D2.3 KNOWLEDGE FRAMEWORK, INITIAL VERSION

Project Acronym:	DiDIY
Project Name	Digital Do It Yourself
Grant Agreement no.	644344
Start date of the project	01/01/2015
End date of the project	30/06/2017
Work Package producing the document	WP2 - Creating and maintaining a shared knowledge framework on DiDIY
WP Lead Partner	LIUC
Other Partner(s) involved	all
Deliverable identifier	D2.3
Deliverable lead beneficiary	LIUC
Due date	M6 (June 2015)
Date of delivery	30/06/2015
Version	1.0
Author(s)	LIUC
Classification	PUBLIC
Document Status	APPROVED
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 644344.	
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Executive summary

Deliverable D2.3, "Knowledge framework, initial version", presents the first version of the DiDIY-related Knowledge Framework aimed at "providing a common conceptual and lexical ground to the activities performed in [the Project] by integrating the different competencies of the interdisciplinary Project team, in particular by harmonizing languages, approaches and research methodologies", by "interpreting the DiDIY phenomenon" (from the Project Proposal, and now in the Grant Agreement).

As such, D2.3 completes the first stage of the activities related to WP2 - Creating and maintaining a shared knowledge framework on DiDIY, by complementing the contents proposed in D2.1, "Options for the knowledge framework", and D2.2, "Foundational interpretation of DiDIY".

Note on contributors

This deliverable is the result of a collaborative work, and all partners have contributed to its development.

Revision history			
Version	**Date**	**Created / modified by**	**Comments**
0.0	18/06/15	LIUC	First, incomplete draft, resulting from several online documents to which all partners contributed.
0.1	26/06/15	LIUC	Extensions and fixes. First formal distribution to TB.
0.2	28/06/15	LIUC	Extensions and fixes.
0.3	29/06/15	LIUC	Extensions and fixes.
1.0	30/06/15	LIUC	Approved version, submitted to the EC Participant Portal.

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1. Introduction

As stated in our Project Proposal, and now in the Grant Agreement, the Knowledge Framework on DiDIY (KF) is aimed at "providing a common conceptual and lexical ground to the activities performed in [the Project] by integrating the different competencies of the interdisciplinary Project team, in particular by harmonizing languages, approaches and research methodologies", by "interpreting the DiDIY phenomenon". "Multiple information and data gathering methods will be exploited to this goal. With the collaboration of all partners, a set of hypotheses and research questions on DiDIY will be formulated, to inspire and contribute driving the activities of [the Project]".

Under the assumption that DiDIY "is an ongoing social phenomenon requiring the adoption of a diachronic perspective", and therefore its "iterative observation in the course of Project development", after a first version, to be delivered at Month 6 (June 2015, as deliverable D2.3), a revised version (Month 15, March 2016, D2.4) and then a final version (Month 30, June 2017, D2.5) will be produced and validated, "in order to make [the KF] a shareable knowledge base".

The KF builds upon the outcomes presented in the deliverables D2.1, "Options for the knowledge framework", and D2.2, "Foundational interpretation of DiDIY".

As stated in D2.1, the KF is structured as:

- a *descriptive* model, in which the phenomenon is presented according to its main structural dimensions;
- an *explanatory* model, in which, building on the descriptive model, the phenomenon is interpreted according to some hypotheses on its determinants;
- a *prescriptive* model, in which, building on the descriptive and the explanatory models, the phenomenon is proposed as a tool to promote given social objectives and some guidelines for policy makers are suggested accordingly.

A first version of the descriptive model is presented in D2.2. Acknowledging both the spatial and the temporal complexity of the phenomenon under consideration, at least in the first version of the KF its openness is privileged over its specificity. The KF is indeed expected to be:

- *encompassing*, so to allow the consideration, comparison and – where considered appropriate – integration of multiple interpretations;
- *adaptive*, so to allow the modification of its structure in the case new perspectives emerge or the phenomenon itself changes.

