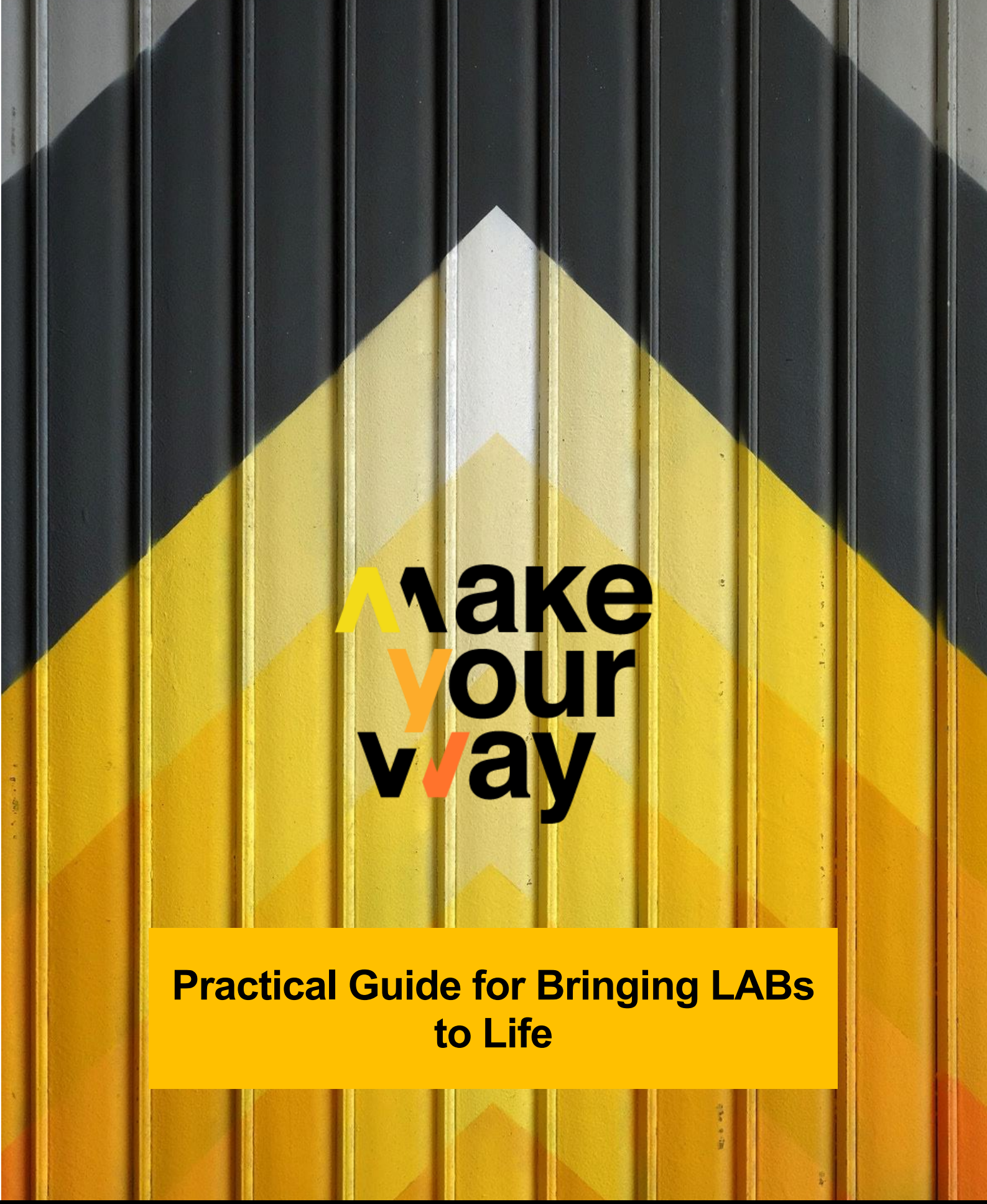

Practical Guide for Bringing LABs to Life

Co-funded by the Erasmus+ Programme of the European Union

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1 Introduction

1.1 Make Your Way Project

Objectives

MAKE YOUR WAY project intends to support the promotion of work-based learning (WBL) in all its forms by developing relevant collaborations to open further opportunities for young VET students to apply knowledge in practical, “hands-on”, and "real life" workplace situations, at the same trying to enhance their entrepreneurial attitudes, in particular by working in LABs. Thus, the project takes benefit of the concept of “Fab labs”, or LAB, a small-scale workshop offering digital fabrication, proven to boost innovation and entrepreneurship, as they are platform for learning and innovation: a place to play, to create, to learn, to mentor, to invent.

Such laboratories (FAB LABs) help connecting a community of learners, educators, technologists, researchers, makers and innovators. There is World Bank data confirming that such LABs help multi-disciplinary teaching, learning, research, and entrepreneurship, and when there is close collaboration between the educational system and industry, based on the strength of all stakeholders this approach can successfully address local needs. LABs can help strengthen and expand VET-industry partnerships through prototyping joint research or products with digital fabrication machines. Also, access to modern equipment, digital modelling and design tools such as 3D printers and laser cutter soften unleash creative talents.

The project also aims to bring more innovation to VET system by contributing to the continuous professional development of VET teachers, trainers and mentors in both school and work-based settings, with a focus on developing effective digital, open and innovative education and pedagogies, by developing materials that can help those professionals assist young VET learners in taking the most benefit from using LABs and from other WBL solutions, as well as spreading the concept of LABs and promoting their closer collaborations with the VET system, while preparing both sides for such partnerships(VET teachers and LABs staff, who often become VET mentors/trainers).

Results

During the project implementation, the consortium will develop three intellectual outputs which are the core deliverables and which should be communicated and disseminated. These are:

- **IO1 - Practical guide for bringing LABs to life –** The practical guide will consist in a catalogue with best practices of various LABs in Europe that promote both entrepreneurial and technical skills.

- **IO2 – Toolkit of learning materials –** This toolkit will consist in a set of self-study materials, videos, tutorials, practical exercises and assignments, diagnostic tools, test, etc, which cover 2 areas: entrepreneurial skills and development of technical skills.

- **IO3 - Roadmap MAKE YOUR WAY and guide for mentoring talent – a roadmap** intended to provide guidance to future implementations of the developed learning materials; plus a

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comprehensive guide for mentors/trainers/facilitators on pro-entrepreneurial mentoring (mentoring talent).

Targets

The project target is divided by groups according by their role on the project implementation. Direct target group will integrate the project activities and will benefit from the project products. Indirect target group represent a second but higher level of implementation, since they will incorporate the elaborated project products into their offer. These target groups are specified as follows:

1. **Direct target groups (primary target group):**
   - VET learners, youngsters aged from 16 up to 26 (who become LAB users);
   - VET teachers, trainers and mentors who are supported in their continuous professional development (to assist young VET learners in taking the most benefit from using LABs and from other WBL solutions);
   - VET providers/institutions and organisations;
   - LABs staff /facilitators - to be better prepared for partnerships/closer collaborations with VET systems/providers and for spreading the concept of LABs further;
   - LABs (their management and staff).

2. **Indirect target group (secondary target group):**
   - Decision makers: municipalities, regional and local authorities (public entities withy responsibilities in school education);
   - Teachers associations and unions;
   - Entrepreneurs (individuals) at local and national level;
   - Training providers (continuous teachers training);
   - Higher Education providers;
   - Business support entities such as: business associations/chambers of commerce; business incubators, business angels at local and national level
   - Partners at EU level from previous and current projects

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1.2 IO1 – Practical Guide for Bringing Labs to Life

The present document consists in a catalogue with best practices of various LABs in Europe that promote both entrepreneurial and technical skills. Its aim is to describe successful stories and to inspire the organisations at the beginning of the path or striving for further development of such LABs. The cases will be defined and analysed within European context, with special focus on the partnership countries (PL; PT; CZ; ES), considering:

- links and collaborations with national VET systems and local VET communities;
- the macroeconomic characteristics of the region where the LAB is located (links with communities, labour market, structure of the economy…);

The intention is to cover various models of LABs, taking into account the LAB format (which actors are involved), content (which is the key topics/areas emphasized by the LAB) and location (urban/rural area, centralized/decentralized educational/innovation policy, European/World context).

Thus, the guide main objectives are the following:

- describe successful stories to inspire the organisations at the beginning of the path or striving for further development of such LABs;
- support the establishment of new LABs, by understanding which factors are common to the Fab Labs/Labs success;
- inspire current and/or future Lab users;

Guide Structure

In order to answer to such objectives, the practical guide will follow a comprehensive, simple structure:

| Chapter 1 – Introduction

| Chapter 2 – A Closer Look at a Fab Lab

| Subchapter: Maker Movement

| Subchapter: Fab Lab

| Chapter 3 – Make Your Way Good practices

| Subchapter: Make Your Way Methodology

| Subchapter: Make Your Way Good Practices

| Chapter 4 - What contributes to the successful implementation of LABS?

| Subchapter: Success Factors

| Subchapter: "LABs" and Education: collaborations with VET providers

| Chapter 5: Conclusions and Recommendations: Practical Tips on how to start a Fab Lab

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During this study, the concept Lab will refer to any fabrication laboratory that has yet not been certified by MIT thus not being officially recognised as Fab Lab.

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2 A CLOSER LOOK AT A FAB LAB

2.1 Maker Movement

To answer the question **"What is a Fab Lab?"** it is important to first understand its preceding concept - the **Maker Movement**.

Over the past few years, Engineers, designers, artists, health professionals, artisans, among others, have been exploring new ways to express their unique skills. Society has witnessed a boom of innovative projects and activities, including involvement in do-it-yourself (DIY) culture around the world (Rosa *et all*, 2017).

The Maker Movement is celebrated as a representation of the do-it-yourself movement, as its extension based on technology and digital fabrication (technology-based extension of DIY culture that intersects with hacker culture). Typically, the Maker Movement culture encompasses different areas related to STEM - technology, engineering, robotics, 3D printing and the use of computer tools, as well as metalworking, woodworking and the traditional arts and crafts. According to Rosa *et all* (2017), within this movement "technology was then seen as an opportunity of emancipation, characterized by a delight trait and the belief that it could empower individuals and make them able to de-institutionalize society".

Core to the Maker Movement concept is the assumption that anyone can and should have access to the tools and knowledge necessary to build anything they might need or want. It's about the people's needs to engage with objects in ways that make them more than just consumers. According to Rosa *et all* (2017), it stands out as a self-empowering vision about the surrounding world where the creation and learning process is of extreme value. Some aspects that are widely recognized as characteristics of the maker movement, such as the focus on hobbies, art and craft groups, shop classes, practical education and science fairs have been also present in other forms of community spaces. It is also expected that the maker movement will give rise to new forms of education and perhaps employment guided by an increased focus on craftsmanship and engagement with the material world.

The Maker Movement materializes itself in 3 different types of physical spaces: **Fab Labs, Hackerspaces and Makerspaces**. These unique spaces can be seen as the physical representations of the maker movement. They seek to provide communities, businesses and entrepreneurs the infrastructures and manufacturing equipment indispensable to turn their ideas and concepts into reality in a risk-free and low-cost manner. Equally important, these open spaces serve as a physical place where individuals can freely gather and share their experience and expertise (Rosa, P. *et all*, 2017).

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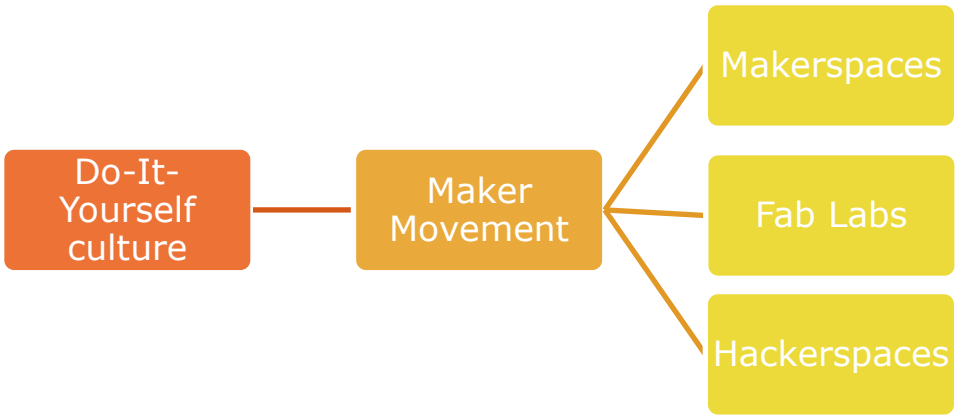

Figure 1 - The Maker Movement Pathway

Although these community oriented spaces appear to converge towards a similar structure, objectives and use, they have significant distinctions and different origins (Rosa *et all*, 2017).

As for **Makerspaces**, the term was originally associated with MAKE Magazine, often in the context of creating tinkering-spaces for children. The concept became more widespread and started to be commonly used by practitioners to refer to any generic space (often also including Fab Labs and Hackerspaces) that promoted active participation, knowledge sharing, and collaboration among individuals through open exploration and creative use of technology. In this sense, makerspaces do not comply with a pre-defined structure and indeed do not need to include a pre-defined set of personal fabrication tools. The focus is on having a publicly-accessible creative space that explores the maker mind-set and tinkering-practices.

Fab Labs (shorter for Fabrication Laboratories or Fabulous Laboratories) are workshops, where people can meet, exchange ideas and collaborate with the common purpose of design and digitally manufacture (almost) anything. The concept was developed by Neil Gershenfeld from Massachusetts Institute of Technology (MIT). A distinctive feature of Fab Labs is that they must comply with the Fab Charter. Moreover, they have at their core structure the same hardware and software capabilities, making it possible for people and projects to be easily distributed across them. Fab Labs are supported by a global Fab Lab association, responsible for the dissemination of the Fab Lab concept as well as being the connection point between the various Fab Labs across the world. The Fab Lab association objectives also comprise the promotion of collaboration among Fab Labs, the share of expertise, the brainstorm of ideas, and the spread of research. Fab Labs are typically set up in the context of an institution, be that a university, a company or a foundation.

