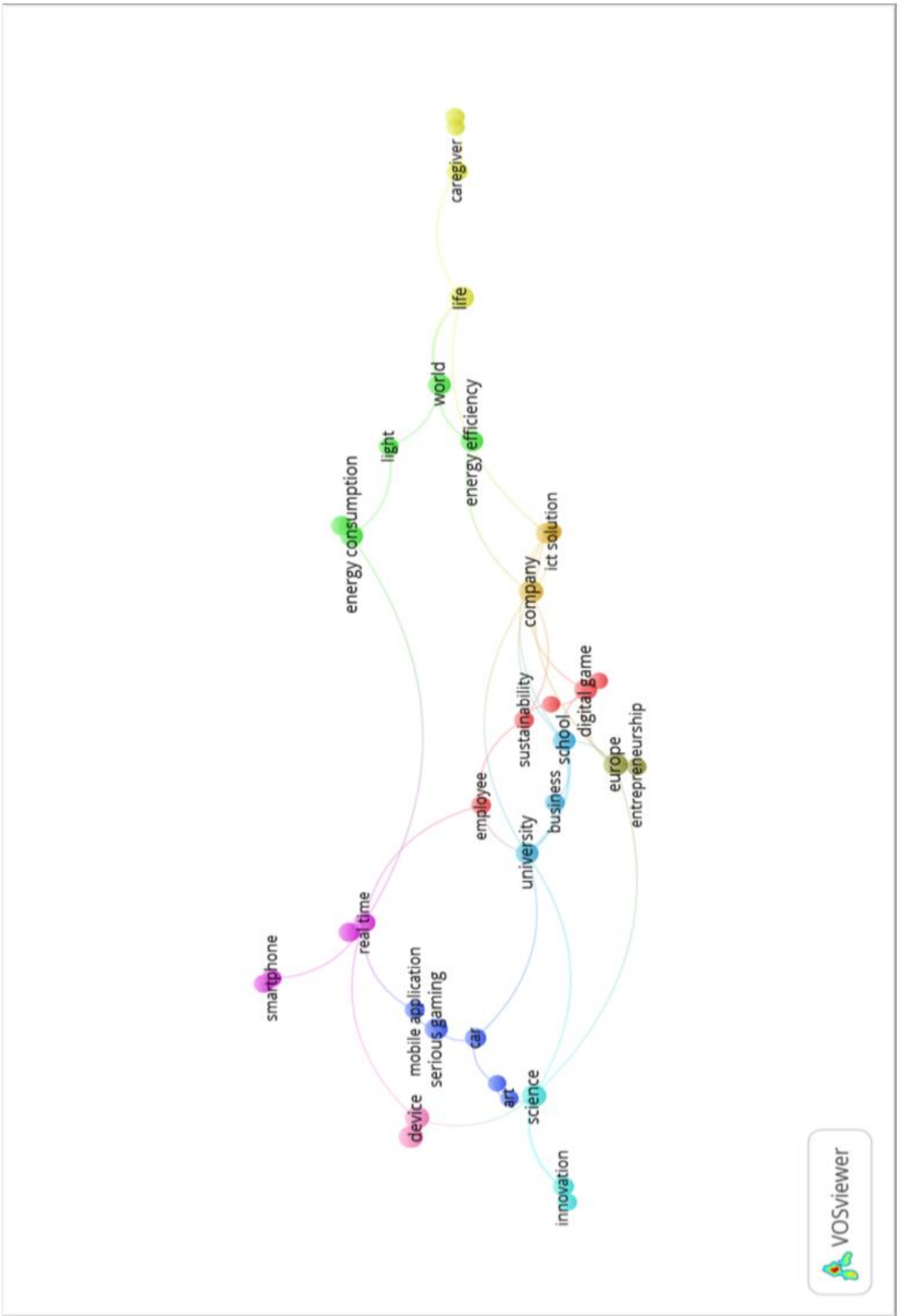


Figure 4.17. Network visualization map of terms

Having into account the importance of the coordination of a project (mostly in the collaborative ones), an accurate descriptive analysis also has been developed on coordinators. From the set of 87 selected projects, it was found that there were 18 participant countries **(Figure 4.18)** that are home to organizations coordinating H2020 projects. The country with the greatest number of coordinations was Spain with 22 projects -more than the 25% of projects- followed at a distance by Greece (14 projects) and The Netherlands (12 projects); the countries with fewer projects were Austria, Republic of Cyprus, Hungary, Norway, Portugal, Sweden and Switzerland (with one project each).

Paying attention to the typology of these organizations, it is noteworthy that a high number of resident coordinators in Spain are companies, similar to what happens on a smaller scale in Italy. In Spain more than the 40% of coordinators are PRC (9 of 22 coordinators) and in Italy this percentage is the 57% (although the PRCs are 4 of 7). In the rest of the countries with more than one project coordination, HES or REC leads the projects (depending on the research policy of each country).

In global terms, **Table 4.7** evidences the high percentage of knowledge producing institutions leading projects (65%), what confirms positively the **Indicator 2.2.**

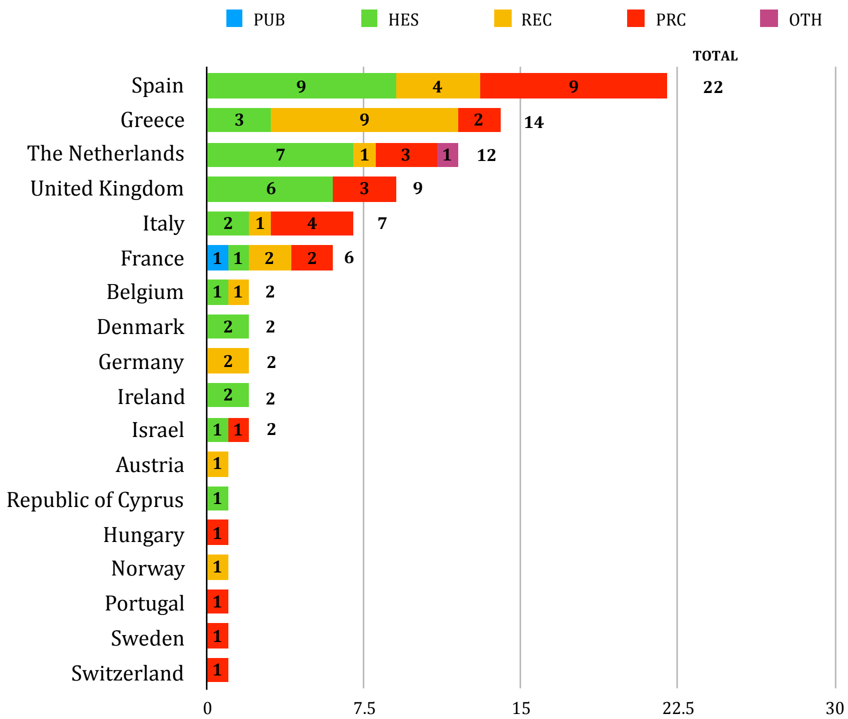


Figure 4.18. Number of projects coordinated by country and type of organization

Table 4.7. Number of projects coordinated by country and type of organization

	PUB	HES	REC	PRC	OTH	TOTAL
Austria	0	0	1	0	0	1
Belarus	0	0	0	0	0	0
Belgium	0	1	1	0	0	3
Bosnia and Herzegovina	0	0	0	0	0	0
Bulgaria	0	0	0	0	0	0
Croatia	0	0	0	0	0	0
Republic of Cyprus	0	1	0	0	0	1
Czech Republic	0	0	0	0	0	0
Denmark	0	2	0	0	0	2
Estonia	0	0	0	0	0	0
Finland	0	0	0	0	0	0
France	1	1	2	2	0	6
Germany	0	0	2	0	0	2
Greece	0	3	9	2	0	14
Hungary	0	0	0	1	0	1
Iceland	0	0	0	0	0	0
Ireland	0	2	0	0	0	2
Israel	0	1	0	1	0	2
Italy	0	2	1	4	0	7
Latvia	0	0	0	0	0	0
Lithuania	0	0	0	0	0	0
Luxembourg	0	0	0	0	0	0
Norway	0	0	1	0	0	1
Malta	0	0	0	0	0	0
The Netherlands	0	7	1	3	1	12
Poland	0	0	0	0	0	0
Portugal	0	0	0	1	0	1
Romania	0	0	0	0	0	0
Serbia	0	0	0	0	0	0
Slovakia	0	0	0	0	0	0
Slovenia	0	0	0	0	0	0
Spain	0	9	4	9	0	21
Sweden	0	0	0	1	0	1
Switzerland	0	0	0	1	0	1
Ukraine	0	0	0	0	0	0
United Kingdom	0	6	0	3	0	9
Turkey	0	0	0	0	0	0
Colombia	0	0	0	0	0	0
Uruguay	0	0	0	0	0	0
Canada	0	0	0	0	0	0
Japan	0	0	0	0	0	0
	1	**35**	**22**	**28**	**1**	**87**
	1%	40%	25%	32%	1%	100%

Regarding to the number of projects coordinated by country and main thematic area, it is appreciable in **Figure 4.19 (Table 4.8)** that Spain leads clearly the coordination of projects (21), followed by Greece (14), The Netherlands (11), United Kingdom (9) and France (8). The next country is Italy with 6 projects when this country is the third one in the list of project participations with 66 **(Figure 4.9)**; it means that only coordinates the 9% of projects in which participates. In relative terms, Spain coordinates the 22% of the projects, Greece the 26%, The Netherlands the 28%, United Kingdom the 12% and France the 19%. It is also relevant to comment that Israel coordinates the 43% of projects in which participates and Denmark the 29% although in absolute terms it means 3 and 2 coordinated projects respectively.

In fact, one of the more relevant data of the analysis is that Germany only coordinates 2 projects of the 44 **(Figure 4.18)** in which participates, representing only a 5%. Finally, the only country with a 100% in terms of coordination of projects is Latvia because only participates in this project. This multiplicity of projects in different thematic areas and coordinated by different countries suggests a full support for **Indicator 1.3**.

When Juan Pérez and Dani Tost are asked about why Spain, Greece and The Netherlands leads the ranking of projects' coordination they answer that this should not come as a surprise because those countries are amongst the most successful EU countries in FP7 participation. At this point, Dani Tost goes more beyond and say that Spain and Greece are countries where investment in research is very low, and that is why researchers apply to European projects.

Table 4.8. Number of projects coordinated by country and main thematic area

Countries	Health	Education	Energy	Environment & Climate Action	Social Sciences & Humanities	Security	ICT	Transport	Video Games Technology	Other	TOTAL	Total participations	Total coordinations/ Total participations
Austria			1								1	19	5%
Belarus											0	1	0%
Belgium			1							1	2	19	11%
Bosnia and Herzegovina											0	1	0%
Bulgaria											0	3	0%
Croatia											0	1	0%
Republic of Cyprus					1						1	8	13%
Czech Republic											0	4	0%
Denmark	1	1									2	7	29%
Estonia											0	2	0%
Finland											0	3	0%
France	1		1	2	1		2	1			8	43	19%
Germany	1		1								2	44	5%
Greece	2	5	1	2		1	1	1	1		14	53	26%
Hungary					1						1	4	25%
Iceland											0	1	0%
Ireland	1										1	12	8%
Israel	1	1				1					3	7	43%
Italy	2	1				1	1		1		6	66	9%
Latvia				1							1	1	100%
Lithuania											0	0	0%
Luxembourg											0	3	0%
Norway						1					1	9	11%
Malta											0	4	0%
The Netherlands	4		1	2		1	2		1		11	39	28%
Poland											0	3	0%
Portugal			1								1	16	6%
Romania											0	13	0%
Serbia											0	2	0%
Slovakia											0	6	0%
Slovenia											0	2	0%
Spain	4	6	3	3	3		1			1	21	95	22%
Sweden			1								1	14	7%
Switzerland		1									1	7	14%
Ukraine											0	1	0%
United Kingdom	1	3	1		3	1					9	74	12%
Turkey											0	6	0%
Colombia											0	1	0%
Uruguay											0	1	0%
Canada											0	1	0%
Japan											0	1	0%
TOTAL	**18**	***18***	***12***	***10***	***9***	***6***	***7***	***2***	***3***	***2***	**87**	**597**	15%
											100%	100%	

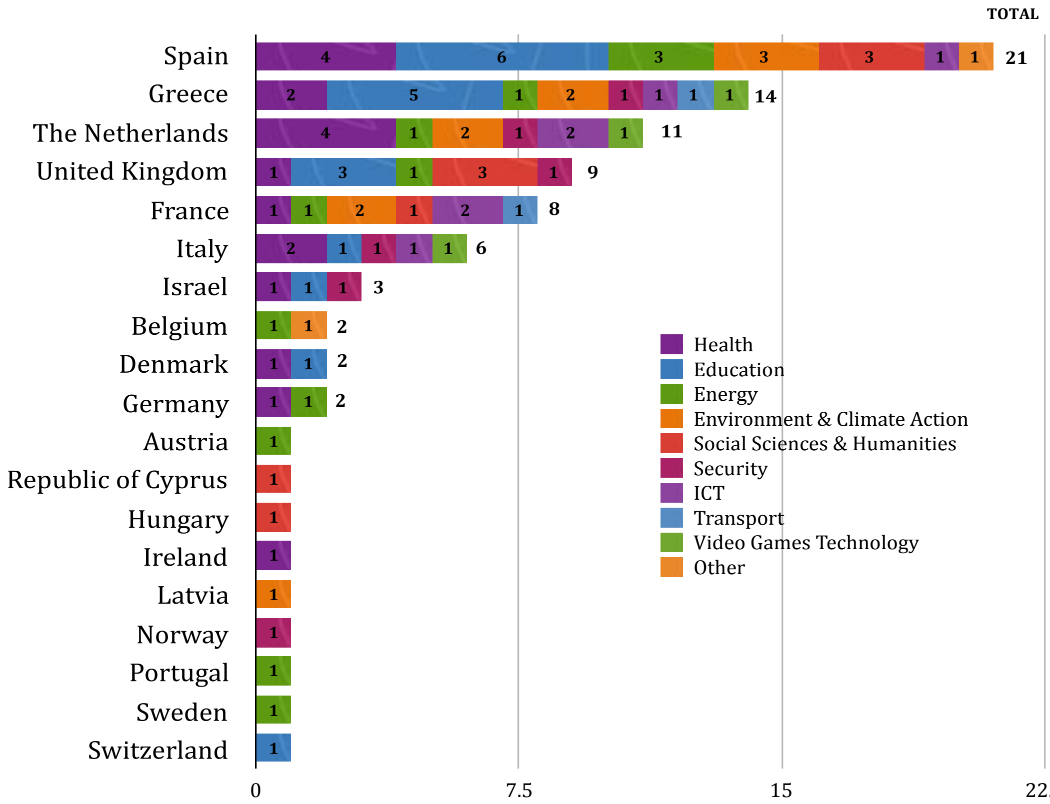


Figure 4.19. Number of projects coordinated by country and main thematic area

In the Spanish case (the state that coordinates more projects), the difference between the provinces of Madrid (7 coordinations) and Barcelona (5) stands out **(Figure 4.20)**; five coordinators in Madrid are PRC but in the case of Barcelona all of them are HES (five). This relevant data must be taken into consideration in order to understand the differences between both ecosystems of innovation. Also, these findings are complemented by the non-specialization of these cities in some specific thematic areas; both have projects from a diverse range of fields (**Figure 4.21**).

According to Juan Pérez, the results obtained are fully in line with the overall results for the Seventh Framework Programme (FP7), where HES and REC partners account for the 71% of the total EC contribution received. Dani Tost justifies these results because video game research projects are more oriented towards serious games. Large gaming companies are focused on playful games and are not too interested in research projects; and the small indie gaming companies develop playful video games. Indie companies compete with big studios and it is very difficult for them to participate in research projects for their limited resources. Therefore, the universities are left to work on projects on this subject. She thinks this is common in all countries.

