D3.1 RESEARCH MODEL

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Executive summary

Deliverable D3.1, Research model, proposes the general research framework under which the research activities of WP3 will be carried out. A theoretical reference framework is presented to show how the DiDIY Knowledge Framework, as introduced in Deliverable D2.3, can be operationalised into research activities to investigate how DiDIY is reshaping work and organization.

A broad and multidisciplinary literature review is presented and discussed, highlighting the variety of academic disciplines and of research perspectives that relate to the theme of DiDIY WP3. Three main research streams have been identified as crucial to start studying the theme of the WP: implications on workmanship, entrepreneurship and development of clusters, implications on managerial roles. D3.1 presents the research motivation and the theoretical background of these topic and proposes the outcomes of a preliminary exploratory investigation.

Revision history			
Version	**Date**	**Created / modified by**	**Comments**
0.0	27/06/15	LIUC	First, incomplete draft.
0.1	09/09/15	LIUC	Extensions and fixes.
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0.3	09/01/16	LIUC	Extensions and fixes.
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0.5	30/01/16	LIUC	Extensions and fixes.
1.0	31/01/16	LIUC	Approved version, submitted to the EC Participant Portal.

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1. DiDIY, organization and work: research motivation

The fundamentals of management and organizational science have been developed and consolidated in an era structurally different from today (Dobbs 2015). Economy was mainly based on goods (atoms) and not on services (bits), economic transactions mainly occurred at the local and not international level (no globalization), the so-called first world experienced a constant economic growth. In that era technology used to provide tools supporting materials handling (atoms) and not information management (bits). From a demographical point of view, this era was characterized by a far shorter life expectancy and a lower average age of the employed population. The managerial models developed in such a context leveraged on an analytical approach, synthesized, almost ideologically, in the Taylor's model of work emphasizing specialization and a representation of organizations as deterministic machines.

Despite criticism about specific aspects (Yetton 1992; Sharp 1996; Merchant 2012), or the way they have been taught (Spender 2011), the dominant models taught as fundamentals in business schools are still the managerial classics of two decades ago, such as Ackoff's, Mintzberg's and Porter's models (Bedeian 2001) which are rooted, more or less explicitly, in the assumptions listed above.

It is at least questionable that these fundamentals, originally designed as conceptual tools to improve organizations and society, constitute as a whole a model appropriate to represent the current state of work and organizations, all the more so to project future scenarios based on disruptive phenomena like DiDIY.

Assuming that DiDIY is characterized by an infrastructural and social nature, it is necessary to explore its impact beyond the changes of the skills of individuals, but also on work and organizations across the industries. As such, this phenomenon should be observed at three different levels of aggregation or layers:

- L1: individual layer;
- L2: organizational layer (more in general: multiple individuals level);
- L3: inter-organizational layer (more in general: multiple organizations level).

Management science models typically simplify the complexity of these layers by flattening them and focusing on L2 (the organization) as the main subject of research. In doing so, the uniqueness of each individual (L1) is lost (or at least blurred) in the attempt of standardizing personal characteristics and behaviours and viewing people as a whole ("human resources") as a component of the organization (L2) as a deterministic machine (Melao 2000). Within the classical managerial models, L3 is seen as the "environment", i.e., the context where the organization (L2) operates facing exogenous, and often hostile, forces (Mintzberg 1979; Mintzberg 1996; Porter 1979; Porter 2008).

An implication of this paradigmatic shift is of a linguistic nature, even before than of cultural and organizational nature. We assume that the semantics of the terms commonly used to define economic / social / technological the phenomena (well established in the previous "era") shall be put under question.

Some basic terms in the business jargon help highlighting this issue:

- "employee", which evocates objectification of human beings, slavery;

- “training”, whose the etymology is from the Latin term “trahere”, evocating the objectification of the learner;
- “management”, from “manager”, to handle, evocating the atom-based (vs bit-based) nature of organizations;
- “tactic” / “strategy”, terms derived from the military lexicon, evocating the principle that interaction in the environment is based on conflicting relationships (rather than collaborative ones).

On the basis of these research gap it is plausible to set up a research plan, where the objectives mentioned above are made:

- specifically pertinent to the aims of WP3;
- convergent with the general aims of the project, as they were defined in the D2.2 Foundational interpretation of DiDIY.

2. WP3 assumptions

For the sake of clarity and synthesis, the document is structured around a series of assumptions, where the term "assumption" shall be interpreted in an "in-progress" acceptation, given the in-progress status of the whole knowledge framework (as drafted in D2.3).

2.1 Premises to the WP3 from the general DiDIY knowledge framework

The first set of assumptions synthesizes the results outlined into D2.2.

A0.1 DiDIY is a human-centred phenomenon characterized by the diffusion:

- of a mindset among individuals: the "DiDIYers";
- of a set of activities enacted by DiDIYers: the "DiDIYing".

In WP3 we need to fully exploit the two sided-nature of the DiDIY concept. In particular, to the aims of WP3 it is essential to characterize DiDIY also in terms of activities.

Activities, and not only individuals, are a core concept of management and organizational science: work can be seen as a structured set of activities, and the definition organization is built not only on the concept of aggregation of individuals, but also on the need of a common aim, providing a direction to their actions.

In WP3, it is necessary not only to focus on the properties of an individual's mindset. We will also refer to activities, more concrete entities, and – more importantly – entities that result from the interaction among different individuals. Referring to activities implies two advantages:

- activities concretely translate in a context – in pragmatic terms – the abstraction of the mindset of an individual;
- activities natively overcome the level of analysis of the single individual.

A0.2 DiDIY is a (Digital Technology)-dependent phenomenon.

In DiDIY digital technology has been addressed as an "enabler" of the phenomenon under investigation. Within WP3 we would like to emphasize even more the fact that the presence of digital technology represents a necessary – but not sufficient – characteristic of DiDIY: the very existence of DiDIY "depends" on the presence of digital technology, but its core properties are human-centric, thus related to individuals' mindsets and activities.

In synthesis, following this approach, an individual can be defined as a DiDIYer when, due to her mindset,

- she regularly *"does things"* on her own ("**DIY"**), and
- these "*things"* could not be "*done"* without digital technology ("**Di"**DIY).

to this extent, firms that make use of DiDIY technology count as DiDIYers, as well as employees of those firms who make use of DiDIY technology.

2.2.1 From the general knowledge framework: DiDIY, organization and work

For the sake of convenience, the following paragraphs contain the definitions provided (in D2.2) about the themes of WP3: organization and work.

DiDIY and organisation

In a narrower view DiDIY is related to single individuals, in a broader view the “self” in “yourself” is an organizational entity of any size, with strong organizational ties (e.g., a function of a company, a firm, a formal network of enterprises) or weaker organizational ties (e.g., a community of practitioners, a cluster, a supply chain).

Possible Research Questions:

- how the work of a workman in a manufacturing firm will be reshaped, due to the influence of DiDIY? how will it change in relation with the evolution of other organizational roles in her firm?
- how the work of a knowledge worker will be reshaped, due to the influence of DiDIY? how will it change in relation with the evolution of other organizational roles in her firm?
- how the work of the CIO will be reshaped, due to the influence of DiDIY? how will it change in relation – in particular – with the evolution of other CxO roles?
- more generally: which organizational roles are most likely to disappear, and which will be most likely created, due to the influence of DiDIY?
- do makers cluster? what are the factors enabling single DiDIYers (makers) get together and create teams to design and develop innovative digital products (e.g., robots)?
- how collaborative innovation networks among DiDIYers (makers) foster cluster initiatives? how can DiDIYers (makers) entrepreneurial ecosystems transform in cluster initiatives?
- in particular: what are the factors enabling SMEs to evolve from single-player subcontractors into components of a DiDIY-like cluster, competing with large companies?

DiDIY and work

In a narrower view DiDIY is related to the activities of single individuals, in a broader view DiDIY influences the activities performed within organizational entities of any size, with strong organizational ties (e.g., a function of a company, a firm, a formal network of enterprises) or weaker organizational ties (e.g., a community of practitioners, a cluster, a supply chain).

Possible Research Questions:

- what are the properties of a co-working space that lead to superior performances of accelerated start-ups due to the interaction among DiDIYers and eventually the development of a community of DiDIYers?
- how the activities performed in an R&D department will be influenced by the advent of DiDIYers among the R&D employees and among the firm customers?
- how the activities of a retailer will be influenced by the advent of DiDIYers among its customers?

- how the activities in the supply chain within the manufacturing industry will be influenced by the diffusion of DiDIY practices among the firms in the supply chain and among its final customers?

2.2 WP3 domain of investigation

A second set of assumptions, derived by the knowledge framework, allow to define the domain of investigation of the WP3.

A1.1 The DiDIY phenomenon, meant as the spread of DiDIY mindset and DiDIY activities among individuals, acts as a strength influencing the evolution of the socio/economic/technological environment, together with other global phenomena, such as technological progress, globalization, migration.

A1.2 WP3 is interested in understanding, foreseeing (and eventually driving) *how a subject evolves due to the influence of DiDIY*, among other socio/economic/technological phenomena.

A1.3 By *subject* we mean the *unit of analysis* of our research:

- a single individual;
- an aggregation of individuals;
- an aggregation of aggregations of individuals.

Within WP3, we want to overcome the simplistic approach described in the introduction, and we want to explicitly address the WP3 issues according a multi-layer research structure. Therefore, we assume that DiDIY provides the individual (L1) with the opportunity to exploit her unique competences and be the maker (the *artifex*) of the environment (physical and social, relational) where she works, that is:

- within L2, we see such environment as a network of relationships between individuals and objects rather than a deterministic machine; such network, or aggregation can be weakly tied, (e.g., a community of practices), or strongly tied (e.g., an organizational unit, a whole enterprise);
- within L3, we see such environment both as an *inter-net*, a network of networks where relationships are made among L2 entities (Lyytinen 2011; Grover 2012), and as a *meta-network* driven by the relationships among single individuals who operate in L2 entities (Menzel 2010). Also in this case, such networks can be weakly tied (e.g., an industrial association), or strongly tied (e.g., an industrial cluster).

In synthesis, the domain of WP3 is multi-layered domain we are interested to study from a dynamic perspective: we are not solely interested in DiDIYers, but in *how work and organizations evolve*, due to the interactions among DiDIYers (and their aggregations) and between DiDIYers and their environment.

We may set a conventional target date as a reference point in time to aim at, with our research: let it be 2020.

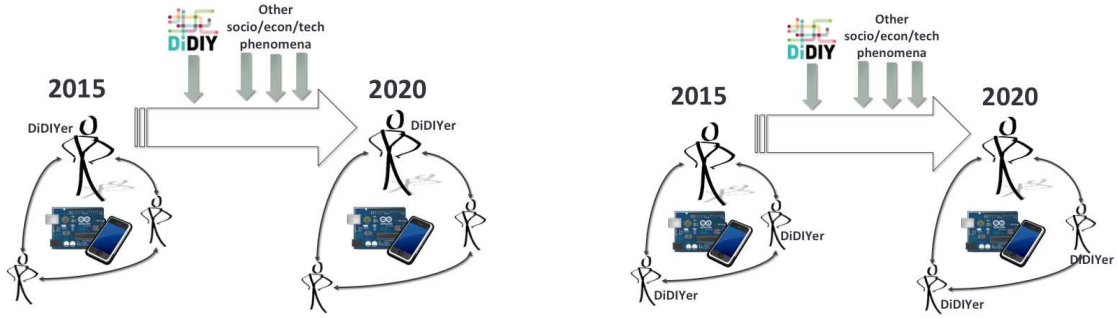

Figure 1 - A representation of the possible domains of investigation of WP3 (L1).

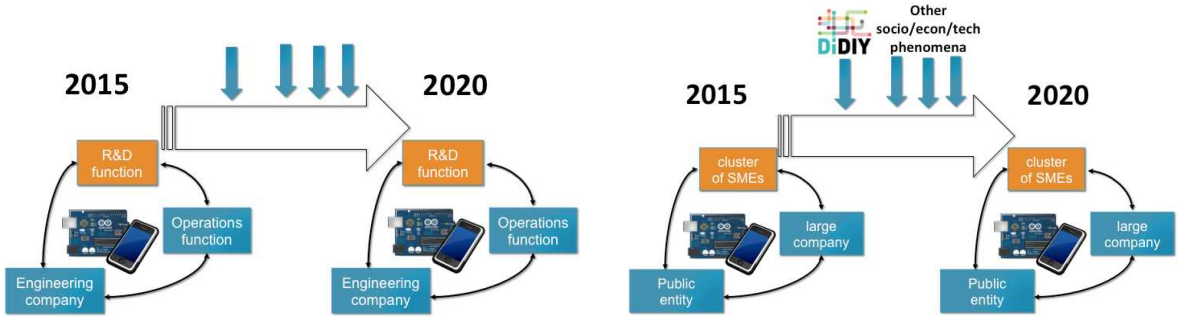

Figure 2: - A representation of possible domains of investigation of WP3 (L2 and L3).

Related (though very general) Research Questions can be:

- how organizational roles evolve (disappear/emerge)?
- how organizational functions evolve (disappear/emerge)?
- how industrial sectors evolve (disappear/emerge)?

2.3 WP3 theoretical reference framework

A final set of assumptions can help identifying a general framework to describe the generic organizational context on which the DiDIY phenomenon exerts its influence.

A2.1 The DiDIY phenomenon operates in a ***social context***, i.e., the DiDIY influence does not occur just on the subject, but on the system of relations in which the subject operates. Even if the *subject* is a single individual (L1), WP3 objectives can be achieved by investigating the **relationships** between the subject and other subjects she interacts with.

A2.2 being technology-dependent (see A0.2), the DiDIY phenomenon contributes to *reshape the Digital-Technology* that the subject (and other subjects she relates with) uses.

The aforementioned hypotheses show a systemic interaction between human and technology components in an organization, thus suggesting – as a general reference framework – the Socio-Technical System (STS, Bostrom 1977).

Under this assumption the investigation of how DiDIY reshapes work and organization can be carried out as the study of the effects of DiDIY on socio-technical systems at all the levels of aggregation (L1, L2 and L3) and the study of the transformation processes that DiDIY activates.

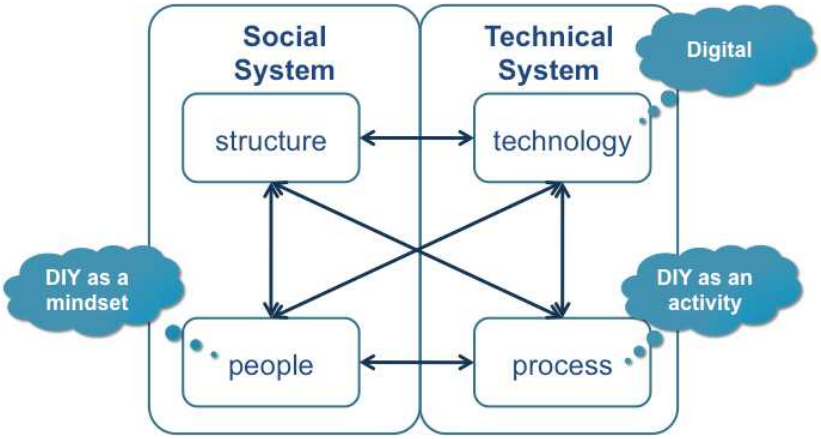

Figure 3 - Application of the sociotechnical model to DiDIY main constructs.

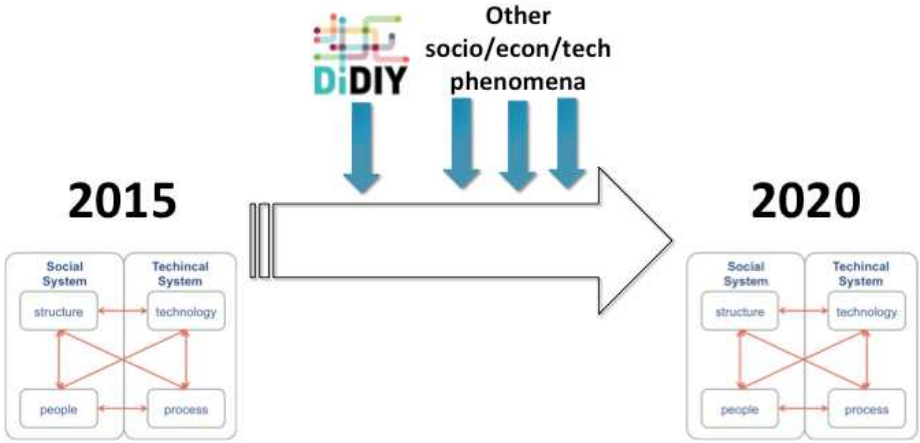

Figure 4 - Application of the socio-technical model to the investigation of WP3.

2.4 Towards an operative definition of DiDIY for WP3

The discussion of the assumptions of DiDIY above presented shows that, within WP3 (impact of DiDIY on work and organization) it is necessary to take into account not only the "DiDIY as a mindset" point of view, but also the "DiDIY as an activity" perspective, that is explicitly linked to work (defined as a set of activities) and organization (defined as a set of entities performing activities with a shared objective).

Under this premise, and in the attempt to identify possible areas of research, we can translate the above assumptions into a synthetic framework, enabling defining constraints (although still blurred) to the identification of DIDIY activities:

a) a DiDIYer, i.e., certain *organizational roles* (or, at a higher level of aggregation: certain organizational units, certain enterprises),

b) carries out on their own certain *activities*, previously carried out by experts (or specialized companies) (this aspect deals with the traditional notion of Do-It-Yourself),

c) by exploiting certain digital *technologies*.

A few examples:

- operation department head, carrying out prototyping activities without asking support to engineering firms, using 3D printers;
- quality managers in a production plant who deal with quality control without support from IT specialist (employees or consultants), by setting up an IoT system along the production line;
- marketing specialists who create advertising campaigns without the support of IT specialists (employees or consultants) by creating a dedicated web site and using social networking platforms;

d) possibly exploiting the knowledge sharing within a certain *community* (of individuals, of organizational entities). This aspects deal with the innovative notion of Do-It-Together, where "together" refers to a community the DiDIYer belongs to.

Following this framework, we might define:

- "core DiDIY activities" those where all the 4 conditions are fully respected, and
- "DiDIY activities" where condition d) is not valid and/or where the autonomy of the DiDIYer from an expert (mentioned in condition b) is not complete.

3. Literature review

With the aim to investigate and understand the state-of-the art literature around DiDIY a literature review has been carried out by using the following keywords: DiDIY and organization, DiDIY and work, Digital Crafts, Makers, DIY and IoT, DIY and 3D-printing, peer production, user-led innovation (e.g., Von Hippel), open innovation, open source hardware. The following academic disciplines have been considered: Software Engineering, HCI, Information Systems, Innovation Management, Organizational Science, Sociology, Entrepreneurship / Strategic Management, Design, CSCW and Social Computing, Creativity and Cognition, Journalism and Society. Articles ranging from 1980 to recent days have been considered for review with the aim to include and analyse a broad spectrum of seminal papers around the keywords selected.

The figure below gives a comprehensive vision of the coverage of WP3 among academic disciplines.

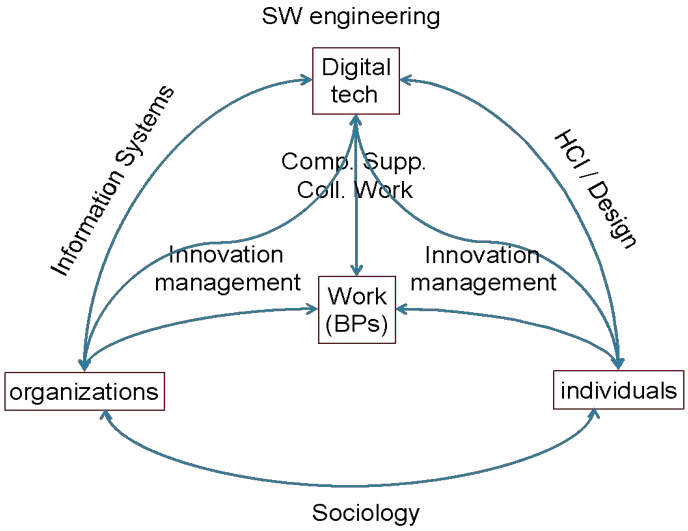

Figure 5 - Academic disciplines covering the WP3 domain.