Hackerspaces are typically setup from within a community for the community, thus being community-funded and community-managed spaces. The concept behind hackerspaces started in Berlin, Germany and can be traced back to August 1995. The idea was to have a non-repressive physical space where people interested in programming and tinkering with technology could meet, work, and learn from each other. As the spaces grew in popularity, the terms "*hacking*" and "*hacker*" became broader, going beyond programming activities to include physical prototyping and electronics. An effort was also made to distance these spaces from the largely negative connotations of the term "*hacking*" presented in the mainstream media. Each hackerspace can be seen as a unique space in the sense that it has its own organization, structure, ideology and focus. More than providing the hardware tools and manufacturing equipment, they provide the learning environment and the

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necessary support for individuals to develop their projects based on their own interests. Hackerspaces are also all completely independent from each other's, although collaboration between spaces is quite common.

For the purpose of this guide, the understanding of the Makerspace concept follows the trend which portrais it as more general and inclusive of Fab Labs and Hackerspaces (*Figure 2*). The following chapters focus directly only on the Fab Lab concept, its objectives, particularities, requirements and good practices in an attempt to provide practical guidance for those who wish to start or even improve their Labs or Fab Labs[1].

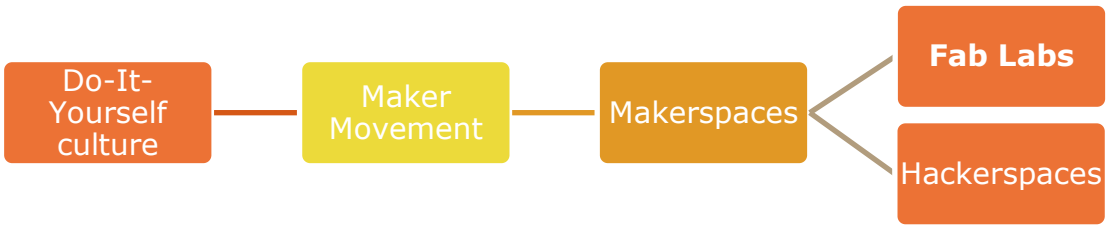

Figure 2 – The Maker Movement Pathway 2.

[1] Labs: not certified digital fabrication laboratories. Fab Labs: digital fabrication laboratories certified by IT.

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2.2 FAB LAB

2.2.1 What's a Fab Lab?

"FabLab" is an abbreviation for "**Fabrication Laboratory**" sometimes also identified with "**Fabulous Laboratory**". The concept emerged at the Massachusetts Institute of Technology's (MIT) Center of Bits and Atoms (BIT) through a research group led by a professor named Neil Gershenfeld, who created a discipline called "How to Make (Almost) Anything". The idea baseline of the concept consisted on the idea that individuals have the ability to do anything that is idealized. Thus, the aim was to provide the environment, skills, advanced materials and technology to make things cheaply and quickly anywhere in the world, and to make this available on a local basis to entrepreneurs, students, artists, inventors, children, community groups, researchers, small businesses and in fact, ordinary people who want to create something new or bespoke, that want to design just about anything. "This is otherwise known as personal fabrication" (Osunyomi *et all,* 2016).

WHAT IS A FAB LAB?

"A Fab Lab, or a digital fabrication laboratory, is a place to play, to create, to learn, to mentor, to invent: a place for learning and innovation. Fab Labs provide access to the environment, the skills, the materials and the advanced technology to allow anyone anywhere to make (almost) anything".

Source: Fab Foundation (https://fabfoundation.org/getting-started/).

Another key aspect of a Fab Lab is the collection of tools for design and modelling, prototyping and fabrication, and other electronic tools, with open source software and other dedicated programs that they offer in order to bring advanced manufacturing technologies to ordinary people, thus involving them in innovative experimental projects and peer-to-peer learning (Osunyomi *et all,* 2016). These laboratories also provide means to solve local problems creatively - providing stimulus for local entrepreneurship. Subsequently, Fab Lab creates an ecosystem for entrepreneurial empowerments which initiates unprecedented domestic opportunities. Moreover, Fab Lab is a user-centric initiative where sustainable or eco-friendly communities are developed (see figure 3).

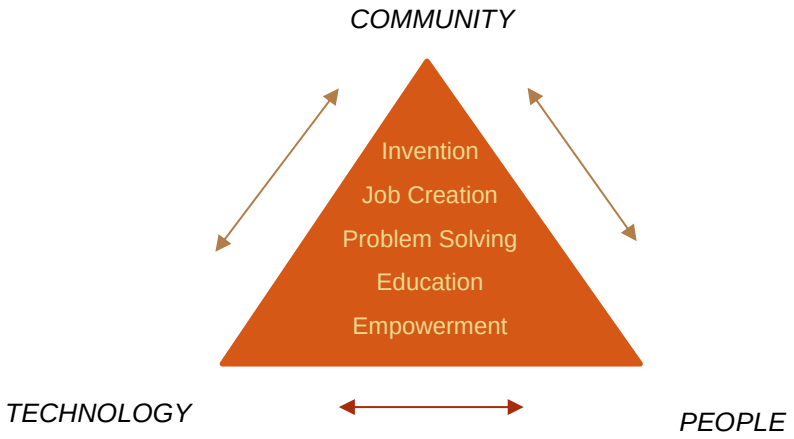

Figure 3: What a Fab Lab offers. Adapted from "Impact of the Fab Lab Ecosystem in the Sustainable Value Creation Process".

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2.2.2 Fab Lab Models

Fab Labs are the most structured types of makerspaces, having to follow specific procedures according to the Fab Foundation, including counting with a set of specific hardware and software required to qualify as Fab Lab. However, and even though considered to be a formalized model (to an extent) and to have as main focus the digital fabrication thematic, these spaces also are dynamic, promote interdisciplinary and focus on different subjects as means to develop digital fabrication competences. Thus, despite a common framework, Fab Labs can be categorized in different models which greatly depend on their offer, fields of activity, business model, main aims and objectives and their targets. Nevertheless, these categorization is not strict nor inflexible. “The breadth of the applications of a Fab Lab is wide and far reaching (...), different categorizations are not mutually exclusive and can be employed simultaneously, however rapidly changing market needs may stipulate that certain emphasis is place on a particular model to accelerate sustainable growth” (Fab Lab Foundation Ireland, 2017).

Due to its dynamism, there is not a consensus regarding types and modules of Fab Labs. Thus, different authors provide different categorizations for these makerspaces, which makes possible to analyse these laboratories in terms of motivations, aims and objectives, as well as regarding impact and their contributions for the communities, entrepreneurship, research & innovation, education, among other aspects.

Fab Lab Foundation Ireland (2017) divides Fab Labs in 4 different modules: enterprise development; educational resource; research & development and community development.

Enterprise Development

- Accessible digital fabrication and prototyping; supporting members, individuals and companies in the production process;
- Focus on developing innovation, helping users increase the effectiveness of their innovations through associated service support; hot desking, incubation space, research, marketing and networking;
- Create value for both the organisation and user. The stakeholders in this area are most likely to be individuals/entrepreneurs, Start-ups, micro business, SME, industrial enterprises and social enterprises;
- The individual or start-up will benefit from knowledge transfer, a community of makers and entrepreneurs and access to production facilities whist retaining control of product development.

Educational Resource

- Machines and skilled personnel are a resource for learning for children, young people and adults with resources being used for different types of workshops and hands on learning experiences directly applicable to the targeted learner;
- Stakeholders typically range from Schools, Colleges, FE, HE, adult & lifelong learning, community organisations and individuals.
- Educational activity may include themed workshops for schools in STEM/STEAM, developing educational resources and accreditations, supporting FE and HE specialised training (Robotics/Digital Craft/Product Design/3D Printing etc.), teacher training and networking and peer to peer learning experiences.

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Research & Development

- Applying design led solutions and digital fabrication technology as means of research and development on a wealth of areas. The breath and flexibility of the processes and technology contained in a lab means that Fab Labs have a unique offer when partnering with other institutions of research and development projects.

Community Development

- Innovative models of engaging communities including creating opportunities for peacebuilding, labour market integration, accelerating new start social enterprises and building collaborations between the social economy, the private sector and intermediaries in finance, mentoring support and skills.
- This has seen children, young people, students, adults and abilities discover ways to participate. A dual approach to building people's skills, understanding and knowledge sit alongside personal development, encouraging imagination and confidence.
- Fab Labs can be identified as a driver of genuine social innovation by offering a space for creative problem solving, replicating and scaling innovative practices and thinking through more ambitious approaches to social problems.

Nevertheless, it is also possible to consider other categorizations. Fab Labs can adopt, for example, the following models: ***Public***, ***Academic*** **and** ***Pro*****.** This categorization follows, in a general way, the 4 categories identified above.

- Being the ***Public*** open to all with the main purpose of giving access to the tools, the practices and the culture of digital manufacturing,
- the ***Academic*** linked to a university or school, developing essentially student projects and fomenting "learn-by-doing" and experimentation, and
- the ***Pro***, allowing the development of projects designed alongside companies, startups and entrepreneurs, thus generating some economic value.

Most of the Fab Labs adopt an approach where the three models combine in a way where the values could be disseminated and, at the same time, guaranteeing the sustainability of the Lab. Usually these combinations stand as **Mixed.**

2.2.3 Becoming a Fab Lab

According to the Fab foundation, in order to become a certified Fab Lab it is necessary to follow a set of key procedures.

Open Source Philosophy

First and foremost, public access to the Fab Lab is essential. Fab Labs need to follow the open source philosophy which means that when users can use free, public time in the Fab Lab and are strongly encouraged to make their designs available to other users so that all can learn from each other. A Fab Lab is about democratizing access to the tools for personal expression and invention. So a Fab Lab must be open to the public for free or in-kind service/barter at least part of the time each week, that's essential.

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Equipment

Fab Labs have to share a common set of tools and processes and usually include:

- **A laser cutter** that makes 2D and 3D structures;
- **A 3D printer**;
- **A high-resolution CNC milling machine** that makes circuit boards, precision parts and molds for casting.
- **A large wood router** for building furniture and housing;
- A **suite of electronic components and programming tools** for low-cost, high-speed microcontrollers and on-site rapid circuit prototyping.

A Fab Lab requires a core set of industrial-grade fabrication and electronics tools, wrapped in open source software to allow certain process to take place; equipment is designed to maximise the breadth of functionality, be robust and maintainable and offer leverage across processes to develop skills and opportunities. It is expected that the equipment needs will evolve over time. Below there is an example of essential equipment that a Fab Lab should count with.

Figure 4 – Fab Labs' Equipment

"The list of equipment available in the makerspaces reflects the interest of the various spaces, nevertheless, digital fabrication tools (namely 3D printers, laser cutters and CNC milling machines) have a dominant role: 558 makerspaces listed they have at least one 3D printer, 389 makerspaces at least one laser cutter, and 373 makerspaces at least one CNC milling machine. The availability of tools to produce electronic circuits was manifested in 403 makerspaces" (Rosa *et all*, 2017).

Physical Space

The concept of a Fab Lab is to house all the equipment in a single room to allow people using the machines to do so together, opening up potential collaboration and learning possibilities. Although MIT does not stipulate a required surface area or endorse a particular floor plan, Fab labs across the globe share similar spatial configurations. A typical physical space includes:

- surface area ranging from 100 to 200 square metres;

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- large central space, where less noisy, dangerous and/or messy machinery is located, in addition to computer terminals, workbenches, desks large enough to double as conference tables or carry several laptops, and a break area with coffee machine, snacks, refrigerator, couches, etc.
- Accommodate optional areas such as dedicated design and learning studio, dedicated electronics room, construction/mixed use/messy area, additional materials storage area, reception area and exhibition area. In this scenario it is likely a Fab Lab will increase its footprint significantly from the above approximation of 100 to 200 square metres

Although Fab Foundation doesn't stipulate a mandatory space structure for a Fab Lab, it does provide recommendations: see more at https://fabfoundation.org/

Fab Team

There are different types of staff, hired on different contracts, who can be used to run the lab. The key position to fill is the Fab Lab manager, and this isn't necessarily the person/people who have initially set up the lab.

- ***The Fab Manager:*** is the incredibly competent, multitasking 'handyman/woman' at a Fab lab. The manager greets and directs the public; manages, maintains and repairs the machines; and organises workshops and user support for software, hardware and Fab lab processes. Many of the people we spoke with explained the "on the ground" evolution of this position. The first Fab labs relied heavily on the skills of MIT student designers, engineers, etc., but with Fab labs cropping up around the world, the position has become more specialised, requiring managers to dramatically develop and enhance their significant arsenal of multi-tasking skills. Independent learning is compulsory: machine maintenance, repair, and process administration are achieved through painstaking trial and error (Eychenne, 2012).

In order to get further support, many labs also count with interns and volunteers**:**

- ***Intern:*** either working for free, or for a small salary, for a fixed period of time (between three months and a year). This is typically to enable them to train to use the equipment and to gain experience with applications of the technology. A standard arrangement is that the intern works one third of their time helping the Fab Lab users and organising the lab, one third learning the machines and one third working on their own projects.
- ***Volunteer:*** Many Fab Labs rely on unpaid volunteers to support them. In most cases, these volunteers perform routine tasks like cleaning equipment and do so to contribute to the community.
- Their contribution is ad hoc so while their combined contribution may be substantial, the Fab Lab cannot rely on this form of labour as it is not guaranteed. New Fab Labs are unlikely to have a large pool of volunteers helping them

If a Fab Lab seeks to be more professional and impactful then it might be necessary to think about staff to cover communications, administrative support community-building and business development.

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Fab Charter

In order to use the MIT "label" (i.e.: use the logo for fundraising, promoting and advertising lab activities) and become a fully-fledged member of the worldwide Fab lab community, essentially a lab must be equipped as described previously, and adhere to the charter here: http://fab.cba.mit.edu/about/charter/.

