

OPEN SOCIAL INNOVATION DYNAMICS AND IMPACT

EXPLORATORY STUDY OF A FAB LAB NETWORK



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Open social innovation dynamics and impact: exploratory study of a fab lab network

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The aim of this research is to explore the dynamics and impact of open social innovation, within the context of fab labs and makerspaces. Using an exploratory methodology based on 12 semi-structured interviews of fab lab founders belonging to The Centres for Maker Innovation and Technology (CMIT) programme – a network of 170 fab labs located in Eastern Europe – this research explores the impact of an adopting an open approach in relation to the different stages of social innovation (prompts, proposals, prototypes, sustaining, scaling and diffusion, systemic change) as well as social impact. The main results of this study are that while the CMIT programme provided each fab lab with similar initial conditions (identical funding, objectives and rules), the open social innovation approached adopted enabled to give birth to a wide diversity of fab labs, each being very well adapted to the local environment, social needs and constraints and able to deliver social impact in just a matter of years; a result that would be hard to achieve with a centralised top-down approach. The study identified three types of CMITs – Education, Industry and Residential – which could be similar or different depending on the stage of social open innovation. Furthermore, this paper discusses the main difficulties social entrepreneurs encounter as a part of the open social innovation process, as well as means to overcome them. In this respect, this study adds to the literature on fab labs by providing more comprehensive view of the challenges faced by fab labs (and makerspaces) founders, as well as suggestions of strategies enabling to ensure their long-term sustainability.

1. Introduction

As noted in Chesbrough and Di Minin (2014), research on open innovation has so far largely focused on the private benefits of this form of innovation, generally leaving aside the social benefits that open innovation can bring. Yet the social benefits of open innovation do not necessarily happen 'by proxy', i.e. as spillovers of the private benefits that innovation brings. There are indeed cases

where open innovation has a direct social impact, for instance, when it is carried out in the public and non-profit sectors. Still, such cases were rather rare, which certainly explains why so little attention has been devoted to this question in the literature. A reason for the renewed interest in the (direct) social impact of open innovation is most likely related to the rise of innovative activities carried out by individuals, as opposed to firms. Indeed, digital technologies enable people to engage in innovative activities,

either entirely independently or with firms, but at their own initiative (Rayna and Striukova, 2016). In this respect, the advent of digital manufacturing technologies, such as 3D printing, is particularly striking, since they provide individuals with the means to carry out innovation and product development from end to end (Petrick and Simpson, 2013; Rayna et al., 2015).

The consequence of individuals – as opposed to firms – carrying out innovation is that their goals (if we leave aside individuals whose goal is to start a regular business) are likely to be significantly different. In this respect, Chesbrough and Di Minin (2014) establish a difference between ‘innovators in the business world’ and ‘social innovators’ who ‘account social change as the ultimate goal of their strategy’. While a significant amount of work has been carried out to understand the link ‘business innovators’ and open innovation, much is left to do in regard to social innovators. The issue is, of course, that the actions of social innovators are far less likely to be observable than those of firms, whose activities (products, pricing or at least the results of these activities, e.g. balance sheet and profit) are generally visible. Besides this question of observability, a second issue is the lack of homogeneity. While for any business it is always possible to find another business that has the same activity, open social innovation is more diffuse, as it takes many different forms and happens in very different contexts. As a result, even assuming that open social innovation can be observed, this makes drawing conclusions particularly difficult.

This is what makes the object of this study particularly interesting. The Centres for Maker Innovation and Technology (CMIT) are a network of (currently) 170 fab labs and makerspaces, launched in 2013 in Russia. All CMIT founders are social entrepreneurs who received the same funding to purchase equipment, share same objectives and face the same constraint. Beyond that, they have total freedom and need to figure out on their own how to reach the social goal they have been assigned. This means choosing the location of the centre, but also its ‘business model’, finding partnerships with firms and institutions and adapt to local constraints. As a result, the 170 CMITs are very diverse and no two are really alike, but because of this rather unique social innovation funding programme, they are observable and comparable, which makes them very useful to study open social innovation.

Therefore, our aim is to investigate, within the context of fab labs and makerspaces, the dynamics of open social innovation and how it delivers social impact. To do so, an exploratory methodology, based on 12 interviews of CMIT founders, is used.

The paper is organised as follows: the first section sets the context and reviews the literature related to open social innovation. The second section presents the methodology and the sample. The third section is devoted to the analysis of the interviews, and is followed by a discussion section.

2. Context

Although the term ‘social innovation’ was only introduced in the literature in the 1970s (Taylor, 1970), its roots can be traced back to the 18th century (Mumford, 2002). The recent growth of this phenomenon (Chesbrough and Di Minin, 2014; Johar et al., 2015), as well as the resulting increased awareness of it, can be linked to the development of governmental programmes and initiatives ‘across all continents’ aiming to bolster social innovation (Boelman et al., 2015).