In the first stages of the Project the KF is mainly aimed at being a tool for mutual understanding, a generator of research questions, and a context in which such questions – and the answers that will be found – are interpreted as components of a concept system.

The KF is structured as:

- a set of "*Pillars*" – presented in Section 2 – that specify the fundamental shared interpretation of what DiDIY is, and on this basis
- a set of "*Dimensions*" – presented in Section 3 – that offer views in specific aspects of what DiDIY may be.

1.1 Terms and acronyms

DIY	Do It Yourself
DiDIY	Digital Do It Yourself
ABC	Atoms-Bits Convergence
IoT	Internet of Things
KF	Knowledge Framework

2. Knowledge Framework Pillars

DiDIY is a complex, multifarious, dynamic phenomenon, and a definitive criterion can hardly be given to establish what DiDIY is and what it is not. Nevertheless, the concept is not empty, nor just subjective or contextual: some of its key features have been identified, and presented here as the *Pillars of the Knowledge Framework*. Even though still revisable in future versions of the KF, they are intended to be the core features of the fundamental shared interpretation of what DiDIY is.

A. DiDIY as a kind of DIY

DiDIY is a kind of DIY. Hence:
- everything that generally characterizes DIY also applies to DiDIY, so that studying DIY is useful also to understand DiDIY;
- not everything that characterizes DiDIY also applies to DIY, and studying DiDIY requires identifying how the 'being digital' contributes to create a specific kind of DIY

(in a complementary way, every case of DiDIY is also a case of DIY, but there are cases of DIY that are not cases of DiDIY: hence DiDIY is a specific way of DIY).

Some related research questions:
- Which components of DiDIY are also integral part of DIY? Which ones can be found in DIY but with significant changes introduced by DiDIY, and which are brand new features of DiDIY with respect to DIY?
- Are the interpretive models that have been proposed on DIY effectively applicable also to DiDIY, and how could they be adapted to the case of DiDIY?

B. DiDIY and ABC

The digital in DIY is the means to integrate physical and informational components ("atoms" and "bits") of entities, a situation that we have proposed to call "Atoms-Bits Convergence" (ABC).

While there is not a principled necessity that ABC is the only significant component of DiDIY, ABC has several important consequences, in particular by making it possible:
- to transfer, store, and process manufacturing instructions without any practical degradation in the final product, thus in many cases guaranteeing the complete replicability of the results even if multiple individuals are involved in the process of design and manufacturing, as in the case of objects produced by 3D printers from 3D CAD data files;
- to create distributed processing and control systems, in which the components can automatically acquire information from their physical environment and exploit it to contextually operate in order to modify the environment, as in the case of 'smart objects', possibly as parts of Internet of Things systems;
- to produce objects even if the producers are unable to operate functionally equivalent non-digital tools, due to distance (the tools are somewhere else), lack of manual skills (the

designer can make a 3D drawing on a computer but might be unable to use a chisel, maybe because of a physical disability), etc.

Some related research questions:

- While something can be ABC-related but not obtained through DIY, how much is ABC intrinsic to DiDIY? Are there relevant examples of DiDIY that are significantly non-ABC? In this case what are the main differences between ABC-related DiDIY and ABC-independent DiDIY?

C. DiDIY as activity and as mindset

There is a fundamental tension in (DIY and) DiDIY, as something that someone:

- does, e.g. an *activity* for the creation, modification or maintenance of objects or services; in this sense DIY and DiDIY are *objective* phenomena, that can be studied from the analysis of tools, products, structure of collaborations, etc;
- has, e.g., a *mindset*, and then a producing and consuming culture; in this sense DIY and DiDIY are *subjective* phenomena, that can be studied from the analysis of motivations, competences, social contexts, etc,

where the co-presence of objective and subjective components activates positive feedback (self-reinforcing) process, thus progressively transforming DiDIY into a socio-technical system.

The dynamics itself of such a system is complex. DiDIY may originate as an activity and later on turn into a mindset, as sometimes it happens in education: students start from an assigned activity, that for them at the beginning is just a task to be completed, and progressively some of them develop a mindset transferring the concept to other learning activities.