Fab Lab Network

Fab Labs must participate in the larger, global Fab Lab Network, that is, you can't isolate yourself. This is about being part of a global, knowledge sharing community. The public videoconference is one way to connect. Attending the annual Fab Lab meeting is another. Collaborating and partnering with other labs in the network on workshops, challenges or projects is another way. Participating in Fab Academy is yet another way. Any Fab Lab is connected to a global community of learners, educators, technologists, researchers, makers and innovators - a knowledge sharing network. Because all Fab Labs use the same tools and processes, a global network is naturally being created, a distributed laboratory for research and invention. This network, according to the website *fablabs.io*, to this today, has 1736 active labs spread across the world.

WHAT IS THE FAB LAB NETWORK?

The Fab Lab Network is an open creative community of fabricators, artists, scientists, engineers, educators, students, amateurs, and professionals located in more than 100 countries and 1750 Fab Labs across the globe. From community-based labs to advanced research centres, Fab Labs share the goal of democratizing access to the tools for technical invention. This community is simultaneously a manufacturing network, a distributed technical education campus and a distributed research laboratory working to digitize fabrication, inventing the next generation of manufacturing and personal fabrication.

Source: Fab Foundation (https://fabfoundation.org/getting-started/).

There are over 800 Fab Labs worldwide with the greatest concentration in North America and Europe and with an estimation that they are growing globally at 10% per year. According to Rosa *et all* (2017), Fab Labs account nearly for half of the makerspaces in the EU28 (48%; 397 makerspaces).

Fab Academy

The Fab Academy is a series of online distributed learning modules (complemented with hands-on training at a Fab lab) support for advanced technical education and to provide a training path for new fab lab managers, Fab Academy has emerged from the Fab Lab program. It provides instruction and supervises investigation of mechanisms, applications, and implications of digital fabrication. The Fab Academy is a fast paced, hands-on learning experience where students learn rapid prototyping by planning and executing a new project each week, resulting in a personal portfolio of technical accomplishments. It offers a distributed rather than distance educational model, students learn in local workgroups, with peers, mentors, and machines, which are then connected globally by content

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sharing and video for interactive classes. The Fab Academy Diploma consists of a 5 month part-time student commitment, from January to June. The Fab Diploma is the result of the sum of Fab Academy Certificates. Progress towards the diploma is evaluated by a student's acquired skills rather than time or credits. For more details go to: http://fabacademy.org/

For more details on Fab Foundation advice on how to start a Fab Lab go to https://fabfoundation.org/getting-started/. Here you will find detailed recommendations regarding the following topics: The Fab Charter; Setting Up a Fab Lab; Key Strategies when Setting Up a Fab Lab; Fab Lab Form; Chicago Layout; Ideal Lab Layout; The Hardware; The Software…

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3 Make Your Way Good Practices

3.1 Make Your Way Methodology

Good Practice Concept

A good practice is a practice that has been proven to work well and produce good results, and is therefore recommended as a model. It is a successful experience, which has been tested and validated, in the broad sense, which has been repeated and deserves to be shared so that a greater number of people can follow it and eventually adopt it. It can also be considered as a real world example of where a method or technique has been applied that has consistently shown results superior to those achieved by other means. (Obsburn *et all*, 2011). Good practice criteria usually helps determine whether a practice is a “good practice”. Depending on the scope, there is a wide set of different criteria that can be considered.

As what regards the Make Your Way good practices a set of criteria was initially defined (see annex 1). The different aspects considered in the criteria allow to understand if the good practice is technically feasible**,** effective and successful. That is to say, if it is easy to learn and implement; if it has proven its strategic relevance as the most effective way of achieving a specific objective; and if it has been successfully adopted and has had a positive impact on individuals and/or communities. Additionally, the criteria selected allow to evaluate if the practice is inherently participatory. Participatory approaches are essential as they support a joint sense of ownership of decisions and actions. Finally, the Make Your Way good practices’ criteria include environmentally, economically and socially sustainable aspects and further include aspects that allow to understand if the selected case has potential for replication and should therefore be adaptable to similar objectives in varying situations.

The Methodology

MAKE YOUR WAY good practices analysis and selection was undertaken in two main stages:

- **Phase 1: Research and Selection**
- **Phase 2: Analysis**.

Phase 1 consisted in a preliminary broad research of Fab Labs and Labs good practices examples within the European Union. For such purpose, INOVA+ initially established the criteria to be used by the partnership during such research. Each partner covered at least 4 or 5 EU countries in its research and had to select at least 1 good practice example per country assigned. From this preliminary research resulted an extensive list of 40 good practices FAB LABs or LABs. The final list it is broader and allowed for changing options in case labs didn’t show interest in the project or simple didn’t answer. The rationale behind this first selection is implicit in the defined criteria (annex 1). It is, however, important to highlight 2 main aspects of the criteria. The first is that priority was given to the analysis of Fab Labs or Labs that are within the partnership. Thus, Make Your Way partners which have such laboratories associated to their activity were invited to present them as good practices. The second is the focus not only on MIT certified Fab Labs, but more importantly on non-certified Labs as a way to portray dynamism and different realities of these digital fabrication spaces.

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Following phase 1 results, INOVA+ did a preliminary analysis of all 40 good examples collected, gathering first results and withdrawing the first conclusions, which mainly addressed Fab Labs typologies. Afterwards, the criteria was updated based on preliminary analysis. The criteria updates are highlighted in blue in annex 1. Afterwards, the partnership proceeded to a voting from which 14 cases were shortlisted as MAKE YOUR WAY Good practices for further analysis and interviewing. The Labs and Fab Lab below were selected (the last column indicates the partner assigned partner for its description).

Nº	Labs/Fab Labs	Country	Assigned Partner
1	Happylab	Austria	KARVINA + RPIC
2	FabLab Berlin	Germany	KARVINA + RPIC
3	Fab Lab Limerick	Ireland	INCUBO
4	WeCreate Workspace	Ireland	INOVA+
5	FabLab Wbijaj!	Poland	INnCREASE
6	IKASLAB	Spain	Tkinka
7	FAB LAB Bilbao	Spain	Tkinka
8	City Lab	Belgium	INOVA+
9	Fablab Amsterdam	Netherlands	INOVA+
10	FryskLab	Netherlands	INnCREASE
11	Fab Lab Raseko	Finland	INCUBO
12	Fab Lab Alto Minho	Portugal	INOVA+
13	FAJNA DILNA	CZ	KARVINA + RPIC
14	IdeaHub	CZ	KARVINA + RPIC

Table 1- Good Practices Voting Results

As a mitigation measure, it was established that in case of any of the selected Fab Labs/ Labs did not answered to our cooperation requests and/or did not wish to cooperate with MAKE YOUR WAY project to be portrayed as one of its good practices, the next Fab Lab/Lab on the most voted list would be selected as substitute.

During the approach to the Fab Labs, partners soon registered difficulties in contacting or gathering feedback from certain Fab Labs, which resulted in the substitution by alternative ones. As it can be seen on table 2 (in red are the Fab Labs rejected and green the final ones).

Nº	Labs/Fab Labs	Country	Assigned Partner
1	Happylab	Austria	KARVINA + RPIC
2	FabLab Berlin	Germany	KARVINA + RPIC
3	Fab Lab Limerick	Ireland	INCUBO
4	WeCreate Workspace	Ireland	INOVA+
5	FabLab Wbijaj!	Poland	INnCREASE
6	IKASLAB	Spain	Tkinka
7	FAB LAB Bilbao	Spain	Tkinka
8	City Lab	Belgium	INOVA

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9	Fablab Amsterdam	Netherlands	INOVA
10	FryskLab	Netherlands	INnCREASE
11	Fab Lab Raseko	Finland	INCUBO
12	Fab Lab Alto Minho	Portugal	INOVA+
13	FAJNA DILNA	CZ	KARVINA + RPIC
14	IdeaHub	CZ	KARVINA + RPIC
15	Hirikilabs	Spain	Tknika
16	FabLab Orange	Poland	INnCREASE
17	VivaLab	Portugal	INOVA
18	OpenLab Hamburg	Germany	INnCREASE
19	Making Rooms	UK	INOVA+
20	Makervirsity London	UK	INOVA+
21	Fab Lab Brno	CZ	KARVINA + RPIC

Table 2 - Good Practices Final Voting Results

Phase 2 consisted in the development of the 13 Make Your Way good practices description through a closer contact, namely by interviewing and in some cases by visiting the Labs and Fab Labs selected. INOVA+ developed a detailed table for good practices collection (annex 3) which consisted in an extension of the first table used for desk research. This detailed template included the following extra aspects: Years running; Community links (how does the Lab impacts the community/how does the lab interact with its community; social concerns (yes or no); local business support; education cantered: university students; VET students; high school students….); Strengths and weakness; Which aspects can be used as benchmark and why do they work?; Personal Testimonial / FAB LAB future sustainability.

Together with the good practice description template, INOVA+ developed a good practices interview guide (annex 2) which was created in a way to allow partners to easily fill in the template for each Fab Lab that was assigned to them.

With both documents, partners proceeded to interview (and eventually visit) the selected good practices. Table 3 consists in the final selection of the good practices Labs and Fab Labs and the assigned partners responsible for describing each case.

Nº	Labs/Fab Labs	Country	Assigned Partner
1	FabLab Wbijaj!	Poland	INnCREASE
2	IKASLAB	Spain	Tkinka
3	Fab Lab Raseko	Finland	INCUBO
4	Fab Lab Alto Minho	Portugal	INOVA+
5	FAJNA DILNA	CZ	KARVINA + RPIC
6	IdeaHub	CZ	KARVINA + RPIC
7	Hirikilabs	Spain	Tknika
8	FabLab Orange	Poland	INnCREASE
9	VivaLab	Portugal	INOVA+
10	OpenLab Hamburg	Germany	INnCREASE

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11	Making Rooms	UK	INOVA+
12	Makervirsity	UK	INOVA+
13	Fab Lab Brno	CZ	KARVINA + RPIC

Table 3 – Make Your Way Good Practices

As a final step, INOVA+ collected all interviews and inputs provided by partners, and proceeded to compare, analyse and identify success and negative aspects of such good practices. The results are discussed in chapter 4.

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3.2 MAKE YOUR WAY Good Practices

3.2.1 Fab Lab Orange

FabLab powered by Orange	POLAND	GOOD PRACTICE

Fab Lab powered by Orange was set up in **2017** and it is recognised by MIT Fab Lab Foundation. Fundacja Orange decided to create a venue in Warsaw which could serve as a creative space for everyone interested in DIY activities and hands-on experience. Fab Lab powered by Orange operates as a not-for-profit entity. It is available for anyone, irrespective of their skills and experience. In Fab Lab there are various initiatives ongoing i.e. Maker Woman is one of its flagship projects - it aims at preventing social and technological exclusion of females through informal education in the field of new technologies and crafts. Within the framework of this project, four training cycles have been completed and a new one is in the pipeline. The offer also contains open workshops for children, adults, families and trainings for high school students.

- **Website:** fablabtwarda.pl
- **Promoter/Funding Body:** Fundacja Orange – Founder.
- **Partner:** Robisz.to Association.
- **Years:** 2 years.
- **Funding scheme:** Free with paid workshops are organised by the Fab Lab partner (Robisz.To)

Targets	Thematic
• **General Public** (depending on projects, emphasis is put on specific groups - youth or women but the general idea is to keep the Fab Lab open for everyone).	• DIY, digital skills.

Community Links

Fab Lab powered by Orange interacts with its community via specific projects, such as Startup Jump! (for youth) or Maker Woman (women). Within the framework of Jump Start, it works closely with the City of Warsaw. Overall, the Fab Lab powered by Orange provides VET and university/high school students with an opportunity to use its workshops and equipment.

Strengths	Weakness
• Friendly environment (open for both DIY geeks and amateurs); • Open to everyone, irrespective of their skills; • Networking opportunities; • Filling in the gap in the education system (schools are not equipped with workshops); • Response to growing consumerism (‘fix it instead of buying a new one’ approach); • Responding to the demands of labour market;	• Still unsatisfactory level of awareness in society about the offer of the Fab Lab.

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- High visibility.

Types of Machinery/Equipment

- 3D printers, laser plotter, electronic workshop, carpentry workshop, sewing workshop.

FAB LAB Future and Sustainability

- The fablab defines its strategy on an annual basis. Based on evaluation of the previous projects, it modifies and approves its strategy for the upcoming year.

3.2.2 VIVA FAB LAB

VIVA FAB LAB	PORTO	GOOD PRACTICE ANALYSIS

VIVA FAB LAB is a hub to p**romote a culture of Education, Innovation and Design** based on the Maker and Fab Lab Movement founded in September of **2018**. Here we combine our pedagogical experience, with the technological tools of the 21st century and to the Maker culture. On this creative space of excellence, we can surprise ourselves, collaborate with improbable partners, take risks and experiment new things. This environment of freedom helps us to change ways of thinking, visualize ideas and put them into practice. Giving access to a space of innovation, education, research, medium productions, equipped with digital fabrication tools and different technologies to the local community. VIVA LAB is officially recognized by MIT Fab Lab Foundation and is located at the Boavista area, one of the main economic and cultural centres of the city of Porto with connection to several high-tech companies, universities, research and qualification **centres**.

- **Website**: www.vivalabporto.com
- **Promoter**: As of this day we don't have any kind of support, but we are seeking mainly financial support. We do collaborate with different international networks and projects as a way to promote our Fab Lab. Projects such as Distributed Design Market Platform (DDMP); Fab Lab Network; WikiFactory; Makeathon Portugal (We Co-Organized & was funded by Fundação Calouste Gulbenkian); Scale Up Porto; Porto Innovation Hub; Câmara Municipal Do Porto Some of Our Partners include: Fab Foundation; Fab Lab Barcelona; Vulca; ESN; Passa Ao Futuro; SYSTEM2020; WikiFactory; Precious Plastic International; FBAUP; LIPOR
- **Years**: 1
- **Funding scheme:** We host several **Open Days** throughout the year so people can learn and have contact with the potential of digital fabrication. We have **a membership Program** called "Maker Crew" with different levels for different kinds of users. We charge a **fee** for the different machines to the general public and to projects we develop with clients.