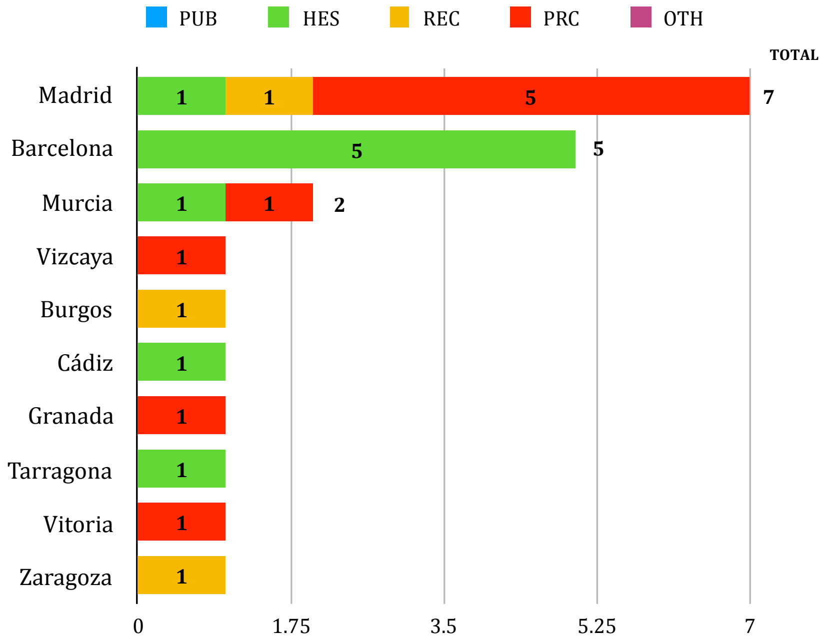


Figure 4.20. Number of projects coordinated by province and type of organization in Spain

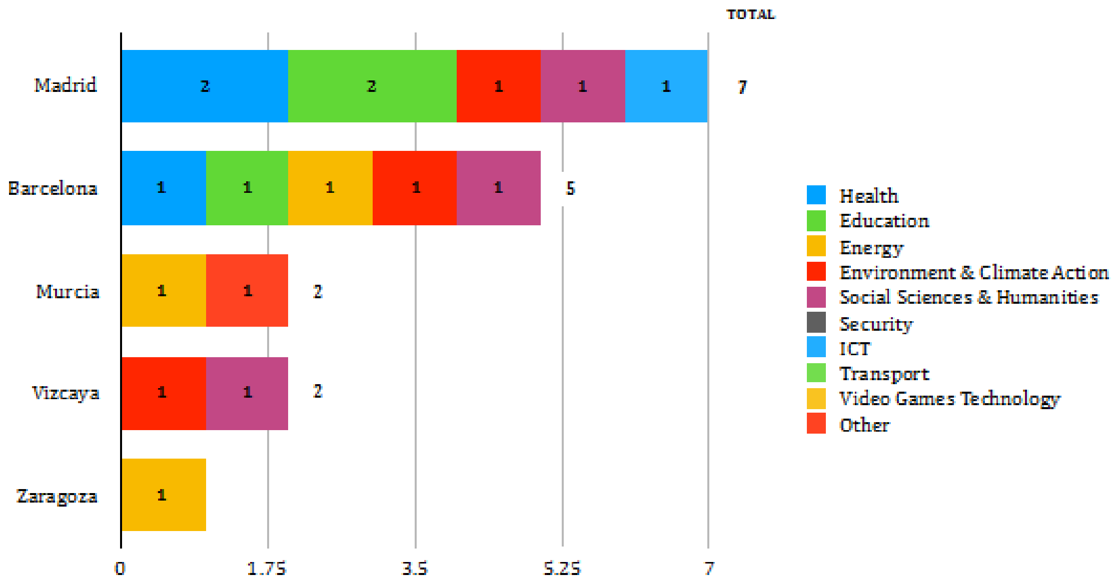


Figure 4.21. Number of projects coordinated by province and main thematic area in Spain

In order to complement the information obtained, I introduced the metrics provided by The Global Innovation Index (GII) -2017- which aims to capture the multi-dimensional facets of innovation. I identified the index of the country with the respective organizations, obtaining a value for a hypothetic average organization. To that end, I have considered the number of organizations per country to measure the weight of each country. Thus, I obtained that the average organization has a score of 51.8 (**Table 4.9**). This score is equivalent to Australia's, country that occupies the 23rd position in the GII. The world top five countries are Switzerland (67.7), Sweden (63.8), The Netherlands (63.4), US (61.4) and United Kingdom (60.9) while the last European state in the list is Belarus with a score of 30 (88th position). Thus, this result is interpreted as a full support to **Indicator 6.1**, evidencing the innovation intensity of the project consortia.

Table 4.9. Global Innovation Index by country

Countries	Orgs (N)	GII Score	Orgs (N)*GII Score
Austria	16	53,1	849,6
Belarus	1	30,0	30,0
Belgium	17	49,9	848,3
Bosnia and Herzegovina	1	30,2	30,2
Bulgaria	3	42,8	128,4
Croatia	1	39,8	39,8
Republic of Cyprus	8	46,8	374,4
Czech Republic	4	51,0	204,0
Denmark	7	58,7	410,9
Estonia	2	50,9	101,8
Finland	2	58,5	117,0
France	42	54,2	2276,4
Germany	34	58,4	1985,6
Greece	41	38,8	1590,8
Hungary	4	41,7	166,8
Iceland	1	55,8	55,8
Ireland	12	58,1	697,2
Israel	7	53,9	377,3
Italy	62	47,0	2914,0
Latvia	1	44,6	44,6
Lithuania	0	41,2	0,0
Luxembourg	3	56,4	169,2
Norway	5	53,1	265,5
Malta	3	50,6	151,8
The Netherlands	32	63,4	2028,8
Poland	3	42,0	126,0
Portugal	14	46,1	645,4
Romania	12	39,2	470,4
Serbia	2	35,3	70,6
Slovakia	5	43,4	217,0
Slovenia	2	45,8	91,6
Spain	77	48,8	3757,6
Sweden	12	63,8	765,6
Switzerland	7	67,7	473,9
Ukraine	1	37,6	37,6
United Kingdom	65	60,9	3958,5
Turkey	6	38,9	233,4
Colombia	1	34,8	34,8
Uruguay	1	34,5	34,5
Canada	1	53,7	53,7
Japan	1	54,7	54,7
TOTAL	519	1976,1	26883,5
Average organization		**48,2**	**51,8**

Other complementary information was needed to analyse the variable of cultural diversity. Heterogeneous teams are more likely to develop creative ideas compared to homogenous teams (Egan 2005) and three indicators (language, size of the cities and gender) are proposed to analyse from different perspectives the variable to conceptualize unity and diversity in the project teams.

I decided to identify the main spoken official language in each state because I was interested in knowing which language is used when partners from different regions of the same state collaborate. That is why I have not considered the Catalan, Basque, Galician, Gaelic, Maltese or other official languages. Only in the case of Switzerland and Belgium I identified the corresponding language of each region. **Table 4.10** illustrates the results obtained showing that the most spoken languages in the analysed organizations are English (16%), followed by Spanish (15%), Italian (12%), French (11%), German (10%), Greek (9%) and Dutch (8%). Thus, English is the most spoken language besides being the lingua franca of the 21st century. The different geographical origin and the diversity of languages spoken by the members of the consortium, confirm the **Indicator 14.1**.

Table 4.10. Most spoken official languages

Categories	N	%
Belarusian	1	*0*
Bosnian	1	*0*
Bulgarian	3	*1*
Croatian	1	*0*
Czech	4	*1*
Danish	7	*1*
Dutch	43	***8***
English	81	***16***
Estonian	2	*0*
Finnish	2	*0*
French	55	***11***
German	52	***10***
Greek	49	***9***
Hebrew	7	*1*
Hungarian	4	*1*
Icelandic	1	*0*
Italian	63	***12***
Japanese	1	*0*
Latvian	1	*0*
Norwegian	5	*1*
Polish	3	*1*
Portuguese	14	*3*
Romanian	12	*2*
Serbian	2	*0*
Slovak	5	*1*
Slovenian	2	*0*
Spanish	79	***15***
Swedish	12	*2*
Turkish	6	*1*
Ukrainian	1	*0*
	519	*100*

Large, creative cities are increasingly viewed as motors of economic charge (Chapain *et al.* 2010; Cohendet *et al.* 2010) and some industries, like the creative ones, are considered as eminently urban and associated to big cities (Curried-Halkett and Stolarick 2013). I classified the cities hosting the organizations in three categories (**Table 4.11)**: big (more than 500000 inhabitants), medium (between 50000 and 500000) and small (less than 50000). The results are very similar when analysing participants and coordinators: more than half of the organizations (51%) are located in big cities, followed by medium ones (37) and only a 12% are in small cities. This result supports **Indicator 14.2**, suggesting that a bigger number of partners from large cities, the more diverse the team is.

Table 4.11. Size of the cities

Categories	**Participants**		**Coordinators**	
	N	**%**	**N**	**%**
Big	264	*51*	46	*53*
Medium	193	*37*	31	*36*
Small	62	*12*	10	*11*
Total	**519**	***100***	**87**	***100***

The last indicator completing the cultural diversity variable is gender. The more women coordinating projects, the more diverse teams are. The study shows that the percentage of women coordinating projects represents the 23% of the 62 collaborative projects –and men the 77%. Therefore, this result is interpreted as a partial support for **Indicator 14.3**.

4.7.2. Management

This survey was addressed to the coordinators of the 62 projects including serious games and/or gamification technologies and supported by H2020 funds. Once the survey was closed, there were a total of 46 valid responses. According to that, 62 project coordinators compose the universe of the research and 46 is the sample obtained, reaching a sampling fraction (n/N) of 0.71 what provides a high representativeness. If the sampling had been random, the estimated margin of error would have been ± 7.5 (at the 95% confidence level).

4.7.2.1. Descriptive analysis

4.7.2.1.1. Profile of the respondent

Table 4.12 shows a brief descriptive statistics of the profile of the project coordinators. Regarding the gender distribution from the 46 respondents, data obtained shows that

30.4% were women and 69% were men. Furthermore, the 28.3% of the respondents are Professors, followed by a 23.9 % of project managers and a 21.7 of researchers.

Table 4.12. Profile of the coordinators

Item	Categories	N	%
Gender	Women	14	30.4
	Men	32	69.6
Job title of position	Professor	13	28.3
	Associate Professor	7	15.2
	Researcher	10	21.7
	CEO	5	10.9
	Project Manager	11	23.9
Total		46	100.0

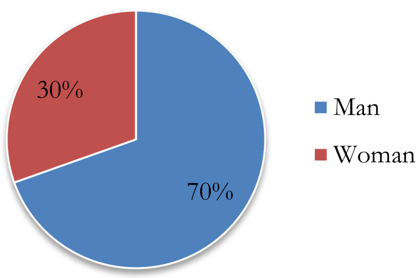


Figure 4.22. Gender distribution

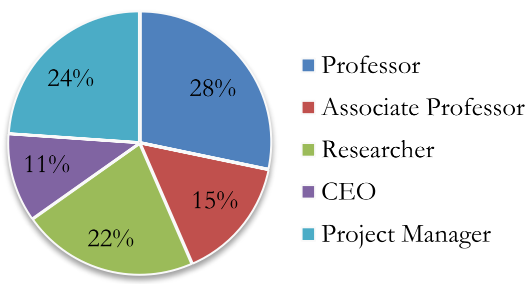


Figure 4.23. Job title or position

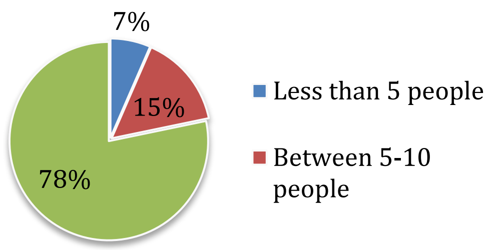
4.7.2.1.2. Profile of the organization

More than half (52.2%) of the interviewed organizations were HES, followed by PRC (30.4%) and REC at 17.4%. But in order to know the profile of the coordinating organizations, I focused the questions specifically on the unit, department or centre that really coordinates the project because many of these institutions are very big and who really works in the project is a smaller structure. **Table 4.13** shows the descriptive statistics of the profile of the coordinating organizations.

Table 4.13. Profile of the coordinating organizations (unit/department/centre)

Item	Categories	N	%
Size	Less than 5 employees	3	6.5
	Between 5-10 employees	7	15.2
	More than 10 employees	36	78.3
Type of organization	HES	24	52.2
	REC	8	17.4
	PRC	14	30.4
People directly involved in scientific/technical/ managerial activities	Less than 5	16	34.8
	Between 5-10	23	50.0
	Between 10-20	6	3.0
	More than 20	1	2.2
Year of foundation	2016-2012	4	8.7
	2011-2007	9	19.6
	2006-1996	15	32.6
	Before 1996	18	39.1
Major technological domain	Health, biotechnologies and food industry	6	13.0
	Sensoring, robotics and new materials	5	10.9
	Data analysis	8	17.4
	Green technologies	7	15.2
	Gaming and Gamification	6	13.0
	Computing sciences	11	23.9
	Other	3	6.5
Total		46	100

The size of the unit, department or centre coordinating the project has more than 10 employees in the 78.3 % of cases, followed by a 15.2% between 5 and 10 employees and 6.5% with less than 5. But obviously the number of the people directly involved in the scientific, technical and managerial activities is less: 50% between 5 and 10 people or 34.8% less than 5 people. The importance that the organization coordinating the project gives to a professional support to the partners of the consortium could be influencing the level of cross-fertilization. That is why the results obtained show a sufficient number of people working in the coordination of the project, supporting the **Indicator 13.2.**



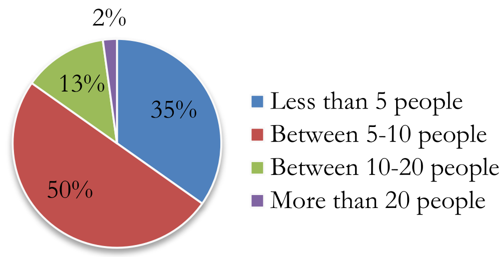


Figure 4.24. Size of the unit/department/centre

Figure 4.25. People involved in the scientific/technical/managerial activities

Related to the foundation of the unit, department or centre, the 39.1% of these structures existed before 1996 and the 32.6% were established between 1996 and 2006. The 19.6% are from the period 2011-2007 and this percentage decreases for the period 2016-2012 (8.7%). Complementarily, the most relevant technological domains (**Figure 4.26**) in these units are computing sciences (23.9%), data analysis (17.4%), green technologies (15.2%) and gaming and gamification (13%).

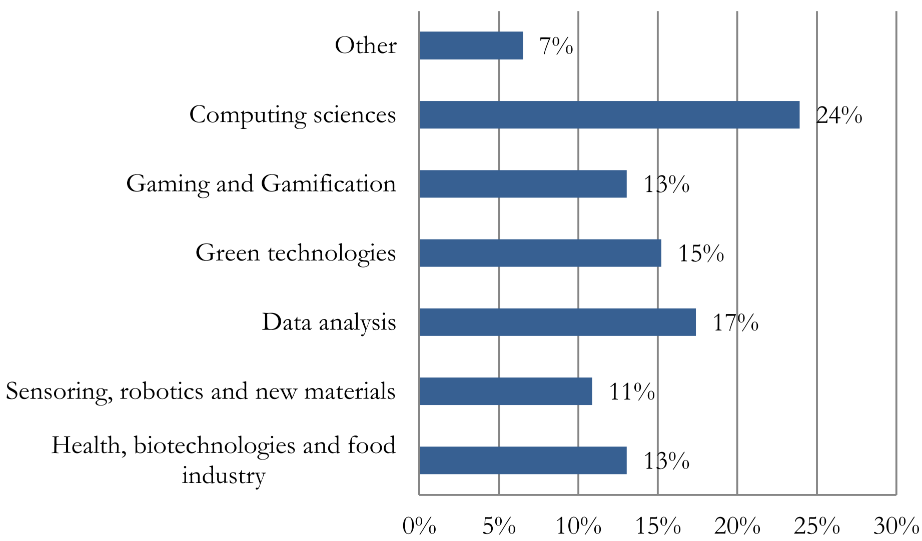


Figure 4.26. Major technological domain

4.7.2.1.3. Project information

The projects coordinated by the respondents have a number of partners between 7 and 10 in the 37% of cases, followed by consortia with more than 10 partners (33%) and others with less than 6 partners (30%) (**Figure 4.27**). In terms of the EU contribution interval, the most important group is about those projects with funds superior to the 3,000,001 euros (43%). It is followed by projects with less than 1.500.000 euros (33%) and finally those with funds between 1.500.001 and 3.000.000 (24%) (**Figure 4.28**).