See also Note 1 "On DiDIY as a mindset" below.

Some related research questions:

- What are the objective and subjective conditions that develop DiDIY as mindset in an individual?

D. DiDIY and the multiple options of 'yourself'

The 'yourself' in DiDIY is originally an individual, but the widespread availability of networked digital information processors (part of the 'activity' component of DiDIY) and the interest to share knowledge (part of the 'mindset' component of DiDIY) have created new dimensions of DiDIY, in which the *yourself can be a group, a class, a community of practice, a company, an industrial cluster, the society as such*. The collaboration is set up not only in face-to-face situations but also through:

- *transmission* networks (from the Internet to the Internet of Things), that enable
- *communication and design* networks (sharing digitally coded information on texts, music, images and videos, geo-localization of objects, shapes of objects, ...), that enable
- *collaboration* networks (thus intended as social, technologically-enabled systems).

See also Note 2 "On the openness of the Internet of Things" below.

Some related research questions:

- What are the significant differences in collaborative DiDIY when performed via technological networks instead of face-to-face?

E. DiDIY and free or open access polices

The effectiveness of DiDIY through transmission → communication → collaboration networks has been emphasized and accelerated by the availability of *free or open access polices*:

- at the *transmission* level, the protocols of the TCP/IP stack, that constitute the technical foundation of the Internet, are free and open by design;
- at the *communication and design* level, both digital, machine-ready designs and the documentation needed to learn how to produce, modify, and use them can be freely shared, sometimes in open formats, that can be processed with free of charge, low-cost software of third parties, accessible to everybody with a computer, not just with expensive applications by the inventor and sole "controller" of the file format;
- at the *collaboration* level, projects can be developed, shared and reused quickly, without paying royalties and/or going through complicated, expensive legal/bureaucratic procedures, or generally asking for permission, and at global scale in the logic of open collaboration and innovation (open source communities, IPR management via Creative Commons licensing, etc).

Some related research questions:

- What are the main opportunities and the main threats in DiDIY when performed according to free or open access polices?

F. DiDIY between producers and consumers

As both an activity and a mindset, *DiDIY further blurs the distinction between producers and consumers* that is already a characteristic of DIY.

Some related research questions:

- What are the main conditions that enable prosumers to create value for the context (group, company, society) in which they operate?

3. Knowledge Framework Dimensions

Some specific points of view to study DiDIY have been identified, mainly through literature analysis and discussion among Project members. These points of view are presented here as the *Dimensions of the Knowledge Framework*, with the same conceptual and lexical structure:

> *in a narrower view DiDIY is..., while in a broader view it is also...*

where there is a tension between the narrower and the broader view, based on the provisional hypothesis that the narrower view is non-controversially acknowledged as DiDIY (and maybe even "stereotypically DiDIY"), whereas the broader view might be accepted as DiDIY only by someone in some contexts (possibly also depending on market conditions, legislation, etc).

The idea of presenting each Dimension as a potentially continuum of options, from a narrower to a broader view, is an attempt to obtain:

- a "shared core interpretation" of DiDIY ("when we talk and research about DiDIY we surely intend at least..."), in reference to the narrower view for each Dimension, and
- a flexible concept system, that admits and allows us studying multiple positions ("when we talk and research about DiDIY we might also intend..."), in reference to the broader view for one or more Dimensions.

A source of interest and complexity of DiDIY is that *it is a socio-technical system*, such that several, and maybe all, these Dimensions have significant correlations worth specific explorations and analyses.

In this view the KF is a valuable target, that in the course of its development can be improved in many ways, and in particular, for each Dimension, by formulating significant research questions, to be then investigated and possibly leading to agreeing that:

- also what is currently presented as the broader view of that Dimension is accepted as DiDIY: in this case the Dimension is removed from the list and added to the list of Pillars, in Section 2;
- even what is currently presented as the narrower view of that Dimension is not accepted as DiDIY: in this case the Dimension is removed from the list and added to the list of further Dimensions, in Section 3.2.