Social innovation relates to new processes and procedures that result in novel social practices, which enable to fulfil social needs or address social issues, such as childcare, education, unemployment, crime prevention and ageing population (Mumford, 2002; Grimm et al., 2013). Social innovation is also considered as a critical tool to overcome skill gaps and lack of opportunities that affect the most disadvantaged groups in the population, and hereby enabling to increase inclusion, social engagement and financial independence of such groups (Grimm et al., 2013).

Social innovation consists in using existing skills and expertise within the population to find more effective, efficient or sustainable ways to address social issues (Chalmers, 2013). Value created through social innovation primarily benefits society rather than individuals (Phills et al., 2008). The changes brought about by social innovation affect profoundly basic routines, resources, authority flows, as well as beliefs in the social system; they are durable and have broad impact (Westley and Antadze, 2010).

While there is a broad understanding of what social innovation is, measuring its impact and the value it creates is generally challenging, as there are different opinions as to what the outcome of social innovation should be (Murray et al., 2010). Furthermore, while social innovation has a relatively young history in the literature, various perspectives (psychology, creativity, social changes and governance) have been used to analyse this phenomenon (van der Have and Rubalcaba, 2016).

The social change approach is one of the most prevalent ones in the literature and focuses on finding ‘innovative solutions to socio-technical challenges or social problems’ (van der Have and Rubalcaba,

2016). While social change and social innovation are often put together, they are related but different concepts. Indeed, social innovation is necessarily intentional, whereas social change (whether good or bad) can occur unintentionally (Howaldt and Schwarz, 2011). When successful, social innovation may result in social change. However, this is not necessarily the case, as social innovation may only have a local and limited impact and, thus, not lead to any significant social change.

Likewise, social innovation is often put alongside social entrepreneurship (Weerawardena and Mort, 2012). Although there are similarities between the two, the main difference between social entrepreneurship and social innovation relates to the role of profitability in the process: unlike social entrepreneurship, and while social innovation does not preclude a commercial interest, profitability is not a necessity (Westley and Antadze, 2010). Furthermore, unlike social entrepreneurship, social innovation transcends sectors and levels of analysis, and results in lasting impact (Phills et al., 2008).

Social innovation can occur at three different levels: individual (micro), organisational (meso) and regional/national (macro) (Habisch and Adai, 2013). While the macro level, through governmental policies, might be thought as the traditional vector of social change, the micro and the meso levels have actually become key mechanisms for social change (Cajaiba-Santana, 2014).

According to Murray et al. (2010), the social innovation process can be decomposed into six distinct stages:

1. *Prompts, inspirations and diagnoses*: Initial stage during which various factors trigger the need for innovation, after which a diagnostic of the problem and the framing of the question ensue.
2. *Proposals and ideas*: Idea generation stage using a variety of methods based on insight and experience.
3. *Prototyping and pilots*: Stage during which ideas are put into practice to be tested and, subsequently, refined.
4. *Sustaining*: Stage at which the idea is adopted for everyday use and is, as a result, streamlined. Income streams are identified at this stage.
5. *Scaling and diffusion*: Stage at which there is an attempt to scale-up and diffuse the innovation beyond its original test bed.
6. *Systemic change*: This stage is the ultimate goal of social innovation, but also the most difficult to achieve due to its wide scale, the large number of stakeholders it involves and the multiple barriers to change that exist.

While each of these stages comes with its respective challenges, the last two stages are by far the most difficult to carry out successfully. As a matter of fact, one of the reasons why social innovations fail is the absence of networks (Mulgan et al., 2007) that are crucial for successful innovation (Ritter and Gemünden, 2003). In this respect, Lettice and Parekh (2010) find that in the case of social innovation, failure to connect to the right network has a negative effect on both the morale of the social innovator and on access to finance and other support. As a consequence, this may prevent social innovation from progressing further than Stage 4. However, in all stages, the main challenge is to access the necessary skills and resources to start, prune and grow the innovation. As a result, keeping innovation open is critical (Murray et al., 2010).

Thus, it is not surprising that social innovation has been recently linked with the concept of open innovation.¹ The open innovation argument, encouraging firms to use both internal and external sources of ideas, as well as internal and external paths to markets (Chesbrough, 2003) has been gaining momentum, and there is strong evidence indeed that open innovation can not only help creating new innovations, but also sustain existing ones (Chesbrough et al., 2006; Dodgson et al., 2006; Rohrbeck et al., 2009; Rayna and Striukova, 2010; Henkel et al., 2014). By enabling access to a larger pool of resources and skills, as well as diffusion paths, applying the open innovation paradigm to social innovation could enable to overcome critical challenges at all six stages of the social innovation process.

When combined, open innovation and social innovation become Open Social Innovation (OSI), which is for Chesbrough and Di Minin (2014) ‘the application of either inbound or outbound open innovation strategies, along with innovations in the associated business model of the organisation, to social challenges’. Chalmers (2013) suggests that applying open innovation to social innovation includes incorporating outside knowledge – e.g. user innovation (von Hippel, 1988) – as well as using problem solutions from other fields and domains. This also implies that social innovators need to collaborate in an ‘open source’ manner (Murray et al., 2010). As a result, products and services developed through open social innovation will not only help solve social needs, but also foster new social relationships or collaborations (Caulier-Grice et al., 2012), which are particularly critical at the two latter stages of the social innovation process.