3.1 Information systems

Among the papers collected for literature review there is a scientific domain with the highest number of referring papers: Information Systems. It is relevant to introduce a definition of Information system: “an academic study of systems with a specific reference to information and the complementary networks of hardware and software that people and organizations use to collect, filter, and process, create and also distribute data” (Wikipedia 2016). The scientific domain of Information Systems lies in the intersection between management, computer science and engineering domains. Therefore, studies within this domain can deal with topics such as “organizational impact of digital technologies implementation”; “strategic impact of digital technologies adoption”; “business value of digital platforms”. The topics before are an example to help the reader position him/herself within this scientific domain and are not exhaustive at all.

As previously mentioned, a wide database enquiry has been carried out with the aim to collect relevant literature around main keywords that can be related to DiDIY: do-it-yourself; digital-do-it-yourself; Internet of Things (IoT); Big Data; digital technologies; digital innovation; diffusion of innovation. The keywords were selected to be related to DiDIY assumptions and not be exclusively focused on technologies (i.e., a potential bias when dealing with disruptive technologies applications). According to this introduction a set of relevant themes have emerged from papers within this scientific domain.

Yoo et al. (2010) provide richness of theoretical background on digital innovation with the aim to lead to potential research streams. This paper provides useful literature on relevant digital technologies and their impact on organizational innovation. Insights from "a forum of scholars from different fields were collected during an interdisciplinary research workshop" and used to establish a preliminary theoretical framework that can guide future scholarly research on digital innovations. In order to understand the authors view on this topic is necessary to introduce their view of innovation: "by innovation, we mean the creation and adoption of an idea, a product, a technology, or a program that is new to the adopting unit (Gupta et al. 2007). By digital innovation, we mean an innovation enabled by digital technologies that leads to the creation of new forms of digitalization. By digitalization, we mean the transformation of socio-technical structures that previously were mediated by non-digital artefacts or relationships into ones that are mediated by digitized artefacts and relationships. Digitalization goes beyond a mere technical process of encoding diverse types of analog information in digital format (i.e., "digitization") and involves organizing new socio-technical structures with digitized artefacts as well as the changes in artefacts themselves". The combination of scholars from different fields can enhance a multi-disciplinary approach based on several perspectives, from social to economical ones, which can help in understanding the change driven by digital innovation. "Scholars should to try to assemble large-scale, ultra-rich data sets from the pervasive digitalization of our social and economic activities and make them available in the public domain to support more systematic scholarly activities". Scholars are responsible for pursuing new opportunities that can leverage on the continuous availability of a digital infrastructure. In fact the plethora of digital technologies emerging is creating a discontinuity in such a way that traditional business models are reshaped and organizational and markets boundaries are reshaped coherently (Benner 2010; Rothaermel & Hill 2005; Tilson et al. 2010).

Yoo et al. (2010), starting from seminal papers in Information Systems discipline, investigated how a firm's business model and organization are influenced by digital technology (Sambamurthy et al. 2003; Sambamurthy & Zmud 2000). They introduce the relation between digital innovation and network externalities claiming, "Digital innovation creates positive network externalities that further accelerate the creation and availability of digital devices, networks, services, and contents" (Benkler 2006; Hanseth & Lyytinen 2010). Digital innovation has organizing logics and loose couplings that shade across different devices, networks and contexts. It is starting to emerge from literature a need for a digital innovation agenda that can help to identify IS theories on adoption, impact and design of IT and where users naturally collaborate, share best practices, find "shepherds" and work within new a/o reshaped organizational boundaries.

Boland et al. (2003), explore "how new and complex digital technologies and tools enable path-creating innovations in multiple dimensions over a sustained period of time in a specific field of practice". Authors, by using a retrospective case study deal with the path creation processes by which Gehry Partners' innovations with digital 3D representations affect their technologies,

knowledge, work practices and organizational forms and their construction contractors. “Path creation refers to the way an agent mindfully deviates from traditionally reinforced paths of practices and resource use in order to produce a new path of self-reinforcing relationships (Garud & Karnoe 2001)”. This concept was important at that time given the set of digital technologies available. Nowadays it is becoming crucial as long as a set of disruptive technologies is transforming organizations.

The problem of understanding the organizational impact (i.e. collaboration, practices) of digital technologies is central nowadays. As reported by Quinones (2014) in its qualitative study: “the challenge, then, is not just to design innovative ICTs with tailorable system design principles, but to consider the appropriation work that occurs at the user level – supporting good understandings of technology and cultivating practices around it. Such work is akin to establishing what MacLean et al. (1990) called the culture of tailoring”.

A concept emerging from Quinones work relates to the set of practices and sense making around technology: “shepherds”. “Shepherds” are those professionals who formally or informally, within specific groups, help other colleagues in the successful completion of activities. The challenge for organizations is to foster the growth of these practices with the aim to improve the organizational impact of ICT adoption. Finally, the work of Quinones “builds on previous research by further exploring who is involved in appropriation work, building on and refining the concept of gardeners (Gantt et al. 1992; Nardi & O’Day 1999) and putting the social actors in the context of unexpected users”.

What emerges from literature relates not only to traditional organizational settings but also, for example, to innovative ones. This is the case of Nardon and Aten (2012) interpretive study that deals with virtual worlds (specifically on collaboration inside them) and the acceptance of a specific technology. Authors used one of the most important theories within the Information Systems discipline (i.e., the theory of Technology Acceptance and the related model) to investigate the organizational implications of a new technology adoption. Acceptance usually refers to an individual’s positive attitude towards a technology or intention to use it (Davis 1986; Davis, Bagozzi, and Warshaw 1989). According to this literature, technology acceptance and use are viewed as originating in cognition (Orlikowski & Gash 1994; Compeau, Higgins, and Huff 1999) or, more specifically, in potential users’ beliefs about a technology and their affective responses to using it (Davis et al. 1989; Compeau et al. 1999; Davidson 2002). Authors contributed by investigating users’ beliefs about technology and demonstrated that they have been influenced by a specific understanding of a technology. Nardon and Aten report that “participants’ mental categorizations of virtual worlds influenced their expectations regarding what virtual worlds should do and the key criteria used to assess their value”. This concept is fundamental when dealing with the adoption of new technologies within organizational settings because, in order to exploit positively the new digital tools, users (i.e., typically workers) should fully understand their potential and the business value to them.

The last concept – understanding the business value of digital technologies – is another relevant topic that is widely dealt in Information Systems literature. Where a new – disruptive – technology is adopted by an organization, professionals (e.g., managers, knowledge workers, workers …) are typically view it from a pure technological dimension. It is more than ever relevant to understand the impact of technology adoption on the organizational dimension as long as the economic one and not only from a technological one. Assessing the impact of digital technologies sometimes deals

with the creation of new avenues of value not only inside organizations themselves but – most important – outside them. In order to understand the concept of Value we provide a first definition: "Value (economics), a measure of the benefit that may be gained from goods or service; value (marketing), the difference between a customer's evaluation of benefits and costs" (Wikipedia 2016). Grover and Kohli (2012) focus on the collaborative relationship developed because of IT-based value co-creation. They draw the example of 3D printers and their potential "to afford opportunities for various component makers to deliver physical products through the digital channel and thus co-create new avenues for new value". In their paper they draw inspirations from seminal papers dealing with: market positioning and the concept of monopolistic positioning (Porter's 1980 industry structure view); collaboration as a way to respond to specific needs of specialization and short time-to-market frames (Barrett et al. 2011); knowledge sharing and shared strategies for strategic decision-making (Dyer & Hatch 2006); the capability of knowledge absorption at different organizational levels (Cohen & Levinthal 1990); governance as the most important layer to consider when "managing co-creation over several firms in a loosely coupled cooperative arrangement" (Dhanaraj & Parkhe 2006).

In order to understand the impact driven by new digital technologies within organizational settings, several authors dealt with the concept of sensegiving. It is defined as "a process or a sequence of practices meant to 'influence the sensemaking and meaning construction of others toward a preferred redefinition of organizational reality' (Gioia & Chittipeddi 1991, p. 442), that can create a conducive context where consensus is supported. The goal of sensegiving is not to tell others what to think but how to think" (Tallon 2014). In an organization it is the Chief Information Officer (CIO) responsibility to act as a leader and to develop awareness on the role of IT and its effective use (Fiegener & Coakley 1995; Huff et al. 2003) as long as to extend its impact. Tallon (2014), by carrying out a survey on a sample of 133 executives drawn from the executive steering committees at 13 Fortune 500 firms, use distributed sensemaking theory to investigate "the conditions under which executives will reach a consensus as to the extent and locus of firm and process-level IT impacts in their firm". CIO role depicts as a catalyser of value-added relationships based on a great understanding of IT and its business value. As noted by Hansen et al (2011) and Kettinger et al (2011), "the digitization of organizations and processes has shifted the leadership role of the CIO to one of active engagement with business leaders". On sensegiving, Tallon (2014) reports, "sensegiving gives users the confidence and tools to better rate IT impacts, potentially showing them what steps are needed to address underperforming IT investments that fail to create sufficient value".

CIOs have responsibilities of evaluating emerging technologies to be adopted by organizations; he/she has to provide useful frameworks about innovation, shifting and governance of emerging technologies. Tiwana (2014) uses the metaphor of "separating signal from noise" to describe the process of evaluating emerging technologies. Data were collected using in-depth unstructured interviews with senior managers in the U.S. and Japan in 2012 and 2013. These managers spanned a variety of firms in several industries (including appliances, pharmaceuticals, aviation and services) and with multinational operations. Patterns across the cases were identified using cross-case analyses. The qualitative phase of the study was complemented by a survey of senior IS managers in 105 U.S. firms, whose assessments were used to develop insights into the governance of emerging technologies. The author reports "CIOs must remember that emerging technologies are prospective pieces of potential solutions waiting for valuable problems to solve. The rewards go to

firms that find the right place for them in the jigsaw puzzle of their own industry's value chain". Tiwana (2014) still claims that it is CIO's duty to "understand whether an emerging technology can transform a product, service or business process by shifting how it is delivered or purchased, or altering a digital/physical boundary (either way). Examples drawn in the paper come from a variety of industries to illustrate shifts in both directions caused by 3D printing, the internet-of-things and biologically inspired digital platforms.

A last set of papers reviewed within the Information Systems discipline has a typical technological connotation that, as we have introduced in the beginning of this section, is one of the facets of this discipline. Nevertheless, it is important to review papers dealing with technology in order to understand how managers and decision-makers face concepts of adoption and usage, architecture and customization. The development of frameworks of adoption and the design of unique architectures are central bodies of an organization willing to introduce new technologies.

According to the development of a customized architecture Huang et al. (2002), use the DIY (Do It Yourself) approach to explain the concept that SMEs should design, develop, deploy and maintain their own Electronic Business Portal (EBS). Authors explain that "the rationale behind this DIY approach is only valid on the assumed emergence of the concept of portalets which are ready made constructs to facilitate the EBS design, development, deployment and maintenance". This paper concept of extreme customization of software components is fundamental to understand recent papers on digital platforms and related frameworks of adoption.

According to the development of a framework, Riggings and Fosso (2015) conducted a comprehensive review within the following databases: ProQuest Central, Emerald Insight, and the AIS Senior Scholars' Basket of Journals. This last basket has eight (8) journals, namely: European Journal of Information Systems (EJIS), Information Systems Journal (ISJ), Information Systems Research (ISR), Journal of AIS (JAIS), Journal of MIS (JMIS), MIS Quarterly (MISQ), Journal of Strategic Information Systems (JSIS), and the Journal of Information Technology (JIT). They have used a combination of the following descriptors: "Internet of Things" or "Web of Things" or "Internet of Objects" and "big data" or "business analytics". They did not specify any timeframe during the search. As a result, they propose a framework composed of "the individual level, the organization level, the industry level, and the society level". They map these four levels of analysis with three different evolving instantiations of the Internet of Things (things; network of things; internet of things) and they propose a framework to analyze the adoption, usage and impact of the Internet of Things. They investigate how organizations use technology to serve customers better, to change the role of employees, and how employee privacy may be threatened by drawing inspiration from seminal papers on IT adoption (Riggins et al. 1994).

Wang et al. (2015) provide the state-of the-art of and emerging trends in research and practice of IoT by investigating several areas ranging from architecture, design, implementation, to the evaluation. What emerges is that "IoT is a current trend that leads the next generation Internet-based information architecture that involves integration of social networks and inter-object communications (Wang et al. 2014)". They see a plethora of opportunities to apply IoT to supply chain management today or in near future (Bi and Cochran 2014; Li 2012; Xu 2013).

3.2 Software engineering

This section presents the set of papers, resulting from the Database search that can be related to the Software Engineering discipline. With these terms, we refer to "the study and an application of

engineering to the design, development and maintenance of software. The discipline of software engineering was created to address poor quality of software, get projects exceeding time and budget under control, and ensure that software is built systematically, rigorously, measurably, on time, on budget, and within specification. Engineering already addresses all these issues; hence the same principles used in engineering can be applied to software" (Wikipedia 2016).

Nowadays customers have the power to modify products of major manufacturers to their own needs. This adds value to the users' experience that, actually, are encouraged to develop specific products – both physical and digital – that can be innovative in their fields. That is the concept of Windows, Linux, Facebook, and the iPhone App Store where users can download and upload their applications. As Tanz (2011) reports: "once there were modders that have introduced several innovations that have grown into entire product categories—like mountain bikes, heart-lung machines, and rodeo kayaks. But today, unsanctioned tinkerers have more power than ever. Sophisticated computers, sensors, and accelerometers are all common ingredients in personal electronics available for $100 or less at Best Buy. As a result, the kind of equipment that was recently available only to research universities or major corporations is now accessible to anyone with a cell phone and a soldering iron. That has dramatically altered the kind of projects modders can take on". The example presented with this paper is the one of Microsoft Xbox Kinect: a 150 $ add-on that allow players direct the action in a game simply by moving their bodies. Years ago the type of technology that could enable these types of applications would cost many times more than that. Moreover, only inside specific research centers, PhD students or researchers could work on them thus making this types of innovation a privilege for a limited pool of people. What emerges from this paper is the wide number of hacks done by DIYers that started to reverse-engineer the Kinect in order to unfold its sourcing and developing code. The wide interest arisen by this extremely innovative tool, although low-price, set a new era for the market and the role that big players – such as Microsoft – should play in it. Microsoft now is granting access to the high-powered algorithms that help the machine recognize individual bodies and track motion, unleashing the kind of power that was previously available to only a small group of PhDs. This big change in how to engage users has motivated other companies, such as Motorola and Google, to follow Microsoft's approach.

The paper of Tanz (2011) is quite fundamental within the scope of DiDIY. In fact, while telling the story of Microsoft Kinect's birth and its launch on the market it introduces other relevant topics: knowledge sharing inside online communities; open-source software distribution; development platforms. The topic of knowledge sharing inside online communities emerges and it is described by the disruptive advent of robot freaks that were not the only people to explore the Kinect's possibilities. Researchers and visual artists, for example, have all begun cobbling together home-brewed Kinect projects and posting the results online. Tanz reports the example of website Adafruit Industries, the open source hardware company run by hacker impresario Limor Fried. "The company was offering a $1,000 bounty to whoever posted the first open source Kinect drivers to GitHub". This resulted in several attempts to hack the Microsoft device and users worldwide begun to upload their pieces of coding available for the community.

Microsoft took a step further in open-source software distribution and development platforms: after few months, they released their own software development kit. This was a big turn of Microsoft selling policies as long as its perception among customers: "instead of acting like a lumbering,

power-mad hegemon, it had lent its support to what was shaping up to be one of the biggest and most successful open source development projects the world had ever seen".

Knowledge sharing is a relevant topic when dealing with digital technologies: it not only happens inside online communities – as reported before from Tanz paper – but also is a typical process in place within traditional organizational settings (i.e. firms). The concept of managing knowledge (creation, sharing, and usage) by using ad-hoc information technology is widely known. In fact, we refer to Knowledge Management Systems (namely KMS) as "a set of means, approaches, organizational actions, informational repositories, technical resources, and the software. The primary goals of KMS are gathering of knowledge and reuse it" (Piccoli 2012). From literature review, an interesting paper is the one of Lee et al. (2013) where KMS is presented with a focus on knowledge sharing and reuse of digital tools within a shared services company. Their work focuses on how an IT shared Services Company adopts a knowledge management system by identifying the problems of KMS implementation, employees' perception towards KMS and potential improvements in order to achieve the objectives of the company and to stay competitive through knowledge sharing and reuse. The exploratory approach was adopted by authors and they carried out both focus group and interview sessions "to investigate and understand issues and problems that arise from the case study on the usage and perception of the current KMS". Data coming from company documents were examined and studied together with extracts from interview sessions; eventually a questionnaire survey was conducted. Authors based their work on seminal papers around four main topics: KMS and creativity; people factor; capability of retaining and maintaining knowledge and the role of top management. We believe that these assumptions made in Lee et al. (2014) paper could be used for the DiDIY context too. We report authors claim on the four factors:

- KMS and creativity: "knowledge management systems should consist of features that enable users to perform knowledge creation, capture and sharing among employees with ease of use, ease of access, and intuitively friendly design. It was found that (Wang et al. 2009) creativity is one of the most influencing factors for knowledge creation among employees and such behaviour can determine the knowledge creativity by an individual";
- people factor: "the people factors that influence the employees on cultivating knowledge sharing in the organizations are also critical elements to observe (Debowski 2007)";
- capability of retaining and maintaining knowledge: "the capability of retaining and maintaining knowledge in organizations is becoming more crucial in large, medium and small organizations (Chan et al. 2005; Alavi et al. 1999) due to poor knowledge retaining rate";
- the role of top management: "strong support and leadership from the top management will ensure the success of knowledge management initiatives (Lee et al. 2010)".

The paper from Lee et al. contributes on the usage patterns and problem solving within a KMS. In detail, authors found that "motivation from upper management and commitment of employees is needed to ensure information and knowledge shared is useful".

A subset of papers, within the Software engineering section, is focused on Internet of Things (IoT) applications and how they influence the environment and communication of user development. We believe that, according to the freshness of the IoT paradigm, we can draw great insights about organizations of user communities around IoT development of applications.

In order to position the topic, we refer to Atzori et al. (2010) paper that provides some bibliography around IoT paradigm. We believe that, although the richness of the paper, if further researches focus exclusively on IoT literature they have to be carried out they have to be done according to extant literature at the time of research. Nevertheless Atzori et al. (2010) describe the different visions of the Internet of Things paradigm coming from different scientific communities, they review the enabling technologies and illustrate which are the major benefits of spread of this paradigm in everyday-life, eventually, and they offer an analysis of the major research issues the scientific community still has to face.

Two definitions of IoT help readers in understanding the paradigm:

- "The basic idea of this concept is the pervasive presence around us of a variety of things or objects – such as Radio-Frequency IDentification (RFID) tags, sensors, actuators, mobile phones, etc. – which, through unique addressing schemes, are able to interact with each other and cooperate with their neighbors to reach common goals (Giusto et al. 2010)";
- "Internet of Things semantically means a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols (INFSO 2008). This implies a huge number of (heterogeneous) objects involved in the process".

IoT is leveraging on the concept of Web Squared given that it aims at integrating web and sensing technologies (O'Reilly et al. 2009) together so as so enrich the content provided to users. Information about position, voice, images are coming from sensors installed within our mobile devices and they all contributed in building a common – digital – perception of the environment.