3.1 Main Dimensions

DiDIY and outcomes

In a narrower view DiDIY is aimed at producing physical artefacts, while in a broader view it is also aimed at creating intangibles and performing services.

Note: This Dimension aims at further exploring the relation between DiDIY and ABC, as presented in Pillar B.

Research questions:

- What are the role of 'digital' in DiDIY here, and how can they be exploited to make the DiDIY more effective or efficient?

DiDIY and professionalism

In a narrower view, DiDIY is related to activities performed by non-professionals, while in a broader view it is also for professionals who maintain their DiDIY mindset.

Note: This Dimension aims at exploring the appropriateness of extending the scope of DiDIY to cases in which what is done by her/himself is a professional activity.

Research questions:

- What are the differences, if any, in DiDIY if carried out by an amateur or a professional?
- Under what conditions is a professional activity appropriately considered DiDIY if performed with the mindset of the DiDIYer?

DiDIY and technology

In a narrower view DiDIY is associated with state-of-the-art technologies, while in a broader view it is also possible with traditional, well-established technologies.

Note: This Dimension aims at exploring the role of state-of-the-art technologies in DiDIY, whether there is some significant reasons for assuming that DiDIY is related to innovative tools or they are only attractors.

An example somewhere in the middle is that of BetterPress Lab, a group of Italian female makers based in Rome www.betterpresslab.com. They use traditional typography, employing old movable type to create old looking or vintage posters. In many cases they use a 3D scanners and printers to re-create movable types of some letters that had been lost or broken over the years.

Research questions:

- What are the tools currently and mostly used by DiDIYers? Which ones do they consider innovative or state-of-the-art technologies?
- What is the actual role that DiDIYers attribute to state-of-the-art technological tools? Is the being state-of-the-art a significant reason for making DiDIY attractive or is it just an extrinsic element?
- How do the current technologies change the way DiDIY is carried out with respect to the past (e.g., required skills, possibility for collaboration and sharing)?

DiDIY and creativity

In a narrower view DiDIY is about developing creativity, while in a broader view it is it also for repetitive processes.

Note: In quantitative terms it is plausible that the two polarities of this Dimension can be reversed, the more common situation being DiDIY as replication of a model or execution of instructions.

This applies more generally to DIY. An example is making a cabinet from raw wood at home, blindly following the design of somebody else, which we would have never had the creativity to do ourselves, simply because it is cheaper and/or a much better fit for our house than anything we may

buy ready in store. Here the digital only extends the number of practical cases in which repetitive processes are feasible.

Research questions:

- How can DiDIY support people to become more creative, or do more creative things?

- How can DiDIY help to foster a more creative society?

- What is the role of professional designers if everyone does design and (Di)DIY? Can professional designers help in the creative process of DiDIY? Will it be possible to enable collaborative experiences in which the professional designer can support DiDIYers?

DiDIY and organization

In a narrower view DiDIY is related to individuals, while in a broader view the 'self' in 'yourself' is also 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).

Research questions:

- How will the work of a workman in a manufacturing firm 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 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?

- Do DiDIYers cluster? What are the factors enabling single DiDIYers get together and create teams to design and develop innovative digital products (e.g., robots)?

- How do collaborative innovation networks among DiDIYers foster cluster initiatives? How can DiDIY-related entrepreneurial ecosystems transform in cluster initiatives?

- What are the factors enabling small or medium-sized enterprises 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, while in a broader view DiDIY also 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).

Research questions:

- How will the activities performed in an R&D department be influenced by the advent of DiDIYers among the R&D employees and among the firm customers?

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

DiDIY and learning

In a narrower view DiDIY is for those who are already immersed in new technologies, while in a broader view it is also a valuable way for learners to acquire skills and abilities and ways of thinking.