However, because open social innovation occurs in a different context than open innovation, it comes with its own challenges. Indeed, in ‘traditional’ open

innovation, a firm (or group of firms) is still the centrepiece, the 'keystone', of the innovation process. Leaving aside the rather rare cases where social innovation is conducted by public organisations with an opening towards the outside, social innovation generally often implies a far more bottom-up and decentralised process. As a consequence, adequate tools are required for open social innovation to take place.

In the case of 'regular' open innovation, digital technologies and ICTs have been powerful enablers (Rayna and Striukova, 2010, 2015; Rayna et al., 2015). Yet, while social innovation sometimes only relates to digital content and services, it is also frequently the case that more tangible resources are required. In this respect, Bria (2015) mentions that while digital solutions are indeed highly instrumental in resolving social challenges, the next stage of 'digital social innovation' will most likely rely on the use of makerspaces, fab labs and other collaborative spaces, as these spaces allow to further increase the spectrum of social innovation enabled by digital technologies.

Makerspaces are collaborative work spaces equipped with digital (e.g. CNC machinery, laser cutters and 3D printers) and non-digital (e.g. soldering station, woodworking tools, sewing machines, but also Lego blocks or art kits) tools that enable to make, learn and explore. As noted in Mortara and Parisot (2017), such 'fabrication spaces' provide access to sophisticated technologies to non-specialists. Makerspaces can be found in a variety of environments, public spaces (e.g. school, library and university), but also private ones. Some are fully open, other require membership or are even fully closed (e.g. corporate makerspaces). Depending on their specialisation, makerspaces cater for both children (whom they provide with STEM skills) and adults (hobbyists, entrepreneurs and teachers). Makerspaces enable people to develop both hard skills (e.g. technical skills related to 3D printing, 3D modelling, electronics, robotics and woodworking) and soft skills (design thinking, prototyping and creativity). They also serve as business incubation environments (Mortara and Parisot, 2017) and help foster entrepreneurial skills.

Fab labs are, for all intents and purposes, makerspaces. They have similar equipment and generally function in the same manner (which is why the words 'makerspace' and 'fab lab' are often used interchangeably). The only formal difference between a fab lab and a makerspace is that the former has signed the Fab Lab Foundation Charter, while the latter has not (Fonda and Canessa, 2016). Fab labs are more likely to be situated within an educational institution, such as a university or a college (van Holm,

2015), and usually have stronger connections with each other (Menichinelli, 2016).

The first fab lab was created in 2003 at the South End Technology Center by Neil Gershenfeld and Sherry Lassiter (Gershenfeld, 2012). The Fab Foundation was launched in 2009 to 'facilitate and support the growth of the international fab lab network as well as the development of regional capacity building organisations'.²

Worldwide, there are currently over 1,000 fab labs and many more makerspaces. While most of such spaces are, by nature, conducive to open innovation (Fabbri and Charue-Duboc, 2016), in the recent years, some of them – such as Fab Lab Shenzhen, Fab Lab Maastricht – have been explicitly focusing on promoting open innovation.

However, the fact that such spaces are conducive of Open Innovation does not necessarily mean that they enable to promote Open Social Innovation. This will depend not only on the location of the space (within a company, in a local community), its users (students and employees), but also on its objectives. For instance, spaces such as a corporate makerspace or a fab lab located within the faculty of art and design of a university are more likely to foster innovation that benefits individuals rather than the society at large, simply because this is more likely to be the main focus of their users (e.g. who work on individual projects and develop a startup). In contrast, a fab lab or makerspace located within a deprived community may be expected to have a greater social impact.

This is one of the reasons that makes the case of Centres for Maker Innovation & Technology (CMIT) a particularly interesting and relevant object of study when it comes to investigating Open Social Innovation. CMITs are fab labs and makerspaces³ that are specifically devoted to engaging young people in technology and engineering, and providing them with creativity and design skills. Because the objective of CMIT is to promote education and employment, and overcome skill gaps, outside usual education facilities and structures (e.g. schools and universities), they are, just like other makerspaces sharing the same objectives, a form of social innovation. What is particularly interesting in the case of CMITs is that they correspond, originally, to a 'macro' – hence rather traditional – form of social innovation, as they were borne by a national governmental programme.

Noting a sharp decline in STEM and engineering skills in the population, the Russian Science and Technology Development Fund for SMEs (STDFS) decided to fund the creation of fab labs/makerspaces countrywide. As emphasised in Dickens and Minshall (2016), the advent of digital manufacturing

has created a need to improve understanding of the capabilities and limitations of 3D printing and making this knowledge widely available. However, instead of using a 'top-down'/closed approach that would involve specifying the location, equipment and organisation of the new spaces, the STDFS opted for an Open Social Innovation approach. Funds, dispatched to meso level (regional governments) to ensure a better fit with local needs, are allocated through a bidding process. Noteworthy, funding is only made available to entrepreneurs⁴ (promoting employment – a second social innovation objective of the programme) and only cover initial equipment (e.g. 3D printers, CNC machines and computers) costs up to 7 million RUB (roughly €110,000), leaving entrepreneurs sole in charge of finding a sustainable business model for their CMIT. In exchange for the funding, CMITs have to devote 40% of their time to educational activities provided free of charge. In the bid CMITs are asked to fill in 19 pages related to Key Performance Indicators (KPIs). During the annual audit, however, these are not checked and only financial activities (revenues and expenses) are reviewed. Since 2013, around 240 CMITs were funded and 170 are still currently operating.