Targets	Thematic
• **Education** – VET Students, Higher Education Students, Teachers, Universities, Schools, general public (workshops and Courses);	• **Education:** Maker & Digital Fabrication Training programs; Workshops; Lectures;

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• **Design** – Freelancers, Small Businesses, Industry, Start Ups, Designers, Municipalities, Events etc.	• **Investigation & Innovation:** In the areas of Hardware and Software; Small local pilots and prototypes; • **Products & Services (Design):** Prototyping for companies, freelancers and students; Product & Industrial Design; Consultancy; Immersive activities; Lectures and events.

Community Links

This urban hub seeks to support entrepreneurs and communities, creating clusters of innovation and looking for local and international talents. Serving as a model for the development of solutions to local problems which can be scaled, replicated and exported globally. We look to create impact through Design and the products we develop to show a new business model in terms of Product&Hardware businesses and the innovation a Fab Lab can bring to small startups and freelancers. One of the main project we work with in Precious Plastic International, a set of open source recycling machines that facilitates anyone around the world to set up and develop products using waste plastic through recycling. We are working with several schools through consultancy to help establish Makerspaces within the schools, setting up educational programs that take advantage of such a space to improve educational systems. We work closely with schools to give training to teachers as we believe it is an important first step to show the impact the Maker Movement and Fab Labs can have with in the educational system. An extensive program was created of workshops and training to students throughout the year. Next year we will launch an extensive course with the Education University to start educating the future teachers of the potential of Digital Fabrication, Maker Movement and how to create STEAM programs in education. We Believe this community can become a manufacturing network, a distributed technical education campus, and a distributed research laboratory working to digitize fabrication, inventing the next generation of manufacturing and personal fabrication.

Strengths	Weakness
• Working closely with the Community (A Fab Lab is more than a set of machines, A Fab Lab is its Community); • Diversity of initiatives that it promotes; • High number of running projects; • Sustainability plan in short- and long-term Years of Experience working in Fab Labs and Pedagogical programs based in the Maker Movement; • Experience in Product & Equipment Development and Product/Industrial Design International collaboration in Projects and Networks; • Supporting Open Source Projects o Impact in the city and local community (Socially, Economically and Innovation);	• Lack of Financial Support; • Communication and Marketing (Visibility); • Shortage of Staff; • Shortage of Space to expand, as it isn't keeping up with our rapid growth and bigger local rental space rates are too expensive; • Machinery size isn't keeping up with the rapid growth of projects; • Cost of Acquiring new machine sets;

Types of machinery/equipment

- CNC Machine, Laser Cutter 3D printers, Electronics Bench and Machines, Hand Tools, and we built the Precious Plastic Machines.

FAB LAB future and Sustainability

STRATEGIES

- We have clear, both **short term and long-term strategies** we structured for our Fab Lab. We understood from our joint experience of working or setting up international Fab Labs the importance of creating such strategies in an early phase to create a solid foundation so in a long term a Fab Lab becomes sustainable.
- We want VIVALab to have both a social and economic impact in the city but to turn it into a reality we must make it sustainable so we can support those social projects. We defined objectives in Education and Design and we are

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working towards those objectives showing the impact a Fab Lab and the Maker Movement can have by supporting the community and support innovation in the city.

SUSTAINABILITY AND SOCIETIES' IMPACT

- We have seen the tremendous impact such spaces have with in their cities, at a local and global level as they empowered communities to have a voice and create solutions to local problems that can be scaled at a global scale. Such initiative can have an even greater impact in several sectors such as, economical, agriculture, health, energy etc. But for such increased level of impact to become a reality the labs must have: 1 – A better and formalized structure; 2- Develop a sustainable business model adapted to their reality and the community in its city; 3- A communications platform that can shorten the leap between labs to collaborate and interchange ideas & projects. We believe such a platform can become the Wikifactory as its initial years show a great future to shorten such a gap. 4 – A Marketing plan that can communicate clearly to the community; "What is a Fab Lab?", "What Is the impact of a Lab in the Community?", "How can they use the Lab?" etc. 5 – Local Funding Channels to support local labs.
- This new generation of Fab Labs that are being founded, have years of learning and paving made by all the Fab Labs that were founded throughout the past 11 years, making it easier for new Labs to learn from their mistakes and create new business models that will turn them into sustainable Labs.

3.2.3 IKASLAB

IKASLAB	SPAIN	GOOD PRACTICE ANALYSIS

The Basque System of Vocational Education and Training created a net of **3D Printing Laboratories to introduce the additive Manufacturing Technology in Education.** Nowadays it counts with 16 laboratories in 16 centers and more equipment in some departments (mechanical design, electronics, jewelry, ect, one of them being IKASLAB.

- **Website**: http://www.ikaslab.org & http://wiki.ikaslab.org/index.php/Main_Page
- **Promoter:** Our system is totally public funding by the Basque System of Vocational Education and Training. We also collaborate with Strategies in developing knowledge and applications.
- **Funding scheme**: We normally request to users to have a basic training to use equipment properly and safely, at the moment only teachers and students of each center.
- **Years**: 2013

Targets	Thematic
• Mainly VET teachers and students, but also SME-s, lifelong learning, training for unemployed people.	• Mainly Education. We develop applications in all areas of education.

Community Links

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We develop **projects with students with social impact, of social interest** (Enabling the future Project, design and development of adapted prosthetics-orthotics, etc.). We help SME-s in testing the technology and making use of it (prototypes or training, among others). **Our system is centered in VET students**. We do different kinds of trainings and workshops around Additive Manufacturing: explaining the Project and technology to visits, day workshops to deepen in AM technology and applications, commercial events with technology providers, 25-30 hours trainings for management of desktop 3d printers, 30 summer courses with overall training of metal AM technologies, Tailored courses around AM technologies, international trainings, etc. We share our training materials in our system. We developed contents in the EU funded METALS Project, which is available online. The AM technologies appeared disruptively, we have a long-term strategy to introduce this technology in education. We expect that our students know and apply their knowledge in AM in their future working experience. We have all kind of brands of desktop printers, SLA Form labs, Sinter-it powder 3d printer, and industrial Strategies technology, Polyjet and FDM.

Strengths	Weakness
• High numbers of targets achieved/Lab users • Diversity of initiatives that it promotes	• Lack of MIT recognition

Types of machinery/equipment
-

FAB LAB Future and Sustainability
The Fab Labs will help and allow to create and materialize ideas to people. They help to build your own parts and devices, locally.

3.2.4 HIRIKILABS

HIRIKILABS	SPAIN	GOOD PRACTICE ANALYSIS

Hirikilabs is a project by the **International Contemporary Culture Centre Tabakalera** created in **2014** in collaboration with Donostia / San Sebastián European Capital of Culture 2016. This is a citizens' laboratory working in the field of **digital culture**. It fosters the **social, critical and collaborative use of technology**, providing resources for technological literacy, a meeting place for the tech community, know-how and activities for the public in general.

We work to promote open knowledge and share the code of everything we do. We like to think that the democratization of technology does not separate us from life, but connects us with the world and enriches our actions to transform the reality in which we live. We connect with the "do-it-yourself" and "do it with others" philosophy, with the idea that within each person there is a hacker or a maker, a project waiting to be developed if the conditions are right or if there is a connection with the appropriate people. Speaking in few words is a public laboratory, and we do have machines like in the Fab Lab. We usually offer training courses in open & digital fabrication technologies, but also in other kind of technologies or its applied forms. Our spirit is to spread knowledge in an open way and we are pleased to receive citizens' projects and artist or organizations projects too, as we are part of a culture centre, so we are not a (professional) prototyping service or a certified Fab Lab where users can rent spaces or machines.

- **Website**: http://hirikilabs.tabakalera.eu/
- **Promoter**: The lab is part of **ICCC Tabakalera** and is funded by three **public institutions**, the municipality (Ayuntamiento de donostia/San Sebastián), Diputación Foral de Gipuzkoa and basque government (Gobierno Vasco). The whole budget comes directly from Tabakalera.

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- **Funding scheme**: The laboratory is for **public use and free**, the only necessary condition is to understand its framework of action, which includes collaborative creation and open knowledge. In practice, this means that the use of space and machines can be used to carry out prototypes or research processes, but not to carry out elements for private use or strictly commercial purpose.
- **Years**: 3

Targets	Thematic
• **Citizens**: there is a wide program of activities aimed at people interested in taking the first steps in the use of technologies. Also children, youngsters and families have specific programs to learn or experiment and different spaces and moments to make projects in community; • **Makers**; • **Creators or artists:** the presence of the lab in a culture center that receives residencies from artists creates an experimental work space in which artists can use the lab tools, create groups or communities with other people, and so on. The laboratory itself also offers events or projects linked to creative or artistic practice, which involve technologies in some way; • **Specialized communities**: either because of the subject matter (data, education, design etc.) or because of projects promoted by social or specific organizations/groups.	The laboratory works on **five main thematic lines**: • Open design and digital manufacturing; • Education and technologies; • Citizen Science (which includes citizen astronomy); • Data Culture (data visualization, analysis, citizen participation and open data); • Creation, understood as a field of experimentation of disciplines and new technologies.

Community Links

One of the main objectives of the laboratory is to create an informal and collaborative learning framework where the user or citizen has the responsibility and the tools to develop their own capacities. The laboratory promotes the philosophy of "do it yourself" and "do it with others" by creating a program of activities that serves as an introduction to certain knowledge, to later create spaces where projects or working groups can be developed on specific topics. To this end, they have several calls for projects and groups to join.

- The way of learning and the themes proposed in the laboratory try to promote a sustainable conscience with the environment and socially responsible with its surroundings, that is to say, themes and problems present in the society and in the near environment of the laboratory are attended to, to facilitate that the people or entities working on these problems can make use of the laboratory. The Tabakalera project has a mediation and education department that responds to the needs of its environment and does so critically from the point of view of art and culture, which is why the laboratory also joins this philosophy. The integration of migrants, the gender perspective or environmental awareness are inherent ways of responding to these challenges of our environment.
- In principle the laboratory does not respond directly to the needs of businesses or small local companies, because its framework of action is not to focus on the economic or technological impulse, there are other entities that do more and better in our environment. In any case we do not close ourselves to the projects that are created in the laboratory can create an economic or commercial result and if it happens is to support.
- The laboratory contributes to the reflection that the educational community is carrying out on the introduction of technologies in education and in the classroom through the creation of a working group called "From the classroom to the laboratory" and composed of secondary and vocational teachers. Within this framework, a white book of good practices for the introduction of technology in the classroom was published in 2017 under the same name “From the classroom to the laboratory”, and an annual national meeting is held to share reflections and practices.
- In addition to this, education in all phases, from 0 to 6 years (we have a breeding community called 0-6 gunea), childhood and adolescence, are also part of the programs of the laboratory, always as an alternative space that does not come to replace the training of formal education. It is not so much a question of adding technical skills in this phase,

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as of showing the path of possibilities that open up for the youngest in the practice of self-learning and collaborative work or project development.

- In general, the learning offered in the laboratory serves as an initiation into the use of technologies (especially digital manufacturing and open source) and the application of these technologies for the development of other types of results or projects. They are learnings that serve as an introduction, to then create a framework for application and use of technologies in the laboratory itself where users already have the power and responsibility to develop their own process and path.

Strengths	Weakness
• The community (and the lab users in consequence), diverse and active, the fact of being a public resource and the variety of program lines that serve fields such as education, citizenship, technicians and artists at the same time. • Another great value is the creativity that emerges in this kind of communities and which is possible to apply in other spheres in our lives (work, education, activism)	• Lack of resources for a better documentation, one of the main objectives of an initiative such as ours should be to create replicable knowledge and bring it to a global community. It is a hard and difficult job for which we currently do not have the necessary resources and tools, so much of the work done in the laboratory disappears when users leave or projects are finished. • The visibility is another great problem too, it is not easy to convince some people and institutions of the value of processes, rather than objects or results. Nor is it easy to make visible the importance of a critical and technologically responsible society that does not operate solely as a consumer.

Types of Machinery/Equipment

3D Printers

- Ultimaker 3
- Ultimaker 2+
- Irune 3D: Self designed triple extruder Delta

Laser cutter: CO2 laser cutter Perez Camps PC 13-90 II. 130 Watt CO2 laser, 1300 x 900 mm working area, Supported filetypes: DXF and AI for cutting and bitmap (jpg) for engraving. It can cut materials like paper, cardboard, wood, fabric, leather or acrylic, among others.

Vinyl Cutter: Roland CAMM-1 GS-24, material width from 50 to 700mm and 25m length.

CNC Milling machines: Iventables Carvey **-** 3 axis CNC desktop milling machine. 290x200x70mm working area; Perez camps TecCam 1000 - 3 axis large-format CNC. 3000x2000mm working area and 180mm Z axis height, 6kw and 18.000rpm brushless motor and vacuum table.

Large format printer: Epson Stylus pro 9890 large format printer, up to B0 size paper rolls, up to 2.880 x 1.440 ppp resolution

Fabrication, soldering and woodworking tools

- Cutting table
- Metal horizontal saw
- Miter saw
- Sander (disc and band)
- Semiautomatic soldering machine

Workshop tools: Standard hand tools for woodworking, painting, Drills, sanders, electric saws, heat guns, dremel, router, electric screwdrivers, paint spray guns, etc.

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Electronics equipment

- Rigol DS1054Z DSO Oscilloscope. 4 channels, 50Mhz, 1Ms/s, TFT 7".
- Multimeters
- Irons and soldering stations
- CNC PCB Fabrication
- Electronic prototyping: Arduino, Raspberry Pi, Photon, modules, components and kits...

Textiles

- Sewing and embroidering machine Bernette Chicago 7: 800 stitches per minute, 200 stitch patterns, 110x170mm embroidery area: http://www.mybernette.com/en-US/Chicago/Bernette-Chicago-7.html
- Heat transfer press for textile vinyls
- Sewing supplies.