Research questions:

- The many uses of DiDIY in education and research have one element in common: creativity has a crucial role and is often relieved from the burden of the actual "making" of the outputs (if you can imagine it, you can create it). Thus pupils really have the opportunity to work on their ideas, shaping them mostly in a non-physical environment, and even the last part of the process does not require them to have particular dexterity. How do teachers and students use this unique feature of DiDIY?
- Thanks to the widespread and affordable access to the Internet and the growth of the free software and open source and open hardware movements, pupils work on common projects and share working spaces with their colleagues-friends. Does this lead to new ideas or to conformism? Besides they also share the same working spaces with teachers, thus making it harder to predetermine the flow of communication. How is communication and sharing reshaping student-teacher and learning/teaching flows?
- How sharing and learning happens is influenced by cultural models. A possible critique to DiDIY is about the individualism of the model, perhaps implicitly based on western cultural assumptions. Does DiDIY emphasize individualism, and how can the roles of individuals be shaped in DiDIY-related learning processes?
- How can DiDIY be exploited to ease / emphasize the transition from a teacher / curriculum-centered school to a student / experimentation-centered education ("flipped learning")? Is DiDIY also transforming the role of teachers accordingly? How? What new competences are expected from them? (these questions need to take into account that DiDIY educational activities are also related to environments different from schools – such as labs, museums, robotics academies, etc – and educators that are not teachers) Is this transition always a desirable outcome?
- It has been argued that school as institution could have greatly benefited from the computer age, but was somehow reluctant to do so (S. Papert). Will DiDIY have better chances to allow for major changes within the educational system, also taking into account the concurrent existence of multiple forms of DiDIY aimed at substituting schools, such as MOOCs?

- How is the age of individuals related to their possible attitude toward DiDIY? Is the fact that at the moment DiDIY is exploited in learning mainly of young people contingent to the current "DiDIY culture"? May DiDIY effectively exploited as a driver in learning also of adults, and in the case how?

- How can DiDIY help special groups of individuals, disabled, second generation immigrants, specially gifted, etc?

- How is gender of individuals related to the attitude toward DiDIY? (also considering that DiDIY is used in many countries as a special tool to attract more students and make them study more STEM (Science, Technology, Engineering, Mathematics) subjects, and considering that STEM courses have a very low percentage of female attendance, one possible areas of interest could be that of evaluating if and how DiDIY may attract more women to STEM classes)

- At present DiDIY in education is mainly used in close relationship with STEM subjects (and if other subjects are involved, they have an ancillary role). Is there a main role for DiDIY in other subjects, such as humanities, arts, etc, so to move from STEM to STEAM (Science, Technology, Engineering, Arts, Mathematics)?

DiDIY and open communities and releases

In a narrower view DiDIY is about openly sharing knowledge in communities and openly released outcomes, while in a broader view it is also of individuals operating alone and about outcomes that are maintained proprietary.

See Note 3 "Knowledge Sharing and the relation with Free Knowledge & Open Source Hardware" below.

Research questions:

- What are the main (cultural, psychological, etc) factors hindering from openly sharing DiDIY-related knowledge in communities, and how can the attitude to open sharing be promoted?

DiDIY and profit

In a narrower view DiDIY is about activities satisfying in themselves, while in a broader view it is also about activities for profit.

Note: While DiDIY typically focuses on creating solutions to solve one's personal or collective problem, it does not exclude the making of products and then selling them, even if that is for profit. When a business builds certain tools appropriate for their business activity by themselves, this activity can be considered DiDIY, even if it may bring the company certain profits. The existence of profits does not exclude it from DIY.

See also Note 4 "On ecosystems, economic sustainability and business models" below.

Research questions:

- In what conditions past experiences and cases of DiDIY attempted or proved to generate profits?

- Can DiDIY be a resilient business opportunity? What are the barriers to overcome?

- What models of sustainability or business models do people and organisations pursue to dedicate their time and resources to DiDIY?

DiDIY and collaboration

In a narrower view DiDIY is about activities carried out by one person (the "yourself"), while in a broader view it is also about collaboration and transdisciplinarity.

Note: See Note 5 "DiDIY and codesign" below.