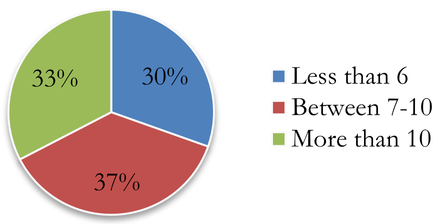


Figure 4.27. Number of partners interval

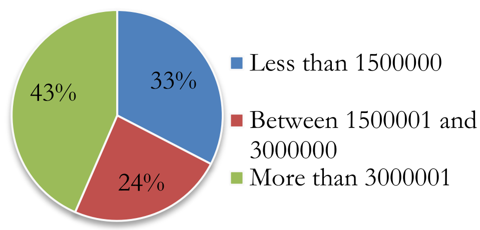


Figure 4.28. EU contribution interval

The starting point of the projects (**Table 4.14**; **Figure 4.29**) is mainly located between TRL 2 and TRL4. It means that it covers the period of research to prove feasibility. Specifically, TRL 3 is the 24% and TRL 2 and 4 the 20% respectively. On the other hand, the expected final stage of the projects is mainly situated in TRL 6 (35%), followed by TRL 5 and TRL 3 (15% respectively). It means that the expected final stages are considered as technology development and only a 13% (TRL 7 and TRL 8) are in a stage of business development. Overall, this result is interpreted as a full support for Indicators **17.1** and **17.2**.

The most relevant technologies included in the development of the projects (**Figure 4.30**) are gaming and gamification (35%), followed at a certain distance by data analysis (21%) and computing sciences (15%).

Table 4.14. Starting point and expected final stage of the projects

	Starting point		Expected final stage	
TRL	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Idea generation (TRL 0)	3	11%	3	7%
Basic research (TRL 1)	1	11%	1	2%
Technology formulation (TRL 2)	3	20%	3	7%
Applied research (TRL 3)	7	24%	7	15%
Small scale prototype (TRL 4)	3	20%	3	7%
Large scale prototype (TRL 5)	7	2%	7	15%
Prototype system verified (TRL 6)	16	4%	16	35%
Pilot system verified (TRL 7)	4	7%	4	9%
Commercial design (TRL 8)	2	2%	2	4%
TOTAL	46	100%	46	100%

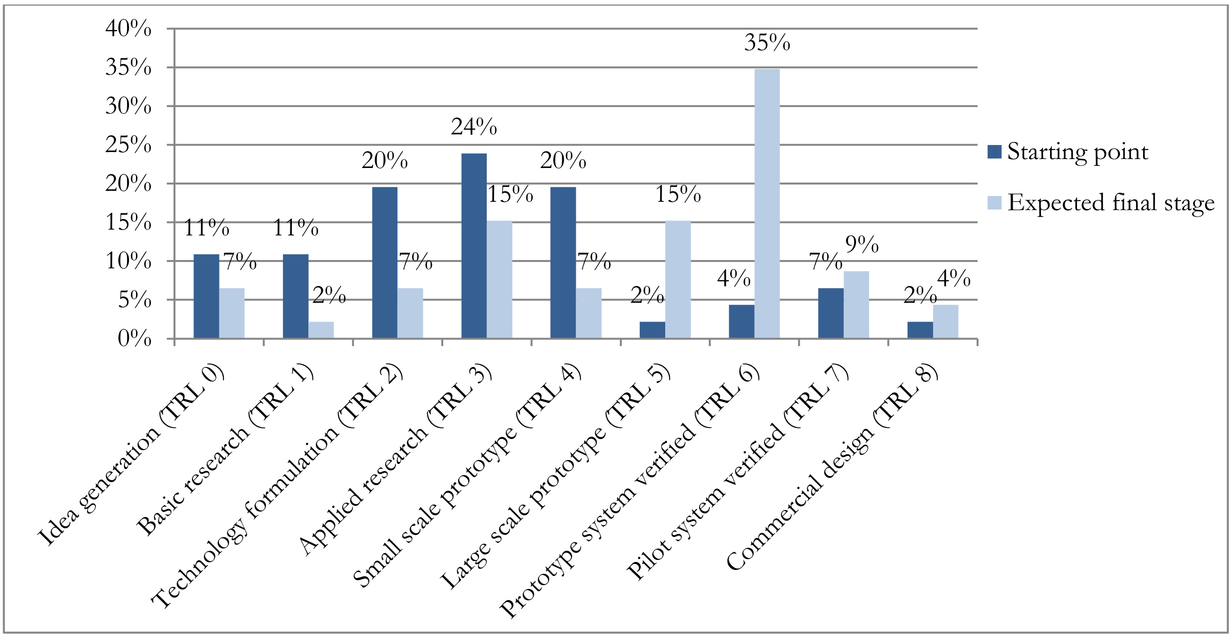


Figure 4.29. Starting point and expected final stage of the projects

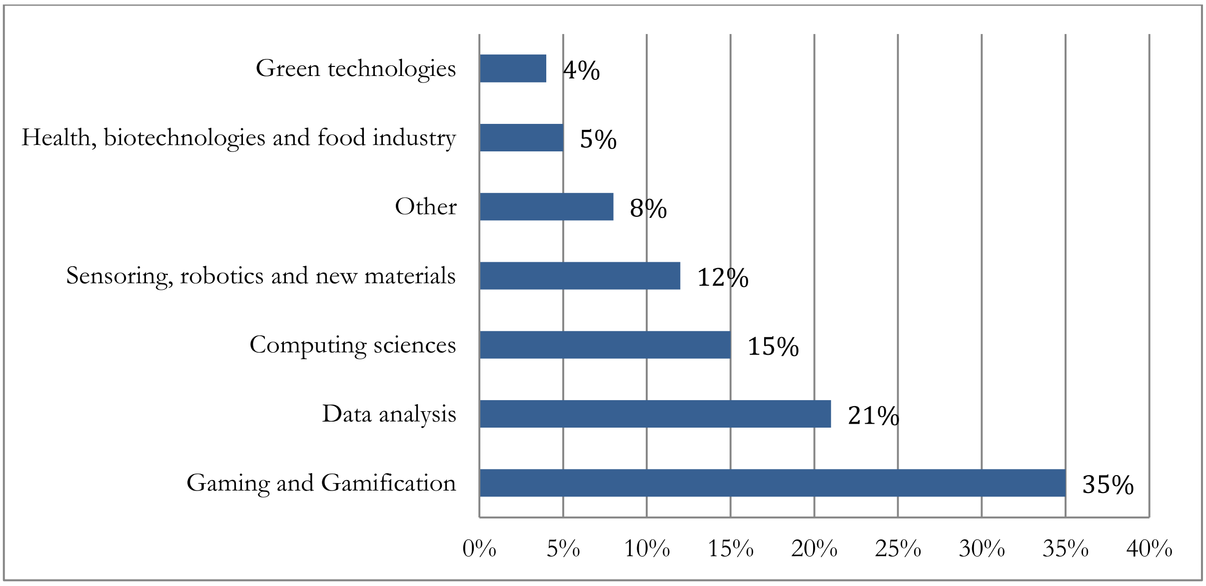


Figure 4.30. Technologies included in the development of the project

4.7.2.1.4. Knowledge and Technology

Project leaders were asked to evaluate the process of communication or agreement with their partners or team members (**Table 4.15; Figure 4.31**). In this answer and the following there were two missing answers, so, the total of answers is 44. The majority of respondents agreed that the process of communication or agreement was very easy (45%) or that there was some misunderstandings finally easily solved (41%). The rest of the respondents consider that there were problems only with some partners (14%). This information suggests a clear and easy process of communication, supporting the **Indicator 7.1**.

In regard to the way in which the decision making/problem solving process within the project (**Table 4.16; Figure 4.32**) is carried out, the 52% of project coordinators said this is a collective decision. It is followed by the 34% who said this process is carried out through a board or coordinator. The lowest percentage is for a vertical bilateral process (7%), informal meetings (2%) or other (5%). Reading the specific responses for this category, two of the three answers say that depending on the problem, they act with a collective decision or through board/coordinators; the third answer informs that they organize consensus meetings with work-package leaders and a core team from three organizations. As it was argued that with shorter technological distances, the process of decision making and problem solving could be perceived as easy, in this case I can fully support **Indicator 7.2**.

Table 4.15. Process of communication or agreement

Categories	**N**	**%**
Very easy	20	45
There were some misunderstandings finally easily solved.	18	41
There were problems only with some partners.	6	14
Total	44	100
Missing	*2*	

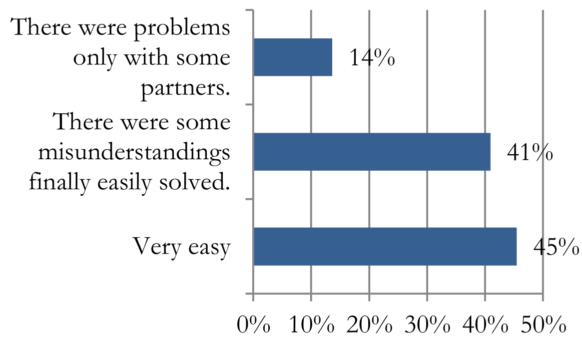


Figure 4.31. Process of communication or agreement

Table 4.16. Decision making or problem solving process

Categories	N	%
Other (please specify)	2	5
As a collective decision	23	52
Through a board/coordinator	15	34
Vertical bilateral	3	7
Only in informal meetings	1	2
Total	44	100
Missing	*2*	

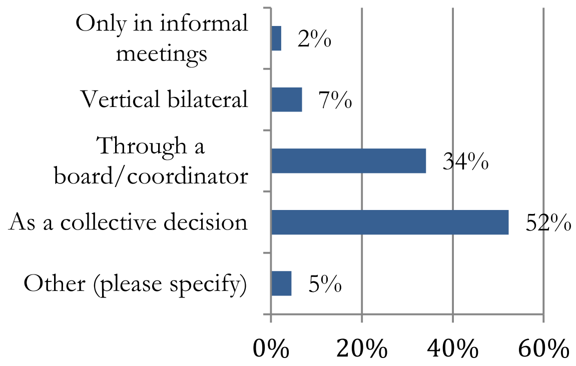


Figure 4.32. Decision making or problem solving process

The 45% of leaders participating in a consortium believed that their technological knowledge was quite similar compared with the technological knowledge of their partners in the consortium. 11% of them answered that their knowledge was very similar (**Table 4.17**; **Figure 4.33**). As it was argued that with shorter technological distances, the perceived technological knowledge form their network could be perceived as easy, findings suggest a partial support for **Indicator 7.3**.

Table 4.17. Technological knowledge

Categories	N	%
Very similar	5	11
Quite similar	20	45
Quite different	17	39
Very different	2	5
Total	44	100
Missing	*2*	

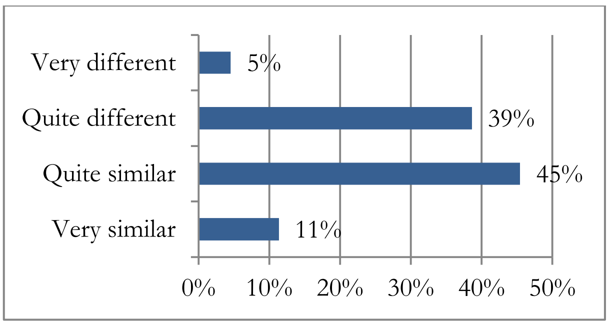


Figure 4.33. Technological knowledge

When the project coordinators were asked about the number of PhDs involved in the project (**Table 4.18**; **Figure 4.34**), the 34% said that between 30 and 50% are PhDs, followed by the 27% who answered between 10 and 30 and a 25% said that more than half are PhDs. Any case, there is a very relevant number of high qualified people in the consortia. In this case, the **Indicator 12.1** is fully supported because in the 59% of projects there are more than a 30% of PhDs.

Table 4.18. PhDs involved in the projects

Categories	N	%
None	1	2
< 10%	5	11
10-30%	12	27
30-50%	15	34
>50%	11	25
Total	44	100
Missing	2	

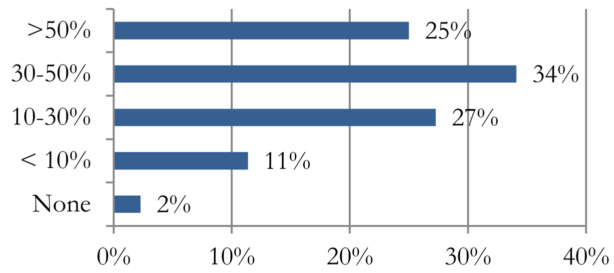


Figure 4.34. PhDs involved in the projects

Project leaders were asked about the level of involvement of Serious Games and/or Gamification in the project (**Table 4.19**; **Figure 4.35**). Including the essence of games – fun, play, transparency, design and challenge- and applying it to real-world objectives rather than pure entertainment (Palmer *et al.* 2012:54; Terlutter and Capella 2013), gamification helps to reduce distance between partners and their knowledge and technology.

One half agreed that Serious Games and/or they are very important, followed by the 23% who said they are important and the 18% who answered moderate. Weak (5%) and unnecessary (5%) were the answers with a lower percentage. The more important gamification and serious games are in the project, the distance is considered shorter. That is why **Indicator 17.4** is fully supported.

In fact, I asked to the interviewed video game companies[81] about their interests in the Serious Games and Gamification and their importance in their own R&D and business strategy. Raval Matic, Abylight, Omada and Ubisoft said they make strategic monitoring of these fields and Abylight and Omada have experience in them. Mrs. Maria Teresa Cordón says that Ubisoft has worked with professional trainers and dancers, and Abylight won with

[81] The interviewees were: Mr. Andreu Taberner (CEO of Creatiulab; www.creatiulab.com), Mr. Javi Sanz (Art director and CEO of Ravalmatic; www.ravalmatic.com); Ms. Inma Chapín (CEO of Omada; www.omada.es); Ms. Eva Gaspar (CEO of Abylight and president PAD –Professional Associated Developers-; www.abylight.com); Mr. Pere Torrents (Co-director of GAMEBCN and Marketing Manager of Incubio; www.gamebcn.co); Ms. Maria Teresa Cordón (Managing director of Barcelona Studio of UBISOFT; www.ubisoft.com).

Afterzoom- Microbe Hunter the Best Educational European Game Award at the Fun & Serious Game Festival. On the other hand, BCNGame and Creatiulab prefer to focus their developments in the fun games. As Prof. Simon McCallum[82] said in the interview held, traditional video game companies have an opportunity developing video games for the purpose of changing player's attitudes and behaviours, being both an expressive and persuasive medium.

Table 4.19. Role of Serious Games and Gamification

Categories	**N**	**%**
Very important	22	50
Important	10	23
Moderate	8	18
Weak	2	5
Unnecessary	2	5
Total	44	100
Missing	*2*	

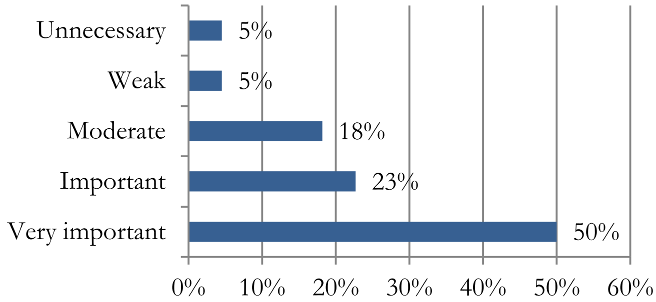


Figure 4.35. Role of Serious Games and Gamification

The hours devoted to data and knowledge sharing among all participants per month (**Table 4.20**; **Figure 4.36**) is more than 12 hours in the 48% of projects. This percentage is higher than the rest: between 4-8 hours (20%) and between 8-12 hours (18%). The lower percentage allocates less than four hours (14%).

Table 4.20. Hours a month of data and knowledge sharing

Categories	N	%
Less than 4 hours	6	14
Between 4-8 hours	9	20
Between 8-12 hours	8	18
More than 12 hours	21	48
Total	44	100
Missing	*2*	

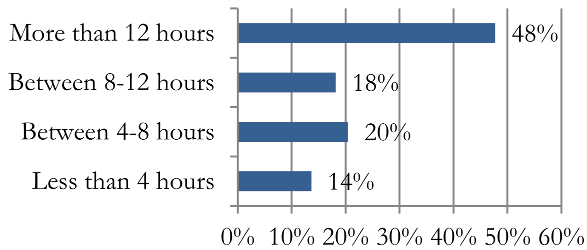


Figure 4.36. Hours a month of data and knowledge sharing

[82] Simon McCallum is an Associate Professor at the Faculty of Information Technology and Electrical Engineering, NTNU Norwegian University of Science and Technology, Gjøvik, Norway.