FAB LAB Future and Sustainability

It seems logical to think that there is a space in the societies of the future for something similar to fablabs or laboratories, although it is true that the stories that have been created about certain technologies and their probable real impact do not exactly contribute to that space being free from not fulfilling expectations. I certainly do not believe that 3D printing is going to revolutionize the lives of ordinary citizens, as probably no other low-cost technology is going to, so perhaps it is better to be prepared to understand the technologies that come to us and to be able to make the best use of them, to defend a space for citizens to also use and understand them, as prosumers perhaps.

It seems interesting that citizens can count on their own advanced tools for the development of their hobbies, capacities, needs and projects. It also seems important that, in this ecosystem, spaces for private use, spaces for commercial prototyping and initiatives of a necessarily public nature can co-exist and can offer and contribute to the training of citizens. The great challenge of this is sustainability, since as we said, the story of a commercially viable maker universe that is creating the technology of the future seems more a way of obtaining funds in the present than a possibility of creating a real industry (beyond what has been up to now the hobbyism and the Make.com environment, which has also been shown to be unprofitable). Therefore, we consider that it is important to shape a new universe in which the physical, as the digital have a space for the exchange of practices, solutions and who knows, if an economy of proximity and small scale that can be sustainable. In any case, as with libraries, a public model may make a definite contribution to creating that universe.

3.2.5 FabLabs "Rodzinna Warszawa"

FABLABS "RODZINNA WARSZAWA"	POLAND	GOOD PRACTICE

Wbijaj!, Kamera Akcja! and Pobite Gary! are 3 Fab Labs belonging to the Family Support Centre "Rodzinna Warszawa". They are unconventional places, where all Warsaw residents can meet, talk to each other, transfer their skills and exchange experiences. The Fab Labs are not about learning in the pure sense of the word, but about improving through fun, supporting and developing potential, being together and drawing from life what is best, what gives joy and pleasure. Experienced professionals are always available for good advice, help and valuable tips. They are also happy to learn something new from the passionate Fab Labs visitors, as it is well known that people learn all their lives.

- **Website**: https://centrumwspieraniarodzin.pl/ and http://www.fablabwbijaj.pl/fablab
- **Promoter**: Centrum Wspierania Rodzin
- **Funding Scheme**: free use
- **Years**: 4

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Targets	Thematic
Fab Labs are intended for all residents of Warsaw: • organized groups such as **nursing and educational institutions,** • **MOS (Youth Sociotherapy Centre),** • **MOW (Youth Educational Centres),** • **schools,** • **seniors and** • **individuals** who would like to learn to DIY under the guidance of instructors.	• **FabLab Wbijaj!** is a friendly place where all Warsaw residents, regardless of age, are introduced to the world of woodwork, furniture renovation and recycling. During the workshops, small and large DIY enthusiasts have the opportunity to meet, talk and exchange experiences. Tools, materials and practical tips are provided by FabLab Wbijaj! • **FabLab Kamera Akcja!** is an open project addressed to the residents of Warsaw, especially children, youth and young adults. It has a space and equipment to create journalistic materials, entertainment programmes, stop-motion animations, music videos and simple film forms. • **FabLab Pobite Gary!** is a fixed point on the map of Warsaw, where musicians of all ages can come to develop their musical passions. The main goal of Pobite Gary! is to create conditions for musical activities

Community Links

The Family Support Center is an organizational unit of the Capital City of Warsaw, performing public aid tasks, defined in law as the commune's own tasks and the poviat's own tasks. Activities are carried out for the activation and integration of local communities, as well as for the development and promotion of volunteering. "Rodzinna Warszawa" cooperates with many cultural and art institutions, schools, non-governmental organizations and other aid agencies.

Strengths	Weakness
• Strengths of Fab Lab Wbijaj are: its general accessibility for all Warsaw residents, lack of financial barriers and convenient location in the city centre.	• Fab Lab Wbijaj! - is constantly growing but has insufficient workshop and warehouse space. Therefore, it does not always meet the growing demand and interest. • Fab Lab Camera Action! Too small number of computers. • Fab Lab Beaten Gary! - the workshop space and music equipment are limited.

Types of machinery/equipment

- FabLab Wbijaj!: a range of power tools that can be used by visitors. The joinery is equipped with: spindle milling machine, format saw, band saw, CNC milling machine, band grinder, etc. The newest purchase is a laser plotter, which enables precise cutting, engraving and making the same elements in large quantities.
- FabLab Kamera Akcja! consists of a live room and a production room. It is equipped with three Blackmagic studio cameras, a dedicated image mixer with preview and sound system, a full set of lights in the lamp suspension system, a green screen stand, as well as photographic facilities, which include Canon cameras with lenses. It is equipped with a computer with Adobe package.
- FabLab Pobite Gary! provides residents with a rehearsal room with instruments and a recording studio. The recording studio provides education and activities in the field of: creating and recording own music and dubbing; soundtrack for movies and performances; music arrangements for amateur songs; ways to create, improve, direct and compose music; learning programs and applications for creating music and sound processing.

FAB LAB Future and Sustainability

Fab Labs are becoming more and more popular, both among children and adults. People often come back with new ideas and friends to whom they recommended the place. Our observations show that such initiatives are necessary and there is

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a growing demand for them. There are no places in the city where it is possible to do a given thing without any fees under the supervision of experienced people.

3.2.6 Fajna Dilna

FAJNA DILNA	CZECH REPUBLIC	GOOD PRACTICE

FAJNA DILNA is the **first public workshop and craft incubator in Ostrava.** The mission is to promote craft industry and support new entrepreneurs.

- **Website**: fajnadilna.cz
- **Promoter**: Run by association: Řemeslný inkubátor Ostrava. Founders: Ostrava City and VSB – Technical University of Ostrava
- **Funding scheme**: The basic scheme is signed contract according to our tariff. Tariffs include number of hours for free. Extra time above the limit is charged 65CZK per hour.
- **Years**: 2 (August 2017 first three workshops open)

Targets	Thematic
• Everyone who wants to create something with their own hands.	• We do not have any specific theme, we are here for DIY people and all their projects and needs

Community Links

We cooperate with local community and our users directly in our workshops, we introduce them to the equipment, help, and also try to find materials or machines they need for their particular project. For the wider public, the Facebook proved to be the most useful communication tool – we publish the schedule of our public workshops and pictures of our activities.

Strengths	Weakness
• Support from the municipality – city of Ostrava • Professionally equipped workshops – from the opening day • Large community of users with signed contract • Our own ideas for creative workshops and ability to organise them	• Not enough full-time job employees – causing time pressure or postponing activities or projects in demand

Types of machinery/equipment

Metalworking, woodworking and ceramics and sewing machines. The most frequently used machines are in carpenter's workshop, which is professionally equipped. We also have CNC router for wooden plank 120cm x 240cm

FAB LAB future and Sustainability

Public workshops and fablabs are very much in demand. Our users are either general public, wiling to build something with their own hands or start-up entrepreneurs, who do not need to buy expensive machines in the beginning when they are developing their product. But this may not be enough to make the project sustainable. So, it must either be supported by a donator (ideally city or the regional government) or run its own business.

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3.2.7 IdeaHUB

IDEAHUB	CZECH REPUBLIC	GOOD PRACTICE

IdeaHub is a **shared development centre based in the area of Moravian-Silesian Innovation Centre (MSIC),** next to the campus of VSB – Technical University of Ostrava. IdeaHub develops and produces project in the field of **mechanics and mechatronics**. We provide prototype laboratories and workshops for commercial projects, our own activities or thesis. We have the technologies, and team of technical and design experts.

- **Website**: ideahub.cz
- **Promoter**: Founder: IdeaHUB association; Supporters: MSIC (subsidized rent), Moravian-Silesian Region (subsidy in particular projects); Partner organizations: donations of software, equipment, mentoring etc.
- **Funding scheme**: Single person 1000CZK/year (500 CZK/year for students) Company – 10.000CZK/year
- **Years**: 2 (open September 2017)

Targets	Thematic
• **Students** – working on development projects for thesis or internship. • **Small and medium companies** – we can serve as development centre, create a prototype and test the functionality.	• **Technical development projects** – mechanics, mechatronics and low-cost automation.

Community Links

We cooperate with MSIC, which uses us as technology centre and we participate in their technology programmes.

Strengths	Weakness
• Top quality technological background • Team of technologically skilful professionals • Strategic position	• Marketing • Sales

Types of machinery/equipment

Laser printing and engraving, robotics and robotic welding, 3D printing, NI – LabView, CNC machining, professional construction CAD software

FAB LAB future and Sustainability

Fab Lab and similar shared concepts will be developing in future. There is a need of effective usage of sources, knowledge and skills.

3.2.8 OpenLab Hamburg

OPENLAB HAMBURG	GERMANY	GOOD PRACTICE

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The OpenLab Hamburg was set up in December **2016**. It is **organized and run by the Institute of Production Engineering at the Helmut Schmidt University** and is recognized by MIT. The lab belongs to the Fab Labs (fabrication laboratories) movement - a global network of open workshops and is a member of the international Fab Lab Association. The OpenLab Hamburg is an open high-tech workshop that gives the general public access to modern, digital fabrication technologies to realize their own ideas. It offers various programs for the education and training of different target groups. There are regular machine introductory courses for 3D printers, the laser cutter and the CNC milling machine, as well as courses, lectures and workshops on the subject of "digital production". The OpenLab Hamburg provides access to top-grade digital fabrication equipment, offers workshops, lectures and weekly meetings to groups and individuals. The main aim of the Fab Lab is encouraging creativity, innovation, networking, mutual learning, as well as having fun while creating something new and significant together. The Fab Lab can be used for research and student projects, the development of prototypes for start-ups, as well as for tinkering.

- **Website**: **Promoter**: Helmut Schmidt University
- **Funding scheme**: free
- **Years**: 3

Targets	Thematic
The OpenLab Hamburg is aimed at everybody who is inquisitive to solve problems: students, pupils and private individuals, as well as companies and other institutions that are interested in craftsmanship, design and technology.)	Empowering community development, research and development, value creation. The lab can be used both for the development of prototypes for StartUps, as well as for research and study work or for tinkering and leisure time.

Community Links

The OpenLab Hamburg:

- Has impact on local community: it organizes OpenLabDay - every Tuesday from 14:00 to 18:00 anyone can come by and work on developing and implementing own ideas.
- Encourages collaboration among Fab Labs all over the world.
- Addresses global challenges: Project Make a Difference - competition to collect projects to address current global and local issues such as climate change, scarcity of natural resources, vulnerable ecosystems, refugee crisis, gender inequality, inadequate medical care and education infrastructure. The overall project objective is to demonstrate cooperation, collaboration and interdisciplinary research as the first steps towards overcoming the challenges outlined above.
- Supports local business in terms of prototyping.
- Offers workshops and courses.
- Supervises and trains interns.

Strengths	Weakness
• it is focused on people • it fills the gap in society by providing people with the possibility to be creative and find solutions on their own • it collaborates with FabLabs around the world • it provides open and friendly environment • it is open to everyone • it supports various initiatives	• not enough time and open days to the community • people who use milling machine or laser plotter need to bring own resources (wood, plexiglass)

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Types of machinery/equipment
3D printers, hydraulic press, laser cutter, CNC lathe, CNC milling machine, hand tools and power tools
FAB LAB future and Sustainability
The long term strategy of the OpenLab Hamburg is to build a sustainable society using global approach and sharing knowledge with Fab Labs around the world. Short term strategy is to contribute and serve people by encouraging them to take advantage of using Fab Lab, it is based on appreciation of Fab Lab in day to day life.

3.2.9 Fab Lab Raseko

FAB LAB RASEKO	FINLAND	GOOD PRACTICE

Lab is located in Urban area (city called Naantali inhabitants about 20 000). Our Fab Lab is owned by VET organization (www.raseko.fi) so it is very much connected to VET and its qualifications. FabLab Raseko in the municipality of Naantali (Finland) is owned By Raisio Regional Education and Training Consortium (Raseko). Raseko is a vocational education and training institution, which adds to the uniqueness of the FabLab as the only one attached t a VET school in Finland. In addition to broaden the learning environment to the students, the college provides the FabLab as part of a study module on digital fabrication with special tools. Students can create prototypes and produce items using a 3D printer or a laser cutter. The study module consists of introduction to tools and working methods relevant to one's own vocational background, e.g. in textile and fashion. The study module gives also knowledge on calculating production costs. Raseko FabLab is focused on education and community. The Lab promotes the use of digital technology in making art, small scale production and prototyping of new ideas. Students can realize projects that otherwise would be left without opportunity for prototyping and finalizing steps. As per its mission, the FabLab helps to realize student's passion to take their creative projects to higher levels and to improve their skills. The FabLab is also active in international cooperation. Students are able to visit other FabLabs through mobility programs and they have spent periods, in Iceland, for example, at a FabLab there.

The Raseko Fab Lab also offers local companies in food sector an opportunity to fine tune their products and services. This can be, for example, for restaurants to improve their recipies and the outlook of their portions in their à la carte menus. The Fab Lab benefits from the existing network of companies and other stakeholdes of the VET institution and the active collaboration with higher education institutions in the region. With the university of Turku the Fab Lab has cooperation e.g. in food sector development. An added benefit to the location is that in the region there are both industrial and creative activities.

- **Website**: www.raseko.fi/raseko-fab-lab/
- **Promoter**: owned by VET organization (www.raseko.fi). Turku University is our partner and we are closely working with them. Other co-operation is made with our owner cities elementary school and secondary schools. Public supported
- **Funding scheme**: Our Fab Lab is open on Mondays for public. Other days are open not just our students but by booking others can come too.
- **Years**: 3

Targets	Thematic
• Anyone who is interested advanced manufacturing or STEAM.	• Art is main but we are operating also with technical skills and entrepreneurship. We also have LEGO Education pedagogy that we are using fro robotic and programming education for compulsory education levels.

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Community Links	
We have designed concepts that are firstly our own students learning environments and through those environments we are offering different theme days for secondary and elementary (even pre-primary) levels. One concept is called Childrens VET (www.lastenamis.fi) where we publish all our courses or theme days that our students are offering and then other school levels can book them.	
Strengths	**Weakness**
-	-
Types of machinery/equipment	
FAB LAB future and Sustainability	
No yearly action calendar.	