Hence, the STDFS fund is genuinely an Open Social Innovation programme. On the one hand it promotes social innovation goals (education, skill gap reduction and employment), but also it is actually open for anyone to participate. Aside from minimal and fairly generic requirements, CMITs are not only free, but actually must fulfil local needs, as their sustainability and long-term survival depend on it. As a consequence, as will be shown in Section 3, CMITs are very diverse in nature.

Furthermore, the CMIT programme, is not only itself a case of Open Social Innovation, but it also, in turn (as discussed in 3), promotes Open Social Innovation.

3. Methodology

As noted in Section 1, Open Social Innovation is a relatively young field in the literature and there are few studies exploring how open social innovation arises and how it delivers social impact. Because of that, this research is based on an exploratory methodology, as this methodology is especially relevant when issues that are being studied are still evolving (Yin, 2003).

The choice of sample is particularly critical for explorative studies (Miles and Huberman, 1994). In particular, sample size – which reflects the representativeness of the study – and sample composition

– which reflects the diversity of the sample, and therefore, its exhaustiveness – are important. The sample size should provide scope for possible generalities, but remain small enough for individuals to keep their own identity (Robinson and Smith, 2010). According to Guest et al. (2006) saturation (a point where no more new information is collected) is reached very quickly, and already six interviews can enable to collect most of the critical information, with perfect saturation often reached with 12 interviews. Following Silverman (2013), we decided to monitor data collection as it progressed and alter sample size according to the results of the interviews. No new themes were added during the ninth interview, three more interviews were nonetheless conducted to ensure that saturation had effectively been reached.

In an exploratory study, diversity is critical to ensure the full extent of the phenomenon is observed. Consequently, the 12 CMITs in the study (Table 1) were chosen according to their region (the study covers six out of eight administrative regions of the Russian Federation), their specialisation, their location (the population of cities where the 12 CMITs are located ranges from 7,000 to 12 million people),⁵ as well as whether they had signed the Fab Lab charter (five of them) or not (in which case, they are, actually, makerspaces). Because semi-structured interviews are the most common type of interview used in qualitative research (Alvesson and Deetz, 2000) and are one of the most effective means of gathering information (Kvale and Brinkmann, 2009), this form of interviews was used for the 12 CMIT founders. Interviews lasted between 30 and 45 min. During the interviews, participants were asked to keep to the topics defined in the interview guide, but yet encouraged to speak freely (Yin, 2003).

The topics discussed during the interviews were based on informal discussions authors had during their visits to CMIT centres in 2013–2016 as well as during a CMIT meeting held in Moscow in summer 2016, where many CMIT founders were present. Topics were:

1. Detailed information about the CMIT.
2. Background of the CMIT founder.
3. Objectives and motivation for opening a CMIT.
4. Development of the CMIT (choice of location, staff hire, etc.) before and after funding was obtained.
5. Activities carried out at the CMIT and reasons for such a choice.
6. Business model of the CMIT and sources of revenues.
7. CMIT users and their purpose.

Table 1. Centres for Maker Innovation and Technology (CMIT) included in the study (* are official fab labs)

| Code | Region | Founded | Funded | Location | Focus |
|------|-------------|---------|--------|--------------|--|
| NC1* | N. Caucasus | 2009 | 2014 | University | Agricultural machinery and R&D |
| NW1* | North West | 2011 | 2013 | University | Education |
| C2* | Central | 2013 | 2013 | Residential | NPD and startups |
| V1 | Volga | 2013 | 2013 | Techno park | Biotech, medical startups and R&D |
| C4* | Central | 2013 | 2013 | University | Design |
| S2 | Siberia | 2013 | 2013 | Incubator | Education |
| S1 | Siberia | 2013 | 2013 | University | Robotics and electronics |
| C1 | Central | 2014 | 2015 | Art cluster | Education, design thinking and prototyping |
| C3 | Central | 2014 | 2015 | Residential | Classes for schoolchildren |
| NW2* | North West | 2014 | 2015 | College | Classes for schoolchildren |
| NC2 | N. Caucasus | 2016 | 2016 | Youth centre | Education |
| C5 | Central | 2016 | 2016 | Residential | Classes for schoolchildren |

8. Involvement of the local community in delivering activities (whether paid or not) at CMIT.
9. Projects and activities carried out at CMIT that had social impact at local, regional and national levels.

Interviews were recorded, transcribed and then coded independently by two investigators, to enhance confidence in the research findings (Yin, 2003). Deductive coding (Miles and Huberman, 1994) was used to match identified patterns against the six-stage framework of social innovation (Murray et al., 2010).