Chandrakanth et al. (2014) paper has the aim to give an overview of Internet of Things and a brief description about the applications and challenges faced by it. They claim that although "there has been much advancement made in many standard areas, more progress is needed by focusing on main areas such as security, network structure and communication". Further steps have to be carried out in the direction of standardization of protocols and ad-hoc architecture.

Mzahm et al. (2014) also investigate the topics of standardization and architecture under the light of the IoT environment and communication. According to IoT and environment, they consider that both physical and virtual world are fused together (Tan et al. 2010; Huang et al. 2010; Leong et al. 2014), thus creating a link to exchange data between real devices and cyber applications in a secured connection (Fan et al. 2010). On communication, Mzahm et al. claim "the ability and significance of the things in IoT to communicate with each other depends on the service type they are assigned to do (Khan et al. 2012; Bari et al. 2013). They conclude, "Although IoT is revolutionizing the way things are managed it lacks the intelligence in its architecture to capitalize on changes of the environments that offer value-added services to humans. The Agents of Things extends and enhances the IoT concept by embedding the things with intelligent software agents, which enables the things to reason on its environment".

End-user development is central when dealing with IoT application. Tetteroo et al. (2014) reports insights from a workshop where researchers and practitioners gathered to discuss and exchange their experiences on the role of these aspects for end-user development across various domains. Tetteroo claims, "We need new ideas on tools, services and architectural infrastructures able to support EUD (end-user development) in the context of the IoT". The introduction of design strategies could seek for a proper balance according to the amount of data to be collected; the variety of data; the velocity of data creation; the reliability of data.

The last paper focused on IoT deals with the development of an open source IoT platform enabling the semantic interoperability of IoT services in the cloud. The paper of Soldatos et al. (2015) is technology-focused but according to DiDIY context its contribution is relevant under the concepts of user-created contents and communities. In fact, the paper describes the creation of an innovative platform for IoT/cloud convergence, which enables integration of IoT data and applications within cloud computing infrastructures and deployment of and secure access to semantically interoperable applications.

3.3 Computer-Supported Cooperative Work and Social Computing

This section reviews literature related to two main topics that are intertwined with the DiDIY context: Computer-Supported Cooperative Work (CSCW) and Social Computing (SC). “CSCW is a generic term, which combines the understanding of the way people work in groups with the enabling technologies of computer networking, and associated hardware, software, services and techniques. Essentially, CSCW goes beyond building technology itself and looks at how people work within groups and organizations and the impacts of technology on those processes” (Wikipedia 2016). We believe that understanding how new digital technologies are reshaping the work and the organizations encompasses literature on CSCW. Together with CSCW, a second topic is tied to the project background: Social Computing. “Social computing is an area of computer science that is concerned with the intersection of social behavior and computational systems. It is based on creating or recreating social conventions and social contexts through the use of software and technology. Thus, blogs, email, instant messaging, social network services, wikis, social bookmarking and other instances of what is often called social software illustrate ideas from social computing, but also other kinds of software applications where people interact socially” (Wikipedia 2016).

Although the database search did not result in several papers such as, for example, Information Systems, Entrepreneurship/Strategic Management, Software Engineering and HCI sections, we believe that the paper we collected are rich in contents. In fact, they study the interaction of users with technology within different types of organizations: manufacturing firms, non-profit cultural associations, online communities.

A first article whose relevance is transversal to different sections of this literature review (see Section on Software Engineering, HCI, Innovation Management and Entrepreneurship/Strategic Management) is the one of Tanz (2011).

Within this section, we review the paper from the dimension of user interaction with software systems throughout sensors and cameras. The opportunity for users to develop projects and share their results online opens new avenues of value. They can benefit from feedbacks and contributions by other users that are working on similar projects. Tanz (2011) describes the impact brought by Microsoft Kinect: a 150 $ add-on that allow players direct the action in a game simply by moving their bodies. Years ago the type of technology that could enable these types of applications would cost many times more that. Moreover, only inside specific research centres, PhD students or researcher could work on them thus making these types of innovation a privilege for a limited pool of people. Today sensors, sophisticated computers and accelerometers are present inside several mobile devices and available at a cheap price on the market. Therefore, tinkerers or DIYers can exploit the opportunity to use these components in an easy way for their projects. “If you’re talking about changing the spoiler on the back of a Ford, that serves a very specific purpose,” says Eric von

Hippel, a professor of technological innovation at MIT's Sloan School of Management. "But a depth camera or an accelerometer or a GPS chip enables not just one application but a wide range of new activities." Different companies have benefited from cheap but extremely sophisticated devices such as the Microsoft Kinect. For example, a German company called Evoluce built a gesture-based control system for Windows. A group of interactive designers conjured a way to use the Kinect to turn any surface into a multitouch interface, so a user could control the action on a screen by dragging their finger across a desk, wall, or book. In addition, two artists based in New York designed a digital puppet, a giant bird that moved in coordination with a user's arm, wrist and hand. Eventually, a university in Konstanz demonstrated the use of Microsoft Kinect for helping blind people to navigate within different environments.

What emerges is that DIY amateurs can exploit new avenues of innovation thanks to cheap digital tools and the explosion of online collaboration. This change is not affecting manufacturing only but it is happening within non-traditional organizational settings. That is the case of non-profit cultural association as reported by Vowels (2005). Her study investigates a significant area that has been under explored, namely, the use of non-traditional or "do-it-yourself IT" workers, and to explore the possibility that with the advent of more user-friendly and ubiquitous IT productivity tools, the use of non-professional IT staff, or "DIY-IT," is becoming an attractive and viable option, particularly for non-profit organizations and small businesses. Specifically her study "will examine the impact of web design software products and cost-effective hosting solutions on website development and website maintenance staffing by non-profit arts organizations and by small businesses". She hypothesize that in the non-profit world, DIY-IT is performed by volunteers and by paid employees who are not primarily IT workers and whose primary job descriptions focuses on broader tasks. By adopting a multi-stage, phased field study data are collected throughout a survey carried out on non-profit arts organizations in Delaware. The research contributes with insights useful to develop a model that can be generally applied to IT staffing by non-profit organizations and small businesses.

A different context is analysed by two papers: the one of Cheatle et al. (2014) and the one of Williams et al. (2014). In the paper of Cheatle et al. (2014) is described a studio experience with integrating digital fabrication tools into their studio practice, and its implications for the collective organization of work and creativity. Authors claim "the pace of technological creation and its incorporation into everyday life alters the power, shape, and meaning of human practice. Relationships between people, social and natural environments, work and leisure, and how we conceptualize and interact with the material world are being (re)mixed because of this encounter. Artists, as sophisticated makers, are often at the forefront of this process. They act as creative and critical users of tools – both computational and otherwise – whose practice has the potential to reveal new insights and understandings about the world in which we live, while also generating new theoretical frameworks that may apply to other contexts of human-computer interaction".

Cheatle et al. (2014) work lies in the intersection between creativity, production and technology. In fact, they study the integration of a CNC robot into the collaborative work practices and material flows that collectively constitute the processes of imagination and production that define the Castle studio and its unique creative process and vision. The contribution of the authors is on understanding how "the introduction of new computational tools into longstanding and craft-based forms of creative work carry deep implications: both for the experience and organization of work and the values that surround it. It can reorganize the nature and sites of creativity, and the forms of collaborative work that give rise to it".

Advances in manufacturing, provided by the introduction of new digital tools (e.g. robots a/o 3D printing) falls within the concept of "Democratization of Manufacturing". This concept is introduced by Anderson (2012) and The Economist (2012) and has been called the "This Industrial Revolution" and, indeed, its impact is on a global scale. It takes into consideration advances in prototyping, knowledge sharing and reuse, adaptive manufacturing systems that are both affecting traditional organizations but even influencing new types of organizational settings such as the "maker movement". The concept of "democratization of manufacturing" is used as the background for another relevant paper we selected for review, the one of Williams et al. (2014). Authors want to share their experiences lived during the prototyping phase of a smart product, Arduino-enabled. They tell the issues and opportunities faced from sourcing components and managing a supply chain through designing for easiness of assembly until testing, and communication between supply chain actors. This paper is relevant, according to DiDIY context, because authors, by describing their experience, provide insights on how traditional organizational boundaries and activities are reshaped from the advent of new opportunities provided by digital tools. They even deal with the issue of raising funds to support ideas and sustain the business model. They explain the concept of crowdfunding and its potential to involve and motivate "backers" (i.e., people involved in the creation of innovative products that provide financial support throughout dedicated online platforms) to support a project and make it scale fast.

The last paper falling within the category of CSCW and SC is the one of Harburg et al. (2015) and its topics connect with the previous paragraphs. In fact, authors explain how to use crowdfunding sites not only to help entrepreneurs to find money, but also to validate their business idea and to increase their self-confidence. Authors are trying to learn "how the tools in the crowdfunding ecosystem support not just the exchange of funds, but also the exchange of ideas and instruction ranging from programming and manufacturing to marketing and project management". By carrying out a qualitative study on 53 entrepreneurs that used crowdfunding to finance their projects, they reported that crowdfunding is influencing self-efficacy according to different factors. The first one is public validation: "the process of a group verifying their work which in turn shapes their own opinions about themselves". The second one is role modelling: "seeing examples of similar others as motivation for self, which can boost self-efficacy". The third one is mastery: "seeing oneself succeed or fail at a task". The last one is physiological state supported by socio- technical features: "running a crowdfunding campaign physically and emotionally exhilarating".

3.4 Sociology and organizational science

This section combines papers pertaining to Sociology domain and Organizational science one. The database search was not rich in relation to these two domains: in fact, we could categorize one paper within the Sociology domain and one within the Organizational one. Nevertheless, the research carried out within these two papers provide interesting insights – and foundational literature – on digital craft and craft activism. These concepts can be used to better understand the DiDIY impact on work as long as the organization.

The first paper is the one of Solomon (2013) and pertains to the Sociology domain. The purpose of this paper is to provide an overview of the literature on the intersections of craft activism as it stands within larger DIY craft culture and the professional-amateur divide. Author claims, "It uses a wider body of literature to highlight a contradiction between the ethos of "Do It Yourself," or DIY, which touts self-sufficiency and a romanticisation of the handmade, and the very real connection

between DIY gathering sites, whether virtual or in-person, and neoliberal consumerism. The piece discusses Do It Yourself culture as a whole, with special attention as to how physical and virtual DIY sites connect with consumerism, then overviews interrelatedness of the DIY lifestyle and professional-amateurism, paying specific attention to collaborative projects between professionals and amateurs".

A further contribution on the topic of craft, and specifically craft-work and material labour, is provided by Bratich (2010) whose article falls within the Organization Science domain. This article analyses the recent resurgence of DIY craft culture around the following themes: 1) immaterial and affective labour; 2) gender and the home; 3) time and capitalism's historicity. It challenges the periodisation of immateriality by highlighting the informational and communicative practices embedded in craft culture. Author claims "The gendered dimension of digital labour displays affective and immaterial qualities that have persisted resiliently before, during, and, in time, after capitalism. Craft as power (the capacity to act) is an ontological accumulation of species being that pushes us to rethink the 'organizing' of subjects".

3.5 Creativity and cognition

This section, together with Journalism and Society one, is represented by one paper only. This does not mean that there is no contribution to DiDIY coming from this scientific domain but simply that in our database search the journal population pertaining to this domain was not so rich.

Despite this, the paper of Mota (2011) introduces a topic that is relevant according to DiDIY impact on work and organization. Mota (2011) investigates the topic of "Democratization of Manufacturing" that is defined as "a trend that promises to revolutionize the means of design, production and distribution of material goods and give rise to a new class of creators and producers". The context in which this new revolution takes place is animated by several disruptive innovations: digital fabrication tools as long as software and database become open and public thus available to a big audience instead of simply professionals. A consequence of this big change is the birth and growth of the Maker culture: "Typical interests enjoyed by the maker culture include engineering-oriented pursuits such as electronics, robotics, 3-D printing, and the use of CNC tools, as well as more traditional activities such as metalworking, woodworking, and, mainly, its predecessor, the traditional arts and crafts". Finally, users have become more and more demanding for products and goods personalization. The paper of Mota (2011) is an overview of the current state of personal digital fabrication and the trends that are shaping it.

First the author deals with the topic of DIY addressing a description "is commonly used to describe the act of creating, producing, modifying or repairing something that lies outside of one's professional expertise". DIY encompasses the acquisition and learning of new knowledge and skills not only related to technical ones but even creative ones. The example that Mota provides to clarify the impact of a digital revolution happening within the traditional production settings is the following: "A whistle designed in Germany can be held in the hands of someone else in New York City in as little as 15 minutes; we can be 3D scanned in under five minutes and our likeness published and 3D printed a few hours later; a replacement part can be fabricated for a few cents, avoiding a repair which would otherwise cost hundreds of dollars".

Author concludes that traditional production ways and organizational settings are reshaping because of this new revolution brought by digital technologies available at a low-cost and to an extended

audience. In this light, the research on DiDIY will contribute on explaining the most promising directions for organizations and work.

3.6 Journalism and society

The section on Journalism and society is not rich of several papers like the previous ones; on the contrary, our search on the Databases produced only one result. Nevertheless, the paper of Deuze (2006) is rich of contents and provides interesting insights on the topics of participation, bricolage and remediation. The category we identified for the paper of Deuze is Journalism and society, given that his paper is an essay dealing with participation, remediation and bricolage from a journalistic point of view. Although examples of DIY are provided only few times and quite broad, the paper provides useful bibliography on digital culture.

Deuze (2006) aims to identify the principal components of an emerging global digital culture as these are expressed "in examples of (radical) online journalism, weblogging, and the online praxis of independent media centres". Author investigates the concept of digital culture by drawing literature on Internet phenomena such as the proliferation of independent media centres and popularity of weblogging that are carried out by individuals or groups. Digital culture in this paper is considered as "an emerging value system and set of expectations as particularly expressed in the activities of news and information media makers and users online". Digital culture expresses through individualization and globalization where, in this contexts, humans and machines interact in society digitalized and computerized. Especially this last concept is interesting for the current DiDIY work package: individuals or groups face these big trends in their daily life and they expect to find similar patterns of innovation within organizations. The opportunity to exploit digital technologies within organization is a reality but their impact on business processes as long as the reshaping of activities and organizational roles is still under the light of researchers studies and, therefore, a challenge.

Previous authors, for example Manovich (2001) have explained the concept of digital culture as "the convergence of media content and form, of national and cultural traditions, characters, and sensibilities, as well as a mixing of culture and computers". Deuze (2006), starting from seminal papers, introduces the three concepts presented above: participation, remediation and bricolage.

We below provide a short description of each one of them:

- *participation*: "as a core element of the currently emerging digital culture has its roots in "DIY" (do-it-yourself) culture, particularly flourishing during the 1990s, with people increasingly claiming the right to be heard rather than be spoken to";
- *remediation*: "in terms of digital culture, it makes sense to look at some of the most successful online applications for everyday individual use—of which weblogs and the various ways in which these are redistributed are an excellent example";
- *bricolage*: "digital culture consists of the practices and beliefs of the bricoleur—whose activities should not be confused with boundless freedom and endless creativity".

Authors conclude that his analysis both reifies digital culture as well as arguing for a processual remaking of it, in that it acknowledges the identified components as contingent trends rather than as a definitive set of characteristics.

3.7 Entrepreneurship and strategic management

For a long time, innovation has been a privilege of the R&D departments or research centers with high financial capacity. But thanks to the Internet and the potential for exchange of information, support and cooperation of the network on the one hand and access to technologies previously inaccessible because of high costs, the speed of innovation has reached high (Tanz 2011; De Roeck 2012; Lindtner 2014).

This kind of innovation and change in the style of R&D, with all the practical implications that can have in the company, has recently attracted the attention of scholars from various disciplines who have sought to understand the impact of this phenomenon on organizations as much as on the strategic development and management of companies. The kind of equipment that was recently available only to research universities or major corporations is now accessible to anyone with a cell phone and a soldering iron. Sophisticated computers, sensors, and accelerometers are all common ingredients in personal electronics, available for $100 or less at Best Buy. That has dramatically altered the kind of projects modders can take on.

Many successful technology companies have encouraged independent developers to build on top of their platforms consider, for instance, Windows, Facebook, and the iPhone App Store. And over the years, modders have introduced several innovations that have grown into entire product categories like mountain bikes, heart-lung machines, and rodeo kayaks.

This, not only has changed the access to technology that now is much less expensive, more and more companies rather than hindering the “creative” use or misuse, encourage community hackers or modders to implement the modifications or improvements to make it more efficient and versatile their product. “For example for 25 years the field of robotics has been bedeviled by a fundamental problem: if a robot is to move through the world, it needs to be able to create a map of its environment and understand its place within it.” (Tanz, 2011). At that time, many solutions were particularly cheap but not so efficient, while other were sophisticate but expensive. The solution was discovered in 2011 in a videogame “That’s the day Microsoft released the Kinect for Xbox 360, a $150 add-on that allows players to direct the action in a game simply by moving their bodies. Most of the world focused on the controller-free interface, but roboticists saw something else entirely: an affordable, lightweight camera that could capture 3D images in real time.”

Sometimes the launch of a digital product or technology, as it happened for the Kinect, has prompted hackers or simple modders to try change the product itself to improve it, adapt it to particular needs, or adapt it to other hardware/software. Business owners tend to counter the misuse of their product but with poor results. It is difficult to control the web community as individuals. But some companies have seen in these individuals the potential to improve their product and restricting investment in research and development. This happened for example with Microsoft and Kinect but also, for example, with Lego Mindstorms or Motorola and that made it easy to modify their devices. Other companies that have continued to struggle against hackers have instead suffered incalculable damage as such. Sony suffered the attack hackers that have penetrated its PlayStation Network using existing sensitive data of thousands of users (Tanz 2011).

Some authors focalised their attention on a 3D printing or 3D scanner looking at the change on competition rules as much as traditional production models. In their paper Petrik and Simpson (2013) address the role of 3D printing as a game changer for traditional production models and competitive rules. They suppose economies of scale and economies of one will continue to coexist,

but they will not be used for the same things. Companies based on economies of scale will still support commodity and high-volume production, but in instances where end-user customization is highly desirable, where production is single unit or very small volume, or where the end product requires features that cannot be manufactured by traditional means, 3D printing and additive manufacturing will become available and competitive option.

The emerging dynamics of economies have five likely outcomes.

1. There will be few clear boundaries in the design-build deliver paradigm.
2. Design and production will be tightly coupled through experimentation.
3. Competitive advantage will reside in both designs that are simple to manufacture and assemble and designs that are highly customized and complex; the challenge will be in arenas where manufacturers are seeking simple designs, and customers are seeking customized, complex products.
4. Proximity between supplier, manufacturer, and customer will matter, and localized production will be not only more feasible but more desirable.
5. Planning will go from long term to real time.

In some cases the scholars look at the importance of the role these new technologies play on change or in improving the organizational structure of the firms.

Gast and Lansink (2015) in their analysis describe the range of business contexts in which executives are increasingly making use of social media. The authors focus on the importance of adopting a wider approach that includes not just the latest Enterprise 2.0 technology platforms but also “human dynamics” and organizational behaviours.

The aim of this work was to present four specific approaches to the creation of what we call digital “hives” to drive organizational change. Given the speed of technology’s development, the authors recognize that digital hives are still an area of fertile experimentation and that new models will evolve over time. What they know already is that the hive’s transparent, inclusive, and egalitarian nature amplifies well-established psychological mechanisms, such as peer pressure and social recognition. Out in the limelight, with clear rules of engagement and a level playing field, people tend to stimulate and encourage others, perform well, and seek recognition. Collective adoption and participation can grow in hives as each one of them becomes a catalyst for change and causes a wider ripple effect throughout the organization.