3.2.10 Fab Lab Alto Minho

FAB LAB ALTO MINHO	PORTUGAL	GOOD PRACTICE

Fab.Lab Alto Minho was created in 2014 as a project from ACIBTM / In.Cubo, and the main objective was to support the installed startups. It developed into a wider lab model, also being open to schools and general public. Fab.Lab Alto Minho is listed on the *fablabs.io* platform.

- Website: http://www.fablabaltominho.pt/
- Promoter: Since the Lab was created as a project from ACIBTM/In.Cubo, it's supported by the association. Financially and logistics.
- Funding scheme: Fab.Lab Alto Minho has 2 days/month with free usage. Otherwise, each machine has its own cost/hour.
- Years: 3

Targets	Thematic
Entrepreneurs, Start-ups and Students but opened to general public as well.	General
Community Links	
Yes, as said before, Fab.Lab Alto Minho was created to support the entrepreneurs and start-ups. We also have a link with a VET school – EPRAMI – so the students of some courses can come to the lab and learn the basic processes of digital manufacturing – usually 2/3 classes per year - and also develop their final school projects. Our main goal, at this moment, is to captivate the students and young population so they can learn what can be done in a lab. And the focus goes through the VET schools, mainly because this approach requires acceptance from the institutions and VET ones are more prone to it. In the meantime, we are primarily working with the incubated start-ups and renting the machines to those companies and other local business.	

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Strengths	Weakness
• Being part of the pre-existing "network" of the incubator – incubators, companies, universities, etc. Wide range of machinery	• Maintenance costs and low visibility due to low population density area.

Types of machinery/equipment
3D Printer, 3D Scanner, Laser Cutting, CNC Milling, Vinyl Cutting, Electronic Prototyping (Arduino, Solder Station), Embroidery Machine

Which aspects can be used as benchmark?
Wide range of machinery and link to VET school

FAB LAB future and Sustainability
The sustainability may be an issue when the Lab doesn't have support or if it's located in a remote area. The income generated in those scenarios may not be enough to cover the overall costs (mostly the maintenance). Labs could be of great importance, not only helping the business and start-ups to develop and test their ideas/projects/products, but also to empower the individuals of a community – focus on students – so they can have a different, practical and accessible way to "create almost anything".

3.2.11 Making Rooms | Fab Lab Blackburn

MAKING ROOMS | FABLAB BLACKBURN	UK	GOOD PRACTICE

The Making Rooms is a unique facility that brings together art and technology. The Making Rooms is a state of the art technology and manufacturing hub that aims to place Blackburn (UK) back on the map as a place for start-up businesses and manufacturing innovation. Lancashire has a long and proud manufacturing heritage; formerly it was the centre of the world's cotton industry and has a long tradition of machinery manufacture. With 12.9% of the County's jobs in manufacturing, it is still one of the UK's highest concentrations of manufacturing industries. Lancashire is also home to a growing creative sector and the number of jobs in creative industries rose by 15.8% from 2011-2014, 3 times the national average.

The key aim is to make Blackburn and Darwin the Digital Making and Creative Hub for the North West of England. The building is a three story city centre location and aims to quickly be known as a creative, digital, accessible hub for emerging talent in the region. It also creates opportunities for Lancashire partners to learn and be inspired by other economic, regeneration and engineering collaborations. The potential for creative digital collaborations is exciting to the creative, education and health sectors. The facility opened in late 2016 and has begun trading with a programme aimed at services to local business and industry and education establishments. The Making Rooms is home to FabLab Blackburn, a digital manufacturing facility with the focus of helping people learn new skills, develop ingenious ideas and manufacture beautiful products.

The Making Rooms in Blackburn, in the North-West of England, was founded in 2017 with a strong social mission in collaboration with the city council, and now operates as a community interest company (CIC). Based in a former bank in the city centre, the ground floor contains the 'FabLab' space, consisting of a workshop containing digital manufacturing equipment and various tools for design and making. Upstairs, a number of smaller rooms are rented to up to a dozen local artists and businesses – the members of the space – who in return have a discount on use of the equipment downstairs. In addition, Making Rooms also has a number of other revenue streams including classes and prototyping services for local businesses.

Location Blackburn, Lancashire, UK

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- **Website**: https://makingrooms.org/
- **Promoter**: Making Rooms
- **Years**: 3

Targets	Thematic
• start-up businesses and manufacturing innovation	• Art • Technology

Community Links

The Making Rooms intends to be somewhere that "creativity, technology and advanced manufacturing come together in a community facility, for use by businesses, artists, inventors, students, children and just about everyone else". As such, the space provides:
- Access to tools at low cost, to individuals making physical products – be it professionally, as a hobby, or as a 'side hustle' alongside their regular job
- Skills training in design, manufacturing and running a business – improving their employability and/or their capacity to run a business themselves.
- Opportunities for young people to engage with science, technology, engineering, arts and mathematics outside a conventional classroom setting

One example of the structured skills training that Making Rooms provides is a twelve-week business incubation and mentorship programme, Tech Blackburn. Over a twelve-week programme, a diverse cohort of up to eight creative and innovative businesses receive discounted access to shared workspace and equipment, business mentorship, and skill-building sessions. These eight day-long sessions cover a range of topics from design thinking and business strategy, to marketing and social media, to more future-oriented topics such as the Internet of Things. The programme is aligned with the council's efforts to increase the value-add of the local economy by raising the level of creative and technical skills in the region, and is attracting young people to stay in Blackburn, rather than move to larger towns such as nearby Manchester. The Making Rooms has nearly completed its first cohort and is recruiting for its second.

Strengths	Weakness
-	-

Types of machinery/equipment

The lab is a complete FabLab with full equipment inventory.

FAB LAB future and Sustainability

-

3.2.12 Makerversity

MAKERVERSITY	UK	GOOD PRACTICE

Makerversity is a membership community of professional makers and disruptors, based in Somerset House in Central London. It operates as a catalyst for innovation and future-making through its physical workshop space, fabrication facilities and meeting rooms, through a series of thoughtfully designed coworking spaces, and through events that foster a dynamic and collaborative community spirit amongst its members.
Makerversity was founded in 2013, with the support of the Somerset House Trust, the body which manages the historic building next to the River Thames. It is now the largest resident of Somerset House Studios, a major new cross-disciplinary

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workspace championing collaboration and experimentation in the centre of London. Makerversity's creative community includes design studios, hardware startups, games designers, researchers, artists, freelance engineers and more.
The space offers several tiers of membership, from individual part- and full-time memberships upwards. In the five years of Makerversity's existence, a significant number of innovative product companies have based their operations here, sometimes as individual or two-person teams, and have grown through the space, relocating to spaces elsewhere in the building as their needs change. Throughout their journey, members are able to take advantage of the community and shared facilities. Makerversity proactively supports the exchange of knowledge and support within the community through a programme of internal events, including a popular weekly Friday breakfast. Other facilities include a staffed café-bar, well-used by members as a location for informal meetings and breaks.

- **Website**: https://makerversity.org/
- **Funding scheme**: free*, open access days. *Free for personal projects; hobbies; etc. There are charges for materials, and we carry a range of standard materials in stock. Used material cut-offs are free. Alternatively you can bring your own, as long as they are compatible with our machines (details can be found on the Equipment pages). Any activities that are externally funded or development of commercial products do not qualify and machine hire charges will apply.
- **Years**: 5

Targets	Thematic
• General public • professional makers and disruptors	• General maker thematic

Community Links
• A thriving public programme, engaging members of the public, domain experts, and the students and graduates of London's many top-tier art, design and engineering colleges. • A learning programme, working with 16 - 25 year olds to foster creativity, design skills and career opportunities. • An extensive network of private partnerships and collaborations, pairing Makerversity members with businesses or brands, for mutual benefit.

Strengths	Weakness
-	-

Types of machinery/equipment
-

FAB LAB future and Sustainability
-

3.2.13 Fab Lab Brno

FAB LAB BRNO	CZECH REPUBLIC	GOOD PRACTICES

FabLab Brno is 24/7 open workshop for everyone who wants to get in touch or work with digital manufacturing devices.

- **Website**: Fablabbrno.cz; Fablabexperience.cz; czechitas.fablabbrno.cz

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- **Promoter**: Established by JIC, z.s.p.o (Business innovation centre); Founders of JIC South Moravian Region, Brno and 4 universities BUT, MU, MENDELu and VFU
- **Partners**: Honeywell, Thermo Fisher Scientific, BUT, AT&T, Y Soft, Vodafone, Portiva, Prusa Research, Aubo, Czechitas, Fillamentum, Schunk, 3D Wiser, Solid Vision, Czechitas
- **Funding scheme**: FabLab Tour and basic workshops are for free. To be a member and use equipment they need to pay from 150 CZK (5 EUR) to 1000 CZK (40 EUR) for 24/7 access.
- **Years**: FabLab Brno since April 2017; FabLab Experience since February 2019; Czechitas FabLab since September 2019

Targets	Thematic
Students, entrepreneurs, general public and lately women.	We do not have any specific theme, we are here for DIY people and all their projects and needs

Community Links

We cooperate with universities, high and elementary schools in regions (more than 60 per year), companies (they sponsor us with equipment and also money), with students organization, with afterschool education and informal education centres.

Strengths	Weakness
• Ease of use – inexpensive and not that much time demanding to finish basic instructional workshops. • High tech equipment • Big community of users • Connection to business innovation centre give us stability and also from maker to market topic that is recently more and more discussed in the network • We have probably one of the best mobile FabLabs. Father of FabLabs Neil Gershenfeld from MIT told us: "This is the most impressive mobile FabLab I have ever seen." • Strategic planning with regional level politics. We were asked to cooperate with building strategy of development of technical education	• With hundreds of members, it is difficult to maintain strong connections in the community • FabLab Brno is in the 4th floor. We are having struggle with heavy machines. • We need to say no to a lot of projects, because we don't have the capacity to do everything that is in our scope, but we need to prioritize.

Types of machinery/equipment

- Electronics/IoT
- 3D printers
- Laser cutters
- CNC routers
- CNC sewing machine
- Vinyl plotter
- Mechalab

FAB LAB future and Sustainability

- We are going to apply for FABx event
- We are doing research with aim to build center of informal education

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- We are planning to tech the teachers
- Keeping strong relationship with companies
- Staying involved in regional strategies for STEAM education

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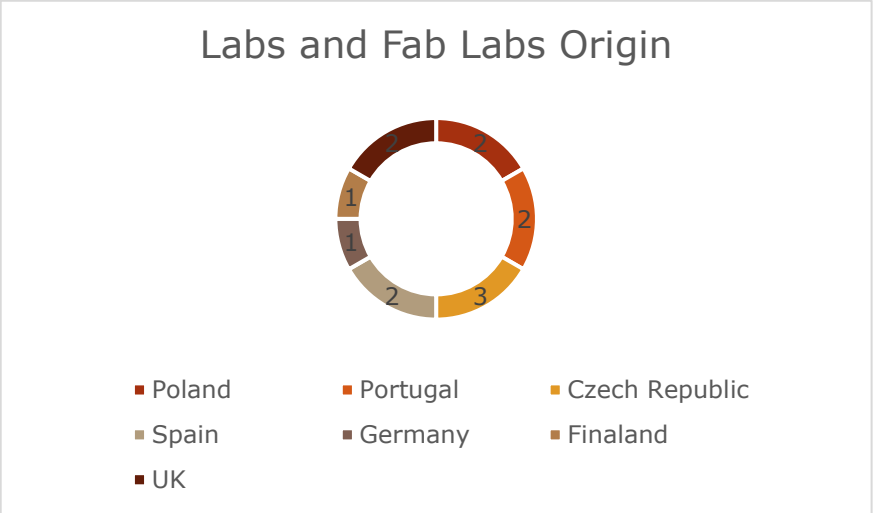
4 What contributes to the successful implementation of LABS?

4.1 Success Factors

Years Running and Certification

The Make Your Way good practices analysed consist in a set of 13 different Labs and Fab Labs from 7 different EU countries (Poland; Portugal; Czech Republic; Spain, Germany; UK and Finland).



Graph 1 – Labs and Fab Labs Origin

Within these 12 labs, it was possible to acknowledge that they run on different typologies, some being recognized by MIT as Fab Labs and others being classified only as labs (potentially interested, or not, in becoming certified). As it can be seen on graph 1, half of the good practices are certified and half are not. This reflects the Fab Labs dynamism and their different realities, as well the different stages of development.

Additionally, the thematic of certification has two sides. On one hand, Labs that are not certified often focus on one specific thematic and are not so diverse and dynamic, usually not counting with all equipment necessary to become a Fab Lab. Nevertheless, they gradually invest in their equipment and have as midterm objective to apply for certification. On the other hand, there are not certified Labs that have it has their own initiative not to be certified since they are part of a larger body, such as a culture centre, university, municipality which supports them financially but also defines the Lab aims, objectives and some of the annual programme activities. Thus, MIT certification is key factor to consider when analysing Lab and Fab Lab success, however, the weight of such aspect must be analysed having in mind the Lab context, framework, funding scheme and promoter/founder.

The years of experience also reinforce this idea (see graph 3). Indeed, Labs and Fab Labs can represent a good practices from its early years of constitution, counting already with key factors which contribute to their fruitful development. It is also true, that less successful labs are always in time to improve their framework and work towards success. As such, and even though experience builds on

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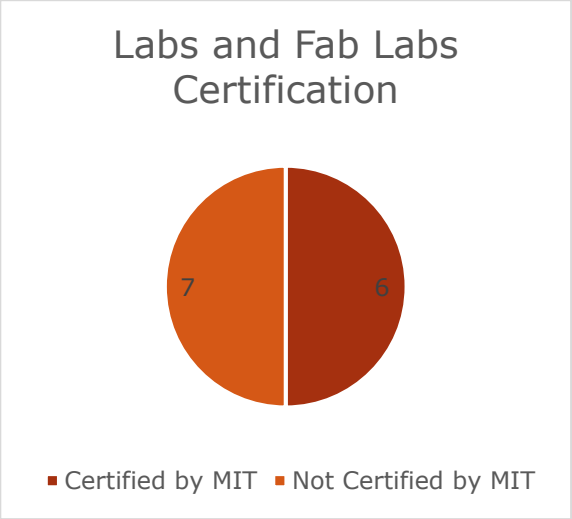
knowledge, we consider the years running is not factor that greatly influences the success of Labs and Fab Labs.