Project leaders were asked about the involvement of the end users/costumers in the development of the project (**Table 4.21**; **Figure 4.37**). The 98% said yes but giving different hints in their answers: 45% answered that they participate as a partner of the consortium, the 36% said they are represented by one/ or more of the partners and 14% said through outsourcing (directly contracted by one/ or more of the partners). On the contrary, only a 2% said "No". According to these results, the **Indicators 10.2** and **16.1** are fully supported. At this point, Prof. McCallum[83] points out that "people are hungry of internet". They want to participate in the process of development, and maybe in a more active way than just giving their opinions. According to the skills of our end users, organizations would think new ways to include them at the early stages of the value chain. Thus, the results will be more satisfactory for all parties.

Table 4.21. End users/ costumers involved in the development of the project

Categories	**N**	**%**
Yes, as a partner of the consortium	20	45
Yes, they are represented by one/ or more of the partners	16	36
Yes, through outsourcing (directly contracted by partner/s)	6	14
No	2	5
Total	44	100
Missing	*2*	

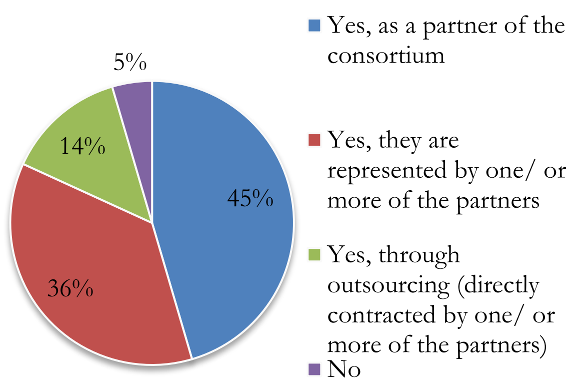


Figure 4.37. End users/costumers involved in the development of the project

The previous question (**Table 4.21**; **Figure 4.37**) was answered positively in the 95% of cases. In order to know more about those who answered positively, I introduced a question

83 Simon McCallum is an Associate Professor at the Faculty of Information Technology and Electrical Engineering, NTNU Norwegian University of Science and Technology, Gjøvik, Norway.

to know the stage of the value chain in which the end users or costumers started to collaborate (**Table 4.22; Figure 4.38**). The 27% of the respondents answered the TRL4, followed by a 17% who answered the TRL 2 and the 12% chose the TRL0, TRL3 and TRL6. It means that mainly collaborations started in a stage of technology development (TRL4, TRL5 and TRL6; the 44%) or in a stage of knowledge development (TRL1, TRL2 and TRL3; the 36%). Only in the 7% of projects the collaboration with end users and customers started in a business development stage. Finally, it is interesting to observe how adding TRL 0 (12%) to the knowledge development stage (36%), it equals 48%. In this case **Indicator 10.3** (stage in which started the collaboration with the end users) complements **Indicator 10.2** and both are fully supported.

Table 4.22. Stage in which end users/costumers started to collaborate

Categories	N	%
Idea generation (TRL 0)	5	12
Basic research (TRL 1)	3	7
Technology formulation (TRL 2)	7	17
Applied research (TRL 3)	5	12
Small scale prototype (TRL 4)	11	27
Large scale prototype (TRL 5)	2	5
Prototype system verified (TRL6)	5	12
Pilot system verified (TRL 7)	3	7
Total	41	100
Missing	*3*	

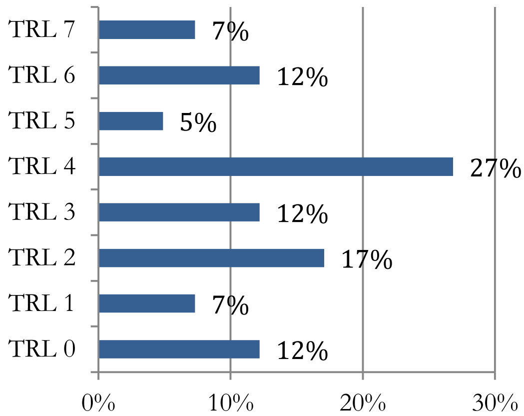


Figure 4.38. Stage in which end users/costumers started to collaborate

4.7.2.1.5. Collaborative experience

When organizations were asked about previous collaborations with some partners of the current project (**Table 4.23**; **Figure 4.39**) the most prevalent answer was "few of them" in the 68% of cases although a 14% answers "most of them" and a 2% "all of them". Only a 16% of respondents said that never worked with any partner of the current project. These findings give support to **Indicator 11.1** considering that a good collaborative experience in previous alliances, gives organizations relational capabilities that fosters the development of superior competences (Mooi and Sarstedt 2011) and the effective selection of future alliance partners (Rogers 1995). **Table 4.24** and **Figure 4.40** show at which stage of the value-chain the collaboration started in the previous collaboration, supporting **Indicator 11.2**.

Previous collaborations with same partners also demonstrate that organizations share values, confidence and aims, and it is a good measure of experience in higher TRLs. That is why this previous thesis is also supported by the **Indicator 17.3**.

Table 4.23. Previous collaborations with current partners

Categories	N	%
All of them	1	2
Most of them	6	14
Few of them	30	68
None of them	7	16
Total	44	100
Missing	*2*	

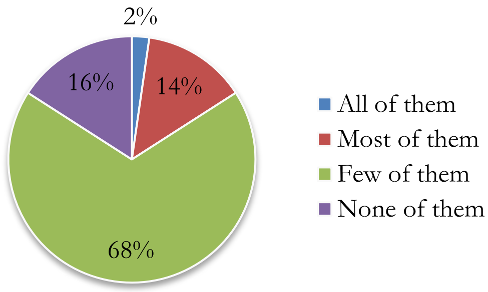


Figure 4.39. Previous collaborations with current partners

Those who answered positively to the previous question (**Table 4.24**; **Figure 4.40**) started to collaborate with these partners in previous projects, mainly in TRL0 (31%), TRL1 (19%) and TRL3 (19%). It means that mainly collaborations started in the stage of knowledge development and they could have a deep knowledge of those partners, supporting **Indicator 17.4**.

Table 4.24. TRL at previous collaborations

Categories	N	%
Idea generation (TRL 0)	11	31
Basic research (TRL 1)	7	19
Technology formulation (TRL 2)	3	8
Applied research (TRL 3)	7	19
Small scale prototype (TRL 4)	5	14
Prototype system verified (TRL6)	2	6
Commercial design (TRL 8)	1	3
Total	36	100
Missing	*10*	

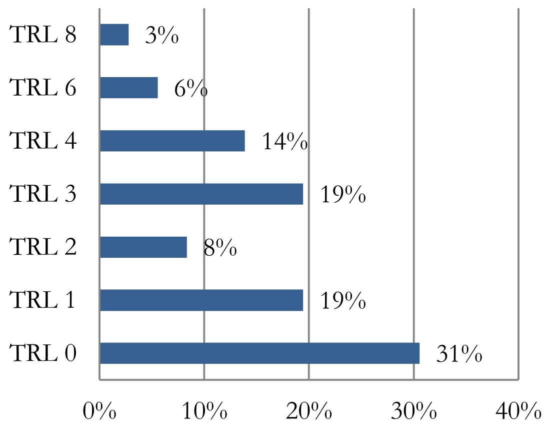


Figure 4.40. TRL at previous collaborations

Project coordinators leading a consortium were asked about the main reasons to collaborate with other partners in the project (**Figure 4.41**). 42% of respondents ranked access to knowledge/ technological resources as a very important reason, 36% mentioned speeding up the innovation process and 11% gaining competence advantage in the market. Accessing to new markets was a less important reason with 7% of respondents. These results supporting the open innovation theory, affirming that collaborating with competitors is associated with external search strategies, fully supports **Indicator 9.1**. In the case of **Indicator 13.3**, it is argued that different reasons to collaborate require different kind of partners in the consortium. That is why Indicator 13.3 is fully supported.

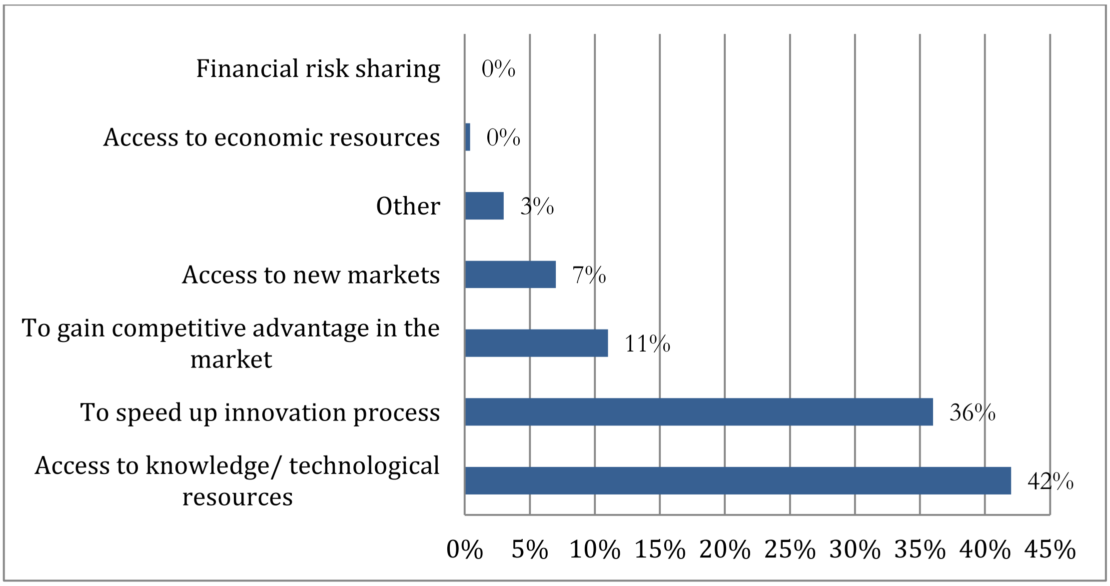


Figure 4.41. Main reasons to collaborate

4.7.2.1.6. Market orientation

Partners cover all the value chain (**Table 4.25**; **Figure 4.42**) in the 84.1% of cases. The creation of value takes places along the value chain, from research to market. This result is a clear full support for **Indicator 15.1**.

Table 4.25. Partners cover all the value chain

Categories	N	%
Mostly	37	84.1
No	7	15.9
Total	44	100.0
Missing	2	

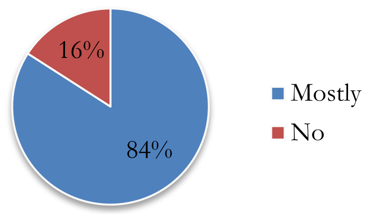


Figure 4.42. Partners cover all the value chain

From the 44 respondents, 21 of them (48%) said that market research is very important in the development of the project, followed by a 36% who answers quite important (**Table 4.26**; **Figure 4.43**). Only a 16% says it is not important for the development of their project. These results show the importance of market research for taking good decisions in terms of accessibility and acceptability of customers. Overall, this result is interpreted as a full support for **Indicator 15.2**.

Table 4.26. Importance of market research

Categories	N	%
Very Important	21	48
Quite important	16	36
Not important	7	16
Total	44	100
Missing	2	

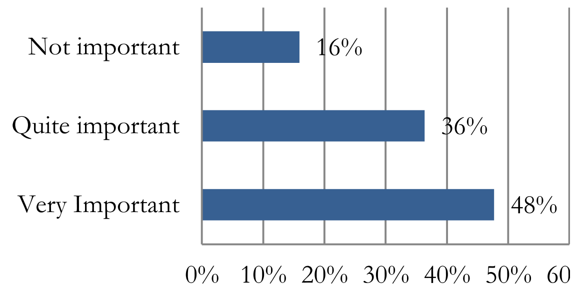


Figure 4.43. Importance of market research

Project coordinators were also asked to choose what they considered to be the principal driver of the product demonstration or pilot production at their organizations (**Table 4.27**; **Figure 4.44**). A great majority answered that information on research activities, such originating from universities, research and technology organizations, customers or competitors, are the principal drivers. Market reasons is the second chosen category, as competitive pressure, customer requirements or estimated potentials. Other reasons as market regulation activities and others were less often selected.

In this context the **Indicator 15.3** is related to knowing if market reasons are the principal driver of product demonstration or pilot production for organizations. The results obtained show how the first driver is related to the information on research activities, rejecting the Indicator 15.3.

But Mr. Simon Lee[84] considers that the market strategy is basic to guarantee the success of the project. From a gaming perspective, "projects must monetize the frustration to achieve a clear competitive advantage". Besides, he supports that the introduction of serious games and gamification in a project could help to extend the product's shelf life. In parallel, Javier Celaya[85] also puts the emphasis on the business model and considers that the example to follow is that of the video game industry. The reason is that the video game industry understood before anyone that it was necessary to go from selling objects to services. So, the company hooks the customer with a fremium model and then when they want more, it makes them pay to cover their need.

Table 4.27. Main drivers of the product demonstration or pilot production

Categories	**N**	**%**
Market reasons	14	32
Information on research activities	19	43
Market regulation activities	2	5
Other	9	20
Total	44	100
Missing	2	

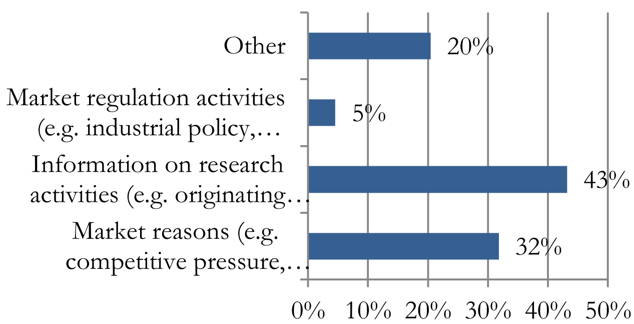


Figure 4.44. Main drivers of the product demonstration or pilot production

The vast majority of respondents said that the final costumer or end user is being involved during the product demonstration activities (**Table 4.28**; **Figure 4.45**). This finding does

[84] Simon Lee is CEO of Peninsula -a corporate incubator for Startup's- and director of Canòdrom, the Creative Research Park of Barcelona. Also, he was founder of Incubio and Gamebcn.
[85] Javier Celaya is the CEO and founder of Dosdoce.com, as well as the vice president of ARDE (the Spanish Digital Magazines Association) and member of the Executive Board of the Digital Economy Association of Spain as well as a strategic advisor and investor of leading publishing digital initiatives.

fully support **Indicators 10.4** and **16.2** and confirms the relevant rol of end users and customers in these projects. Runa Haukland[86], CEO of Hamar Game Collective, considers a key point the contact with end users along all the value chain. This collective acts as an incubator for indie companies aiming to reach for a share of the market and they are all driven by a desire to have a common place to meet, work and exchange knowledge between companies, end users and potential partners.

Table 4.28. End users/costumers involved in the product demonstration activities

Categories	N	%
No	3	7
Yes	41	93
Total	44	100
Missing	2	

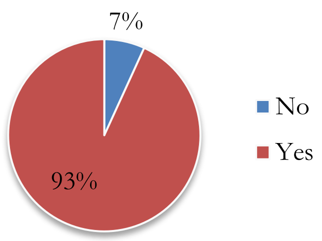


Figure 4.45. End users/costumers involved in the product demonstration activities

4.7.2.2. Statistical tests

In the previous section, different variables have been described as fundamental to obtain information on project consortia. From a more specific perspective, it is necessary to select certain exogenous variables that influence directly in the development of other endogenous variables. In this research, I selected some variables that firstly I crossed between them (**3.8.2.1.1**) and then with the rest of variables (**3.8.2.1.2**).

4.7.2.2.1. Statistical significance between the key variables

To establish the existing relationships, different statistical methods[87] are performed and the results are summarized in **Table 4.29**. The table shows how a relationship between the

[86] CEO of Hamar Game Collective .

[87] In cases in which the associated significance is less than 0.05 using the Pearson Chi-square test, ANOVA and Pearson coefficient, the null hypothesis (independence of the variables) will be rejected and a statistical

variables “type of organization” and “gender” exist; these variables are not independent of each other, existing a statistically significant relationship (p=0.004).

These two associated variables (“type of organization” and “gender”) show how projects coordinated from HEC and REC (knowledge producing institutions) are clearly leaded by men, while projects coordinated by private companies are mainly leaded by women. The rest of variables analysed are independent of each other and there is not a statistically significant relationship between these variables.