Some authors look at the implication of using 3D technology the hot topic of Industry 4.0. First of all Baur and Wee (2015) provide a clear definition of it. They define Industry 4.0 as the next phase in the digitization of the manufacturing sector, driven by four disruptions: the astonishing rise in data volumes, computational power, and connectivity, especially new low-power wide-area networks; the emergence of analytics and business-intelligence capabilities; new forms of human-machine interaction such as touch interfaces and augmented-reality systems; and improvements in transferring digital instructions to the physical world, such as advanced robotics and 3-D printing. The four trends are not the reason for the “4.0,” however. Rather, this is the fourth major upheaval in modern manufacturing, following the lean revolution of the 1970s, the outsourcing phenomenon of the 1990s, and the automation that took off in the 2000s.

Then the authors address 3 moves that manufacturers (and most in general organizations) have to do.

Primarily, companies can gather much more information and make better use of it. Because usually the 99% of data was lost due to problems of data transmission, storage, and architecture.

Second, the traditional manufacturing business model is changing, and new models are emerging; incumbents must be quick to recognize and react to these new competitive challenges.

Third, to get the most out of Industry 4.0 technologies, and to get past square one with a digital business model, companies will have to take another step: prepare for a digital transformation. Manufacturers should begin today to join the hunt for the best digital talent, and think about how to structure their digital organization. Data management and cyber security will be critical problems to solve. Many companies believe that “two speed” data architecture can help them deploy new technologies at the speed required, while also preserving mission critical applications.

Most of these digital technologies have been brewing for some time. Some are not yet ready for application at scale. But many are now at a point where their greater reliability and lower cost are starting to make sense for industrial applications. However, companies are not consistently aware of the emerging technologies (Baur and Wee 2015).

The introduction of new technologies such as software for the 3D representations are dramatically changing relationships, work practices, organization structures and strategies. This is particularly evident and impact in the field of architectural design.

Boland et al. (2003) analysed how new technologies impact: on the relationships between the various actors involved in the planning phase and development, work practices, organization structures and strategies. The authors examine the wake of innovations in architecture and construction propelled by the adoption of digital three dimensional (3D) representations of buildings and their parts. Departing from the traditional view of innovation that treats information technology adoption as an unproblematic, singular event, they examine IT induced innovations and their consequences as path creation created by the network of professional communities involved in architect Frank Gehry’s projects. Their analysis suggests that the consequences of a complex information technology innovation like the use of digital 3D representations of buildings and their part cannot be fully understood as a singular adoption event. Instead, a more holistic and integrated view of the innovation process as continuous path creation by multiple actors sharing practices and feedback across professional communities while they appropriate 3D representations is required. Information technology innovation is not a single event created by a heroic individual or champion, but it involves multiple agents’ mindful deviations from established paths of practices and resource use.

It is not so much a question of a particular technology being adopted by a firm or group of firms as it is a question of changes in the relationships, work practices, organization structures and strategies that are stimulated by various aspects of three dimensional technologies. Driving it all is a design vision.

Even Lindsey (Lindsey 2001) demonstrates the significant developments in the potential and utilization of three-dimensional representation technologies these systems enable digital design and simulation of the physical products and processes. They can meet a broad spectrum of tasks such as mechanical design, shape design, styling, product synthesis, equipment and systems engineering, NC manufacturing, analysis and simulation, and industrial plant design using an open and component-based architecture.

The use of 3D information to manufacture directly building components through mass customization is one of the most promising areas of innovation in this industry. This change casts designers into a non-traditional role as they can in future manage centrally the information flows between the production, standardization and prefabrication of components.

The DiY phenomenon makes unlocking latent entrepreneurship possible. There exist many ‘amateur inventors’ who enhance innovative ideas for products but find themselves unable to move those designs from conception to market reality. Achieving viable consumer price points for such inventions is typically cost–prohibitive for the individual or micro organization, requiring substantial capital investment to cover steps such as specialized R&D services, industrial rapid prototyping, mass production in large quantities, and corporate distribution. However, new opportunities are emerging for ambitious small–scale inventors to bypass these barriers. With the co-evolution of novel spaces for fabrication, citizen empowerment, the evolving consumer, and new conceptions of labour, there now exists notably greater potential to unlock entrepreneurial ventures that would otherwise lay latent and untapped. The focus of the authors in this article is on the use of rapid prototyping by creative professionals such as architects, designers, and DIY advocates, since it is within these contexts where the popular themes of 3D printing are currently most concrete.

In this paper they have highlighted a variety of social and technological innovations associated with digital desktop fabrication (DDF). One aspect of DDF is clear — it is not merely a new tool or apparatus, but constitutes a new mode of material engagement that both productively and problematically recombines knowledge work, craft, and design in novel ways. Equally, DDF can be considered a social phenomenon, one in which the crowdsourcing, sharing, and ‘mash–up’ practices that are already mainstream around other digital media forms become instantiated in material artifacts. While such moves entail shifts in how objects are designed, produced and evaluated, also disrupted are the professional roles of designers, the relationships between producers and consumers, and the nature of work itself.

Several people are going to be more engaged in making and the role and purpose of traditional manufacturers will ultimately change: making, appropriation and modifying as collaborative acts of alternative modes of consumption and civic engagement, rethinking notions of what constitutes hand–made, machine–made, well– crafted or customized products; individuals and micro organizations taking amateur inventions from conception to final market through newly formed spaces and channels. The authors outlined how these developments are encouraging increased citizen involvement in the economy through making, pro-sumption, and micro entrepreneurship.

It becomes more and more important also education and training of the workforce on these issues and on possible developments, because it will also become increasingly urgent for craftsmen using manufacturing technologies like 3D printing in addition to digital knowledge to navigate forum network and online community for suggestions, improve their work, etc. At the same time, even those who are accustomed to working exclusively within a digital environment may find themselves, to a greater degree, confronting (often problematic) issues of materiality, mechanics and structural assembly as it becomes more common for the digital content they create to be transformed to physical form.

Some authors also mention the legal implications of the development of DIY digital, because it will become increasingly easy to evade the laws as much as guarantee citizen security as the ability to download catalogs of objects or parts of them to be printed and adapt to the its purpose is currently uncontrollable. The debate on intellectual property is increasing, the widespread appropriation

practices already seen with digital music and video will inevitably migrate from virtual environments to the physical, and the ensuing challenges will require decisive policy that strikes the appropriate balance between freedom and constraint.

Collaborations and interactions are the backbone of the contemporary Do-It-Yourself (DIY) or 'maker culture', a distributed milieu of open software programmers and hardware hackers, but also crafters, backyard tinkerers, hobbyists and homesteaders. The maker culture is thus less of a DIY and more a do-it-together culture, merging collaborative play and interactions, often for the sake of shared curiosity. The mindset of the participants is that of the explorative craftsman; using a practical attitude of sharing ideas, methods and skills among practitioners, and the interactions are managed in a flat and mesh-worked manner through the use of protocols. The author supports the idea that the maker culture is not only a loose network of dispersed tinkerers, it is also a close-knit molecular assemblage of materials, tools, skills and makers, thus introducing the concept of molecular management.

Von Busch (2012) specifically examines the protocols of the maker movement, finding an immediate connection between hardware protocols, like the 'makers bill of rights' guiding the principles of open source hardware, and the principles reflected in the social protocols of two hacker spaces. They use different protocols for collaboration than what has before been common in the world of craft. They use what the author could call 'molecular' management models.

The maker community exhibits a very different mode of management and coordination than the hierarchical models of the traditional firm, which is a hierarchical or sedentary mode of organization, static and accumulative as it tends towards increasingly the equilibrated and homogeneous. These modes of organization has been popularly studied the last years as Complex Adaptive System (Holland 1999; Axelrod 1997; Axelrod & Cohen 1999; McMillan 2004) and put down in more popular jargon as 'wikinomics' (Tapscott & Williams 2006).

The molecular model is nomadic and transversal, dynamic and in motion, striving away from equilibrium and tends to assemble self-organizing 'meshwork' structures. This molecular approach is a mantra ringing through the hacker community, it is an ideal of no present boundaries between hacker and information (or matter) in the continuous quest for knowledge, improvement and spending own time with technology. Reduce rules to a minimum, promote transparency and self-organization; from free information autocatalysis will emerge. It is in this setting that emerging culture of collaboration exhibited on the Internet replaces the Cartesian 'I think' with a distributed 'we think'. This molecular promotion of decentralization can be also traced to the maker protocols.

Some researchers (Nylander & Rudström 2011; Kuznetsov & Paulos 2010) despite having a different focus from the study of the implications of DiDIY on changes in business models of business development strategies, focusing more on the importance of social network development the network of labour relations; They have indirectly revealed the importance of social networks as a tool for sharing and validation of their business ideas. The places in which to develop ideas and business opportunities are being changed, the ideas will validate the first network, and the network grow by sharing improvements and suggestions. The development of prototypes no longer takes place in the laboratories but in different Fields, FabLab and makerspace are becoming more or less conscious incubators of business ideas.

3.8 Human-Computer Interaction

Human-Computer Interaction (HCI) is a discipline concerned with the study, design, construction and implementation of human-centric interactive computer systems. HCI goes beyond designing screens and menus that are easier to use and studies the reasoning behind building specific functionality into computers and the long-term effects that systems will have on humans.

HCI is a very broad discipline that encompasses different specialities with different concerns regarding computer development: computer science, design and engineering of the human interfaces, sociology and anthropology, work and organization and the way that human systems and technical systems mutually adapt to each other; etc.

A large community of scholars for years has been devoted to HCI in relation to new emerging phenomenon of community DIY and DiDIY. Emerge as interesting studies compared to issues such as: the sharing of knowledge, the development of new products and prototypes that no longer pass through the traditional channels, the use of new technologies such as 3D printers or scanners, or software such as Raspberry Pi or Arduino; the development of new places to work or take advantage of new technologies as the FabLab, the hackerspace, etc; modification of certain work roles.

Later in the 1980's, computer hobbyists formed communities to create, explore and exploit software systems, resulting in the Hacker culture. Today's DIY cultures reflect the anticonsumerism, rebelliousness, and creativity of earlier DIY initiatives, supporting the ideology that people can create rather than buy the things they want. Over the past few decades, the integration of social computing, online sharing tools, and other Human Computer Interaction (HCI) collaboration technologies has facilitated a renewed interest and wider adoption of DIY cultures and practices through easy access to and affordability of tools and the emergence of new sharing mechanisms.

Recent breakthroughs in technology afford sharing such that anyone can quickly document and showcase their DIY projects to a large audience. An emerging body of tools allows enthusiasts to collaboratively critique, brainstorm and troubleshoot their work, often in real-time. This accessibility and decentralization has enabled large communities to form around the transfer of DIY information, attracting individuals who are curious, passionate and/or heavily involved in DIY work.

Thousands of DIY communities exist today, varying in size, organization and project structure. Some allow members to contribute asynchronously on a variety of topics, while others focus on specific projects, some revolve around smaller in-person gatherings and some enable hobbyists to trade or sell their projects.

Kuznetsov and Paulos (2010) present a large-scale study of Do-It-Yourself (DIY) communities, cultures and projects; they focus on the adoption and appropriation of human-computer interaction and collaboration technologies and their role in motivating and sustaining communities of builders, crafters and makers. Their survey of over 2600 individuals across a range of DIY communities (Instructables, Dorkbot, Craftster, Ravelry, Etsy, and Adafruit) reveals a unique set of values, emphasizing open sharing, learning, and creativity over profit and social capital.

The authors define DIY as any creation, modification or repair of objects without the aid of paid professionals and the term "amateur" not as a reflection on a hobbyists skills, which are often quite advanced, but rather, to emphasize that most of DIY culture is not motivated by commercial purposes. Theirs study of six DIY communities suggests that the typical values of DIY as a vibrant

culture with a long history of learning, creating and sharing are embedded in everyday practices and supported by the technologies that bring DIY communities into being. Drawing from numeric and qualitative data, the authors presented opportunities for identity management across digital and physical domains, expressive knowledge transfer tools, and systems to support iterative studio practices.

Hardware and software tools, that were previously available only to universities and research centres or large companies because of the prohibitive cost, are now accessible to anyone remotely interested and with a minimal investment.

Thanks also to the spread of the network and online community access to knowledge and information sharing to implement ideas and projects suffered an unbelievable acceleration. Those that were simple users of goods and services were gradually aggregated and have evolved into community modders with the intent to change your product to improve it and / or making customized improvements often real. Some forward-thinking companies have realized the potential contained in the user communities and have given rise to genuine partnership with the community of users. This has improved the performance of products, increased sales and reduced costs of R & D in this way you outsource overturning on consumers (Tanz 2011). This is what emerges from an article in Wired magazine: Tanz emphasizes the change of course undertaken by the day after the release of Microsoft Kinect for Xbox 360.

Tanenbaum et al. (2013) focused their attention shifting the focus from the recreational elements of the DIY practice to the ways in which it democratizes design and manufacturing. This democratized technological practice, they argue, unifies playfulness, utility, and expressiveness, relying on some industrial infrastructures while creating demand for new types of tools and literacies. Thriving on top of collaborative digital systems, the Maker movement both implicates and impacts professional designers. As users move more towards personalization and re-appropriation, new design opportunities are created for HCI.

The practices of hacking, craft, and DIY have been of increasing interest to HCI researchers in recent years. A 2009 CHI workshop attempted to establish a dialogue between CHI attendees and DIY aficionados, many local to the conference venue. Discussions of “expert amateurs” examine the underlying value of low barriers to entry to creating DIY projects, creativity, learning and sharing. This collection of literature from the HCI community has emphasized the pleasure, expressiveness, and communicative practices involved in DIY and crafts, rather than the utility of their end products or their ability to generate profit.

In 1962 one of the first games developed was available for a very limited audience, was used only by educated white males who could have access to the servers at MIT. Now high technology is beginning to support its own democratization, with profound implications for the professional practices of HCI and system development. But the democratization of creative practices now applies not only to knitting, car modding, and ham radio, but increasingly includes the technologies and practices that the HCI community deals with professionally: computer-aided design, programming, microcontrollers, mesh networks, tangible interaction, and mobile applications. It is deeply implicated in our professional practices as HCI researchers. Online sites like Youtube Instructables with high resolution allow makers to learn important details of the production process. The use of rich media such as high resolution images, videos, and step-by-step descriptions facilitates distributed sharing. In addition craft knowledge to on-line facilities for sharing, physical

spaces as hackerspaces and Fab Labs allow professionals to learn from each other, collaborate and share projects.

Tanenbaum et al. (2013) demonstrate how Maker cultures challenge traditional conceptions of the technology user. The dominant paradigm of user-as-consumer gives way to alternative framings of the user as creative appropriator, hacker, tinkerer, artist, and even co-designer or co-engineer. These behaviours, taken as part of a broader movement, begin to form a politics of appropriation.

As well as shifting the notion of the user from consumer to appropriator, these practices shift us from considering technology use as primarily a productive or useful experience to an aesthetic experience as well.

This relationship to technology is characterized by a spirit of playfulness combined with a commitment to critical resistance and material creation, both challenging and celebrating the current conditions of technical production.

The social and interactive technologies that HCI creates and studies have enabled the democratization of digital technologies discussed here. The creation of innovative software, new interactions, and physical prototypes is no longer restricted to well-funded professional designers and researchers. We are probably on the verge of a paradigm shift, and we are witnessing the birth of new design and a completely new relationship to be established with the users no longer passive users but active and stimulating co-producers.

In 2012 de Roeck et al. submit to Copenhagen NordiCHI a paper manifesto addressing developers and designers of internet-of-things platforms creation. In the last decades, a number of manifestos specifically related to DiY have been published. The first of these manifestos was probably The Hacker Manifesto, published in 1986. It is a set of guidelines aiming at providing an ethical framework for novice hackers. MAKE magazine has in 2005 published a Crafter's Manifesto. In 2008, Brett Gaylor presented a Remixers' Manifesto in an open source documentary film about the world of mash-up media.

Although the existing DiY-related manifestos described above do offer links and starting points, many issues related to DiY IoT (Internet of Things sometimes called "machine-to-machine" (M2M) communication technologies, is a series of networked "smart devices" that are equipped with microchips, sensors, and wireless communications capabilities. Thiere and Castillo (2015) creation have not yet been touched upon. Therefore, the aim of the authors was to present a manifesto that aims at systems for DiY IoT creation. The manifesto presented is primarily aimed at developers who design and implement digital creation systems for end users. By presenting the research findings as a manifesto, the authors wanted to highlight the relation to the maker movement and communicate the findings in the maker tradition.

The manifesto for DiY internet-of-things creation that is presented in this paper originated within the context of a European research project called DiYSE: Do-it-Yourself Smart Experiences. This project aimed at enabling ordinary people to easily create, setup and control applications in their smart living environments as well as in the public internet-of-things space.

In order to create this manifesto, the authors made a qualitative research conducted to understand how and why users would create their own smart experiences in an Internet-of-things world.

The manifesto is composed of a series of 13 statements.

"1. Inspire to be creative. The system should be a platform that inspires and supports people to be creative, to self-actualize in their projects.

2. Support a spectrum of expertise in computational thinking by offering different layers of computational abstractions.

3. Help people to create useful components. The system should guide users to reformulate or organize ideas, solutions or content into useful components.

4. Not teach how to program, but should provide an ecosystem to support people in creating ideas, solutions.

5. Equally support starting from ideas, material (new and scrap) or other projects.

6. Be a cradle-to-cradle system offering playgrounds and recycling belts.

7. Support sharing of unfinished or evolving projects.

8. Support & facilitate collaboration between users with various roles.

9. Help users to finish projects by subtle coaching without harassment.

10. Allow users to use their own terminology.

11. Allow the use of multimodal system input, using body and objects.

12. Express and clarify ambiguous situations with the user.

13. Provide added value for all."

This manifesto is particularly interesting because it is the result of a cross both qualitative research conducted on users and the support given by the literature review, so each item has a scientific explanation that validates it.

The thirteen guidelines were formulated in the format of a manifesto to support the development of IoT creation systems for all. Although the work presented in this paper clearly relates to work done on topics such as end user programming and appropriation, the approach taken in the manifesto is different.

The goal of the authors (Lindtner et al. 2014) in this paper has been to document the design and innovation practices arising at some of these sites, with an eye towards understanding the implications for HCI. Their work suggests that we need to understand the broader contexts within which these emerging sites of HCI innovation are embedded. To draw an analogy with open source software, open source is both a form of collaborative programming and a new institutional form, with all its regional, technological, organizational, and political consequences. Similarly, when we turn our attention to hackerspaces, we see not only a space experimenting with new sorts of fabrication tools, but also a community that reshapes the very meaning of innovation. The research suggests that we need to see the hackerspace not just as a place that amortizes the cost of a laser cutter and a 3D printer across hundreds of people. It is a place where people are experimenting with new ideas about the relationships amongst corporations, designers, and consumers. It is from this perspective that we approach questions of expertise, materiality, and criticality – topics which increasingly also define the relationship between HCI as a discipline and other cultural groups with which HCI interacts.

HCI can serve as a source of knowledge in the DIY era by establishing partnerships with these cultural groups, hackerspaces and hardware startups alike. For instance, as hackerspaces and maker initiatives are receiving not only substantial interest from a wider public, but also funding from government agencies, HCI researchers and designers can productively work with makers to build new research initiatives, summer school programs, and curricula.

In an other interesting analysis Maxigas (2012) has traced three waves of hackerspaces; the first wave constituent of hackerspaces like L0pht that were started covertly in the 1990s and provided access only to a selected few; second of hackerspaces like C-base in Berlin, that started with a more public profile and a strong commitment to Internet freedom; and the third wave of hackerspaces like Noisebridge in the Bay area, committed to a global hackerspace movement. We add a fourth wave, here; the hackerspace as incubation of startups and as functioning in the realm of research and development.