4. Analysis

The 12 interviews of CMIT founders were coded using the six-stage framework of social innovation developed by NESTA (Murray et al., 2010). The sections below present the results of the exploratory study for each of the stages.

4.1. Stage 1: prompts

Prompts are the first stage in a social innovation process and correspond to the identification and the framing of the problem (Murray et al., 2010). While this study focuses on the CMIT centres, it is useful to mention the prompts of the CMIT programme itself. The main prompt for the CMIT programme was the sharp decline – in interest of young people towards engineering – and STEM subjects in general – which had an adverse effect on the entire economy, as engineering affects virtually every aspect of our society (Bugliarello, 1991). While this disaffection towards engineering subjects has happened in other countries, this was particularly striking in the case of Russia, a country where between 1960 and 1990

close to half of students (45%) studied engineering, with over a million engineers graduating every year.⁶ In contrast, by 2008, the proportion of Russian students enrolled in engineering degrees had dropped to 18% and has remained low ever since. Furthermore, nowadays, out of 63% of Russian children who attend after-school activities only 5.8% attend activities related to technology and engineering.⁷ Noting the potential of fab labs and makerspaces to address such kind of issue, the Russian Science and Technology Development Fund for SMEs (STDFS) decided to launch the CMIT programme.

While some CMIT founders perceived the same prompts as the STDFS, other founders' prompts were different from the programme's objectives.

NW1, S1, S2 and C5 are among those who mentioned prompts similar to the CMIT programme. All four founders reported having been inspired by their visit of national and international fab labs and by the way these spaces helped engage students in engineering. In this respect, it is worth noting that both C3 and S2 had been involved in youth education prior to CMIT and saw digital manufacturing as a way to make STEM and engineering more engaging. V1 also saw the same prompt as the creators of the CMIT programme, albeit indirectly. Indeed, V1 was created as an intrapreneurship CSR project within a large medical equipment and prosthetics company that was facing difficulties recruiting qualified engineers.

Yet, other CMIT founders saw different prompts, not necessarily related to STEM and engineering education. For instance, C1 saw a business opportunity within an art cluster, where members of the cluster were in great need of digital manufacturing solutions, but did not have the resources to do so. Likewise, NW2 was founded by a serial entrepreneur

who also saw a business opportunity in 3D printing technologies. More surprising, NC1, who is located on university premises, had an initial prompt that was not related to education, but instead to research. Digital manufacturing technologies were indeed seen by NC1's founder as a means to significantly speed up the development process of agricultural machines. C4 is in a similar situation: while located in a university, the initial prompt was not so much related to education, but instead to bolstering creativity through digital manufacturing. While education of STEM and engineering was not the original prompt in these four cases, the launch of the CMIT programme enabled to promote further the education agenda of the programme, as these four CMITs adopted, as a result of the funding they received, STEM education as one of their key objectives.

As noted in Section 1, employment was another of the key prompts of the CMIT programme. In this respect, it is interesting to note that one founder (NW2) was unemployed before receiving CMIT funding and that three others (C2, C3 and NC2) saw the funding programme as an opportunity to change job.

4.2. Stage 2: proposals

Once the problem is identified and framed, comes the ideation stage from which potential solutions will emerge (Murray et al., 2010). The four respondents who had worked for universities (NC1, NW1, C4 and S1) proposed as a solution to the problem of promoting STEM and engineering to open a CMIT on university premises, which could be used both by university students and visitors. Likewise, the founder of NW2 – who did not have any particular link with the education world – thought that a professional college would be the best location for his CMIT, which is specialised in activities for schoolchildren.⁸

Three of the interviewees thought that helping businesses and startups adopt digital manufacturing was just as important as promoting STEM and engineering and, as such, chose to open their CMIT in an incubator (S2 and V1)⁹ and an art cluster (C1). The founder of NC2 thought that a youth centre, located at close proximity both to schools and train station, was the best location to foster engagement in STEM. Finally, the founders of C1, C2 and C5, whose main goal was to provide after-school engineering clubs for children in their neighbourhood, chose a local residential building to establish their CMIT.

4.3. Stage 3: prototyping and pilots

The prototyping and pilots stage is when 'ideas get tested in practice' (Murray et al., 2010). For most of

the interviewees (C2, C4, C5, NC2, S1, S2 and V1), this stage began when their proposal was accepted and they received funding from the CMIT programme. Yet, five CMITs (C1, C3, NC1, NW1 and NW2) had started their business before they received funding. This does not mean, however, that all prototyping and pilots had been done beforehand. For example, while NC1, NW1 and NW2 started as fab labs, only NW2 provided activities for kids prior to the programme launch.

All interviewees reported issues and difficulties to get to a 'working' prototype, and went through many trials and errors before they arrived at a point where their centres could run efficiently and smoothly. A reason for that is that founders often lacked knowledge of both technology and business-related matters, and had to 'learn on the job'. For example, although the majority of interviewees (9/12) have an engineering degree, only one of them had an extensive (5 years) experience of digital manufacturing technologies at the time his CMIT was launched. In order to learn more about the technology and its usage, most of the respondents visited professional exhibitions, as well as existing fab labs (in Europe and in the United States) and (for those who launched later) existing CMITs.