Table 4.29. Statistical significance between the key variables

	Type of organization	Gender	Number of partners	Major technological domain
Type of organization	-----	Pearson Chi-Square **0.004**	Kruskal-Wallis 0.391	Pearson Chi-Square 0.484
Gender	-----	------	Mann-Whitney 0.250	Pearson Chi-Square 0.233
Number of partners	------	------	-----	Pearson Chi-Square 0.557
Major technological domain	------	------	-----	-----

4.7.2.2.2. Statistical significance between the key variables and the remaining variables

After having crossed all the variables and done their statistical tests, I decided to show some of the most relevant results. With this aim, I crossed some variables with the key

relationship between the cross variables will be confirmed. However, in the case of using ANOVA we could assume the normality of the data but not the homogeneity or homoscedasticity, the nonparametric test H of Kruskal-Wallis will be used through the Levene statistic. In this case, the null hypothesis will be also rejected when the associated significance is less than 0.05.

ones but adding an additional one: the role of Serious Games and Gamification. The result of the statistical tests is shown in **Table 4.30.**

In reference to the number of PhDs, the data shows how there is a dependent relation with the type of organization, existing a statistically significant relationship (p=0.001). There is a clear higher percentage of PhDs in HES and REC; on the contrary, the percentage of PhDs in private companies is lower. The rest of key variables crossed with the number of PhDs (gender, number of partners, major technological domain and role of serious games and gamification) are independent and there is not a statistically significant relationship between them.

Regarding to previous collaborations, the Kruskal-Wallis test rejects the null hypothesis, showing the existence of a relationship between the variables "previous collaborations" and "number of partners"; these variables are not independent of each other, existing a statistically significant relationship (p=0.043). So, it is shown a concentration of answers saying respondents collaborated with few partners of the current project, drastically decreasing the number of answers in the following categories ("most" or "all of them"). Also, it draws my attention that projects with less than 6 partners did not collaborate with none of these partners in the 43% of cases.

The thematic area has a dependent relationship with the major technological domain variable, existing a statistically significant relationship (p=0.048). It is observed how some thematic areas are clearly dependent of some major technological domain. It is the case of the following: the health area is more connected to computing science (57%) and biotech (43%); the education area to gaming and gamification (36%); the energy area to green technologies (57%); environment and climate change to data analysis (38%); or security that is more connected to computing science (50%). The rest of key variables crossed with the thematic area are independent and there is not a statistically significant relationship between them.

The fourth row shows a significant relationship with a high positive correlation (r=0.833; p=0) between the EU contribution and the number of partners. It means that the more partners per project, the greater the funds received from the EU (**Figure 4.46**).

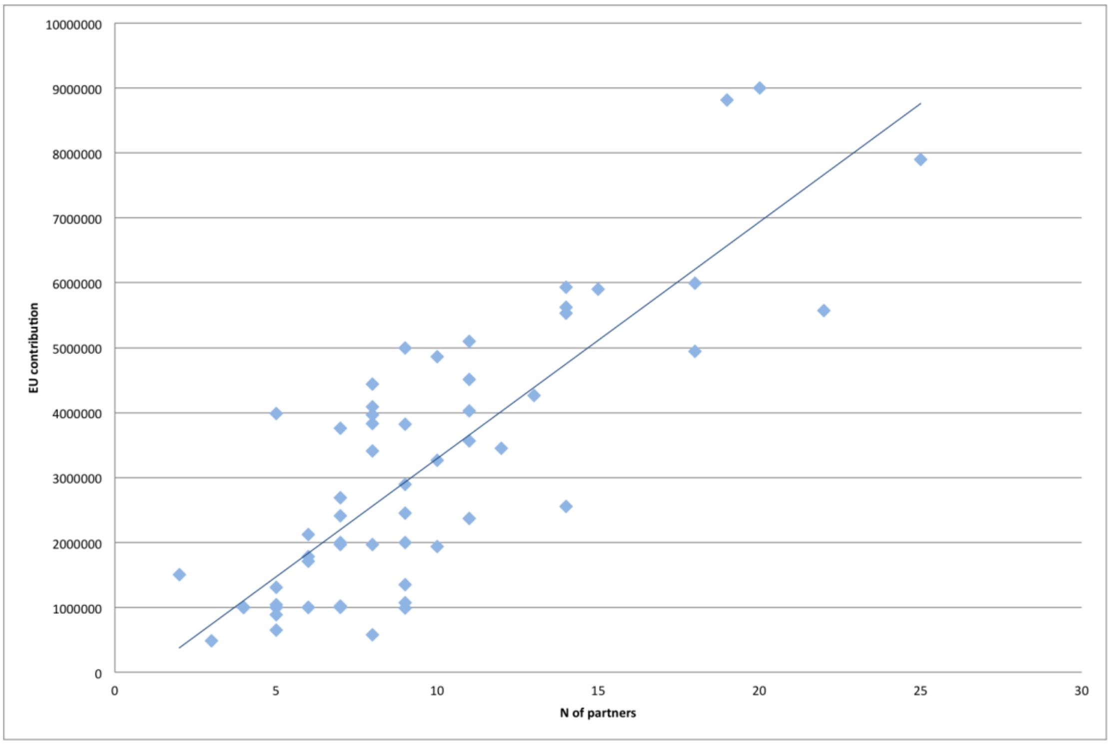


Figure 4.46. Scatter Plot Graph with Linear Regression Trendline of EU contribution and number of partners per project

The fifth row shows how the "role of Serious Games and Gamification" variable has a dependent relationship with the major technological domain, existing a statistically significant relationship (p=0.002). In this case, the more important the role of Serious Games and Gamification is, the greater the number of projects in each technological domain (supporting **Indicator 7.4**). Specifically, in the 50% of projects the role of Serious Games and Gamification are very important. Furthermore, it is interesting to remark that the "role of Serious Games and Gamification" and the "number of partners" are independent and there is not a statistically significant relationship between them.

The sixth row shows a significant relationship between the job title or position with the type of organization (p=0.003). There is a clear higher percentage of Professors (69%), Associate Professors (100%) and Researchers (50%) in HES, while CEOs (80%) and Project Managers (64%) are a majority in the private companies. These results fully support **Indicator 7.5**.

Finally, I want to comment two results in which there is not a statistical relationship between variables but maybe because the size of the universe. The relation between the type of organization and the previous collaborations shows how there is a big percentage of respondents who say they previously collaborated with few partners (68%) and on the other hand the 16% responded they never collaborated with any partner. So, it is important to observe how knowing somebody in the consortium from a previous experience is the most usual for a majority of organizations. The second relationship that draws my attention is between EU contribution and the role of serious games and gamification. The answers "very important" (50%) and "important" (23%) show how relevant is the role of serious games and gamification in these projects.

Table 4.30. Statistical significance between the key variables and other variables

	Type of organization	**Gender**	**Number of partners**	**Major technological domain**	**Role of Serious Games and Gamification**
PhDs interval	Pearson Chi-Square **0.001**	Pearson Chi-Square 0.071	Kruskal-Wallis 0.873	Pearson Chi-Square 0.681	Pearson Chi-Square 0.727
Previous collaborations	Pearson Chi-Square 0.055	Pearson Chi-Square 0.233	Kruskal-Wallis **0.043**	Peason Chi-Square 0.527	Pearson Chi-Square 0.239
Thematic area	Pearson Chi-Square 0.801	Pearson Chi-Square 0.127	Kruskal-Wallis 0.12	Pearson Chi-Square **0.048**	Pearson Chi-Square 0.092
EU contribution	Kruskal-Wallis 0.756	Mann-Whitney 0.152	Pearson Correlation **0 0.833**	Kruskal-Wallis 0.848	Pearson Chi-Square 0.051
Role of Serious Games and Gamification	Pearson Chi-Square 0.564	Pearson Chi-Square 0.740	Kruskal-Wallis 0.119	Pearson Chi-Square **0.002**	-----
Job title or position	Pearson Chi-Square **0.003**	Pearson Chi-Square 0.241	Kruskal-Wallis 0.592	Pearson Chi-Square 0.312	Pearson Chi-Square 0.203

4.7.2.2.3. Statistical significance between some remaining variables

After crossing all the remaining variables[88], other significant relationships between variables were found. These are the following:

- **TRL starting point/ Expected final TRL**: Pearson Chi-Square **0.000.**
  There is a significant relationship between the TRL starting point and the expected final TRL (p=0). It means that the higher the TRL starting point is, the higher the expected final TRL is.

- **Expected final TRL/ Previous collaboration with same partners**: Pearson Chi-Square **0.002.**
  The data shows how there is a dependent relationship between the expected final TRL and the Previous collaboration with same partners, existing a statistically significant relationship (p=0.002). It is observed that in the case of no previous collaborations the most relevant expected final TRL is TRL1, but when the answer is few of them the TRL advances to TRL7. The TRL for the answer "all of them" is between the TRL5 and TRL7 range.

- **Perceived technological knowledge/ Invested time in knowledge sharing**: Pearson Chi-Square **0.027.**
  There is a significant relationship between the perceived technological knowledge and the invested time in knowledge sharing (p=0.027). When the perceived technological knowledge is "quite similar" and "quite different", the time invested in knowledge sharing is more than 12 hours for the 50% and 59% of cases, respectively. On the contrary, when the perceived technological knowledge is very similar the time for knowledge sharing is lower in the 80% of cases.

[88] In cases in which the associated significance is less than 0.05 using the Pearson Chi-square test, ANOVA and Pearson coefficient, the null hypothesis (independence of the variables) will be rejected and a statistical relationship between the cross variables will be confirmed. However, in the case of using ANOVA we could assume the normality of the data but not the homogeneity or homoscedasticity, the nonparametric test H of Kruskal-Wallis will be used through the Levene statistic. In this case, the null hypothesis will be also rejected when the associated significance is less than 0.05.

The more equal perception of benefits from the alliance network, the greater technological effort can be done (**Table 4.17; Figure 4.33**). In this case, the answers of "quite similar" and "very similar" makes a total of 56%. Furthermore, analysing the variable time in knowledge sharing (**Table 4.20; Figure 4.36**), organizations with stronger technological efforts spend more hours in data and knowledge sharing. In the **Figure 4.36**, 66% of the interviewees spend more than 8 hours a month. These two results and their dependent relationship between both variables (p=0.027) give a full support to **Indicator 8.2** and **8.3** what means that a bigger technological effort must be done because cross-fertilization of technologies is being boosted when organizations make stronger knowledge and technological efforts to import the ideas from the network (**H8**).

4.8. Discussion

The results obtained in this study are summarised in **Table 4.31**. Findings give rise to the belief that the cross-fertilization of knowledge and technologies in projects including serious games and gamification is a process developed through an open innovation strategy. In a world of widely distributed knowledge, the boundaries between an organization and its environment have become more permeable; innovations can be easily transferred inward and outward.

The first evidence that suggests this open innovation strategy is the relevance that organizations leading higher cross-fertilized projects use external as well as internal ideas. In this study, project leaders have shown that they are not afraid to lose their internal know-how because they believe that obtaining external knowledge is more beneficial for their organizations and projects. A resulting effect is that these organizations make stronger efforts for knowledge and technology sharing.

The second evidence is related to the informal type of collaborative partnerships in projects with higher level of cross-fertilization. Organizations are motivated by the importance of forming ties to the larger scientific community in order to access to basic knowledge. They become more efficient learners and have a higher absorptive capacity. An open innovation strategy supports the fact that cooperative environments contribute to better exploitation of limited research capacities (Roger and Brookes 1999; OECD 1999) and to the development of valuable and more radical ideas and solutions adjusted to the increasing complexity of problems, especially when more than one technology is involved (Harvey *et al.* 2015; Paez-Aviles 2015).

The third evidence is related to the market strategy, a priority from an open innovation perspective. Business models change and evolve over time to remain sustainable and innovative. They need to be adjusted over time in order to remain viable, particularly in the context of changing environmental conditions and constraints (Amit and Zott 2012; Bucherer *et al.* 2012; McGrath 2010). In fact, rapidly changing ecosystems (Teece 2010; Casadesus-Masanell and Zhu 2013) force firms to adapt to new conditions and transform their business models in order to exploit new market opportunities that are defined by the needs of both the current and the potential target customers and the use of knowledge for creating superior value for them (Naver and Slater 1990). Prioritizing customers facilitates adoption and implementation of new innovations (Boon *et al.* 2011).

On the other hand, the result obtained with the **Indicator 15.3**[89] suggests that project coordinators put more emphasis on research activities instead of the market driver. This finding suggests the contrary that the open innovation policy defends, which is putting more emphasis on the business model (Linder *et al.* 2003; Chesbrough 2003). A plausible explanation could be related to the configuration of the research consortium, with partners more interested in developing knowledge than in exploiting the results; a second reason linked to the previous one is the great weight of universities and research centres in the consortia. Those reasons have generated a long tradition of partners who have worked according to the premises of the previous seven Framework Programmes for Research and Technological Development[90] of the European Commission in which the exploitation of results could be justified just with few activities of dissemination.

89 Indicator 15.3 makes reference to the main driver of the product demonstration/pilot production.

90 These were the funding programs created by the European Comission to support and foster research in the European Research Area. They covered five-year periods and were the following: FP1 (1984-1987), FP2 (1987-1991), FP3 (199o-1994), FP4 (1994-1998), FP5 (1998-2002), FP6(2002-20006), FP7 (2007-2013).

This research suffers from a number of limitations. Firstly, the database sample covers a period of 28 months. I focused my attention on this period because H2020 specifically prioritized the serious games and gamification for the first time with two specific ICT calls (ICT-21-14 and ICT-24-16) and secondly because there is an explosion of projects including serious games and gamification[91] in the last four years. These facts can be understood as a way to push the research along the value chain in order to get superior TRLs, helping the end user to interact with the outcome or output resulting from the exploitation strategy.

A second limitation could be that the survey was addressed to coordinators of 62 projects. Although the response rate is very high (74.1%), extremely superior to those of e-mail surveys involving senior executives (Kriauciunas *et al.* 2011), in some questions resulted in limited levels of variation in the dependent variable. Nevertheless, this survey was always understood as a complement to the database analysis, in order to better understand the project coordinators' behaviour and to know more about the operation of the consortium.

Finally, although the number of topics covered was quite broad, the third limitation makes reference to the European focus of the projects. This decision implies that there were possibly missed regional initiatives or priorities that can result in different national strategies for application areas and have not been identified and studied. The long-time debate between the Europe of states and the Europe of the regions (Borrás-Alomar *et al.* 1994; Bauer 2002; Bache *et al.* 2004; Bauer and Börzel 2010; Boeva 2014) has been intensely reopened last year although the purpose of this study was not to analyse the best strategy for financing collaborative projects in the European ecosystem.

[91] Experts predict that the gamification market will grow by 500% to roughly $11.10 billion by 2020. Retrieved from: https://blog.atrivity.com/why-gamification-industry-will-grow-to-11-billion-by-2020 [accessed 20 April 2018].