Several of the hackerspaces we worked with functioned – even if informally – as incubator programs for hardware startups. Prominent examples of companies that emerged from such hackerspaces are the Pebble Watch (a programmable watch whose team is the recipient of the largest Kickstarter campaign in history) and MakerBot (a low-cost 3D printer that has become a key symbol for an industrial revolution via DIY making).

Many of the founders and members of hackerspaces interviewed considered hackerspaces as emerging sites of innovation, research and development. They stressed that this was because hackerspaces experiment with different materials, open collaboration, and rapid prototyping.

Lindtner et al. in their work underline that while many makers stressed that a hackerspace should not be reduced to its potential for entrepreneurial practice, they were nevertheless instrumental movers and shapers in local or international start-up scenes. Instead other hackerspaces centrally incorporated incubating practices and/or industrial production. Broadly, they observed that many makers strongly believed that the work of hackerspaces and hardware startups could support the development of their respective local economies.

To sum up, hackerspaces are sites where people actively explore new approaches to what constitutes a tech organization, research and development.

3.9 Innovation management

The literature on the topic of innovation management is extremely sparse in this field of study and it is difficult to make a comprehensive review, however, what interests us is to note that even in this discipline the implications of the phenomenon of the makers and the DIY have become of interest to scholars. The consequence of this is the absence of a comprehensive framework that covers the range of activities needed to transform ideas into marketable products and profits.

The term “innovation” is notoriously ambiguous and lacks both a single definition or a measure recent projections of the economic and social benefits of networked IoT technologies suggest that their technological and economic impact will be significant. These analyses predict that tens or even hundreds of millions of networked devices will proliferate globally as industrial and infrastructure inputs, consumer wearables, smart home technologies, and automated transportation services. The economic gains in terms of cost savings and enhanced productivity growth are projected to be enormous. Trillions in value will be created through cost-savings through preventative health care, minimized accidents, patient monitoring, efficiencies in manufacturing and distribution, and seamless home and municipal infrastructure improvements.

3.10 Design

The finding of new DIY movement and the broader Makers, indicating the communities of people, mostly amateurs, that design and manufacture goods in physical and virtual spaces shared with

methods of group work and digital tools, is driving away sector by sector is productive, that recreational and educational. It is a movement still evolving, it is difficult to define. And the same thing happens to related concepts such as design and open design, the drafting of a formal definition is still under discussion. Indeed, there are profound differences between the professional designers who produce their own objects and the great home furnishings industry of Home Depot, Leroy Merlin and the like, despite the centrality of the working method, of self and autonomy took part in many movements since the advent of the Industrial Revolution. By John Ruskin, William Morris and the Arts and Crafts movement to the counterculture of the sixties and, more recently, to Craftivism.

In addition, the democratization of technology and access to materials hardware and software once available only to large universities or laboratories of R & D has allowed to intervene in a creative and makes you even in the humanities (museums, art galleries). Maye (2013) focus on how current DIY technology can be shaped to serve cultural heritage professional in producing sustainable, interactive, experience. The research is part of the Encounters with digital Material Cultural Heritage project, Whose vision is to Shops provide cultural heritage professionals with the means connect the digital information related to cultural heritage to the physical aspect, The project comprises of twelve partners, who are from seven different European countries, and includes three cultural heritage institutions: the Allard Pierson Museum in the Netherlands; Pozzacchio strong, part of the Italian Museum of War in Italy; Museon - Museon Stichting in the Netherlands. Even she collaborates with a variety of local heritage institutions. The use of interactive installations made possible to improve the use of information in some Irish museums while the use of printers and 3D scanners has allowed the reconstruction of historical materials that users could touch and experience. This involved more end users by showing them possibilities for development have new technologies also for the future of the cultural heritage.

The use of new 3D technologies is allowing designers to experiment with hypothetical scenarios. Starting from the virtual scenarios are developed highly sophisticated three-dimensional objects that are subsequently produced. Choma (2010; Oxman 2007) in particular focuses on the use of technology to develop 3D objects but they must be printed in parts and then assembled at the end, working on tactile sensitivity and manual man.

3.11 Literature review – themes

This section aims at providing a synthesis of the main themes emerging from the literature review presented above. Each theme is presented, described according to the extant definitions available and contextualized according to the paper reviewed that deal with each one of them.

The objective of this section is to set the boundaries of WP3 (DiDIY impact on work and organization) with respect to themes (or topics) which have a relevant visibility also among practitioners.

3.11.1 Makers

Makers are an emerging community of self-described DIY-enthusiasts, tinkerers and hobbyists. Popularized by the quarterly magazine MAKE and annual Maker Faire events a first definitions was undertaken via literature review spanning several academic disciplines. The term maker was found in articles concerning the maker movement itself. Dale Dougherty, founder of MAKE Magazine and Maker Faire festivals, identified as a thought leader in a growing maker movement, is quoted as

describing a maker as someone who “looks at things a little differently” (Dougherty 2012). The term maker and its meaning seem to have originated in the context of the maker movement and the do-it-yourself world (Anderson 2012; Lang 2013; Hatch 2013). McFedries (2007) calls the maker: “high-tech tinkerer who lives to take things apart, modify... them to perform some useful or interesting task, and then (sometimes) put them back together”.

Several of the reviewed articles (McFedries 2007; Kafai 2011; Dougherty 2012; Campbell 2012; Schön 2014; Hallaq 2014; Frissen 2015) that had mentioned makers in the context of the movement also referred to it in an educational context. In one of Dale Dougherty’s (2012) articles he describes making as “learning by doing”. The article goes on to discuss advantages of hands-on learning as opposed to teaching to a standardized test using diagrams. He specifically mentions a case where students were asked questions about microscopes from an image, as they would be on a test, rather than using the actual instrument. Maker, in this context, refers to an interactive approach to education someone who learns by building and trying rather than from a book. In the context of the maker movement Honey and Siegal used the terms circuit bender, personal fabrication, and risk takers. The Economist used the terms enthusiasts, digital culture, and accidental entrepreneurs. These terms are a mix of terms that would be associated with inventing and entrepreneurship and those that would be associated with hobbyist culture. This would imply that making could be somewhere in between the two. Lange et al. in 2013 analysed the meaning of the concept of Maker understood as a movement, both through a literature review that crosses academic disciplines, and through a survey made during a World Maker Faire New York in September 2012, which provided participants of post it on which they had to write their own definition of Makers and attach it to a wall. The result was overall interesting, responses tended to have to do with creating some new thing. The common verbs used are all action verbs, with the exception of being. This would imply that the perception of making is that of an action to be taken. The surveys also had interesting trends. Many responses described building or making something from a creative viewpoint.

3.11.2 DIY

Academic research describes DIY as behaviours where “individuals engage raw and semi-raw materials and component parts to produce, transform, or reconstruct material possessions, including those drawn from the natural environment (e.g., landscaping)”. DIY behaviour can be triggered by various motivations previously categorized as marketplace motivations (economic benefits, lack of product availability, lack of product quality, need for customization), and identity enhancement (craftsmanship, empowerment, community seeking, uniqueness) (Wikipedia 2016). Papers dealing with this topic are present in our literature and pertain to different domains such as Information Systems, Software engineering, Computer-supported cooperative work and social computing, Journalism and society. Papers deals with several concepts: software customization within the SMEs context (Huang et al. 2002); the overall landscape characterized by the diffusion of low-cost but complex technologies (e.g. the spread of sensors within the IoT paradigm as long as 3D printers for personal fabrication) (Tanz 2011); the rise of DIY within nonprofit associations (Vowels 2005); digital culture as “a value system and set of expectations as particularly expressed in the activities of news and information media makers and users online” (Deuze 2006).

3.11.3 Collective intelligence DIY

It is “shared or group intelligence that emerges from the collaboration, collective efforts, and competition of many individuals and appears in consensus decision making” (Wikipedia 2016). In the light of WP3 the topic of collective intelligence can be related to DIY by considering, for example, online communities as workplace where DIYers are meeting and sharing knowledge on specific topics. Their collaborative work can generate a group knowledge bigger that the knowledge generated by the individuals.

3.11.4 Digital ecosystem

“Digital ecosystem is a distributed, adaptive, open socio-technical system with properties of self-organisation, scalability and sustainability inspired from natural ecosystems. Digital ecosystem models are informed by knowledge of natural ecosystems, especially for aspects related to competition and collaboration among diverse entities” (Wikipedia 2016). Yoo et al. (2010) deals with digital innovation and the impact of digital technologies on organizational innovation. Grover et al. (2012) investigates how co-creation and IT business value can help in assessing the impact of digital technologies on the organization. Yoo et al. (2010) focus on the power of network externalities to work as a catalyser for digital innovation. Eventually, Tiwana (2014) focus on the centrality of the Chief Information Officer (CIO) within the organizational layout and provide a framework about innovation that can help the CIO to take the best choices when evaluating emerging technologies.

3.11.5 Digital craft/Digital crafting

It can be explained by citing Bratich (2010): “the gendered dimension of digital labour displays affective and immaterial qualities that have persisted resiliently before, during, and, in time, after capitalism. Craft as power (the capacity to act) is an ontological accumulation of species being that pushes us to rethink the ‘organizing’ of subjects”. Further insights emerge from Cheatle (2014) regarding the integration of 3D printing with ABB industrial robots to improve production.

3.11.6 DIY community

The topic of DIYers is gaining importance in the actual context. Tanz (2011) while telling the story of Microsoft Kinect’s birth and its launch on the market it introduces other relevant topics: knowledge sharing inside online communities; open-source software distribution; development platforms. Tanz (2011), reports the example of website Adafruit Industries, the open source hardware company run by hacker impresario Limor Fried. “The company was offering a $1,000 bounty to whoever posted the first open source Kinect drivers to GitHub”. This resulted in several attempts to hack the Microsoft device and users worldwide begun to upload their pieces of coding available for the community.

3.11.7 Digital creativity

Lee et al. (2014) study the concept of creativity with a focus on knowledge sharing and reuse of digital tools: “Knowledge Management Systems (KMS) should consist of features that enable users to perform knowledge creation, capture and sharing among employees with ease of use, ease of access, and intuitively friendly design. It was found that (Wang et al. 2009) creativity is one of the

most influencing factors for knowledge creation among employees and such behaviour can determine the knowledge creativity by an individual".

3.11.8 Digital self-expression

One of the profound changes that are taking place at the beginning of the 21st century is the creation of many new affordances for creative expression caused by the digital technology revolution that is taking us into a new era of social learning and new culture of active participation in where the development and the creation of objects and hardware and software components are shared online is to get information to improve their product and to share and spread its use. Aided by the Internet and its associated technologies, society is changing the way people find and share information to develop new knowledge and meanings and to allow a freer expression of himself, the world is full of things and creators of content and rich in opportunities work together to co-create new knowledge, objects and relationships. Social media allow and encourage creative self-expression, as they allow you to share information socially (Schon 2014; Kuznetov & Paulos 2010; De Roeck 2012; Tanenbaum et al. 2013; Ratto & Ree 2011).

4. Research streams

The literature review highlighted three main research streams: new organizational roles and competences; entrepreneurship; digital manufacturing. For each one of the research streams the researchers extracted relevant theoretical concepts and examples from the literature and consequently generated a set of research questions.

4.1 Digital Manufacturing

Literature review on digital manufacturing is quite rich of relevant sub-streams of research. A first one is highlighting the role of 3D printers on affording opportunities for various component makers to deliver physical products through the digital channel and thus co-creating new avenues for new value (Grove & Kohli 2012). 3D printing is considered as a game changer for traditional production models and competitive rules: design and production will be tightly coupled through experimentation (Petrick & Simpson 2013). The explosion of 3D printing, laser cutting, and garage-scale CNC mills have created contexts of democratized technological practices: has given hackers and hobbyists modes of production previously only available to large organizations (Tanenbaum et al. 2013).

A sub-stream related to the process of digitization (aka “process of ABC”) is reporting that the next phase in the digitization of the manufacturing sector is driven by four disruptions: rise in data volumes, emergence of analytics and business-intelligence capabilities; new forms of human-machine interaction; and improvements in transferring digital instructions to the physical world (McKinsey Quarterly 2015). Rapid prototyping technologies are impacting business processes because the offer this knowledge to the people (Oxman 2007). Specifically thy impact the work of traditional craftsmanship involving the knowledge and skill-set of particular practical arts. By bringing new methods and technologies for production (e.g. digital desktop fabrication), knowledge work, craft, and design are recombined in novel ways (Ratto & Ree 2010).

About end-users DiDIY technologies are empowering people to create applications for smart environments that exist both in the natural and in the digital world (De Roeck et al. 2012). Within this context the challenge is on supporting – at the user level – good understandings of technology and cultivating practices around it (MacLean et al. 1990; Quinones 2014).

At the same time recent developments in digital fabrication have opened avenues for creating artefacts with embedded digital information easily (Maye 2013). Additive Manufacturing and Internet of Things provide far more opportunities for creating positive network externalities. They exhibit complementarities more frequently than physical assets because the potential joint value of a combination of two digitized assets often exceeds the sum of the parts of their value in isolation (Tiwana 2014).

Some of the main research questions generated are as follows.

- How will 3D printing improve the transfer (in terms of performances of manufacturing business processes) of digital instructions to the physical world? Is this affecting any organizational unit? And if so, how to measure this improvement?
- How will rapid prototyping technologies reshape skills and knowledge of traditional craftsmanship?

- How will digital manufacturing transform traditional business models into new – and innovative – ones? Which are the relevant components of new manufacturing business models?
- How will digital manufacturing transform the way companies access to marketplace?
- New product development: how will digital manufacturing impact on design activities?
- Marketing: is the usage of digital manufacturing tools impacting on the launch of new products into new markets or improving existing products in existing markets or both?
- Delivery/Retail: is digital manufacturing creating opportunities for various component makers to deliver physical products through the digital channel and thus co-creating new avenues for new value?
- How will network relations of companies change, given the disruptive potential of digital manufacturing? How will companies benefit out of this new scenario?

By strengthening the perspective of knowledge management within digital manufacturing hereby is presented a set of research questions that aim at understanding this impact at the level of a single firm or a cluster of firms.

- Is 3D printing impacting on the mechanisms of knowledge management within a single firm? 3D printing helps people to shape and create their ideas in a faster and easier way than before. Therefore the aim is to investigate how knowledge on 3D printing is typically managed within a firm and how people could exploit it as its best.
- How knowledge regarding digital manufacturing is stored and transferred within a firm? 3D printing is a disruptive innovation that is rapidly changing the way people work and produce products. Therefore gains attention the way people store information about new technologies adoption in order to facilitate the sharing of best practices and, at the same time, to improve existing applications.
- Is 3D printing facilitating the sharing of best practices within a supply chain or cluster of firms? If so, which are relevant enablers that could speed up its adoption or, on the opposite, which are the relevant barriers to that could slow down it adoption?
- Is digital manufacturing helping firms, characterized by similar activities (e.g., in a supply chain or cluster of firms) to strengthen their relationships and align their activities? More specifically what kind of activities are impacted?

4.2 Entrepreneurship

The second important research stream is entrepreneurship that appears to be a meta-theme underlying several papers in several disciplines. A first definition is related to the impact of the Digital-Do-It-Yourself phenomenon on competitiveness and on smart manufacturing clusters (Porter & Heppelmann 2014). An interesting set of papers deal with places where entrepreneurship and digital technologies are combined. Places where people exchange information for purposes of finalizing or having support and encouragement have changed into places to co-design, test, crowdfund of products and services based on knowledge. DiDIY is reshaping the traditional concept of places before mentioned by renewing many concepts as entrepreneurship, management, and in general the way in which people become entrepreneurs and manager. Therefore we consider both online spaces such as digital platforms (Adijita 2014; Mota 2014; Williams 2014; Ratto 2012)

and physical spaces such as hackerspaces, hardware incubators, makerspaces (Lindtner 2014; Tanenbaum 2014). Within these places democratization of entrepreneurship and transformation of entrepreneurial ecosystems after the makers revolution (Aldrich 2014) take place. There is the opportunity to the generation of conceptual frameworks, methodologies and software to analyse collaborative open innovation networks in order to grasp the digital do-it-yourself phenomenon (Gloor 2014) as long as impacting at managerial levels given the generation of new forms of management (von Busch 2012; von Hippel 2013).

Some of the main research questions generated are as follows.

- Do makers cluster?
- How collaborative innovation networks among makers foster cluster initiatives?
- How can makers entrepreneurial ecosystems transform in cluster initiatives?

4.3 A critical role: the CIO

O'Neill and Overby 2014 reported the need to optimize the internal organizational structures and the ability to manage hybrid delivery models with insourced services, outsourced services and cloud-based point solutions. Recent studies have shed the light on the need for the CIO to add an "A" for Arts in STEM (Bannister 2015). The role of the CIO is changing according to the most recent and disruptive technologies such as 3D printing. CIOs need to work with design, manufacturing, and quality teams to determine what data should be collected and maintained (Deloitte 2015). There is a rising need for creating a common agenda between IT and other departments (marketing) for defining, building, and acquiring advanced analytics capabilities (Ariker 2014).

Some of the main research questions generated are as follows.

- How will the work of a knowledge worker be reshaped due to the influence of DiDIY? How will it change in relation with the evolution of other organizational roles in her firm?
- How will the work of the Chief Information Officer (CIO) be reshaped due to the influence of DiDIY? How will it change in relation, in particular, with the related evolution of other CxO roles? And more generally: which organizational roles are most likely to disappear, and which will be most likely created, due to the influence of DiDIY?
- What new feats might people achieve if they had better thinking machines to assist them? Will machines take over not just low-skilled tasks but high-skilled ones too?
- Platforms on which production is dynamically orchestrated, blueprints are stored and updated, raw materials are purchased and customer orders are received, will be managed by providers: will be their role central and powerful in the ecosystem because of the tremendous volume of industrial transaction and valuable information?

5. WP Research Framework

This section aims at presenting and discussing the Research Framework (RF) by introducing different dimensions of work and organization influenced by DiDIY. We can represent such influence as a multi-dimensional space, characterised at least according to:

D1: object (unit of analysis)

D2: phase in the life-cycle of the object

D3: geographical location

D4: digital technology adopted and used by the object

D5: strength of organizational ties

D6: size of the object

D7: industrial sector

To clarify how this RF can be applied we provide an example for each level of analysis that the framework is taking into consideration: L1 – an individual; L2 – an organization.

Example of application of the RF to L1

D1: object (unit of analysis): an individual (L1)

- D1.1 competence profile
- D1.2 occupation: employed vs unemployed vs self-employed
- D1.3 organizational role (if employed)
- D1.4: age of the individual: eg: kids vs teenagers, vs 60s

D2: geographical location

D3: digital technology used

D4: phase in the life-cycle of the organization where the person works

- e.g., startups vs established organizations

D5: strength of organizational ties of the organization where the person works

- e.g., NA vs weak (e.g., community) vs strong (e.g., enterprise)

D6: size of the organization where the person works

- e.g., NA vs micro vs small vs medium vs large

D7: industrial sector of the organization where the person works

- e.g., services vs manufacturing

Example of application of the RF to L2

D1: object (unit of analysis): an organization (L2)

D2: phase in the life-cycle of the organization

- e.g., startups vs established organizations

D3: geographical location

D4: digital technology adopted and used by the organization

D6: strength of organizational ties

- e.g., community vs enterprise

D5: size of the organization: micro, small, medium, large

D7: industrial sector

- e.g., services, manufacturing

A Research Topic (RT) is defined as a hyper-cube characterized by specific values for each dimension. Once defined the RTs, it should be easier to identify the related Research Questions and the appropriate theoretical background.

5.1 WP3 Research Topics

The following is a set of examples of possible Research Topics (RT) following the structure presented above. Each RT is presented by showing an example for each dimension mentioned above, providing a short description of the RT and presenting the related research question.