Graph 2 – Labs and Fab Labs Certification

Graph 2 – Years Running

Within the 12 Labs and Fab Labs analysed and interviewed it was possible to outline further variables that contribute to their success.

Models: Thematic, Promoters and Business Models

Thematic

Following the methodology portrayed above, a set of 40 good practices were collected from 28 European Countries. Deriving from a first preliminary analysis (Phase 1), it was possible to understand that even though all labs share digital fabrication as a necessary condition for its existence, each lab adopts slightly different thematic. Thus, it is possible to list the following themes:

- Agriculture;
- Architecture;
- Design;
- Engineering and technology;
- STEM;
- Library/books;
- Wood work/traditional crafts;
- Digital skills;
- DIY;
- Art.
- Education;
- Additive Manufacturing;
- Digital manufacturing;
- Data culture;
- Media;

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- Music.
- Mechanics, mechatronics and low-cost automation

This is aligned with the results of a study that maps the Maker Movement in the European Union. Based on work developed, topics addressed, and interests highlighted by the different makerspaces' homepages, it is observed that the main thematic areas of interest are very similar among the various spaces (and as expected STEAM related). 546 makerspaces indicated interest in digital fabrication, 273 in programing and 247 in electronics. Topics related to design, arts and education were also frequently mentioned (Rosa *et all*, 2017).

The Labs selected as MAKE YOUR WAY good practices focus on different groups, some being more embracing than others:

1. General public, citizens of a certain region (with emphasis on specific audiences according to different projects); people interested in taking the first steps in the use of technologies, design and DIY;
2. Children, youngsters and families;
3. Education related – Primary School students; Secondary School students, VET Students, Teachers, Schools;
4. Higher Education - Universities. Higher Education Students working on development projects for thesis or internship;
5. Design related – Labs can serve as development centre, create a prototype and test the functionality for Freelancers, Small Businesses, Industry, Start Ups, Designers;
6. Lifelong learning and training for unemployed people;
7. Creators or artists.

From the 40 Fab Labs and Labs analysed, it is possible to divide them in 4 main categories: promoted by universities and addressed to its students; addressed to children, young students and schools; paid and high-tech labs; addressed to children, young students and schools; addressed to general public.

As stated before, Fab Labs can adopt one of the following models: ***Public***, ***Academic*** and ***Pro***. This categorization follows, in a general way, the 4 categories identified above.

Originally designed for communities as prototyping platforms for local entrepreneurship, Fab Labs are increasingly being adopted by schools as platforms for project-based, hands-on STEM education. Users learn by designing and creating objects of personal interest or import. Empowered by the experience of making something themselves, they both learn and mentor each other, gaining deep knowledge about the machines, the materials, the design process, and the engineering that goes into invention and innovation. In educational settings, rather than relying on a fixed curriculum, learning happens in an authentic, engaging, personal context, one in which students go through a cycle of imagination, design, prototyping, reflection, and iteration as they find solutions to challenges or bring their ideas to life.

A Fab Lab and its users must also guide itself by a set of "rules" – Fab Charter – that state that Fab Labs are available as a community resource, offering open access for individuals as well as scheduled access for programs, but the users must be responsible for the safety of people and machines, assist

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with cleaning, maintaining and improving the lab and contribute to documentation. This way, the designs and processes developed in Fab Labs can be protected and sold however the inventor/user chooses, but should remain available for other users to use and learn from. Commercial activities can be prototyped and incubated in a fab lab, but they must not conflict with other uses, they should grow beyond rather than within the lab, and they are expected to benefit the inventors, labs, and networks that contribute to their success.

Hereupon, the Fab Labs can be defined as three main models: ***Public***, ***Academic*** **and** ***Pro*****.**

- Being the ***Public*** open to all with the main purpose of giving access to the tools, the practices and the culture of digital manufacturing,
- the ***Academic*** linked to a university or school, developing essentially student projects and fomenting "learn-by-doing" and experimentation, and
- the ***Pro***, allowing the development of projects designed alongside companies, startups and entrepreneurs, thus generating some economic value.

- ***Success factor: Fab Labs adopt an approach where the three models combine in a way where the values could be disseminated and, at the same time, guaranteeing the sustainability of the Lab.***

Promoter

A key factor that defines the specific model of each Fab Lab from its beginning is the exiting of a promoter or a funding body associated to it. While, in some cases, the Labs and Fab Labs are created in association with an entity, others they seek for cooperation with such institutions in order to guarantee financial support. However it is important to note that there are Labs that still succeed without a promoter body. There is a wide variety of different promoters:

1. Fully or partially funded by private institutions, such as telecommunication companies;
2. Fully or partially public funded from local authorities; municipality; regional government and provincial delegation;
3. Financial support from cultural and creative industries programmes;
4. Fully funded by universities;
5. Supported only in specific projects by public or private entities;
6. Supported with hardware donations by public or private entities.

According to Rosa *et all* (2017), "*The economic sustainability of a makerspace is greatly dependent on secured funding, for instance via sponsorships, and sources of income. From the data collected, the most common sources of income are (1) via a membership fee that can either be flat (monthly or annual payment) or varied (payment based on the frequency someone uses the makerspace); or (2) via the payment of a fee based on the equipment usage time or material consumed. In Figure 11 it is possible to see the number of makerspaces by country that can be described by the funding schemes listed above*". Overall, 335 makerspaces were identified with a membership scheme (representing 72% of the makerspaces with this type of data available); 73 makerspaces (16%) with a payment

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scheme based on equipment usage or material consumed; and 55 makerspaces (12%) with no fee at all (clearly stated as such) (Rosa *et all*, 2017).

- ***Success factor:* A Fab Lab closely linked or joined to larger organisation with a broad remit that is well placed to provide support in establishing the Fab Lab in its inception will see Fab Lab activities develop outside of the narrow focus of exclusively using design and fabrication tools to prototype, thus, most likely extending it to education programmes, community development, social impact, health and wellbeing, supporting micro business and social enterprise, rehabilitation and research.**

At the same time, it is possible that by being linked to a promoter, the Lab gets restricted to a field of action (nevertheless, this is not the usual consequence). This organisational relationship will influence the programme of the Fab Lab; although spaces have broadly similar outputs, how this is weighted in each will be influenced by a potential parent organisation.

Business model

As explained before, even though the Labs are generally within attributed categories it doesn't mean that they don't have any feature of another given module. It is actually considered to be of added value if Labs are broader and can reach in a meaningful way a larger audience (being general public; related to academia or to companies, start-ups). Additionally, the type of fab lab typology is closely linked to its business model. There is usually a wide variety of paying schemes for different fab labs, even for those that formally fit within the same typology:

1. Free to all people who wish to use the lab facilities and equipment; but workshops are paid;
2. Membership programme with different levels of users with free open days throughout the year so people can learn and have contact with the potential of digital fabrication;
3. Free for schools and students, but with fees for the use of different machines to the general public and to clients projects;
4. Free for general public, children and students; for higher education students to carry out prototypes or research processes, but not open to private use or strictly commercial purpose;
5. Generally free, up to a limit of hours. Extra time above the limit is charged with a tariff;
6. Payed with a tariff for different targets: single person; students; company.

According to Fab Lab Foundation Ireland (2017), paying schemes can be divided as follows:

- **Machine Hire/Fabrication service** – Charged at hourly or daily rates for individuals or organisations to use equipment in the lab under both commissioned and unsupervised circumstances.
- **Design Service** - A 2D or 3D design service to prepare drawings for manufacture within the Lab or for other external processes. This requires access to skilled staff members (employees or freelance) who are experienced in a range of relevant software packages.
- **Membership models** – Drawing on Creative Spark's membership model of the print studio, a similar scenario would have individuals paying monthly or annually a fee to use FabLab services with an element of exclusivity. These maybe limited to an upper limit dependant on the space and resources FabLab has to offer and will be grown over a three year period to maximum capacity.

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- **Training & workshops** – A range of knowledge transfer experiences for groups or individuals to learn new techniques related to design and fabrication. There are numerous ways in which to deliver these, being short and temporary, one off masterclasses for example or longer term with an option of accreditation, a six week 3D design class for example.
- **Corporate Engagement** – This will involve training/team building experiences for staff teams within SME and larger corporations delivered as a half day or full day experience using design and fabrication tools. This can involve entrepreneurial thinking and action, teambuilding and design led problem solving with established teams/companies.
- **Small Business Incubation spaces –** (Space dependant) locating small micro businesses in or close to the Fab Lab to attract product orientated/tech start ups space to grow. Rent would be charged over a12 moth period.

There is a close relation between the targets, the type of promoter and business models of the labs and fan labs. Thus, generally:

- **Public** fab labs are free with some paid initiatives such as workshops. Some might have restrictions for private initiative use.
- **Academic** are free with some paid initiatives such as workshops or services for companies/clients such as allowing them to test prototypes. These are many times linked to universities and are always free for students, allowing them to develop research projects.
- **Pro** are free for schools and include open days, but make use of membership programmes or tariffs and can include some paid initiatives such as technical workshops, but also for more advanced developments that usually small business, start-ups and municipalities are interested in.

- ***Success factor: There is no obvious single business model for Fab Labs or maker spaces, most Fab Labs use a mixed model of funding, private investment and self-generated income to sustain the resource and activity programmes.***

Community Links

There is a wide variety of different types of space, from coworking offices on the one hand, to Fab Labs and maker spaces that maintain digital manufacturing equipment for their members' use. One clear conclusion from the experiments and evidence gathered is that each space has its own distinctive identity, which is a result of factors including the personalities of the management team, the members (or users), the location and surrounding community, any partner organisations and founding bodies, and the reasons why the space was founded initially (Blikstein, 2013). In order to give members a feeling that they can, and should, contribute to the community, it is first necessary to communicate to new members what the purpose of the space is, and what is expected of them within the culture of the community. Many spaces do this by displaying a set of values and a charter or short list of objectives of the space, in a prominent location.

Thus, many Fab Labs explicitly seek to engage with the communities they are part of, in many different ways:

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- **By supporting entrepreneurs and communities, creating clusters of innovation and looking for local and international talents,** serving as a model for the development of solutions to local problems which can be scaled, replicated and exported globally;
- **By creating impact through Design** and the products we develop to show a new business model in terms of Product & Hardware businesses and the innovation a Fab Lab can bring to small start-ups and freelancers;
- **By supporting education**, by **working with several schools** through consultancy to help establish Makerspaces within the schools, setting up educational programs that take advantage of such a space to improve educational system; **by giving training to teachers** as a first step to show the impact the Maker Movement and Fab Labs can have with in the educational system; **by creating extensive programs** which include workshops and training in the Fab Labs for students; **by developing projects with students** with social impact and/or of social interest (Enabling the future Project, design and development of adapted prosthetics-orthotics, etc.); **by providing workshops and training on different topics** (such as Additive Manufacturing) in order to support VET students in their technical learning and final projects; **by providing VET students with hard skills and processes knowledge** that they will need in their future workplace;
- **By creating an informal and collaborative learning framework** where the user or citizen has the responsibility and the tools to develop their own capacities. The way of learning and the themes proposed in the laboratory try **to promote a sustainable conscience with the environment and socially responsible with its surroundings**, that is to say, themes and problems present in the society and in the near environment of the laboratory are attended to, to facilitate that the people or entities working on these problems can make use of the laboratory;
- **By helping SMEs** in testing the technology and making use of it (prototypes or training, among others);
- **By promoting activities that are carried out for the activation and integration of local communities,** as well as for the development and promotion of volunteering.

- ***Success Factor: Informal knowledge transfer is one activity of coworking and maker spaces that members find consistently valuable, along with the facilitation and promotion of a sense of community. These outcomes, though intangible and subjective, are strongly linked with the success of a space in terms of user satisfaction, which is in turn important for the long-term viability of the space.***

Location

The environment and geography in which the Fab Lab operates plays an influential part. A Fab Lab located in a commercial district of a city may create a different programme of activities from one in a residential area. In this instance the Fab Lab will be responding to the immediate community in which it is located in. In turn, a rural Fab Lab will develop programmes that suit their geography and population size and community need which may differ from that of an urban environment.

Spaces can be situated in a variety of locales:

- in universities or schools;

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- within sites specifically dedicated to innovation, like incubators or innovation centres;
- at purpose-built Fab labs;
- in museums;
- in mobile Fab labs: in a truck that criss-crosses a region or country

- ***Success factor: having in mind the location of a Lab it's crucial for its success, since this aspect will influence in terms of services provided, technical expertise available and business model.***

Sustainability, Strengths and Weaknesses

Not all Labs and Fab Labs focus their efforts on analysing positive and negative factors of their action and understanding what is valuable and indispensable within their activity and what is contributing for a poor efficiency. Thus, not all Fab Labs recognize the importance of developing short and long-term strategies.

When having a clear idea of both short term and long-term strategies it is possible for the Labs to recognize their strengths, weaknesses, needs and improvement measures and especially to create a solid foundation so in a long term a Fab Lab becomes sustainable. More precisely, developing such strategies usually allows Labs to understand the importance of creating links with other international Fab Labs, thus building a sustainable society using global approach and sharing knowledge with Fab Labs around the world. Additionally, it allows Labs to understand what is their social and economic impact in the communities they are part of.

After interviewing the 13 Make Your Way good practices, and even though each Lab or Fab Lab has its own unique identity, it was possible to reveal some similar positive and negative points, or in other words, some common strengths and weaknesses.