Table 4.31. Verification of hypothesis

Research Question	Hypothesis	Variables		Indicator	
RQ1	H1. The degree of multidisciplinarity of a project is positively associated with the creation of multidisciplinary knowledge and technology.	**V1. Degree of multidisciplinarity**	☑	I1.1. Number of topics (colorimetric map) I1.2. Thematic areas I1.3. Number of projects coordinated by country and main thematic area	☑ ☑ ☑
	H2. The size of the joint knowledge base of organizations within a project is positively associated with the creation of multidisciplinary knowledge and technology.	**V2. Knowledge base**	☑	I2.1. Type of organizations I2.2. Percentage of projects coordinated by HEC and REC I2.3. Correlation between type of organizations and thematic areas I2.4 Universities in the 2017 European Universities Rank (QS) I2.5. Research Centres in the 2017 European Ranking Web of Research Centres.	☑ ☑ ☑ ☑ ☑
	H3. The number of organizations in a project has a positive association with the creation of multidisciplinary knowledge and technology.	**V3. Number of organizations**	☑	I3.1. Average number of organizations per project	☑
	H4. The diversity of organizations in a project has a positive association with the creation of multidisciplinary knowledge and technology.	**V4. Diversity of organizations**	☑	I4.1. Diversity of typology of organizations per project. I4.2. Correlation between type of organizations and thematic areas.	☑ ☑
	H5. The degree of clustering around a project is negatively associated with the creation of multidisciplinary knowledge and technology.	**V5. Degree of clustering**	☑	I5.1. Number of connections. I5.2. Number of projects with a high percentage of organizations in local clusters.	☑ ☑
	H6. The innovation intensity in a project is positively associated with	**V6. Innovation Intensity**	☑	I6.1. Average of Global Innovation Index by project consortium	☑

	the creation of multidisciplinary knowledge and technology.				
RQ2	H7. Cross-fertilization of knowledge and technologies is being boosted when there are larger knowledge and technological distances in the network.	**V7. Knowledge and Technological distance**	☑	I7.1. Process of communication or agreement (q0010) I7.2. Decision making/ problem solving (q0011) I7.3. Perceived technological knowledge from their network (q0012) I7.4. Level of involvement of Serious Games and Gamification in the project (q0014) I7.5. Degree of complementarity of organizations	☑ ☑ ☐ ☑ ☑
	H8. Cross-fertilization of technologies is being boosted when organizations make stronger knowledge and technological efforts to import the ideas from the network.	**V8. Technological effort**	☑	I8.1. Openness in knowledge sharing (number of HES and REC) I8.2. Perceived technological knowledge from their network (q012) I8.3. Invested time in knowledge sharing (q0015)	☑ ☑ ☑
	H9. Cross-fertilization of knowledge and technologies is being boosted when organizations consider important to have access to external information.	**V9. Access to external information**	☑	I9.1. Perceived benefits from the network (q0021)	☑
	H10. Cross-fertilization of knowledge and technologies is being boosted when users participate in the innovation process at different stages of the value chain.	**V10. Participation of end users**	☑	I10.1. Organizations of end users (OTH) I10.2. End users involved in the development (q0016) I10.3. Stage in which the collaboration started –when they are involved in the development (q0017) I10.4. End users involved in the product demonstration activities (q0026)	☒ ☑ ☑ ☑
RQ3	H11. Cross-fertilization of knowledge and technologies is being	**V11. Having previous collaborative experience**	☑	I11.1. Previous collaboration with same partners (q0019)	☑

	boosted when organizations have had previous collaborations at early stages of the value chain.			I11.2. Stage in which the collaboration started –when there is a previous collaboration with the same partners (q0020)	☑
	H12. Cross-fertilization of knowledge and technologies is being boosted the greater the number of doctors in the collaborating organizations is.	**V12. Knowledge intensity**	☑	I12.1. Percentage of PhDs in the project (q0013)	☑
	H13. Cross-fertilization of knowledge and technologies is being boosted when the type of collaborative structure tends to be formal.	**V13. Types of collaboration network**	☑	I13.1. Partnerships with universities/ research institutions and industry. (presence of HES, REC and PRC in a project) I13.2. People involved in the scientific/technical/managerial activities as coordinator (q004) I13.3. Main reasons to collaborate (q0021)	☑ ☑ ☑
	H14 The linguistic and gender diversity is positively associated with the creation of knowledge and multidisciplinary technology.	**V14. Cultural diversity**	☑	I14.1. Language/s of the countries I14.2. Size of the cities I14.3. Gender of project coordinators (q01)	☑ ☑ ☐
RQ4	H15. Cross-fertilization of knowledge and technologies is being boosted when this is a market-oriented process.	**V15. Market orientation**	☑	I15.1. Partners cover all the value chain (q0023) I15.2. Importance of market research (q0024) I15.3. Driver of the product demonstration/pilot production (q0025)	☑ ☑ ☒
	H16. Cross-fertilization of knowledge and technologies is being boosted when customer needs are being prioritized.	**V16. Customer prioritization**	☑	I16.1. End users involved in the development (q0016) I16.2. End users involved in the product demonstration activities (q0026)	☑ ☑

	H17. Cross-fertilization of knowledge and technologies is being boosted when organizations have experience in higher levels of technological maturity.	**V17. Experience in higher TRLs**	☑	I17.1. TRL starting point (q007) I17.2. Expected final TRL (q008) I17.3. Previous collaboration with same partners (q0019) I17.4. The stage in which the collaboration started –when there is a previous collaboration with the same partners (q0020)	☑ ☑ ☑ ☑

*The check marks show the level of support to the indicators and the variables of measurement as follows:

☑Total support
☐Partial support
☒Rejection

4.9. Conclusions

The combination of newness and often asymmetric dispersion of knowledge suggests that relevant knowledge will most likely reside in networks of organizations, rather than in individual members of a technology innovation system (Powell *et al.* 1996). This chapter has attempted to explore and define theoretically and empirically two characteristics found in the innovation ecosystems: the level of multidisciplinarity and the level of cross-fertilization, by distilling its enablers of Knowledge-Technology and Management strategies to ensure the robustness of my conceptualizations. Furthermore, the study is focused on projects that combine diverse technologies but always including serious games and/or gamification in order to identify the benefits and advantages provided by these technologies.

From the **knowledge and technology perspective**, the hypotheses were tested on data from the funded H2020 projects that include serious games and/or gamification and prioritize the cross-fertilization of emerging technologies. A LDA and a network analysis were applied to study the content of these innovation projects.

The main addition to the literature is that the degree of the multidisciplinarity of a project and a large knowledge base enhances recombinant innovation, increasing the possibilities of emerging and transferring into the market the new technologies –confirming **RQ1**. These results clearly support that the degree of multidisciplinarity of a project and the size of the joint knowledge base are positively associated with the creation of multidisciplinary knowledge and technology.

Secondly, findings suggest that larger project teams provide a larger chance of recombining different types of knowledge, expertise and ideas, and thus innovation (Powell *et al.* 1996; Ruef 2002). Thus, results show how Rijnsoever arguments are not supported and there is a positive association between the number of organizations and the creation of multidisciplinary knowledge and technology in projects including serious games and gamification. Furthermore, every organization brings to the project unique knowledge and skills that can be recombined to form novel concepts and designs (Mo 2016), creating more technological multidisciplinarity and diversity (Rijnsoever *et al.* 2015).

Thirdly, the study has tried to make a contribution to the open debate about the degree and the effect of clustering on innovation. Results suggested that the degree of clustering around a project is negatively associated with the creation of multidisciplinary knowledge and technology. In fact, excessive cognitive resemblance may limit innovation opportunities, since there would be litter left to learn (Boschma 2005; Nooteboom 1999). Homogeneity of knowledge must be avoided venturing further afield but balancing the composition of clustered networks.

Fourthly, the innovation intensity was measured by the Global Innovation Index, supporting a positive association with the creation of multidisciplinary knowledge and technology. The more emphatically knowledge is learned and absorbed, the higher the performance an organization can achieve through the capability of innovation (Lane *et al.* 1998). Also, the more dynamic or complex the environment, the greater the compulsion to innovate and the more innovative organizations are likely to be. Hence, the intensity of innovation is one of the decisive factors for making them competitive although this external variable depends on the local and national ecosystems.

The results obtained from the knowledge and technology perspective can serve as guidelines to policy makers, especially at the EU-level, for fostering the success of emerging technologies on the basis of their cross-fertilization and the creation of multidisciplinary knowledge and technology. In order to encourage the creation of multidisciplinarity, emphasis should be placed on subsidizing the following projects: (1) involving or developing different disciplines, (2) including a large knowledge base for enhancing the ability of organizations to make novel combinations, (3) including different typology of organizations giving unique knowledge and skills, (4) with different number of partners but not too closely connected with each other, (5) with balanced consortia in terms of innovation intensity. The first three are already explicit or implicit criteria in H2020 although findings recommend reducing the size of some consortia for not overlapping knowledge and capacities. In fact, the fourth recommendation introduces that partners must provide diversity of knowledge that later could be used by the consortium to make novel combinations. Finally, the fifth contribution also emphasizes the importance of the innovation intensity because the local network also influences and increases or decreases the chances of developing new knowledge and technology.

The **second perspective** analysed in this study, the **management** one, takes as a starting point Maine´s (2014) exploration of how convergence of technologies can lead to the creation of radical innovation and subsequently the emergence of new industries. According to her, there are three central innovation management strategies in this convergence that have been explored in this study: i) *to import ideas from broad networks*, ii) *to create environments for deep collaboration* and iii) *technology-market matching*. Also, other aspects related to network theories, absorptive capacity and dynamic capabilities' literature have been considered.

The first strategy refers to the search and synthesis of ideas that could be taken up from networks with different technology streams. This strategy was studied by the analysis of the knowledge and technological distance, the technological effort, the access to external information and the participation of end users along the value chain. Results confirm **RQ2** showing that the level of cross-fertilization is higher when there are larger knowledge and technological distances in the network, when organizations make stronger knowledge and technological efforts, when organizations open up the innovation process to external knowledge flows (because belonging to the network is critical to access to external information and so having a competitive advantage) and when end users participate in the process of development along the value chain.

The second strategy involves the dynamic collaborative flow of knowledge between R&D groups. The existence of these collaborative networks has been explored by the analysis of the partners' previous collaborative experiences, the knowledge intensity, the types of collaboration networks and the cultural diversity. Findings confirm **RQ3** suggesting that cross-fertilization of knowledge and technologies is boosted when: organizations tend to collaborate from the beginning of the process, there is knowledge intensity and organizations tend to concentrate efforts in the employability of doctorate holders, there are formal collaborations between partners, and teams celebrate and reflect cultural diversity. Therefore, this team-based collaboration foster cross-functional activities, creates innovative value, often leads to new ways of working (Ashkenas 2012) and has a positive impact on creativity.

The third strategy complements the previous two by considering market needs. The technology-market matching is analysed through the level of orientation to market, the customer prioritization and the experience of higher TRLs. Findings confirm **RQ4** suggesting that market-oriented and customer prioritized projects boost higher levels of cross-fertilization. In fact, this continuous understanding of the needs of both the current and potential target customers and the use of that knowledge for creating superior value for companies is indissoluble form the market orientation strategy. The experience in higher levels of technological maturity boosts the cross-fertilization of knowledge and technology although the analysis of data shows that the starting point of projects is mainly located between TRL 2 and 4 and the expected final stage is mainly situated in TRL 6 (35%) and TRL 5 (15%); thus, just a 13% of projects arrive to a stage of pilot system verification or commercial design.

Another contribution of this work is related to the significant role of serious games and gamification in the cross-fertilization of knowledge and technologies. The presence of those technologies in a project is seen as very important and important for the 73% of the respondents and moderate by the 18%. In a redefinition of the previous EU-funding

Programs[92], the current H2020 could help to address the European Paradox, fostering the market orientation of the projects; in fact, serious games and gamification are seen in the majority of cases as a tool for developing market-oriented solutions closer to commercialization and better oriented to customer needs. Furthermore, the important role of end users along the value chain is emphasized by this study. 93% are involved in the product demonstration activities and 95% in the development of the project. These data highlight the proximity that the introduction of gamification and serious games generates with technology, facilitating communication and interaction with the end users. So, from an open innovation perspective, the end user becomes a co-creator and/or a co-developer.

Findings of this innovation management perspective could be used as a guideline for policy makers and project leaders that aim to create innovation on the basis of the cross-fertilization of technologies. Managing innovation is essential to increase the creation of knowledge, to understand the competitive implications of partners' selection and to develop strategies or actions in order to influence the productivity, to develop collaborative strategies and to create and reinforce customer loyalty for a better understanding of the end-user needs. Therefore, in order to encourage this process of cross-fertilization and innovation management strategies, findings suggest considering projects where: (1) partners have different knowledge and technologies, (2) there is a capacity for establishing an open prioritization for importing knowledge that could accelerate the commercialization, (3) value generation is possible thanks to co-creation with current and potential users of our products or services, (4) organizations have had previous collaborations at early stages of the value chain and greater knowledge intensity, (5) cultural diversity is an opportunity for generating creativity and added-value technologies, (6) market orientation improves organizational, product performances and satisfies better end-user needs and demands.

Considering this contribution, new scientific policies and strategies could be inspired by some of the results presented in this study to redefine, support and reward those collaborative projects that include the cross-fertilization of knowledge and technologies -

[92] FP1 (1984-1987), FP2 (1987-1991), FP3 (199o-1994), FP4 (1994-1998), FP5 (1998-2002), FP6 (2002-2006), FP7 (2007-2013)

including serious games and gamification. I not only provide the variables to understand the innovation management strategies in a particular moment in time but I also reflect on how they evolve over time and allow organizations to adapt to changing and evolving ecosystems. I also provide some insights to understand the factors that influence and the outputs derived from the cross-fertilization strategy. In fact, I consider the cross-fertilization of knowledge and technologies a strategy that, thanks to the research performed in this thesis, has shown what elements can be influenced to favour the process of innovation.

CHAPTER 5
Conclusions

Based on the empirical contributions presented in the previous chapters, this last chapter discusses the general conclusions, contributions and suggested future areas for research arising from the study as a whole. First and foremost, it must be pointed out that over the last decade the hype attached to the terms 'open innovation' and 'business models' has become accentuated, used in designing new external knowledge acquisition strategies and they are often referenced superfluously by academics, practitioners and policy makers. This doctoral thesis provides scientific findings, upon which future (multi-level) studies on open innovation (mainly through cross-fertilization of knowledge and technologies) and business models can build. My approach to this study of innovation through cross-fertilization encompasses an empirical analysis of organizational and business model strategies, ranging from descriptive to explicative studies.

5.1. Discussion and limitations

Findings obtained in this research give rise to the belief that the cross-fertilization of knowledge and technologies in projects including serious games and/or gamification is a process developed through an open innovation strategy. In a world of widely distributed knowledge, the boundaries between an organization and its environment have become more permeable; innovations can be easily transferred inward and outward.

The first evidence that suggests this open innovation strategy is that organizations leading higher cross-fertilized projects use external as well as internal ideas. In this study, project leaders have shown that they are not afraid to lose their internal know-how because they believe that obtaining external knowledge is more beneficial for their organizations and projects. A resulting effect is that these organizations make stronger efforts for knowledge and technology sharing.

The second evidence is related to the informal type of collaborative partnerships in projects with higher level of cross-fertilization. Organizations are motivated by the importance of forming ties to the larger scientific community in order to access to basic knowledge. They become more efficient learners and have a higher absorptive capacity. An open innovation strategy supports the fact that cooperative environments contribute to better exploitation of limited research capacities (Roger and Brookes 1999; OECD 1999) and to the development of valuable and more radical ideas and solutions adjusted to the increasing complexity of problems, especially when more than one technology is involved (Harvey *et al.* 2015; Paez-Aviles 2015).

The third evidence is related to the market strategy, a priority from an open innovation perspective. Business models change and evolve over time to remain sustainable and innovative. They need to be adjusted over time in order to remain viable, particularly in the context of changing environmental conditions and constraints (Amit and Zott, 2012; Bucherer *et al.*, 2012; McGrath, 2010). In fact, rapidly changing ecosystems (Teece 2010; Casadesus-Masanell and Zhu 2013) force firms to adapt to new conditions and transform their business models in order to exploit new market opportunities that are defined by the needs of both the current and the potential target customers and the use of knowledge for creating superior value for them (Naver and Slater 1990). Prioritizing customers facilitates the adoption and implementation of new innovations (Boon *et al.* 2011).

On the other hand, findings suggest that project coordinators put more emphasis on research activities instead of the market driver. This finding suggests the contrary that the open innovation policy defends, which is putting more emphasis on the business model (Linder *et al.* 2003; Chesbrough 2003). A plausible explanation could be related to the configuration of the research consortium, with partners more interested in developing knowledge than in exploiting the results; a second reason linked to the previous one is the great weight of universities and research centres in the consortia. Those reasons have generated a long tradition of partners who have worked according to the premises of the previous seven Framework Programmes for Research and Technological Development[93] of the European Commission in which the exploitation of results could be justified just with few activities of dissemination.

This research suffers from a number of limitations. Firstly, the database sample covers a period of 28 months. I focused my attention on this period because H2020 prioritized specifically the serious games and gamification with two specific ICT calls (ICT-21-14 and ICT-24-16) and secondly because there is an explosion of projects including serious games and gamification[94] in the last four years and this growth continues (Adkins 2017). These facts can be understood as a way to push the research along the value chain in order to get superior TRLs, helping the end user to interact with the outcome or output resulting from the exploitation strategy.

A second limitation could be that the survey was addressed to coordinators of 62 projects. Although the response rate is very high (74.1%), extremely superior to those of e-mail surveys involving senior executives (Kriauciunas *et al.* 2011), in some questions resulted in limited levels of variation in the dependent variable. Nevertheless, this survey was always understood as a complement to the database analysis, in order to better understand the project coordinators' behaviour and to know more about the operation of the consortium.

Finally, although the number of topics covered was quite broad, the third limitation makes reference to the European focus of the projects. This decision implies that there were possibly missed regional initiatives or priorities that can result in different national strategies for application areas and have not been identified and studied. The long-time

[93] These were the funding programs created by the European Commission to support and foster research in the European Research Area. They covered five-year periods and were the following: FP1 (1984-1987), FP2 (1987-1991), FP3 (1990-1994), FP4 (1994-1998), FP5 (1998-2002), FP6(2002-20006), FP7 (2007-2013).