Further difficulties at the pilot stage were related to the fact that, besides technology, founders, who only receive a one-off funding, had to become rapidly astute businessmen: 'not only founders need to be technology experts, but they also need to know how to create a startup' (NC2). Interestingly, only one of interviewees had a business degree, and two more had some entrepreneurial experience, which meant that virtually all the founders had to acquire business skills, and acquire them quickly: 'I wasn't either an entrepreneur or a lawyer, I was a physicist, a geek and a maker, so in 2 months I had to learn how to run a business' (S1). Because funding could only be used to purchase equipment, founders tinkered with bootstrapping techniques: they looked for sponsors (C2, V1 and NW1), used free premises (NC1, NW1, NW2 and S1) or paid a discounted rent (C5), and made use of free software (C2 and C3).

Once the business side was 'prototyped', founders often ran into further difficulties related to the fact that they had to offer (at least) 40% of activities to young people, which in all cases but one (C3), meant learning about markets and 'customers' they were not familiar with. For instance, the founder of S2 mentioned that he realised he had to organise activities for children, but that he 'had no clue of what activities [he] was expected to offer'. Similarly, the founder of C1, who knew very well how to manage corporate clients and their demands, was at first

really unsure as to what kind of events and training activities she could offer to children. Using her own experience as a mum, she decided to first offer events specifically designed for families in order to bring family members together to her CMIT.

Another important step – and source of difficulties – in this prototyping stage was to form a team. Founders not only had to find people with the right mindset (creative, enthusiastic, proactive, at ease with children), but also had to consider budget constraints, as CMIT funding could only be used to buy equipment. An easy way out was to hire students, as they tend to have all the required qualities and do not require a high salary. For this reason, all 12 CMITs, regardless of whether location (within a university or not) employ mainly students as members of staff. In most cases, however, this did not solve the problem completely, as running 40% of free educative activities for children and young adults requires a lot on manpower. After a few burnouts, most CMITs in the sample began experimenting with external resources with the aim to minimise HR expenses, which led to new strategic decisions. For example, CMIT members who help other members or take part in external events were offered free use of equipment (C2, S1 and S2) or given special bursaries (S1). This means that ‘the line between an employee and a member is blurred’ (NW1) and, ultimately, volunteers even often come with better ideas than paid employees (NC2).

4.4. Stage 4: sustaining

Sustaining happens ‘when the idea becomes everyday practice’ and the prototype/pilot gets refined and fine-tuned. Sustaining also corresponds to the identification of means (such as income streams) that ensure long-term sustainability (Murray et al., 2010).

While all CMIT founders were able to launch their centre, all of them reported that they ran rapidly into trouble and had to adapt their practice to stay afloat. In particular, in addition to facing managerial and financial problems, founders mentioned difficulties in finding the right balance between commercial and educational activities. Indeed, founders who had mainly commercial activities in mind still had to provide free educational activities, either to meet the conditions of the programme, or because of their attitude towards education: ‘I see education as a main contributor to economic development of the region in particular and country in general’ (NC2). On the other hand, even founders who aim at popularising engineering and creating better skilled workforce cannot ignore the financial aspect of the venture in order to become financially sustainable: ‘our goal

is to create a sustainable CMIT (NW2)’. Therefore, during this sustaining stage, CMIT founders were forced to find solutions that combined business interests and social aspects, which was challenging: ‘we believe that social side is very important [...] how to balance the two is not very clear’ (C3).

Furthermore, faced with space and staff constraints, founders reported they experienced difficulties finding the right balance in terms of activities. In particular, all centres enable members to work on projects, but find that members are discouraged when their work is interrupted by a scheduled class. On the other hand, prioritising projects too much undermines the sustainability of the centre. CMITs therefore face a trade-off between member engagement and income streams, and finding the right balance is the key to sustainability.

A further issue reported that makes sustaining difficult relates to staff turnover. While finding a good team is a part of prototyping, maintaining it is critical in order to sustain. For instance, C1 mentioned that ‘in 3–5 years they [instructors] will want to do something else with their life and we will need a replacement’, which means that a new ‘generation’ of instructors needs to be trained in the meantime, which adds financial stress and uncertainty. C5 mentioned that though experts had agreed to give classes from time to time, it was very difficult to retain them, due to low payment CMITs are only able to offer.

Another important aspect of the sustaining phase is to identify relevant external partners (mentors, workshop and masterclass organisers), while keeping financial constraints in mind. Interviews show that CMIT founders are very much aware that ‘not all smartest people work for [them]’ (Chesbrough and Di Minin, 2014). Finding external partners is thus a necessary step, in particular to fill in knowledge gaps identified by the members (C2).¹⁰

Finally, finding steady income streams is a particularly critical aspect of the sustaining stage for CMITs. Indeed, unlike other fab labs and maker-spaces that may receive recurring subsidies, CMITs only obtain funding for equipment and imperatively have to find ways to become financially sustainable. Because the CMIT proposals, prototypes (and even prompts) were different, as a result, they chose different sustaining paths. While all carry out charged educational activities (alongside free ones), this is generally not sufficient. Consequently, they engage in paid R&D (V1, NW1 and NC1), interior design (S1), help with prototyping (S2), offer 3D printing services (NC2), rent out co-working spaces (NW1) and even create display stands and artistic objects for events (C4).