Research questions:

- Is the ability to manage collaboration a strategic dimension of DiDIY? And in particular how do DiDIY collective actions influence the sense of ownership, personal involvement, motivation and satisfaction?
- What kind and which codesign tools might be implemented into collaborative actions lead by non-designers? And how do codesign tools influence the way people construct new meanings on DiDIY?
- Might codesign be both a valuable research approach used to investigate DiDIY and a valuable method to be used by non-designers in digital DIY activities independently? And would implementing codesign in collective digital DIY activities increment creativity and therefore innovation?

3.2. Further possible Dimensions

DiDIY and individual motivations

There may be several distinct reasons for an individual to operate as / become a DiDIYer, including ethical principles, reputation, skills development, money saving, etc.

DiDIY and individual decisions

While DiDIY seems to be typically related to voluntary activities, the idea of a "reluctant DiDIYer" is not contradictory, and in principle someone might perform a DiDIY activity to order, without a DiDIY mindset.

DiDIY and routine and timespan

While DiDIY seems to be typically related to non-routine activities spanning relatively short amounts of time, this does not prevent that it is applied also to routine long lasting activities.

DiDIY and sustainability

DiDIY has complex relations with sustainability: it is typically based on small-scale technologies, with limited efficiency and low repeatability, but it may help saving items otherwise discarded, reducing the purchase of new items, developing skills.

DiDIY and cheap resources

The software and hardware tools exploited in DiDIY are often very cheap, and often also "free as in freedom", thus in principle widely affordable.

DiDIY and aesthetics

DiDIY has complex relations with aesthetics: in some cases it might be considered mainly finalized to functionally appropriate outcomes, but in some other cases search for beauty might be the motivating reason.

DiDIY and social risk

DiDIY has short, medium and long term risks for society. The experience that the flow of digital information is difficult or even impossible to control suggests that the control of physical systems generated through digitally driven DIY will be equally difficult. Control of intellectual property rights (design, patents, etc) and dangerous materials (weapons, chemicals, drugs, microbes, viruses, nanoscale materials, etc) will thus be a challenge, or perhaps needs to be given up. The tension between freedom and control will remain central to the future of DiDIY.

Notes

Note 1. On DiDIY as a mindset

The possibility of DiDIY becoming a mindset is interesting in relation to its potential social and ethical implications. If widespread enough, it could mark a shift in social practices and expectations that made it more difficult to implement certain types of regulation. As an analogy, one can think of the way in which a number of people have been conditioned to expect music to be available online for free: this new mindset seems to have made online music providers more cautious about trying to abolish free streaming services (funded by ads) in favour of a subscription-only system or other paid services.

Another dimension in which DiDIY becoming a mindset is interesting is the "repair" culture, (e.g., http://www.didiy.eu/resources/rusz-refurbishment-repair-services).

Note 2. On the openness of the Internet of Things

The entire stack of TCP/IP protocols, on which the Internet is based, is free and open, and so are most applicative protocols on top of TCP/IP, as HTTP that is the core component of the web. Will the applicative protocols of the Internet of Things (IoT) be free and open?

The best assumption / forecast / hope we can say on this, at this point in time, is that IoT is likely to have an evolution similar to the original one: a first stage of lots of competing non-interoperating protocols (regardless of their IPR status, i.e., whether they are patented / copyrighted or not), followed by extinction of most of them, and survival of one or a very few ones, maybe just for protectionism reasons (think power plugs in different countries) but with almost full interoperability. Of course, the hope is that the surviving standard(s) will be open. And China with its general attitude towards western-style IPR may have a big part in this.

Note 3. Knowledge sharing and the relation with Free Knowledge & Open Source Hardware

One of the foundational pillars of DiDIY is the sharing of knowledge. Where DIY is something that one theoretically can do completely alone and keep private, in the case of DiDIY there is practically always a form of knowledge sharing (imagine that one buys a household 3D printer or an electronics product that helps her/him set up a little sensor network for oneself: even if they are proprietary systems, in some way some shared knowledge is involved).