[94] Experts predict that the gamification market will grow by 500% to roughly $11.10 billion by 2020. Retrieved from: https://blog.atrivity.com/why-gamification-industry-will-grow-to-11-billion-by-2020 [accessed 20 April 2018].

debate between the Europe of states and the Europe of the regions (Borrás-Alomar *et al.* 1994; Bauer 2002; Bache *et al.* 2004; Bauer and Börzel 2010; Boeva 2014) has been intensely reopened last year although the purpose of this study was not to analyse the best strategy for financing collaborative projects in the European ecosystem. In this regard, future research could include national projects and consider national and regional initiatives in order to expand the scope of the research.

5.2. Conclusions and contributions

This doctoral thesis has analysed the process and ecosystems of innovation in projects that include serious games and/or gamification by considering the cross-fertilization of knowledge and technologies. It has endeavoured to improve the understanding of how cross-fertilized alliances are formed, what their outcomes are, what causes them to generate value (or not) and what capabilities organizations need in order to successfully manage and reap value from the innovation process. For this purpose, two approaches that support innovation have been complementarily taken into account: the knowledge-technological perspective and the management perspective.

Organizations' orchestration of activities within their activity systems and transformation of their business models through innovation to realize opportunities with the objective to increase value creation is part of the topic of this dissertation. Especially, how cross-fertilization of knowledge and technology creates adequate multidisciplinary knowledge and technology (Van der Bergh 2008; Adler and Heckscher 2006; Van Rijnsoever *et al.* 2015) to ensure the success of an emerging technology, and how important is the research and innovation that takes place in the practitioners' communities (Starkey and Madan 2001; Søraa *et al.* 2017). In addition, this thesis introduces a new idea, the "liquid technology", that inspired by Bauman's "liquid modernity" refers to the infinity of changes and improvement of a technology due to its liquidity.

Key issues and current concerns of innovation and technology transfer have been addressed. By doing so, this work has sought to extend scientific, industrial and innovation knowledge attempting to answer the new challenges that publicly-funded research is facing. Additionally, the relevance of collaborative interaction and the environmental factors associated with the success of gaming-related emerging technology were highlighted in this thesis by consolidating the redefinition of the video game value chain and how it affects the business and monetization models.

Findings from this research could have implications for evolutionary economics regarding technological diversity creation in innovation systems. The data obtained supports once again the idea that innovation system literature is connected with the social network approaches. In this regard, it has been shown that external collaboration plays an important role in emerging technologies.

Moreover, this thesis exhibits a methodological original contribution, which is the implementation of the probabilistic text modelling method LDA for analysing the degree of a project's multidisciplinarity. Even though this method is well accepted by the research community, text analysis is less frequent and has been only used once for studying technological diversity (Paez-Aviles 2016). Nevertheless, this is the first work that used topic modelling for analysing technological diversity in serious games and gamification-related European projects in a convergent scenario of technologies. Additionally, since project information has been used as the source of data, this study offers a differentiated methodology compared with publications and patents, which have been the common source of data used for analysing information. Therefore, this work has considered complementary techniques by utilizing from the increasing power of machine learning and computation.

The combination of newness and often asymmetric dispersion of knowledge suggests that relevant knowledge will most likely reside in networks of organizations, rather than in individual members of a technology innovation system (Powell *et al.* 1996). This doctoral thesis has attempted to explore and define theoretically and empirically two characteristics found in the innovation ecosystems: the level of multidisciplinarity and the level of cross-fertilization, by distilling its enablers of knowledge-technology and management strategies to ensure the robustness of my conceptualizations. Furthermore, the study is focused on projects that combine diverse technologies but always including serious games and/or gamification in order to identify the benefits and advantages provided by these technologies.

From the **knowledge and technology perspective**, the hypotheses were tested on data from the funded H2020 projects that include serious games and/or gamification and prioritize the cross-fertilization of emerging technologies. A LDA and a network analysis were applied to study the content of these innovation projects. The main contribution to the literature is that the degree of multidisciplinarity of a project and a large knowledge base enhances recombinant innovation, increasing the possibilities of emerging and transferring new technologies into the market. These results clearly support that the degree of multidisciplinarity of a project and the size of the joint knowledge base are positively associated with the creation of multidisciplinary knowledge and technology.

Secondly, findings suggest that larger project teams provide a larger chance of recombining different types of knowledge, expertise and ideas, and thus innovation (Powell *et al.* 1996; Ruef 2002). Thus, results show how Rijnsoever arguments are not supported and there is a positive association between the number of organizations and the creation of multidisciplinary knowledge and technology in projects including serious games and gamification. Furthermore, every organization brings to the project unique knowledge and skills that can be recombined to form novel concepts and designs (Mo 2016), creating more technological multidisciplinarity and diversity (Rijnsoever *et al.* 2015).

Thirdly, the study has tried to make a contribution to the open debate about the degree and the effect of clustering on innovation. Results suggested that the degree of clustering around a project is negatively associated with the creation of multidisciplinary knowledge and technology. In fact, excessive cognitive resemblance may limit innovation opportunities, since there would be little left to learn (Boschma 2005; Nooteboom 1999). Homogeneity of knowledge must be avoided venturing further afield but balancing the composition of clustered networks.

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The third strategy complements the previous two by considering market needs. The technology-market matching is analysed through the level of orientation to market, the customer prioritization and the experience of higher TRLs. Findings suggest that market-oriented and customer prioritized projects boost higher levels of cross-fertilization. In fact, this continuous understanding of the needs of both the current and potential target customers and the use of that knowledge for creating superior value for companies is indissoluble form the market orientation strategy. The experience in higher levels of technological maturity boosts the cross-fertilization of knowledge and technology although the analysis of data shows that the starting point of projects is mainly located between TRL 2 and 4 and the expected final stage is mainly situated in TRL 6 (35%) and TRL 5 (15%); thus, just a 13% of projects arrives to a stage of pilot system verification or commercial design.

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Programs[95], the current H2020 could help to address the European Paradox, fostering the market orientation of the projects; in fact, serious games and gamification are seen in the majority of cases as a tool for developing market-oriented solutions closer to commercialization and better oriented to customer needs. Furthermore, the important role of end users along the value chain is emphasized by this study. 93% are involved in the product demonstration activities and 95% in the development of the project. These data highlight the proximity that the introduction of gamification and serious games generates with technology, facilitating communication and interaction with the end users. So, from an open innovation perspective, the end user becomes a co-creator and/or a co-developer.

Findings of this innovation management perspective could be used as a guideline for policy makers and project leaders that aim to create innovation on the basis of the cross-fertilization of technologies. Managing innovation is essential to increase the creation of knowledge, to understand the competitive implications of partners' selection and to develop strategies or actions in order to influence the productivity, to develop collaborative strategies and to create and reinforce customer loyalty for a better understanding of the end-user needs. Therefore, in order to encourage this process of cross-fertilization and innovation management strategies, findings suggest considering projects where: (1) partners have different knowledge and technologies, (2) there is a capacity for establishing an open prioritization for importing knowledge that could accelerate the commercialization, (3) value generation is possible thanks to co-creation with current and potential users of our products or services, (4) organizations have had previous collaborations at early stages of the value chain and greater knowledge intensity, (5) cultural diversity is an opportunity for generating creativity and added-value technologies, (6) market orientation improves organizational, product performances and satisfies better end-user needs and demands.

Considering this contribution, new scientific policies and strategies could be inspired by some of the results presented in this study to redefine, support and reward those collaborative projects that include the cross-fertilization of knowledge and technologies - including serious games and gamification. I not only provide the variables to understand

95 FP1 (1984-1987), FP2 (1987-1991), FP3 (199o-1994), FP4 (1994-1998), FP5 (1998-2002), FP6(2002-20006

the innovation management strategies in a particular moment in time but I also reflect on how they evolve over time and allow organizations to adapt to changing and evolving ecosystems. I also provide some insights to understand the factors that influence and the outputs derived from the cross-fertilization strategy. In fact, I consider the cross-fertilization of knowledge and technologies a strategy that, thanks to the research performed in this thesis, has shown what elements can be influenced to favour the process of innovation.

The conclusions summarized here, and the detailed conclusions of each chapter, could have practical implications for all the stakeholders involved in innovation and technology transfer. On the one hand, it could be particularly useful for researchers wishing to transfer their basic research, and on the other hand, industrial entrepreneurs challenged to scale and bring new knowledge and technologies into the marketplace. Innovation managers and project leaders could also benefit from the insights presented in this work in order to apply adequate innovation strategies in the development of cross-fertilized outputs. Also, game developers could work on the design and development of new methodologies and technologies that favour the engagement of users with new products; designing new tools that favour the cohesion of knowledge and technologies between partner organizations; and giving more efficient answers to the real needs of users. Furthermore, this work could guide policy makers in reshaping and improving priority lines related to serious games and gamification. In this context, it is suggested that policies could: i) foster an open, collaborative, integrative and balanced ecosystem; ii) influence the level of diversity in groups and projects; and iii) foster excellent science and technological quality, but also strategic innovation management capacities of all the stakeholders that participate in the innovation ecosystem of serious games and gamification. Following these guidelines, this work contributes to redefine innovation strategies and long-term success when commercializing new (serious) gaming and gamified solutions applied to any field.

5.3. Avenues for future research

While this doctoral thesis has been greatly influenced by the empirical phenomenon of open innovation mainly through the strategy of cross-fertilization, I believe that my findings, combined with current developments in the field, open up a number of interesting avenues for future research.

Open innovation in companies should be a dynamic process that co-evolves with changes in technology and idea markets, which themselves are partly driven by the rapid growing possibilities offered by multidisciplinarity and cross-fertilization of knowledge and technology and innovation management strategies. Consequently, the close analysis of the development of organizations' abilities to adapt to changing collaboration modes offers an interesting avenue of future research.

Further investigation is also necessary in regard to the processes and outcomes of research collaboration between partners at different stages of the value chain. Additional research on the processes and outcomes of the cross-fertilization process (knowledge and technologies) would be useful for fostering the transfer, accelerating its intensity and determining whether collaboration with external partners improves over time. Longitudinal research is needed in order to more fully understand long-term outcomes, both for society and partner organizations. Also, it would be interesting to analyse how the variables that determine the cross-fertilization of knowledge and technologies affect the speed of innovation, e.g. market dynamism and uncertainty, market size or access to resources.

This research also suggests new ways to enhance the scholarly knowledge about the role and the effect of gaming technologies in the definition of new outputs. Gaming technologies is one of the best examples of cross-sector and offers the possibility of bringing technology closer to the people, making it fun, friendlier and easier to use. Therefore, more studies about the role of these technologies in the definition of new projects, outputs and social impact are required.

The innovation through cross-fertilization is becoming the new paradigm for external knowledge acquisition and integration and a key pillar of future innovation policy making. Due to the relevance of the innovation strategy analysed in this doctoral thesis and how it affects many organizations and its impact on society, it is my hope that the research begun in this thesis may serve scholars and practitioners by improving our understanding of the possibilities given by a well-designed strategy of cross-fertilization of knowledge and technologies required for generating commercial and social value.

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Annex 1. Survey

University of Barcelona, Department of Economics
University of Barcelona, Department of Electronics
Inland Norway University of Applied Sciences, Centre for Innovation in Services

Version 5.0/English
August 2017

Survey:
Cross-fertilization of Knowledge and Technology in projects including Serious Games and Gamification in H2020 Framework Program

Survey addressed to the project coordinators of H2020 projects including Serious Games and Gamification

ORGANIZATION'S INFORMATION

1. Name of the organization:

2. Job title or function:

3. Size of the unit/department/centre coordinating the H2020 project:

□ Less than 5 employees
□ Between 5-10 employees)
□ More than 10 employees

4. How many people of your unit/department/centre are directly involved in the scientific/technical/managerial activities within the project?

□ Less than 5 people
□ Between 5-10 people
□ Between 10-15 people
□ More than 20 people

5. Year of foundation of your unit/department/centre:

□ 2016-2012
□ 2011-2007
□ 2006-1996
□ Before 1996

6. Which of the following areas is the major technological domain of your unit/department/centre? Please select one.

□ Medical and neuro-technologies
□ Biotechnologies
□ Data analysis
□ Green technologies
□ New materials
□ Robotics
□ Game and Gamification
□ Computing sciences
□ Sensoring
□ Others: ____

PROJECT'S INFORMATION

7. What was the starting point of your H2020 project? Please, select the one most appropriate.

□ Idea generation (TRL 0)
□ Basic research (TRL 1)
□ Technology formulation (TRL 2)
□ Applied research (TRL 3)

□ Small scale prototype (TRL 4)
□ Large scale prototype (TRL 5)
□ Prototype system verified (TRL 6)
□ Pilot system verified (TRL 7)
□ Commercial design (TRL 8)
□ Full commercial application (TRL 9)

8. What is the expected final stage of your H2020 project? Please, select the one most appropriate.

□ Idea generation (TRL 0)
□ Basic research (TRL 1)
□ Technology formulation (TRL 2)
□ Applied research (TRL 3)
□ Small scale prototype (TRL 4)
□ Large scale prototype (TRL 5)
□ Prototype system verified (TRL 6)
□ Pilot system verified (TRL 7)
□ Commercial design (TRL 8)
□ Full commercial application (TRL 9)

9. Which of the following technologies are being included in the development of your project? Please choose the two most relevant.

□ Medical and neuro technologies
□ Biotechnologies
□ Data analysis
□ Green technologies
□ New materials
□ Robotics
□ Game and gamification technologies
□ Computing sciences
□ Sensoring
□ Others (please specify): ____

KNOWLEDGE AND TECHNOLOGY

10. The process of communication or agreement with the partners of the project team has been:

□ Very easy.
□ There were some misunderstandings finally easily solved.
□ There were problems only with some partners.
□ There were problems with most of the partners.

11. How the decision making/ problem solving process within project is carried out?

□ As a collective decision
□ Through a board/coordinator
□ Vertical bilateral
□ Only in consensus meetings
□ Only in informal meetings
□ Other (please specify):____

12. What do you think about the technological knowledge of your organization compared with the technological knowledge of your partners (on average)? It is:

□ Very similar
□ Quite similar
□ Quite different
□ Very different

13. What percentage (approx.) of people involved in the project are PhDs?

□ None
□ < 10%
□ 10-30%
□ 30-50%
□ >50%

14. How important is the role of Serious Games and Gamification in the project?

□ Very important
□ Important
□ Moderate
□ Weak
□ Unnecessary

15. Approximately how many hours a month your organization spends in activities related to data and knowledge sharing among all participants in the project?

□ None
□ Less than 4 hours
□ Between 4-8 hours
□ Between 8-12 hours
□ More than 12 hours

16. Do end users/costumers get involved in the development of the project?
□ Yes, as a partner of the consortium
□ Yes, represented by one/ or more of the partners
□ Yes, through outsourcing (directly contracted by one/ or more of the partners)
□ No

17. If you answered positively to the previous question, please specify in which stage of the value chain they started to collaborate. Please select one.
□ Idea generation (TRL 0)
□ Basic research (TRL 1)
□ Technology formulation (TRL 2)
□ Applied research (TRL 3)
□ Small scale prototype (TRL 4)
□ Large scale prototype (TRL 5)

□ Prototype system verified (TRL 6)
□ Pilot system verified (TRL 7)
□ Commercial design (TRL 8)
□ Full commercial application (TRL 9)

18. Do you have any additional comment related to knowledge, technology or participation of end users? (Optional)

COLLABORATIVE EXPERIENCE

19. Has your organization previously collaborated with some partners of the current project?

□ All of them
□ Most of them
□ Few of them
□ None of them

20. If your answered positively ("all of them", "most of them" or "few of them") to the previous question, please specify in which stage of project development the collaboration started. Please select one.

□ Idea generation (TRL 0)
□ Basic research (TRL 1)
□ Technology formulation (TRL 2)
□ Applied research (TRL 3)
□ Small scale prototype (TRL 4)
□ Large scale prototype (TRL 5)
□ Prototype system verified (TRL 6)
□ Pilot system verified (TRL 7)
□ Commercial design (TRL 8)
□ Full commercial application (TRL 9)

21. In your opinion, what are the motives to collaborate with partners in the project (beyond the requirements of the collaborative calls)? Please choose the two morst relevant.