4.5. Stage 5: scaling and diffusion

While not all CMITs have proven sustainable (70 out of 240 have closed), others reached a stage where they could start scaling up and diffuse their model. First of all, as more and more members join a CMIT, it often grows in size. For example, one of CMITs (V1) has grown from a room in a business incubator to 1,200 square metre premises in a techno park. Also, once CMITs reach a sustainable state, they typically start broadening and scaling up their activities to foster greater outreach. For some, scaling and diffusion imply carrying out activities outside the CMIT. For instance, C4 started organising events in city parks, which several times attracted more than 10,000 people. Also, two CMITs (S1 and NC2) launched training programmes for schools related to digital manufacturing. They have also helped schools install and set up the equipment, train teachers to use equipment and help them integrate digital manufacturing in the school curriculum. S1 branched out into robotics and created guidelines and manuals that can be used to set up robotics clubs. Finally, to foster greater outreach, NC1 started to run free one day workshops for schoolchildren located in less populated areas (200–300 km away from the city), who were brought in by bus to the CMIT for the day.

Once founders have been successful with one CMIT, there is evidence that they attempt to diffuse their successful model. One of the founders (NC2) opened a CMIT in another city, while another one (C1) was even more prolific and went on to launch another 10 CMITs in various regions of Russia and even abroad. Creating new CMITs is not the only manner to scale and diffuse a successful model. For instance, NW1 and C2 are helping set up new CMITs (they mentor new CMIT founders and help them run the CMIT at the beginning). Following his successful experience of launching and sustaining a CMIT, one of the founders (C2) also launched the 'CMIT Academy', a training facility and platform for educational projects related to digital manufacturing, which can be used not only by CMITs, but also by other educational institutions.

4.6. Stage 6: systemic change

Systemic change is the 'ultimate goal of social innovation' and involves interaction between diverse elements, e.g. social movements, business models, laws and regulations, data and infrastructure (Murray et al., 2010). For Chesbrough and Di Minin (2014), achieving systemic change requires models and practices to be both economically and socially sustainable.

It is important to note that the CMIT programme is still rather young, as it started in 2013. This makes it is rather unlikely that significant systemic change could be observed at such an early stage.

While the CMIT programme has been rather successful, with 240 CMITs launched in 6 years, it would be hard to argue that CMITs have become 'the norm'. Yet, beyond economic sustainability, interviews show that some form of social sustainability already exists. For instance, all interviewees reported that they had been able to establish strong links with the local community – whether individuals, businesses, schools and universities, local authorities – who regularly engages in the CMITs' activities. For example, C3 reported that the number of children attending day camp they organise is constantly growing. Similarly, events organised by C4 have grown from a few hundred to thousands of participants.

Furthermore, the achievements of some of the CMITs have led them to be acknowledged as important actors at regional and national level. NW2, for instance, has played an important role in helping connect the Department of Innovation and Department of Education at national level. Likewise, C2 has been asked to serve as an advisor on educational matters by several regional Departments of Education.

Another sign of such systemic change relates to the higher retention rates. For instance, V1 mentioned that while originally barely 1% of the children and young adults that passed by the CMIT would subsequently become regular members, this proportion had significantly increased over the years.

While it is too early to assess systemic change, there is already evidence of social impact delivered by CMITs. For instance, all participants mentioned that a large number of their members were applying for engineering degrees. While it could be argued that there might be a selection bias (e.g. people attending CMITs would have done engineering anyway), it is worth noting that all interviewees reported that a significant number of children in their CMITs only started to consider engineering studies after they had joined the CMIT. C3 mentioned that the CMIT experience is also valuable for schoolchildren who decided not to pursue engineering studies, as it is then an informed choice and not a decision based on prejudice or someone else's opinion.

Besides a direct impact related to STEM and engineering education, the CMITs also deliver social impact through the social innovation activities carried out by its members. Actually, most interviewees mentioned that one of their goals was to encourage members, children in particular, to engage in social innovation projects, so that they become 'good citizens'. For

example, S1 mentioned that ‘when kids grow up they will choose different career paths, but hopefully will remember that there are people in need’.

5. Discussion

Perhaps one of the most surprising outcome of this research is that depending on the stage of social innovation, CMITS could be similar or different and these differences are primarily related to their choice of location, which arises at [Stage 2–Proposals]. Among the 12 CMITs interviewed, three models can be identified: ‘educational’ CMITs, located within university or school premises, ‘industry’ CMITs, located in incubators, accelerators, or techno parks and ‘residential’ CMITs located in residential areas (Table 2).