Research Topic 1

D1: object (unit of analysis)	L1
D1.1 competence profile	workman
D1.2 occupation	employed
D1.3 organizational role	any
D1.4 age	any
D2: geographical location	Italy
D3: digital technology	any
D4: phase in the life-cycle of the org	established
D5: strength of organizational ties in the org	high
D6: size of the organization	SMEs
D7: industrial sector	any manufacturing industry

This RT is at the individual level where a workman employed in any kind of organization and independently from his/her role and age is impacted by the influence of DiDIY. This research topic aims at studying SMEs of any manufacturing industry that have strong organizational ties and are established in the life-cycle.

RQ: *how the work of a workman in a manufacturing firm will be reshaped in 2020, due to the influence of DiDIY? how will it change in relation with the evolution of other organizational roles in her firm?*

Research Topic 2

D1: object (unit of analysis)	L1

D1.1 competence profile	knowledge worker
D1.2 occupation	employed
D1.3 organizational role	any
D1.4 age	any
D2: geographical location	Italy
D3: digital technology	any
D4: phase in the life-cycle of the org	established
D5: strength of organizational ties in the org	high
D6: size of the organization	large
D7: industrial sector	any

This RT is at the individual level where a knowledge worker employed in any kind of organization and independently from his/her role and age is impacted by the influence of DiDIY. This research topic aims at studying large organizations of any industrial sector that have strong organizational ties and are established in the life-cycle.

RQ: *how the work of a knowledge worker will be reshaped in 2020, due to the influence of DiDIY? how will it change in relation with the evolution of other organizational roles in her firm?*

Research Topic 3

D1: object (unit of analysis)	L1
D1.1 competence profile	tbd
D1.2 occupation	employed
D1.3 organizational role	CIO
D1.4 age	any
D2: geographical location	Italy
D3: digital technology	any
D4: phase in the life-cycle of the org	established
D5: strength of organizational ties in the org	high
D6: size of the organization	large
D7: industrial sector	any

This RT aims at studying the influence of DiDIY at the individual level, where the competence profile is to be defined yet, employed in any kind of organization as the. This research topic aims at studying large organizations of any industrial sector that have strong organizational ties and are established in the life-cycle.

RQ: *how the work of the CIO will be reshaped in 2020, due to the influence of DiDIY? how will it change in relation – in particular – with the evolution of other CxO roles?*

Research Topic 4

D1: object (unit of analysis)	teenager in a team participating to a contest to build robots (L1)
D1.1 competence profile	high school student + DiDIY-related skills
D1.2 occupation	unemployed
D1.3 organizational role	NA
D1.4 age	teenager
D2: geographical location	Italy
D3: digital technology	robots
D4: phase in the life-cycle of the org	start-up
D5: strength of organizational ties in the org	low
D6: size of the organization	micro
D7: industrial sector	NA

This RT aims at studying the influence of DiDIY at the individual level specifically a teenager in a team participating to a contest. The competence profile is an high school student that has DiDIY-related skills, is unemployed, and is quite young. This research topic aims at studying micro teams that, as a start-up, compete using specific digital technologies (i.e., robots).

RQ: *what are the factors enabling single DiDIYers (makers) get together and create teams to create innovative Digital products (eg robots)?*

Research Topic 5

D1: object (unit of analysis)	community of workers in a co-working space / start-up accelerator (L2)
D1.1 competence profile	NA
D1.2 occupation	NA
D1.3 organizational role	NA
D1.4 age	NA
D2: geographical location	Italy
D3: digital technology	any
D4: phase in the life-cycle of the org	start-up
D5: strength of organizational ties in the org	low (in the community; high in each start-up)
D6: size of the organization	medium
D7: industrial sector	services

This RT aims at studying the influence of DiDIY at the level of an organization and specifically a community of workers in a co-working space/start-up accelerator (L2). The organization is

medium-sized and is a startup in the service industry with low strength of organizational ties in the community while high in each start-up.

RQ: *does a co-working space lead to superior performances of accelerated start-ups due to the development of DiDIYers community?*

Research Topic 6

D1: object (unit of analysis)	**industrial cluster** (L3)
D1.1 competence profile	NA
D1.2 occupation	NA
D1.3 organizational role	NA
D1.4 age	NA
D2: geographical location	Italy/Europe
D3: digital technology	any
D4: phase in the life-cycle of the org	established
D5: strength of organizational ties in the org	medium
D6: size of the organization	SMEs
D7: industrial sector	any

This RT aims at studying the influence of DiDIY at the level of an industrial cluster (L3) located in Italy/Europe. Organizations are SMEs, that are well established and have medium strength of organizational ties.

RQ: *is it possible for SMEs to evolve from single-player subcontractors into components of a cluster competing with large companies?*

Research Topic 7

D1: object (unit of analysis)	functional unit (L2)
D1.1 competence profile	adult with DiDIY-related skills
D1.2 occupation	employed
D1.3 organizational role	R&D Managers
D1.4 age	baby boomers
D2: geographical location	Italy
D3: digital technology	any
D4: phase in the life-cycle of the org	established
D5: strength of organizational ties in the org	low
D6: size of the organization	SMEs
D7: industrial sector	any

This RT aims at studying the influence of DiDIY at the level of a functional unit (L2) where the competence profile of people is adults with DiDIY-related skills. They are employed as R&D managers and are baby boomers. Organizations are SMEs, well established and with low strength of organizational ties.

RQ: *how digital technologies can reshape the way R&D activities are carried out?*

Research Topic 8

D1: object (unit of analysis)	adults in a team participating to a contest (L1)
D1.1 competence profile	adult with DiDIY-related skills
D1.2 occupation	employed
D1.3 organizational role	any
D1.4 age	+20
D2: geographical location	Italy
D3: digital technology	any
D4: phase in the life-cycle of the org	start-up
D5: strength of organizational ties in the org	low
D6: size of the organization	micro
D7: industrial sector	any

This RT aims at studying the influence of DiDIY at the individual level of adults in a team participating to a contest (L1). The competence profile of people is adults with DiDIY-related skills of age higher than 20. They are employed in micro organizations, at a start-up phase, with low strength of organizational ties.

RQ: *what are the factors enabling single DiDIYers (makers) get together and create teams to create innovative Digital products (e.g., robots)?*

Research Topic 9

D1: object (unit of analysis)	community of people → industrial association = institution (L2)
D1.1 competence profile	adult (some of them with DiDIY-related skills)
D1.2 occupation	employed
D1.3 organizational role	managers
D1.4 age	+20
D2: geographical location	Italy
D3: digital technology	robots

D4: phase in the life-cycle of the org	established
D5: strength of organizational ties in the org	high
D6: size of the organization	medium-large
D7: industrial sector	NA

This RT aims at studying the influence of DiDIY at the level of an organization and specifically a community of people in close relations with industrial associations and institutions (L2). The competence profile of people is adults (some of them with DiDIY-related skills) of age higher than 20 and managers working on robots. The organization is medium-large sized, is well established, with high strength of organizational ties in the community while high in each start-up.

RQ: *how the role of an institution, supporting manufacturing companies, is changing given the advent of DiDIY? How they can facilitate the diffusion of DiDIY best practices (if not slowing them down)?*

Research Topic 10

D1: object (unit of analysis)	Supply Chain (L2+L3)
D1.1 competence profile	workman
D1.2 occupation	employed
D1.3 organizational role	any
D1.4 age	old people
D2: geographical location	Italy
D3: digital technology	3D printers
D4: phase in the life-cycle of the org	established
D5: strength of organizational ties in the org	high
D6: size of the organization	Medium size
D7: industrial sector	any manufacturing industry

This RT aims at studying the influence of DiDIY at the level of a supply chain (L2+L3). The competence profile of people is old workmen, employed in any manufacturing firm medium sized. They are in contact with 3D printers and firms are characterized by being well established and high strength of organizational ties.

RQ: *how 3D printing technologies impact on the supply chain in terms of sustainable competitive advantage?*

6. WP3 research plan

Given the multifaceted nature of WP3, we assume a bottom-up methodology in the development of the research outcomes. We assume that it would not be feasible to build a general research model describing all the possible variables involved in the change enacted by DiDIY on work and organization, able to capture the whole complexity of WP3. Rather, we simplify such complexity by defining a common research framework, and choosing a subset of focused Research Topics (RTs) among the many possible. The outcome of WP3 will derive by the integration of the outcomes of the study of each RTs.

The research plan is below detailed:

- we will create a background basis (pertinent and relevant), continuously updated, on:
  - systematic review of the scientific literature;
  - ongoing collection of white papers / reports;
- we will launch a series of studies, focusing on specific Rts;
- we will merge outcomes of the studies to create a picture of DiDIY and work and organization.

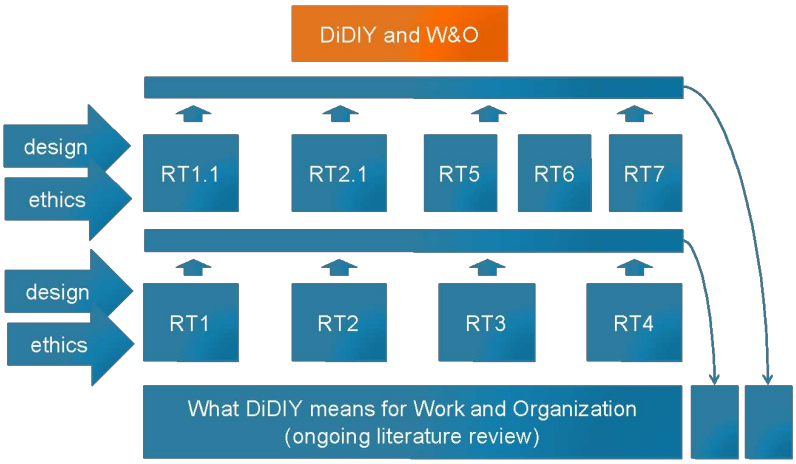

Figure 6 - WP3 research plan.

The first studies to be launched are in the fields of 1) work in manufacturing firms and 2) clusters and entrepreneurship. The next sections present the research model we will follow to deal with these subjects.

7. Research Topic 1: workmen in the industry 4.0 era

7.1 Introduction

A research domain emerging from the literature review relates to new business roles reshaped by the rise of new DIY technologies. The impact is at the employability level given that some of them need “a long education to develop new skills” (Davenport & Kirby 2015). Bernstein and Raman (2015) reported, “technological progress has decreased the demand for low-skilled information workers and increased it for highly skilled ones”. The opportunity to have optimization of operations, easiness of design and flexibility in reconfiguring ecosystems is boosting the rise of digital manufacturing (D’Aveni 2015).

A so-called “digital tsunami” is generated by new computing capabilities and rise in digital data generation thanks to the diffusion of disruptive technologies such as additive manufacturing, autonomous robots, data analytics tools and industrial internet of things (IoT). “Digital technologies are transforming manufacturing value chain, from research and development, supply chain, and factory operations to marketing, sales, and service” (McKinsey, August 2015). Eventually, the large-scale availability of fast and pervasive internet connection is transforming the information flow inside and outside firm boundaries. Manufacturers are waking up to the opportunities and threats of digitization that is led by the above digital transformation: big data analytics together with large storage capacity are driving new insights on manufacturing data. Additive manufacturing, for example, has blurred boundaries between building and productions of products thus setting the competition on designing better products customized on customers’ needs. Together with design, is the production that is facing one of the biggest disruptive changes: manufacturers will perform better if close to the customers and therefore, more feasible and localized. At the strategic level of an organization, strategic decisions will be tightly coupled with operational ones as long as there will be a need for real-time decisions (D’Aveni 2013).

A specific mention has to be done to 3D printing, and the digital tools that support it, given that it is playing a key role in this changing scenario (Koten 2013). 3D printing is not a brand new technology since it was used for several years with the aim to rapidly prototype new components (Gibson, Rosen, and Stucker 2010) but the way it is used nowadays is different. Due to the birth of low-cost 3D printers and the expiration of several patents, 3D printing has opened to path to innovation. “Bursts of innovation happen when an emerging technology removes a once prohibitive barrier of cost, distance, or time” (Lipson & Kurman 2013). Gibson, Rosen, and Stucker (2010), studied the combination of digital technologies and entrepreneurship thus coining the term ‘digiproneurship’ to describe the phenomenon of where people are “returning to the garage and making things that satisfy the needs of one or a very few customers”.

Summarizing all the relevant changes presented, we can say that digital technologies are helping manufacturing firms to connect physical assets altogether thus unleashing a flow of digital data between different departments. Data digitally-generated at production level can be accessible throughout the overall organization thanks to a shared and cloud-based infrastructure. Sensors, distributed inside manufacturing lines, are collecting data from the field and populating online database where these “big data” are analysed in real-time in order to take corrective actions. Lastly, managers and workers are facing a steady introduction of digital technologies (both hardware and software) in their daily activities that puts them in a condition to digitally-advance their skills.

Regarding this last topic several questions are rising in the C-level executive agenda and their answers have to be identified clearly and rapidly. Some of these questions, generally taken from McKinsey and lately rephrased in the corresponding section, are hereby presented: ”What new capabilities, skills, and mind-sets will we need in our organization? How will we identify, recruit, and retain the right new talent?” (McKinsey, August 2015).

7.2 Preliminary empirical findings

Evidence of the relevance of the role of DiDIY in manufacturing firms can be found also in two recent innovation projects that LIUC has been able to follow. In both cases, the introduction of digital technology aiming at tracking materials in the operation department and warehouses led freed the workman of operational tasks and allowed them to gain autonomy (with respect to their chief of department) in the management of the decision process, thus enriching their job profile with more sophisticated tasks.

7.3 Theoretical background

Under this consideration, we aim at understanding how digital technologies, enabling DIDIY-ing, are reshaping the work of a worker in a manufacturing firm. To understand the reshaping of a work we believe that it is relevant to take into consideration the concept of job characteristics and therefore referring to the job characteristics model (JCM; Hackman & Oldham 1980) as the theoretical set of lens that let us understand the impact of digital technologies on employees’ jobs. We start from the work carried out by Morris and Venkatesh in 2010 on ERP systems and we adapt it to digital technologies. JCM posits that various job characteristics together influence job satisfaction. The JCM takes into consideration five constructs that pertain to job characteristics. The first is task significance: “the extent to which a job has impact on the lives of people in an organization or society in general”. The second is task identity: “the extent to which a job involves completing a whole identifiable outcome”. The third is skill variety: “the extent to which a job requires the use of different talents”. The fourth is autonomy: “the extent to which a job provides the employee with discretion to choose how the work is done and to set the schedule for completing the work activities”. The fifth is feedback: “the extent to which carrying out the work activities provides the employee with clear information about his or her performance”. As reported by Morris and Venkatesh, “Job satisfaction is defined as the extent of positive emotional response to the job resulting from an employee’s appraisal of the job as fulfilling or congruent with the individual’s values (Janssen 2001) and other key job outcomes, such as organizational commitment, turnover intentions, and job performance (e.g., Couger et al. 1979; Goldstein 1989; Griffeth et al. 2000; Singh et al. 1996; Tett & Meyer 1993; Thatcher et al. 2002)”.

Although widely dealt in IS literature (e.g., Ang & Slaughter 2001; Igbaria & Guimaraes 1993; Igbaria et al. 1994; Goldstein 1989; Thatcher et al. 2002; Wong et al. 1998), the topic of job characteristics is becoming nowadays central given that the deployment of new technology is representing one of the most significant organizational change events in today’s firms (Herold et al. 2007; Jarvenpaa & Stoddard 1998). A theory according to which is possible to analyse the problem, is the sociotechnical one. It takes into consideration that job outcomes can be influenced by job design initiatives (Campion & McClelland 1993; Parker & Wall 1998). Managerial studies widely dealt with job performance: for example under the personality perspective (Tett & Burnett 2003), or social networks (Burt 1992; Cross & Cummings 2004; Mehra et al. 2001; Sparrowe et al. 2001) or

job characteristics (Fried & Ferris 1987; Hackman & Oldham 1980). Past authors have studied performances at the organizational level such as: the interdependencies between technology and organizational power (Jasperson et al. 2002) or technology as enabler of digital networks (Straub et al. 2004; Wareham et al. 2005). Nowadays, studying job characteristics and performances together with the role that digital technologies are playing is still new to researchers, leaving them a plethora of new opportunities (DeLone & McLean 1992; 2003; Rai et al. 2002; Seddon 1997).

Under these assumptions, emerges clearly that the topic of "how will the work of a worker in a manufacturing firm be reshaped due to the influence of DiDIY" has not been widely dealt in literature, both managerial and IS one.

7.4 Research questions

Given the definition in DiDIY document: "In DiDIY digital technology has been addressed as an "enabler" of the phenomenon under investigation. Within WP3 we would like to emphasize even more the fact that the presence of digital technology represents a necessary - but not sufficient – characteristic of DiDIY: the very existence of DiDIY "depends" on the presence of digital technology, but its core properties are human-centric, thus related to individuals' mindsets and activities."

RQ1: *how will the work of a worker in a manufacturing firm be reshaped due to the influence of DiDIY (Morris & Venkatesh 2010)?*

RQ1.1: *how will the work of a worker in a manufacturing firm change in relation with the evolution of other organizational roles in her firm (Zhang & Venkatesh 2013)?*

7.5 Methodology

A qualitative methodology, as reported in literature (Dubé & Paré 2003), aims at providing valuable insights into proposed interaction between constructs. A team of researchers will collect all the data and analyse them: this approach will be helpful in capturing greater findings and maximizing reliability. Following Yin (2003) a case-study protocol will be designed including the following sections: overview of the project (objectives and issues), field procedures, questions, and guidance for the report.

Wood et al. (1999), proposed a set of criteria to support researchers in the task of identification of the most appropriate method to conduct a study. These criteria can be summarized as follows:

- internal validity: the extent to which some causal conclusions can be made from the study;
- external validity: the extent to which the results may be generalized to the population and to other contexts;
- ease of replication: the ease with which the study can be repeated under the same conditions;
- potential for theory generation: the potential to generate new theories;
- potential for theory confirmation: the potential to test a theory and to provide supported findings;
- cost per subject: the relative cost of the study.

With respect to the current study, two criteria will drive the choice of a case study research: the cost per subject and the potential for theory generation. In fact:

- the time spent in the detailed literature review and the peculiar research context are putting authors in the condition to discharge other methodologies such as action research and ethnography methodologies that require a long time frame for completion (Myers 2006);
- in terms of potential for theory generation, case study research has been largely recognized as a method that could enlarge theoretical knowledge and generate new theories (Myers 2006).

A multiple-case study approach (Miles & Huberman 1994; Stake 2006; Yin 2003) will be chosen for investigating the theoretical framework on how DiDIY is reshaping the work of a worker in a manufacturing firm. The approach will be appropriate in order to answer to our research questions on which are the phenomena characterizing the reshaping of the work of a worker (Benbasat et al. 1987; Yin 2003). It does not mean to imitate a survey-based procedure whose target is "to gather as many data as possible for each variable of the model thus enabling the statistical generalizability" (Yin 2003). The rationale of using a multiple-case study approach lies in" treating each case as a separate test of the theoretical framework in order to achieve an analytic generalization of the framework" (Yin 2003) in which previously developed propositions will be compared against the empirical results of the case studies. By using "replication logic" researchers will assume that each case is comparable to a new experiment and achieve "generalization".

7.5.1 Case unit

The unit of analysis identifies what constitutes the "case" (Yin 2003) and must be consistent with the research questions in order to generate adequate solutions (Darke et al. 1998). To answer the research questions of this study, the unit of analysis chosen will be a worker in a manufacturing firm.