Most typically actors engage in online knowledge sharing platforms that are open for participation and share knowledge about techniques, solutions and projects providing certain rights to other users. Very typical are projects classified as Free Knowledge, Free Software, Open Source Software, Open Source Hardware and Free Cultural Works. These are different terms for expressions of knowledge ("works") that are shared with the following four freedoms:

a) the freedom to use for any purpose;

b) the freedom to study and adapt to ones' needs;

c) the freedom to copy and share with ones' neighbour, and

d) the freedom to distribute modified versions.

Not all DiDIY projects come with these four freedoms. One restriction that may apply is the non-commercial one (e.g., under the CC BY-NC license), which limits the use or sharing of the works for non-commercial contexts. DIY typically is done for solving a person's or group's problems and not directly commercial exchange (though selling of the results may occur). Another restriction that sometimes is used is a non-derivative restriction (e.g., CC BY-ND), which restricts users from distributing modified versions. Note that for anything to be considered DIY in the first place, it should allow modifications, but not necessarily the distribution of these. Now when one or more of such restrictions apply, these works can not be considered "free" (as in freedom) nor "open" (as in "open source") and (thus) they would not be part of the collection of free knowledge. That said, the use of free licenses – that guarantees the mentioned four freedoms – is often a considerable advantage for communities to become sustainable and very common under practitioners of DiDIY. This relates also to the sustainability / business models.

Note 4. On ecosystems, economic sustainability and business models

Typically the sharing of knowledge of DiDIY takes place in online communities where people participate with a large variety of motivations. Peers produce collectively digital resources that some use to solve their personal needs, while others offer professional services "on top" of the digital common. This is particularly known for the Free Software community where a large part of developers make a living with services related to their contributions to the common resource. In this sense it can be argued that DiDIY thrives particularly well when people have full rights to engage in any kind of activity related to the digital resources shared. More concretely this can be observed in the Open Hardware communities, where artists, researchers, entrepreneurs, activists, hackers and makers of all sorts come together and contribute to shared projects as they see fit.

Some models for sustainability or business models that can be observed include:

- sell products as kits: users buy a kit and self-assemble it instead of making all individual components themselves - the original developers tend to make a margin on the sales;
- sell finished products: even though you can make it yourself, some people prefer to buy a finished product - the original developers tend to make a margin on the sales;
- platform model: people can replicate freely the hardware and/or software but connect to an online platform (cf. gitHub, particle.io);
- services: provide value added services while keeping the designs under free/open licenses.

Note 5. DiDIY and codesign process

DiDIY, as stated before, is a complex phenomenon having implications in many different environments at different levels. Such complexity calls for a transdisciplinary research methodology able to enhance people needs and visions. A bottom-up approach where people are directly involved in the research and production of knowledge seems necessary to achieve a complete understanding of DiDIY practices and potential. One of the foundational pillars of DiDIY is codesign, a

transdisciplinary and collaborative process through which people can learn and produce knowledge as they engage with the challenges they are involved in.

Going to its essence, what characterizes codesign is the involvement of non-designers in collaborative activities: collaboration is then key element of the process and knowledge is produced and shared as a collective action.

Making is at the heart of codesign as it is of other design disciplines: "one key ingredient of the designerly ways of doing research is that they involve creative acts of making. These acts of making are not just a performative act of reproduction, but a creative act which involves construction and transformation of meaning." (Sanders and Stappers, 2014). As Sanders and Stappers state "methods and tools for making give people – designers and non-designers – the ability to make 'things' that describe future objects, concerns or opportunities.".

Hence, one might say that are two dimensions strategically embedded in codesign useful for analysing DiDIY: one being the social and rational idea of democracy setting the conditions for proper and legitimate people participation, the other being the importance of eliciting participants' tacit knowledge (not just their formal and explicit competencies, but those practical and diverse skills that are fundamental to collective making). In this view collaboration through codesign might be seen as a collaborative process to implement the practices of DiDIY.