Below, it is possible to assess that many reveal concerns regarding **visibility and marketing**. While at the beginning of the Fab Labs trend, the concern for each lab was mainly related with learning, having the adequate equipment and programme for its users, now the focus naturally derives to another aspect which is visibility. Indeed, in order to capitalize the Labs and Fab Labs initial efforts, it is crucial to invest in a well thought marketing and communication strategy that should be aligned with the Fab Lab strategy, aims and objectives, targets and even business model.

Strengths	Weaknesses
• Friendly environment (open for both DIY geeks and amateurs and Open to everyone, irrespective of their skills; Filling in the gap in the education system (schools are not equipped with workshops)	• Low visibility still unsatisfactory level of awareness in society about the offer of the Fab Lab
• Response to growing consumerism ('fix it instead of buying a new one' approach)	• Lack of Financial Support
• Responding to the demands of labour market	• Communication and Marketing (Visibility)

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• Working closely with the Community (A Fab Lab is more than a set of machines, A Fab Lab is its Community)	• Shortage of Staff¸ Not enough full-time job employees – causing time pressure or postponing activities or projects in demand
• Diversity of initiatives that it promotes	• Shortage of Space to expand, as it isn't keeping up with our rapid growth and bigger local rental space rates are too expensive Machinery size isn't keeping up with the rapid growth of projects
• High number of running projects	• Cost of Acquiring new machine sets
• Sustainability plan in short- and long-term	• Lack of MIT recognition
• International collaboration in Projects and Networks (learning opportunity!)	
• Impact in the city and local community (Socially, Economically and Innovation).	
• Diverse and active, the fact of being a public resource and the variety of program lines that serve fields such as education, citizenship, technicians and artists at the same time.	
• Lack of financial barriers	
• Convenient location in the city centre.	
• Support from the municipality.	
• It fills the gap in society by providing people with the possibility to be creative and find solutions on their own.	

Table 4 – Fab Labs Strengths and Weaknesses

- ***Success factor: The Fab Lab defines its strategy on an annual basis. Based on evaluation of the previous projects, it modifies and approves its strategy for the upcoming year.***
- ***Success factor: Labs and Fab Labs should invest time in developing a well-defined marketing and communication strategy.***

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4.2 “LABs” and Education: collaborations with VET providers

One of the main drivers of Labs success is their engagement with community, particularly (but not only) their involvement in education.

The maker movement in education has been a revolution in waiting for a century. It rests on conceptual and technological pillars that have been engendered in schools and research labs for decades, such as project-based learning, constructivism, and technological tools for “making things,” such as physical computing kits, programming languages for novices, and inexpensive digital fabrication equipment (Blikestein & Krannich, 2013).

Mike Eisenberg was one of the early pioneers of advocating for digital fabrication in education, having prepared the ground for what would come next. Around 2005, programs such as “Learn2Teach, Teach2Learn” from MIT brought children into a community centre Fab Lab for the first time. Toward the end of the 2000s, researchers and educators started to consider a more sustainable use of digital fabrication in education. In 2008, Stanford University launched the FabLab@School project. *Fablab@school, promoting science and technology learning at School* Stanford professor Paulo Blikstein has an innovative use for the Fab lab. Fewer and fewer high school students are interested in studying science, so Blikstein now offers a series of workshops for high school students to put the “fun” back into science (Blikestein & Krannich, 2013). The objective is to allow students and teachers to use the Fab lab as an educational tool: program participants work on experiments, prototype/product development and robotics that deal with current issues in the scientific field.

One of the first and most striking results of the initial workshops in digital fabrication is that students reported have gained a new appreciation for the ‘manual’ labour they used to do, and also for the occupation of their parents. In the lab, students had to first design their creations on a computer, often after several types of measurements and calculations. However, they were still constructing, building, and using their hands, but all the work was permeated with two socially valued practices: computation and mathematics. Again, the familiar practices of building and making were augmented with computational tools, which generated not only more refined and sophisticated projects, but also empowerment and increased self-esteem (Bilkstein, 2013). By building onto students’ familiar practices and adding a layer of expressive technologies, a digital fabrication lab, which merges computation, tinkering and engineering, has the potential to augment rather than replace familiar and powerful practices that students already possess, therefore they can recognize their own previous expertise in what they accomplish in the lab, rather than acquiring a new identity altogether (Bilkstein, 2013).

According to Bilkstein (2013), an additional benefit of digital fabrication is that …”*it accelerates the processes of ideation and invention. It eliminates manual dexterity as the “middleman” in transforming an idea into a product, so students can focus their attention on improving the design rather than taking care of mundane issues with the materials—and many more cycles of redesign are possible in the same time interval*”. Moreover, the fact that the products generated in the laser cutter and the 3D printer were aesthetically pleasing had a strong impact in students’ self-esteem. Finally, the establishment of this new space in schools often allows students to engage in intellectual activities and practices that would not be possible anywhere else, and experience new ways of work, as well as new levels of team collaboration (Bilkstein, 2013).

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The Make Your Way guide analysed a wide variety of Fab Labs with a range of approaches for engaging with formal regular education, non-formal education to formal vocational and educational training sector. Some spaces may not see themselves as operating in an educational sector, while others will have outreach as a primary objective. It is clear that the world of co-working and maker spaces has as much to offer the vocational training sector as do large industrial organisations, in terms of promoting an entrepreneurial problem-solving mind-set, peer learning and resourcefulness. Particularly when regarding VET system, there are some aspects that Labs and Fab Labs should address when engaging with such educational institutions:

- **Host Sprints, Workshops and Programmes with VET Teachers and Students**: Whether as a formal part of a VET curriculum, or as a stand-alone programme outside school that is targeted to students in the VET system, many spaces support outreach programmes to bring people from the VET sector into the space.
- **Promote Project-Based Learning among VET Teachers**: The 'maker mind-set' training, directly addressing VET teachers and giving them an immersive experience of design thinking and project-based learning, and using a maker space to learn new skills and achieve a goal in a short time. These kinds of initiatives are also made more powerful when followed up by mentorship and coaching to integrate these practices into the VET curriculum.
- **Hold Regular Open Hours and Tours:** Part of Fab Lab charter, to which spaces that call themselves Fab Labs must adhere, requires these spaces to be open to the public regularly, for example for a few hours each week. This enables a wide range of people to come and experience ways of working in the space, to meet people who use the space, and to begin to imagine how they would benefit from such an arrangement themselves.

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5 Conclusions and Recommendations: Practical Tips on how to start a Fab Lab

Labs and Fab Labs have a tremendous impact in their cities, at a local and global level as they empowered communities to have a voice and create solutions to local problems that can be scaled at a global scale. Such initiative can have an even greater impact in several sectors such as, education, economical, agriculture, health, energy etc. But for such increased level of impact to become a reality the labs must consider what brings them to success. Thus, it is crucial for such spaces to consider: the **development of a sustainable business model adapted to their reality and the community in its city; a marketing plan that can communicate clearly to the community**; “What is a Fab Lab?”, “What Is the impact of a Lab in the Community?”, “How can they use the Lab?” etc and finally consider an **appropriate funding scheme.** This new generation of Fab Labs that are being founded, have years of learning and paving made by all the Fab Labs that were founded throughout the past 11 years, making it easier for new Labs to learn from their mistakes and create new business models that will turn them into sustainable Labs. Thus, as main recommendation for future creation of Labs and Fab Labs, it is especially relevant to consider the aspects mentioned below:

1. Why set up a Fab Lab? Think About Motivations, Aims and Objectives

What motivates Fab Lab founders? At the same time, don’t forget to think about your aims and objectives. What is the best model for your Fab Lab. There are many motivations for setting up a Fab Lab. These include:

- formalising an existing Makerspace
- to help regenerate places, communities and neighbourhoods
- to provide services to the local community
- to educate new Makers
- to advance knowledge of digital technologies and explore new possibilities
- to support research and development and upgrade knowledge in existing disciplines
- to provide services to existing industries, especially in prototyping and innovation

2. Get Familiarized

Although not a requirement in itself, get to know the Maker Movement and Fab Lab concept first. You can do this by researching online and on sight – look for already established Fab Labs in your region (certified or not) and visit them. Try to understand what will be key aspects for the successful implementation of your Fab Lab. Analyze Make Your Way Good Practices

3. Follow Fab Foundation Recommendations

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- A Fab Lab must be open to the public for free or in-kind service at least part of the time each week.
- Fab Labs support and subscribe to the Fab Charter.
- Fab Labs have to share a common set of tools and processes. Typically includes: a laser cutter that makes 2D and 3D structures; a 3D printer; a high resolution CNC milling machine that makes circuit boards, precision parts and molds for casting; a large wood router for building furniture and housing; a suite of electronic components and programming tools for low-cost, high-speed microcontrollers and on-site rapid circuit prototyping
- Fab Labs must participate in the larger, global Fab Network.

4. Enroll in Fab Academy

5. Make Your Costs Overview

6. Define Activities and Make Your Business Model

As soon as you have a first draft version of your lab's activities and services, you can start designing the business model and then, later, the business plan. You cannot start a business model without a specific product or service, therefore it is important to have a first version of the project of the lab. You can then further improve both the design of services and activities and the design of the business model in parallel. It is important to consider a self-Generated Income Model. After the business model is ready, you can start developing the business plan. This is the document where you will check the balance between revenues and the costs of developing and running the Fab Lab. Refining the business plan is an activity that will continue throughout the life of the lab.

7. Look for the Right People

Focus on the necessary people. You might start by looking for other people to develop a low-cost, grassroots Fab Lab, or you might hire people for the development of the Fab Lab. The necessary people can have many different roles: they may develop the lab, they may bring education to the people developing the lab, they may form important partnerships, they may run short workshops, they may bring specific knowledge, they may develop the first projects, and so on.

8. Think Carefully About the Location

It is crucial to consider exactly where the best location is for each Fab Lab. In theory a Fab Lab can be located anywhere, but each lab needs to attract users (both the public and businesses). The closer a lab is to public transport and / or parking the easier it will be for users to get to the lab, and to transport materials for their projects. You may want to investigate sharing a space, for example setting up a Fab Lab in a public building like a library. Check with local and national government officials. It will help if you can get in touch with existing Fab Labs in your country to ask if there are any specific rules you need to consider.

9. Choose, Buy and Set Up Machines (according to Fab Foundation Recommendations)

10. Open the Lab!

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7 Annexes

Annex 1 - Good Practices Selection Criteria

Annex 2 - Good practices Interviews Guide

Annex 3 – Make Your Way Good Practices Description Template

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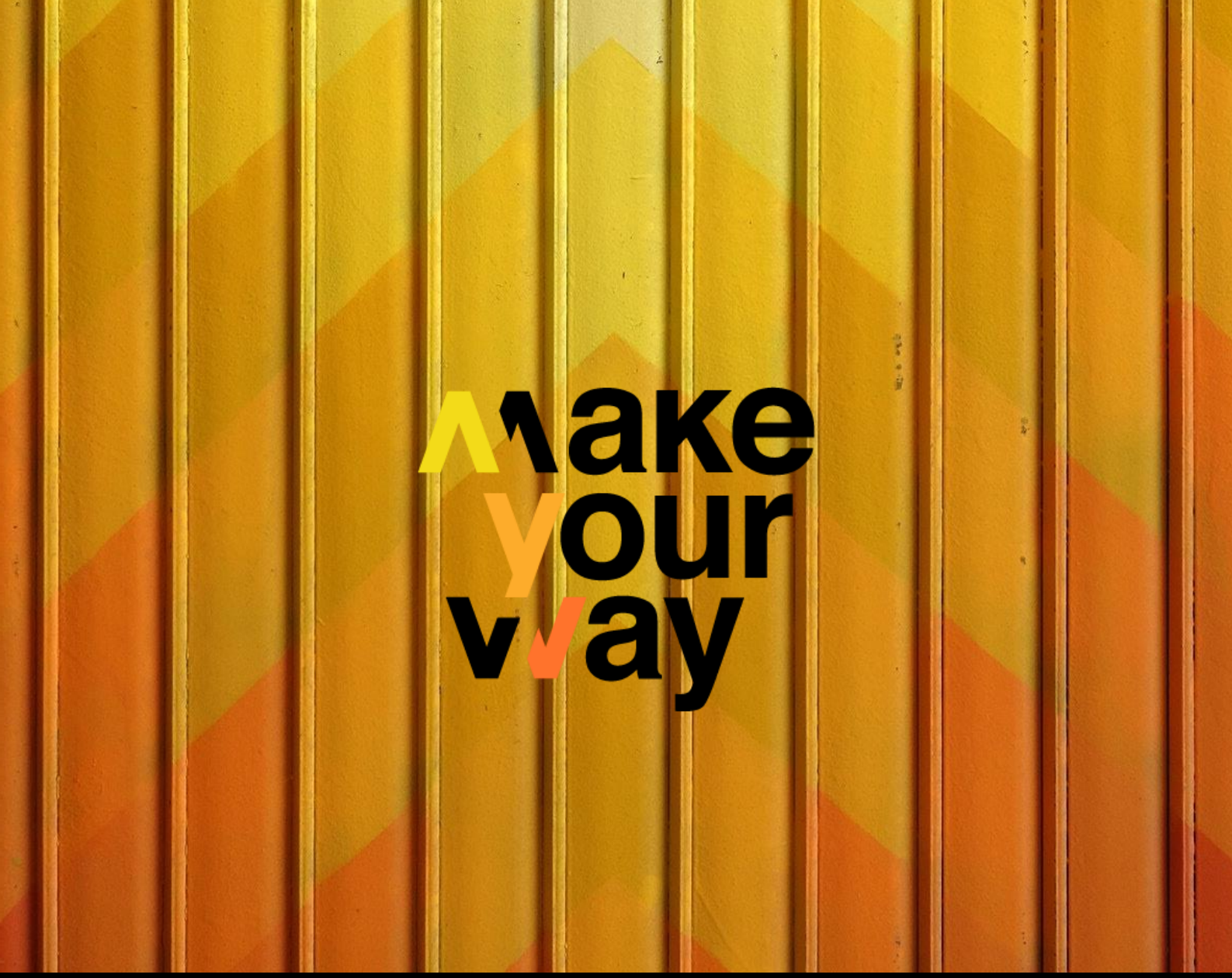

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