7.5.2 Data collection and storage

The case unit will be analysed through the collection of primary and secondary data. Primary data sources are interviews, direct observation, and informal discussions. Secondary data sources will mainly be a set of documents of the firm that are produced as a consequence of the DiDIY transformation. Before starting the collection of primary data (Darke et al. 1998), some preliminary background information will be collected in order to help the interviewer during the data collection process. The preliminary information will come from the Internet web site of the firm and some supplementary information will be given by the organizational interviewee. Together with a representative of each firm, the names and the positions of all the potential participants will be identified and contacted for an interview (Darke et al. 1998). The interviews will be semi-structured interviews (Kerlinger 1964; Emory 1980). In order to operationalise the theoretical constructs and ground the findings, whenever possible, will be interviewed key representatives of a "worker". The interview will be focused on introducing the main themes and sub-themes to discuss together with the interviewee. At the beginning of each interview an introduction on the reasons and the objects of the interview will be performed (Blanchet & Gotman 1992, p. 75; Miles & Huberman 1994). This explanation will reduce the researcher effects at the site, which could bias the data collection (Darke et al. 1998, Miles & Huberman 1994). The interview guide will be designed to gather the characteristics of the interviewee and what is her/his view. In fact, the interview guide will include a

first draft measure of IT capability and a list of questions about the other constructs under investigation. Since the research will be highly exploratory, a pilot-case will be generated and subsequently a multiple case study, involving other firms (Yin 2003; Dubé & Paré 2003), will follow. To build a triangulation and to give rigor to the study other sources of evidence will be included: direct observations, historical archive records, physical artefacts. The quantitative data will be collected directly on a copy of the interview guide by the interviewer, while the qualitative data produced by the interview will be synthesized in a report, immediately after each interview. These reports, the quantitative data collected on the direct observation and the collected secondary data will be archived in a repository.

To increase homogeneity and comparability between the firms, a selection of them will be made according to specific criteria such as B2B or B2C situation and similarity of firm size. Cases will be chosen for enabling theoretical and literal replications (Yin 2003). In order to ensure theoretical replication, at least two firms will be selected.

7.5.3 Data analysis

The set of data produced by each interview will be analysed in parallel with the prosecution of the other interviews in order to use the content of the previous interviews as source of questions to ask in the next interviews (Miles & Huberman 1994). This continuous refinement is expected to influence the depth of the interviews on specific aspects. Regarding data analysis, interview data is believed that give access to facts about the world (Silverman 2011). Then the researcher can process the content to explain the characteristics of the information system, the socio-technical phenomena that influence knowledge and information exchange and contribute to generate effects on the performances.

7.5.4 Case selection

The researcher targets the theoretical replication to strengthen the external validity of the findings (Yin 2003). In general, it is important to select cases with contrasting characteristics (instead of looking for direct replication in similar cases) because the external validity will be stronger than the external validity obtained from a multiple case study of similar cases (Mason 1996, pp. 93- 94; Yin 2003). The sampling method gives the freedom to change the number of cases, composing the multiple case study, during the process of the research (Eisenhardt 1989; Silverman 2011). Therefore, the process of selecting, interviewing and transcribing the information collected from each case will continue until the state of theoretical saturation is reached. Where it will be possible to comprehensively explain the findings of the case studies no additional data will be collected, developed or added to improve the developed model (Eisenhardt 1989).

7.5.5 Questionnaire

#	Section	Questions
1	Introduction	1. Name 2. Age 3. Organizational role 4. Organization 5. Academic background

		6. Professional background
2	Job Characteristics, Job Satisfaction and Perceived Job Transformation, taken from Morris and Venkatesh 2010	7. Job Characteristics a. Task Significance In general, how significant or important is your job? That is, are the results of your work likely to significantly affect the lives or well-being of other people?* This job is one where a lot of other people can be affected by how well the work gets done. The job itself is very significant and important in the broader scheme of things. b. Task Identity To what extent does your job involve doing a "whole" and identifiable piece of work? That is, is the job a complete piece of work that has an obvious beginning and end? Or is it only a small part of the overall piece of work, which is finished by other people or by automatic machines?* The job provides me with the chance to completely finish the pieces of work I begin. The job is arranged so that I can do an entire piece of work from beginning to end. c. Skill Variety How much variety is there in your job? That is, to what extent does the job require you to do many different things at work, using a variety of your skills and talents?* The job requires me to use a number of complex or high-level skills. The job is complex and non-repetitive. d. Autonomy How much autonomy is there in your job? That is, to what extent does your job permit you to decide on your own how to go about doing the work?* The job gives me considerable opportunity for independence and freedom in how I do the work. The job gives me a chance to use my personal initiative and judgement in carrying out the work. e. Feedback To what extend does doing the job itself provide you with information about your work performance? That is, does the actual work itself provide clues about how well you are doing—aside from any "feedback" coworkers or supervisors may provide?* Just doing the work required by the job provides many chances for

		me to figure out how well I am doing. After I finish a job, I know whether I performed well. 8. Job satisfaction Overall, I am satisfied with my job. I would prefer another, more ideal job. (reverse score) I am satisfied with the important aspects of my job. 9. Perceived job transformation The system changed my job significantly. The system altered my job substantially. The system made my job very different. The system transformed my job greatly. *Seven-point anchors (strongly disagree, moderately disagree, slightly disagree, undecided, slightly agree, moderately agree, strongly agree) were used.
3	Job performance, adapted from Zhang and and Venkatesh 2013	Computer self-efficacy (seven-point Likert Scale) (Venkatesh et al. 2003) 10. I could complete a job or task using the system… a. If there was no one around to tell me what to do as I go. b. If I could call someone for help if I got stuck. c. If I had a lot of time to complete the job for which the software was provided. d. If I had just the built-in help facility for assistance. Conscientiousness (seven-point Likert Scale) (Gosling et al. 2003) 11. I… a. Am always prepared. b. Pay attention to details. c. Make plans and stick to them. d. Waste my time. e. Find it difficult to get down to work. Job performance (seven-point Likert Scale) (adapted from Kraimer et al. 2005; Welbourne et al. 1998) 12. Please rate your subordinates along the following dimensions: a. Quality of work. b. Quantity of work. c. Technical competence.

		d. Working as part of a team or work group. e. Help others when it is not part of his/her job. Computer experience (Venkatesh et al. 2003) 13. Please indicate amount of computer experience you have in years: Rank (Mehra et al. 2001) 14. Which of the following best describes your position in this company: a. Junior manager b. Middle manager c. Senior manager d. Non-managerial employee Tenure (Cross and Cummings 2004; Mehra et al. 2001) 15. Please indicate the number of years you have been working for this company: Gender (Cross and Cummings 2004; Mehra et al. 2001) 16. Male Female

7.6 Scenario

It is under investigation the impact of digital technologies (DiDIY-related) on the activities carried out by a workman activities in such a way that his/her role will be critically reshaped. We believe that together with activities competences will be reshaped accordingly. For example, a worker will need not only operation competences to execute specific tasks on a product but event strategic competences traditionally pertaining to manager. This big shift is resulting from the digital potential that nowadays is impacting on the automation of activities, especially in production (McKinsey, December 2015).

An example we expect to gather from our data collection will be the following: understanding how the work of a workman (e.g., a supervisor of job activities in a production cell) in production is reshaped by the introduction of recent digital technologies (e.g., IoT, Mobile, Cloud, …) in such a way that instead of simply allocating jobs to workers (following a schedule defined by top managers) he will take strategic decisions on which are the most critical activities to be prioritized. Clearly, this will put him/her in a position to freely allocate – based on decision taken at production level (related to worker's competences, workstation saturation, …) – the job to be carried out. Therefore this action will carry a set of strategic skills that previously were not part of the skills portfolio pertaining to him/her thus. This flexibility, enabled by both software to support production such as PLM and new hardware to track items and grant visibility such as RFId and sensors, is transforming the traditional production context. Summarizing, according to this technological shift, we aim at investigating the impact, of such opportunity to have big data about production, on the activities carried out by a supervisor of a production process.

7.7 Empirical domain

The context of the empirical study will be a set of manufacturing firms facing a digital transformation within their internal core processes: digitalization of physical assets thanks to the introduction of digital technologies (e.g., auto-identification sensors within a production line thus transforming/reshaping how workers interact with the environment). This will affect their traditional activities that will, now, require a more managerial approach and not technical only. The reshape of work activities is considered fundamental and around this topic will be centred the data collection phase.

8. Research Topic 2: clusters and entrepreneurship

8.1 Theoretical background on clusters

Cluster are defined as a group of related industries operating in a given location by sharing common technologies, knowledge, inputs and cluster-specific institutions. Industries within a cluster benefit from complementarities (Delgado et al. 2010; 2012).

In such a broad area of studies, that crosses many disciplines and research domains, we address cluster theory through the lenses of strategic entrepreneurship, i.e., with a focus on entrepreneurial and innovation processes and entrepreneurial ecosystem with reference to competitiveness. More precisely, we work in three interrelated but distinct sub-topics.

8.1.1 Cluster initiatives and development of ecosystems

Given that the dynamic development of clusters, and hence their competitiveness, depends on the quality of their entrepreneurial ecosystems (Isenberg 2010; Harrison & Leitch 2010), the strength of a cluster ecosystem may depend on a conducive culture enabling policies and leadership, the availability of appropriate finance, the quality of human capital, venture-friendly markets for products, and a range of institutional and infrastructural supports. Institutions for Collaboration (IFCs) – i.e., formal or informal actors promoting the formation and development of clusters amongst actors involved (Porter & Emmons 2003) – are expected to be central to the formation and the development over time of a strong cluster ecosystem. Several terms can be found in literature to refer to these supporting institutions, apart from IFCs (Sölvell et al. 2003; 2008): cluster initiatives (Sölvell et al. 2003; Ketels & Sölvell 2006), cluster organizations (Ketels et al. 2012), cluster associations (Arangon et al. 2012; Aranguren et al. 2013; Valdaliso et al. 2011), industry associations (e.g. Cooke, 2002; Giuliani, 2005; ITD, 2009), regional development agencies (Peck & McGuinness 2003; Seliger et al. 2008) or institutional thickening (Andriani et al. 2005). The research question guiding the study in this sub-topic is:

RQ: *which is the role of cluster initiatives and IFCs in the formation and development of a cluster entrepreneurial ecosystem and, hence, in a cluster competitiveness?*

8.1.2 Clusters and regional competitiveness

Policy makers are relentlessly seeking forms and arrangements for increasing the social and economic prosperity of their cities and regions. International studies suggest that the prosperity of a place is directly related to its competitiveness (Porter 2008). Clusters are believed to increase regional competitiveness, given that they contribute positively to innovative processes, facilitating relations with other institutions, better enabling the consumer needs, canalising knowledge and information needed for development (Malmberg & Maskell 2002; Porter 2000; 2008; Ketels 2011; Porter & Ketels 2009). Recent literature on clusters (e.g., Delgado et al. 2012) show how clusters do impact positively and significantly on regional competitiveness in several respects (e.g. new firms formation, new patents, new jobs, etc.), suggesting econometric models to assess it. The focus on this sub-topic is on the way a cluster ecosystem and specific cluster initiatives may favourably impact on urban and regional competitiveness, especially in terms of innovation and new business formation.

8.1.3 Knowledge sharing for innovation in clusters

Innovation is key in clusters, as the long-term success of a region depends on the ability to continuously renew available resources and create new ones (Staber 2008) in an incessant entrepreneurial process. A vast majority of studies have found that clustered firms show a higher innovative capacity than isolated firms (Baptista & Swann 1998). Scholars agree that innovation is deeply rooted in clusters and is strongly related to knowledge exchanges (Tallman et al. 2004; Maskell 2005; Maskell & Malmberg 1999). Cluster scholars have largely contributed to this debate, suggesting that innovation-related knowledge is selectively and unevenly exchanged in clusters and firms play heterogeneous roles in knowledge exchange within and across clusters (Boschma & Ter Wal 2007; Giuliani 2007a; 2007b; Morrison 2008). Gatekeepers received a lot of attention in literature (e.g., Morrison 2008) even if other brokerage roles have been accounted in literature on clusters (e.g., Giuliani & Bell 2005; Alberti & Pizzurno 2015). The combination of local and global relationships is another extremely relevant issue in the studies about regional innovation networks (Biggiero & Sammarra 2010). In conclusion, research on this topic has revolved so far on innovation-based networks within and across clusters and more specifically on the knowledge exchanges for innovation within and across clusters, using social network analysis as a framework and methodology.

8.2 Empirical domain

The three above-mentioned research views are the ones that we will apply to the exploration and understanding of the DiDIY phenomenon, reading it through the multifaceted lenses of cluster theory.

The ‘digital’ evolution of the DIY culture or – more broadly – the ‘makers movement’ can be considered ‘popular culture’ for its wide accessibility and geographically spread diffusion. The maker movement is a cultural trend that places value on an individual’s ability to be a creator of things as well as a consumer of things. The maker movement is spreading worldwide and its growth rate is impressive. Moreover, the digital DIY phenomenon has induced a democratization of entrepreneurship together with the emergence of an innovative entrepreneurial ecosystem supporting it (e.g., fablabs, makerspaces, techshops, crowdfunding, etc) which fosters innovation networks both in virtual communities and in physical geographical proximity.

8.3 Research agenda

Research in the area of strategic entrepreneurship referring to the phenomenon of digital DIY is still in its infancy. A preliminary check on SCOPUS, ISI and Google Scholar reveals just a few papers on the topic, suggesting that it is a field of study in its inception. Nevertheless, at least three important scholars/schools have very recently converged in this area of research interest:

- Porter and Heppelmann (2014; 2015) on Harvard Business Review stressed the impact of the digital do-it-yourself phenomenon on competitiveness and on smart manufacturing clusters;
- Aldrich (2014) – the leading scholar in entrepreneurship – has held a track at the last Academy of Management on the democratization of entrepreneurship and the transformation of entrepreneurial ecosystems after the makers revolution;

- finally, Gloor (2014) at the Sloan School of Management, MIT has developed conceptual frameworks, methodologies and software to analyze collaborative open innovation networks in order to grasp the digital do-it-yourself phenomenon.

With reference to the area of research interest, i.e. cluster initiatives, entrepreneurial ecosystems and innovation networks in clusters, literature focusing on the phenomenon of digital DIY – or to a larger extent to the one of the the maker movement – is almost inexistent.

The present Project sets a research agenda in the field according to the research design reported hereafter.

8.4 Research design

Our proposed research design builds on two parallel research avenues. The first one consists in exploring and understanding how innovation is produced in digital DIYers networks, with a focus on types of knowledge and innovation, knowledge brokerage roles and social capital, independently from the physical or geographical location of such networks. The second one introduces the hypothesis of a geographical agglomeration of digital DIYers, bringing in the lenses of cluster theory, where knowledge and innovation networks are characterized by stickiness.

8.4.1 Virtual communities

The digital DIY phenomenon – and more broadly the makers movement – can be surely conceptualized as a knowledge-building community, where innovation is put forward by individual's curiosity as well as from an initial agenda and shared in the entire community for further knowledge production. Several concepts compete for understanding this phenomenon: knowledge networks, knowledge communities, communities of interest, communities of practice, etc. Technology, individual expertise and sharing – all common traits to DiDIY – have long been studied as communities of practice (e.g., Lave & Wenger 1991; Brown & Duguid 1991), that in the strict, literal sense are communities that shares practices. These resemble both virtual platforms like Instructables, Makerspace.com, etc. as well as locally based communities of makers either temporary (e.g., Maker Fairs) or stable (e.g., fab labs or makerspaces), where knowledge is co-constructed and shared, through joint problem-solving.

Following the perspective introduced at the MIT by Gloor (2006), our first sub-stream of research will focus on virtual communities. Virtual or on-line communities are groups whose members use ICT as the main means of communication (Cothrel & Williams 1999). They do not exclude using other interaction modes, in particular face-to-face or video conferencing, but the main distinction between real or virtual communities is technology-based interaction in the latter (see De Maggio, Gloor, and Passiante (2009) for a literature review on the topic). In an attempt to provide a systematic taxonomy of virtual communities, Gloor (2006) distinguished among three types of networks:

- Collaborative Innovation Networks (COINs): made up of self motivated people who share a common vision, meeting on the web to exchange ideas, knowledge, experiences and to work in a collaborative way to achieve a common goal;
- Collaborative Interest Networks (CINs): composed of people who have the same interests but don't perform a common work in a virtual team; this kind of community is very frequent on the web, has a lot of silent members, who keep information from web sites, portals,

forum, and a few active members who are inclined to share their knowledge and experiences within the community;

- Collaborative Learning Networks (CLNs): a community made of people inclined to share knowledge and practice to benefit reciprocally from personal mastery and the collective knowledge accumulation of a group of attitudinally similar people.

Although all three types of networks have been around for hundreds of years, they are especially relevant today because the concept has reached its tipping point thanks to the Internet. They are powered by swarm creativity, where their network structure enables a fluid creation and exchange of ideas. 'Coolhunting' – discovering, analyzing, and measuring trends and trendsetters – puts COINs to productive use. Patterns of collaborative innovation frequently follow an identical path, from creator to COINs to CLNs to CINs.

RQ1.A: *how do COINs, CLNs and CINs differ in terms of innovation-related knowledge exchanges?*

RQ1.B: *do actors involved in COINs exchange only one type of innovation-related knowledge? And do they play different roles vis-à-vis different types of innovation-related knowledge?*

RQ1.C: *how do different actors contribute to innovation in COINs?*

RQ1.C.1: *what kind of brokerage roles are identifiable?*

RQ1.C.2: *which are the trends and who are the trendsetters?*

RQ1.C.3: *how do COINs differ in terms of network structure?*

From a methodological point of view, a blended use of textual content analysis (Krippendorf 2004) and social network analysis (Wassermann & Faust 1994) will allow the analysis of virtual communities of DiDIYers.

8.4.2 Sub-stream #2

Collaborative Knowledge Networks (COINs, CINs and CLNs) may end up in geographical clustering, either temporarily and repeatedly (for instance through fairs, conventions and events physically gathering a community's participants) in the form of temporary clusters (Maskell, Bathelt, and Malmberg 2004) or in a stable way with related and supporting industries and institutions in the form of clusters (Porter 1998).

#2A - Temporary clusters

The Maker Faire in particular, but also minor fairs in the DiDIY realm, are not solely trade fairs in the proper sense, but they also have a knowledge-generating and relational potential (Sharland & Balogh 1996). Fairs have become relational platforms able to filter flows of information and

knowledge, and they behave like outright temporary clusters. Vertical and horizontal synergies are in place in temporary clusters: vertical synergies with customers (promotion of products, information on market trends, updates on technological knowledge, exploration of new opportunities, expansion of business, etc.); vertical synergies with suppliers (solution-seeking to technical problems, understanding of market development and scenarios, absorption of technological changes, grasping of opportunities, etc.), horizontal synergies (information about technologies, regulatory aspects, market trends, initiatives, open projects, etc).

Maskell, Bathelt, and Malmberg (2004) and Aldebert, Dang, and Longhi (2008) offer an extensive discussion on fairs as temporary clusters, specifically addressing my area of research, i.e. knowledge exchanges for innovation.

Often the most important part of the value added obtained from participating in fairs consists in the non-deliberate absorption of new knowledge, the renewed capacity to interpret implicit codes of behaviour, and the ability to grasp new trends. During the fair, various actors from different parts of the world, for a limited period, share their experiences and their specialized knowledge. Some scholars – Bathelt et al. (2004) and Maskell et al. (2006) – have called these information flows “local buzz”. Fairs enable participants to create contacts with distant partners through trans-local relationships or ‘global pipelines’. In this way, flows of external knowledge internally enhance firms’ innovative capacities and their business competitiveness. In short, ‘global pipelines’ and ‘local buzz’ are two closely connected phenomena which facilitate processes of inter-organizational learning and knowledge conversion. Information acquired by each actor about, for instance, opportunities in new markets and/or new technological opportunities is then made to circulate collectively within the local network of the temporary cluster, fostering and multiplying the buzz-effect (Belussi, Sedita, and Omizzolo 2008).