□ Access to new markets
□ To gain competitive advantage in the market
□ Access to economic resources
□ Access to knowledge/ technological resources
□ Financial risk sharing
□ To speed up innovation process
□ Other specific reasons (please specify)________________________

22. Do you have any additional comment related to the creation of a collaborative environment? (Optional)

MARKET ORIENTATION

23. Do partners cover all the value chain?

- □ Mostly
- □ No

24. How important is market research in the development of the project?

- □ Very important
- □ Quite important
- □ Not important

25. In your opinion, what do you think is the main driver of the product demonstration/pilot production of your project?

- □ Market reasons (e.g. competitive pressure, customer requirements, estimated market potentials, etc.)
- □ Information on research activities (e.g. originating from universities, research & technology organizations, universities, customers, competitors, etc.)
- □ Access to public subsidies (e.g. tax refunds, investment support)
- □ Market regulation activities (e.g. industrial policy, standardization activities, market deregulation, other environmental, or social legislation)
- □ Other (please specify)

26. During the product demonstration activities, is the final costumer/end user being involved?

- □ No
- □ Yes

27. Do you have any additional comment about the market orientation of the project? (Optional)

28. Consent form:

- □ I agree to include my name in the acknowledgements of the present study.
- □ I want my answers to be treated anonymously and with no personal identifying information included in any document.

In case you agreed to include your name in the acknowledgements of the present study, please specify the terms and name you prefer to use

29. Willingness and availability to continue participating in the present research:

- □ I would like to receive the research results at my e-mail address.
- □ I do not want to receive the research results at my e-mail address.

We sincerely appreciated your participation in this study.
Thank you very much.

Annex 2. Document attached to the survey submission

Study: Cross-fertilization of Knowledge and Technology in projects including Serious Games and Gamification in H2020

Researchers

Lluís Bonet [1], Atle Hauge[2], Esteve Juanola-Feliu[3], Manel González-Piñero[1,2]
[1] Department of Economy, School of Economics, University of Barcelona
[2] Department of Economics and Organizational Science, Inland Norway University of Applied Sciences
[3] Department of Engineering: Electronics, Faculty of Physics, University of Barcelona

Introduction
The study is powered by the University of Barcelona (Schools of Economics -Cultural Management Research Group- and the Physics Faculty –Electronic Engineering Department-) and the Inland Norway University of Applied Sciences. The study is fostered by the European Comission through the H2020 Framework Program.
The aim is to get insights about causal relationships of the process of cross-fertilization and the Innovation Management Strategies. Results gathered will be of great relevance, as these will feed the high impact actions document that will be presented to the European Union as a result of this research project.

Purpose of the survey
The following survey is part of a study about the cross-fertilization of Knowledge and Technology in projects including serious games and gamification, fostered by the European Commission through the Horizon 2020 Framework Program.

The survey is addressed to the coordinators of 62 projects funded by H2020 in which serious games and gamification are one of the technologies included. This study only considers coordinators participating in partnership with other organizations in the period 2014-2016.

The survey is conceived as “semi-structured” with an explanatory purpose. The aim is to get insights about causal relationships of the process of cross-fertilization and the Innovation Management Strategies. In this context, Innovation Management Strategies literature was taken into account (Hellman and Boks, 2006; Howells, 1997; Maine and Garnsey, 2006; Maine et al., 2015, 2014). This study is specially grounded on the findings from Maine et al., (2014) who asserts that there are three central strategies in the convergence of technologies: i) to import ideas from broad networks, ii) a deep collaborative environment and iii) technology-market-matching. Based on these criteria, the interview is divided in three topics: 1) flow of knowledge and competences between organizations, 2) collaboration, and 3) the activities related to the technology-market matching. These concepts are also complemented with other streams of management literature: **absorptive capacity of organizations regarding technological**

effort/capabilities (Adams et al., 2006; Arora and Gambardella, 1994; Cohen and Levinthal, 1990; F. Hacklin, N. Adamsson, C. Marxt, 2005; Jung-Erceg et al., 2007; Srivastava et al., 2015), **interdisciplinary** (Jeong et al., 2015; Juanola-Feliu et al., 2012; Kim et al., 2015; Nordmann, 2004; Palcic and Pandza, 2015; Porter and Rafols, 2009; van Rijnsoever and Hessels, 2011) **and technological and cognitive distances** (Hippel, 2005; Jeong and Lee, 2015; Kim et al., 2015; Llerena and Meyer-Krahmer, 2003; vom Stein et al., 2015).

Study

This survey is part of a global study in which EU projects including serious games and gamification have been selected as the element of study. The selection of these funded projects has been considered adequate for the following reasons:

- Firstly, creating new technological diversity usually takes place in innovation projects in which different organizations such as firms, universities, and research institutes, collaborate among themselves (Niosi ,2011), (Cooke et al., 1997), (Edquist, 1999). For emerging technologies, these innovation projects are often publicly supported. Hence, funding instruments are a tool for policy makers to influence the level of technological diversity (Van Rijnsoever et al, 2015), (Pandza, 2011), and thus, to secure the long-term viability of the technology.

- Secondly, the cross-fertilization of serious games and gamification is highly encouraged by public funding initiatives such as H2020, therefore the level of crossfertilization and the strategies applied for in this process can be evidenced in EU-funded projects.

The study has initially analysed the data obtained from the Community Research and Development Information Centre (http://cordis.europa.eu/). A total of 87 projects were obtained and 516 different organizations as coordinators and participants were retrieved.

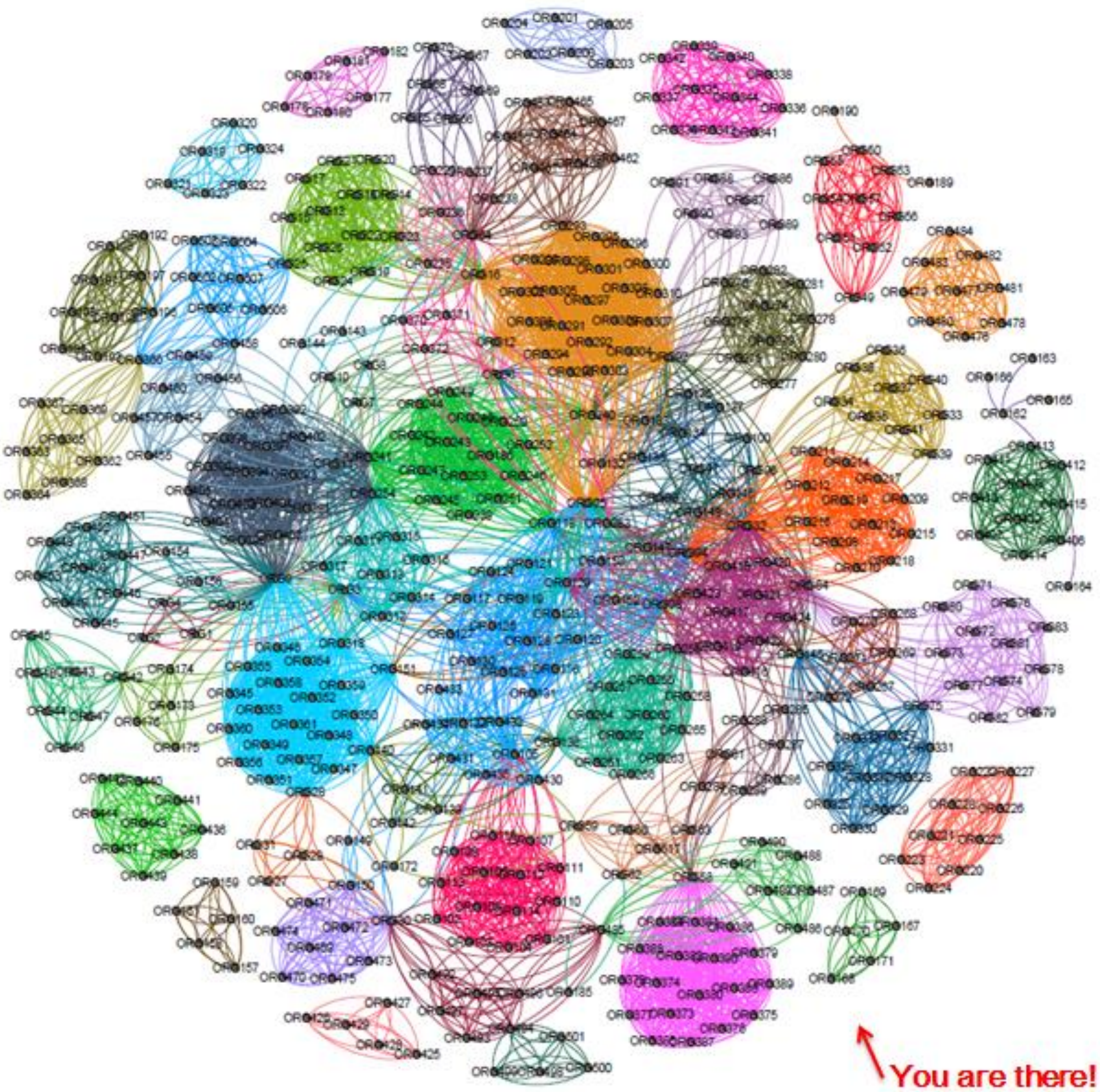
The information retrieved from the selected projects was initially analysed through descriptive statistics, network graphs and text mining approaches in order to have a complete overview of the element of study. Next, to analyse the creation of technological diversity , the Topic Modelling approach was used. This is a novel text mining method for categorizing technological alternatives from text data. This method allows the calculation of diversity creation in a more efficient manner than in conventional qualitative approaches.

For the second section of the study, we need to launch this survey to know more about the projects and their project leaders in order to retrieve information about your innovation management strategies.

The project: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX, coordinated by you and XXXXXXXXXXXX

The following figure shows the dense networks, as well as more than one organization connected through more than one project. Specifically, the figure shows the cluster of organizations and their connection within H2020 projects. **The project: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX, coordinated by you and XXXXXXXXXXXXXXXX** is one of the projects chosen to study. You have been identified as a key actor and the use of the Fruchterman distribution let us show you the position of your institution in the network of H2020 projects which include Serious Games and Gamification. You are one of the dots in the figure 1.

Fig. 1. Networks of 516 organizations and their connections within projects.



If you want to locate yourself in the network and to know more about the study, please, answer the survey and we will send you a copy of the full final report.

Structure of the survey
The survey is divided in **six short blocks** with a total of **twenty-six** questions (multiple choices):

1. **Organization's information**
2. **Project's Information**
3. **Knowledge and Technology**
4. **Knowledge and Technology**
5. **Collaborative Experience**
6. **Market Orientation**

Estimated time: ~9 minutes.

The survey has been first piloted.

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Annex 3. Questionnaire of the video games market in Catalonia

Questionnaire of the Videogames market in Catalonia 2015: set of questions

Interview to ....

BLOCK 1. IDENTIFICATION AND GENERAL INFORMATION ON YOUR ORGANIZATION

1.1. Your organization is:

☐ Enterprise
☐ University
☐ Administration

1.2. The affiliation of the organization is:

Public
National private
Private involving at least 50% foreign capital
Association for research and other research institutions

1.3. Province where the organization is established:

Barcelona
Girona
Lleida
Tarragona

1.4. Type of organization:

University
Science and Technology Park
Business Incubator
Industrial Park
Urban framework
Other (specify):

1.5. Continent of the headquarters of your organization:

Europe
North America
Asia
Other (specify):

1.6. Size of your organization:

1-4 people
5-10
11-20
21-100
+100 people
Unknown

1.7. Distribute the proportion of workers on total employees by its level of education reached (the total must add up to 100%):

Dropdown with the options: 10%, 20%, 30%, ..., 100%
Doctors:
Master's degrees, Engineers:
Graduates, technical engineers, Higher Level Training Cycles:
Baccalaureate, Intermediate Level Training Cycles:
Others:

1.8. Total Incomes 2014:

Over € 5 million
Between € 5 - € 1 million
Between € 1 - € 0.2 million
Less than € 0.2 million

1.9. Projected growth in turnover for 2015:

Positive, above 20%
Positive, between 10-20%
Positive, 5-10%
Positive, between 0-5%
Negative, between -5-0%
Negative, below -5%

BLOCK 2. PROFILE OF THE RESPONDENT

2.1. Years of activity on the field of videogames:

Less than 2 years
2-4
5-10
11-20
+20 Years
Unknown / No answer

2.2. Which is your educative background?

2.3. Rate the degree of intensity (1 means "nothing" and 4 means "a lot") for the following variables related to your specialization in videogames:

Motivations for entry into the videogames activity:	1	2	3	4
Own research interest				
Research interest of supervisor				
Public funding				
New research instruments				
Visit abroad				
Firm needs				
Commercial potential				

BLOCK 3. INNOVATION

3.1. Is there an R&D department in your organization?

3.2. Who is the responsible of the R+D in your organization?

-R&D Director
-Innovation Director
-CEO
-Creative Director
-...

3.3. In what technologies, applications and / or processes does your company invest?

3.4. What is % ratio of your R&D internal investment to your turnover?

3.5. What is your R&D location strategy?

3.6. What are the main motivations for deciding to invest in new technologies, applications and processes?

-To improve the production processes
-To get higher quality results
-To develop work on easier-to-use platforms
-To incorporate quickly the technological advances that occur in the sector
-Try to make innovation a distinctive mark of the projects that are developed
-Other

3.7. What are, from your point of view, the main challenges of innovation in the videogame sector?

3.8. Do you take advantage of current policy initiatives such as tax credits?

3.9. In the case of requiring more scientific or technological knowledge, how does your company proceed?

3.10. In relation to the user empowerment, do you incorporate the final user in the process of co-creation / co-development of your videogames? How?

3.11. How do you measure the economic success of your R&D activities?

3.12. How does your company develop its R&D talent?

3.13.What partnerships have you participated in?

3.14. What partnership(s) would you like to form but are unable to?

BLOCK 4. UNIVERSITY-COMPANY COLLABORATION

4.1. Does your company maintain any kind of collaboration with universities?

In case of an affirmative answer:

4.1.1. What universities do you collaborate with?

4.1.2. What kind of collaborations do you have?

-outsourcing of direct activities
-participation in a national project
-share in the consortium of a European project financed by H2020
-participation in other international projects

In case of a negative answer:
4.2. Would you like to start a collaboration with a university?

4.3. What aspects do you consider most relevant when starting a collaboration with the university?

-Geographical proximity
-Knowledge with one of the team members
-Equipment of researchers
-Experience
-Know-how
-Prestige of the institution

4.4. What do you mainly value in a collaboration with a university?

5. STRATEGY AND BUSINESS MODEL

In relation to the business model:
5.1. How do you adapt the strategy of your organization to the new needs and preferences of users in relation to

5.1.1. the access platforms?:

- web browser.
-Mobile apps.
-...

5.1.2. the strategy?

-Pay to play
-Free to play (F2P) and freemium
-Advergaming
    -In Game Advertising
    -Around-Game Advertising
    -Advergaming

5.1.3. the gaming devices)?

-Consoles
-Computers
-Smartphones
-Tablets
-...

5.2. Are you considering any change in your monetization strategy?

5.3. Which?

5.4.What other aspects would you highlight about your company's business model?

5.5. What target of clients, depending on the age, are more interesting for the strategy of your company?

-Babies (0-4 years old)
-children (5-12 years old)
-Teenagers (12-18 years old)
-Millennials (18-32 years)
-X Generation (33-45 years)
-More than 45 years

5.6. Do you adapt the product or do specific actions depending on the sex of your potential client?

5.6.1. In case of a positive answer, what actions do you develop?

5.7. What other segmentation strategies does your company develop to connect with those potential customers?

6. OPPORTUNITIES AND FUTURE TRENDS

6.1. The videogame industry can provide technology and generate new synergies with other industries. In your opinion, which sectors are the closest to generating these new synergies with the videogame industry?

6.2. Which markets offer the greatest growth opportunities for the Catalan video game industry?

6.3. What benefits does the company provide for its location in Catalonia? What opportunities does the environment offer?

6.4. What difficulties / threats does the environment offer?

6.5. What new trends created as a result of the explosion of the internet as a distribution channel are seen as a business opportunity or with more interest in your company?

-Immersive Gaming (virtual reality and augmented reality).
-Cloud gaming- Game as a Service (GaaS)
-Secondary screens to play
-Serious games
-Gamification

7. SERIOUS GAMES AND GAMIFICATION

7.1. Does your company participate or have participated in the development of a serious game?

7.2. Would you like to participate in the development of any serious game?

7.3. Have you internally assessed the possibility of joining a serious game project with other partners?
SI NO

Please, tell about the experience.

7.4. In relation to serious games, what sectors do you think can benefit most from the serious game experience?
-Education
-Defence
-Health
-Safety at work
-Other

7.5. What capacities do you think can be developed or dealt with through the game experience?
-Training
-Rehabilitation
-Learning

7.6. In relation to improving the player's abilities once he has played, what kind of evidence exists today?

7.7. What are the man difficulties that companies specialized in this type of games face?

7.9. Would this sector require any kind of public support?

7.9.1. If yes, what type of support or tax incentives do you think would be necessary?