Several intriguing topics qualify for further understanding of temporary clusters of DiDIYers. For instance, empirical studies might analyze if temporary proximity allows the different actors in the DiDIY realm to set up or mobilize knowledge and social links without requiring durable co-location. Furthermore, it will aim at identifying if, in a dynamic context of annual event (such as the Maker Faire), the repeated face to face temporary relations can result in trust and durable cooperation between different organizations. It might be expected that a temporary cluster enables to develop or implement innovative solutions, supports technology transfers and backs the creation of new markets as well as the fostering of horizontal and vertical relations between stakeholders.

The research focus will be on the informal network of knowledge transferred through local buzz and global pipelines in temporary clusters.

Preliminary research questions, which will be refined and fine-tuned after an extensive and updated literature review on temporary clusters and its matching with the theoretical view-points and data available through the present Project, are:

RQ2.A: *how does knowledge is acquired and shared in temporary clusters?*

RQ2.B: *whether and how temporary clusters may be considered cluster initiatives, i.e., antecedents of permanent clusters?*

RQ2.C: *which is the role of temporary clusters in open innovation practices of firms?*

RQ2.D: *how does 'local buzz' is exchanged in temporary clusters? And in which roles different actors are involved in 'local buzz' exchanges?*

RQ2.E: *how does 'global pipeline' is exchanged in temporary clusters? And in which roles different actors are involved in 'global pipeline' exchanges?*

RQ2.F: *how do the 'local buzz' and the 'global pipeline' networks differ in temporary clusters?*

RQ2.G: *which is the effect of recurring participation in temporary clusters on knowledge exchange behaviours?*

#2B - Clusters

The rise of the maker culture, and so even the DiDIY one, is closely associated with the rise of a totally new entrepreneurial ecosystem made of hackerspaces, fab labs makerspaces, tech-shops, coworking spaces, crowdfunding platforms, related and supporting industries (first of all laser cutters and 3D printers makers and consultants, but not only; dedicated vocational training and education, academic and corporate research, etc), local and international associations, clubs and institutions.

Makers tend to concentrate mainly around large and medium cities, forming local communities. Often physical proximity and geographical clustering play a critical role in the rise and success of such communities and in the exploitation of their capacity to act as incubators for knowledge creation and sharing and eventually for innovation (De Maggio et al. 2009). We want to dig into this phenomenon of clustering, studying both proto-clusters in Europe as well as consolidated benchmarks overseas that are widely recognized as clustered communities of makers, even if no theoretical conceptualization of clusters of makers is available so far. We are referring to the Central Florida Makers Community or the San Diego Idea District, where a peculiar cluster ecosystem hackerspaces, makerspaces, media, fairs, coworking, together with specialized manufacturers, accessible technology and a dense community of various kinds of makers are co-located. Cities represent the ideal ecosystem for these clusters to occur, hence my focus will be on those clusters that Porter (2010) addresses as inner-city clusters. Several terms are used interchangeably: makers quarters, creative districts, maker-centric local communities, etc. A recent census on Italian makers and fab-labs suggests a marked clustering in Milan, Turin and Rome that deserves further empirical explorations. Hence, despite the fact that there is evidence worldwide on the fact that even makers, or DiDIYers, cluster, together with related and supporting industries, specific institutions and under certain factor conditions and sophisticated local demand (Porter 1998), still a meta-research question guiding this sub-stream of research remains totally unexplored in empirical and conceptual terms:

RQ#3: *do DiDIYers cluster?*

A preliminary review of the literature, drawing on previous studies on the clustering of creative industries – given that the makers movement, and more precisely the DiDIY realm – suggests that several factors are at play to explain why collaborative knowledge networks or communities of practice might cluster (e.g., Lazzeretti, Boix, and Capone 2010):

- urban studies take a policy perspective with a normative/planning view on the phenomenon, focusing on urban endowments, urban regeneration, inner-city clusters and districts as a way to re-convert or re-launch the competitiveness of cities and regions (e.g., Mommas 2004);
- agglomeration economies suggest that cluster forms take advantage from the existence of a skilled labour market for these industries, from the existence of local suppliers specialized in other parts of the creative filière, and to benefit from local knowledge spillovers;
- related variety (Frenken & Boschma 2003; Frenken et al. 2007; Asheim et al. 2007) is a concept drawn from the studies of the evolutionary economic geography and it is defined in terms of industrial sectors that are related because of shared or complementary competences in a cognitive-based definition (Boschma & Iammarino 2007); in other words, a certain degree of cognitive proximity gives place to effective communication and interacting learning among different industries that contribute to an the higher capacity to absorb innovations from neighbouring sectors though cross-fertilisation;
- human capital externalities contribute to explain the concentration of activities in concrete points of the space and can explain creative clustering in cities (Glaeser 2000; Florida 2005);
- 3T (tolerance, talent and technology) à la Florida (2002) remark that some places are poles of attraction for the creative class and conversely the driving force behind the development of a city turns out to be its ability to attract and retain creative individuals.

RQ3.A: *why are DiDIY clusters formed?*

RQ3.A.1: *which are the determinants/antecedents of DiDIY cluster?*

RQ3.B.1: *which factors hamper the formation of DiDIY clusters?*

From a methodological standpoint, after a thorough review of the literature on the determinants of clustering in general and in the creative industries and in the specific DiDIY realm in particular, we will build on Lazzeretti et al. (2010) and Delgado et al. (2010; 2012) to understand the process of clustering in the DiDIY industries. Econometric models and multivariate statistics will be used. A first issue will be to operationalise the independent variable that in clustering studies is typically a location quotient (LQ) that compares the relative specialization of a place in an industry regarding the national average. This would imply the identification of industries that are typically DiDIY and the plotting of LQ on the 686 local labour systems (LLS) in Italy (and/or in Europe). Since it is not easy – at this stage – to figure out which industry codes (NACE) might be considered DiDIY and given the amateur nature of DiDIYing (i.e., makers are often private individuals geographically clustering and not firms), other competing operationalizations of proper LQ might qualify, e.g., a census of makers, the geotagging of makers communities on social networks, a census of fab-labs, etc. As far as independent variables, i.e. determinants of clustering, are concerned, there is abundant

literature on their operationalization. For instance, the five theoretical perspectives reported above all have ready-to-use operationalized variables to be tested in mutlivariate regression as antecedents of clustering in the DiDIY realm. Lazzeretti et al. (2010) will be a guide on that.

The transformation of a typical cluster ecosystem introduced by hackerspaces, makerspaces, coworking spaces, incubators, accelerators, tech-shops, digital manufacturing, etc. deserves empirical investigation and theorizing. We actually do not know anything about how these clusters resemble typical clusters in terms of their ecosystem, how they emerge and evolve, how do they transform along their life-cycle, who can be cluster organizations and how do they operate, what kind of cluster initiatives are occurring and which are their specificities if any, who can play the role of IFCs and how they operate, how innovation takes place in collaborative and open forms, how knowledge is exchanged and broker, etc.

Further, the topic about clusters' formation and its development is a top priority in the agenda of many regional development agencies and national governments (Porter 2010). Clusters are increasingly seen as change agents able to influence the regional's entrepreneurship, innovation and competitiveness (Porter 2000; Mytelka & Farinelli 2000; Sölvell et al. 2003; Alberti & Giusti 2012). As pointed out by Feldman (2001) clusters formation is a process that relies on the co-evolution of technology, business models and local supporting institutions. Likewise, clusters development much depends on the actual capacity of clusters to activate a critical mass of collaborations among heterogeneous actors (firms, capital providers, research organizations, local government, etc.) so that knowledge can flow and innovation flourishes (Malmberg & Maskell 2002).

Hence, the second key research question will be on the functioning of DiDIY clusters, with a focus on how things occur:

RQ#3.B: *how do DiDIY clusters emerge and evolve?*

This calls for additional sub-questions:

RQ3.B.1: *how do DiDIY clusters transform along their life-cycle?*

RQ3.B.2: *what are the components of a DiDIY cluster ecosystem? And how do they relate one each other?*

RQ3.B.3: *how do DiDIY clusters resemble typical clusters in terms of their ecosystem? How do they differ?*

RQ3.B.4: *how does a DiDIY ecosystem promote cluster formation and evolution?*

RQ3.B.5: *how does the DiDIY cluster ecosystem foster competitiveness?*

RQ3.B.6: *how does the DiDIY cluster ecosystem foster innovation?*

RQ3.B.7: *who can cluster organizations be and how do they operate?*

RQ3.B.8: *which is the role of cluster organizations in DiDIY clusters?*

RQ3.B.9: *who can play the role of IFCs and how they operate?*

"How" research questions call for in-depth and longitudinal case studies, where several methods and empirical sources contribute to offer a holistic understanding of the phenomenon of interest. The analysis will rely both on primary and secondary sources of information. Primary data will be originated from in-depth semi-structured open-ended interviews to makers, experts in the field, policy makers, operators in fab-labs, makerspaces, etc. Individuals to be interviewed in each cluster will be select via a snowball sampling technique (Goodman 1961), asking each key informant to indicate a list of other prospective contact persons and then reiterating the process. The sample will be intentionally closed when all new names proposed by informants will be already in the list, thus when the group of contact persons will be self-referring. The underlying logic of data analysis will be grounded theory building, which involves inducting insights from field-based case data (Miles & Huberman 1984). Grounded theory building was chosen because of the aim to generate novel insights into a rarely explored phenomenon. The major results from this study we suppose will be theoretical insights on how can Makers do cluster. As secondary data play an important role in conducting the qualitative analysis also primary data will be used mostly for cross-sectional and processual analyses. Secondary sources are abundant on the topic, web-sources (Make:, etc), social network communities, relevant literature (reputed Journals, indexed in ISI or Scopus), grey literature (unpublished reports, theses, etc.), institutional reports (World Economic Forum, United Nations, World Bank, etc) as well as local research reports (Make in Italy foundation, Deloitte, etc), governmental web sites (Ministries, State Departments, etc), media (newspapers, 'make-oriented' magazines, etc.) and conferences and associations. Secondary data will be collected and analysed to convene the requirements of the research objectives of this paper. We will check for triangulation of different data sources in order to obtain more robust evidence (Jick 1979).

Additionally, policy actions or programs dealing with DiDIY undertaken by the government or by specific IFCs deserve further understanding in the light of the literature on cluster initiatives (CI) on cluster development programs (CDP). Giuliani and Pietrobelli (2011) offer a methodological note for the analysis of the impact of cluster policies on cluster actors relations: knowledge exchanges, social capital, innovation networks, brokerage roles, inflows-outflows relations, etc. hence, first of all the question is:

RQ3.B.10: *what kind of cluster initiatives are occurring and which are their specificities, if any?*

Then adopting the lenses of Social network analysis, following the methodological guide of Giuliani and Pietrobelli (2011) and going more in-depth in the topic, such as:

RQ3.B.11: *how do CDP and CI impact on innovation networks in DiDIY clusters?*

RQ3.B.12: *how do CDP and CI foster knowledge exchange for innovation in DiDIY clusters?*

RQ3.B.13: *what types of knowledge exchanges for innovation are favoured by CDP and CI in DiDIY clusters?*

RQ3.B.14: *how is innovation-based knowledge exchanged in DiDIY clusters?*

RQ3.B.15: *how does innovation take place in collaborative and open forms in DiDIY clusters?*

All these questions may offer also strong policy implications for local cluster organizations, government and H2020 objectives.

Finally, nothing is known about the impact such clusters have on regional competitiveness. There is a quite new and growing sub-field of studies initiated by M. Porter at HBS and S. Stern at MIT, that – starting from cluster mapping projects worldwide – aims at assessing the impact of clusters on competitiveness. Several positive externalities have been already assessed through econometric models testing (Delgado et. al 2010). Hence, the research will try to replicate the same approach and ask:

RQ4: *what is the impact of DiDIY clusters on regional competitiveness? In terms of new firm formation, patenting, open innovation capacity of incumbent firms, development of neighbouring areas, fostering of other clusters in the area, etc?*

The two sub-streams of research (i.e., temporary and stable clusters) will be reconciled through a comparative analysis of virtual vs. clustered innovation networks in the DiDIY field, to explore whether the geographic clustering does produce increased knowledge exchange for innovation compared to virtual settings. This is still a contemporary debate in literature that goes back to mainstream cluster theory à la Saxenian (1994) or Porter (1998) till most contemporary evolutionary economic geography à la Boschma and Ter Wal (2007), where geographical proximity is complemented by other types of proximity in explaining innovation networks. Hence, the final research question will be:

RQ5: *does geographic clustering still benefit innovation?*

From a methodological point of view we plan to adopt the same approach taken by Allen, Raz, and Gloor (2009), who investigated a similar research question in the Cambridge/Boston Biotech Cluster using SNA structural measures and Condor software (Gloor 2006), applied to networks of communication among DiDIYers both in COINs as well as in clusters.

9. Research topic 3: DiDIY and managerial roles

9.1 Impact of digital transformation on managers

To orchestrate digital transformation efforts, those who manage these processes from top must expand their roles: the main example in this case is that of the Chief Information Officer, who should make his historically "toolsmith"-like role of supporting back-office operations evolve, to provide business solutions (Kohli & Johnson 2011). Referring to Earl (1996), the key for being a successful CIOs has always been that of a deep level of knowledge and understanding of the field of Information Technologies and Architectures, and since that is a delicate matter to apprehend, this competence was always searched within candidates even before starting to operate in that role.

Following this stream, several researches have highlighted the challenges CIOs face in meeting these dualistic expectations: in fact, to explore new demand-side opportunities, together with the exploitation of supply-side IT resources is a quite critical aspect (Chen et al. 2010).

Therefore, these roles address two primary organizational imperatives. First, rapidly changing market conditions demand that organizations quickly assemble their resources, to respond with agility. Second, increased competition exerts pressure to reduce operational costs and demands organizational efficiency (Bozon et al. 2007). These, by the way, are not the only aspects to consider, regarding the effects of digital transformation on C-level roles.

According to the previously quoted research from Wargin (2001), the bottom-up perspective is not the only one to consider when a digital transformation is taking place within the firm: the alternative system is that of positioning one person with overall responsibility for efforts concerning the e-business activities and driving change. For this system, in a previously conducted case study by Quinones (2014), researchers proved that "the successful appropriation of IT relies on the invisible work conducted by those people within groups, who formally or informally aid their colleagues in the successful cultivation of practices and sense-making around technology". Analysing further these concepts, means that the manager on top of this transformation has to deal with matters like sharing a common vision, building urgency and finding the right spots within the firm to drive the digital transformation.

This role of "shepherding" technology inside a company can be assigned to different managers, depending on the setting in which this change has to happen: Chief Information Officers result to be the most common choice, but sometimes their interpersonal capabilities and their vertically shaped set of competences lacks of the necessary attitude.

Some firms leave this task to Chief marketing Officers, due to their diametrically opposite set of competences, more prone to collaborate with other people, but in this case the lack of knowledge within the IT field is an important loss.

This absence of clear procedures towards the change process has generated the rise of a new professional role within organizations, the Chief Digital Officer. In fact, this role represents a hybrid fusion between the roles of Chief Marketing Officer and Chief Informatics Officer, rapidly achieving more and more importance and influence over strategic decisions. The definition of the current tasks that a Chief Digital Officer has to accomplish are therefore related to driving change within a company, establish a common vision, look for the gaps in the digital presence and create

functioning links between the different functions of the companies involved in the use of digital technology (Rousselet et al. 2014).

The fundamental reason why organizations bring a CDO on board is to drive change: a CDO in post also helps to crystallize what the organization means by "digital", establishing a vision for what the business will look like, and then he can start to change the people's experience. He also has to demonstrate the tangible value of the introduction of a particular change. More importantly, he has to be able to collaborate with Marketing and IT, as he will represent the previously missing link between those two divisions.

At this point, the manager who has been chosen as agent of change, will have to deal with the usual lack of IT Leadership within the "higher spheres" of the firm: some practical suggestions provided by Clint Boulton (2015), for actions that the chosen agents of change have to take to prove that they are capable of shepherding digital strategies relate to the way they make their firm deal with the surrounding ecosystem.

The first suggestion is to work on a holistic yet agile strategy in the event that CEOs decide to pivot: in this way, they will achieve quick results and build confidence around their managing skills. Secondly, they have to focus on the customer experience ecosystem: now, CEOs are looking for an alignment of multifaceted digital strategies across multiple functions, therefore, the need is to develop the back-end systems to support this integrated pipeline.

The third suggestion provided by Boulton (2015) is to speed up IT simplification and accelerate the Business Technologies' agenda: the agents of change have to rationalize their IT portfolios to accommodate new technologies, such as cloud, mobile and analytics. The fourth consideration is towards a higher level of understanding of the customers: to do this, the agent behind the digital transformation must have a better understanding of marketing and the customer experience field, by adopting an outside-in approach and map the customer journey.

The last important suggestion obtained is that of focusing on cultivating a new culture: that of collaboration and open innovation. In fact, C-level managers who drive the technological transformation must engage with the business and external constituents by running hackathons and setting up targeted incubators.

The research gap concerning this relatively new field is whether it is necessary to institute a new role with a new name, to explicitly state what the roles of these people are, or it is simply necessary to conduct training or directly hiring sessions, to turn traditional managers into e-leaders. Two research questions derive from this gap:

RQ1: *how the work of a knowledge worker will be reshaped in 2020, due to the influence of DiDIY? how will it change in relation with the evolution of other organizational roles in her firm?*

While certain organizational functions might not be affected by the DiDIY phenomenon, the IS function will be – to some extent- inevitably impacted. Therefore:

RQ2: *how the IS function will evolve due to the influence of DiDIY? How the structure of the function will be affected? Which organizational roles will be reshaped, and which competences will be required?*

And in particular:

RQ2.1: *how the work of the CIO will be reshaped in 2020, due to the influence of DiDIY? how will it change in relation – with the evolution of other CxO roles?*

9.2 Preliminary exploration

To address the RQs listed above, a set of interviews with CxOs of Italian large enterprises where carried out between November 2015 and January 2016. The results are at the moment under elaboration, but a few insights can be already pointed out.

In order to successfully perform a digital transformation, managers are undergoing a peculiar transformation: as stated by the peers interviewed and confirmed by the literature, Chief Marketing Officers and Chief Operation Officers are getting more and more vertical, as technologies and their growing ease of use have empowered their autonomy from the previously mandatory support from the IT department.

On the other hand, to not risk the extinction and adapt to the firms' needs, the previously vertically-shaped figure of the Chief Information Officer, that in the past had frequently to report to other C-level officers, providing technical knowledge and hard skills in the single field of IT, has now undertaken a progressive transformation into the true agent of change. This is affecting, on one hand, the set of competences that are requested to these officers, as they need to become more soft-skills oriented, more capable of influencing people and sharing their vision, developing the so-called IT-Leadership, instead of the previous IT-competence. On the other side it also affects the way companies tend to work on technical issues concerning IT: in fact, more and more frequently, these topics are not even assigned to the IT department and the CIO anymore, as it results to be cheaper and much more effective to use consultancy and external operators.

This drastic change of profiles is not commonly accepted by all the firms in the many different industries undergoing this digital transformation, due to several factors: resistance to change by entire established firms and their executive managers, due to a traditional mindset and old procedures, also because the market has not created any urgency; resistance to change by older managers, who are not prone nor capable to shape their set of competences in a different ways, since their work has stayed unchanged for the past tens of years; the difficulty, from younger people, to reach roles of responsibility in firms, due to the long career path to which everyone has to undergo.

One more conservative result is the appointment of a Digital Officer, who has only and specifically to deal with human relationship with digital technologies and potential opportunities to exploit. The critiques to this kind of decision, anyway, arrived by the other peers interviewed lead to think that appointing new managers is not exactly the solution to innovate, but just to postpone innovation.

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