From the interviews, it is quite clear that this choice of location is a highly critical aspect, as it conditions the business model and, hence, the sustainability of the CMIT. As shown on Table 2, Educational CMITs are placed in a low-cost/low-revenue environment. Being located on school/university premises generally means that they do not have to pay any rent. Also, being on campus means that it is relatively easy to attract volunteers that would work in the CMIT for free. Conversely, generating revenue streams is rather hard, as most activities are carried out free of charge (in exchange for the free accommodation) and there are few opportunities to work for businesses, as there are generally few around.

In contrast, Industry CMITs are in a high-cost/high-revenue environment. Indeed, being located in (or next to) incubators, accelerators and techno parks, they have to pay a rent for the premises they use. Yet, being close to businesses, it is relatively easy to offer them services (e.g. prototyping, 3D printing on demand and paid R&D) and generate revenue streams.

Residential CMITs are certainly the ones facing the most difficult –i.e. high-cost/low-revenue

– environment, as they have to pay a rent (although some, like C5, may be able to negotiate a discounted rent) and there are relatively few opportunities to offer paid-for services in residential areas, especially since parents tend to consider that, owing to the initial public funding, all educational activities of her CMIT should be offered free of charge (C5).

A further issue Residential CMITs face is the relatively higher difficulty to attract both volunteers and paid staff. Though some may live nearby, the pool of students who can potentially be hired is dramatically smaller than for Educational CMITs. Furthermore, Residential CMITs are generally targeting a younger crowd (typically 6–17 years old), which makes it less likely that members can be used as volunteers to run activities. While Industry CMITs also face similar difficulties to access labour, their higher revenues enable them to be less reliant on volunteers and, also, to attract more people by offering higher wages.

Hence, Residential CMITs are, in the most fragile situation and sustaining [Stage 4] is more likely to be an issue than for the two other types. This is particularly important because, of the three types, they are also the ones most likely to achieve the systemic change [Stage 6] targeted by the CMIT programme, i.e. rising engineering/STEM awareness among children and young adults. Educational CMITs are located at universities and professional colleges, so the young adults using these spaces have presumably already chosen the discipline they want to study. The same phenomenon is also likely to occur for Industry CMITs, whose users are generally involved in start-ups, or professional working on gaining additional skills. Yet, at this rather early stage, no significant differences in regard to systemic change could be inferred from the interviews.

Interestingly, in regard to the other stages, interviews did not reveal many other significant differences. Prompts [Stage 1] are diverse for the three types of CMIT. Prototyping [Stage 3] revealed very similar issues for the three types.

Table 2. Types of CMIT and differences in Open Social Innovation process (* are official fab labs)

| | Education | Industry | Residential |
|--------------------|--|------------------------|-----------------------|
| CMIT | C4*, NC1*, NC2, NW1*, NW2*, S1 | C1, S2, V1 | C2*, C3, C5 |
| 1. Prompts | Diverse prompts | | |
| 2. Proposals | Low cost/low revenue | High cost/high revenue | High cost/low revenue |
| 3. Pilots | Similar issues | | |
| 4. Sustaining | Easier | Average | More difficult |
| 5. Scaling | More likely to scale up | | More difficult |
| | In breadth/outreach | In size | To scale up |
| 6. Systemic change | No apparent difference (too early to tell) | | |

In regard to scaling up [Stage 5], interviews have revealed many more instances of scaling up for Educational and Industry CMITs. While it would be hard to generalise from such a small sample, it appears that Industry CMITs tend to scale more in terms of size (e.g. size of premises (V1) and number of CMITs (C1)), while scaling up for Educational CMITs appears to relate mainly in increasing the breadth of their activities and outreach (C2, NC1, NC2 and S1). Unsurprisingly, considering their rather precarious business model, Residential CMITs have hardly displayed any signs of scaling.

On a final note, the interviews did not reveal any differences in the open social innovation process between official fab labs (i.e. the five CMITs that had signed the Fab Foundation Charter) and the makerspaces. Instead, differences appear to be rather historical, i.e. older CMIT founders visited fab labs abroad and, as a result, were more inclined to sign the charter, while more recent CMITs could increase their knowledge by visiting existing CMITs, making the link with the Fab Foundation seen a something superfluous.

6. Conclusion

The aim of this study was to explore the dynamics of open social innovation and the way it delivers social impact within the context of a large governmental seed-funded network of fab labs and makerspaces.

The main contributions are twofold. In regard to open social innovation, this research has provided insight into how social entrepreneurs adapt to global and local constraints to deliver social impact. Though considering that the starting points of the programme are similar one could have expected one model of CMIT to emerge, findings suggest that the dynamics and delivery are very diverse.

In fact, three different types of CMITs – Educational CMITs (located at universities/schools), Industry CMITs (located in incubators or techno parks), Residential CMITs (located in residential neighbourhoods) – were identified in this study, each facing different kinds of constraints and requiring different business models. Yet, despite some key differences between each type of CMITs, this research has shown that many aspects of the social innovation process are nonetheless similar across the three types.

A further point of interest in regard to open social innovation relates to policy and has implications for policy makers. Despite the relative youth of the CMIT programme, our interviews tend to show that policy encouraging a ‘lightweight’ bottom-up and open social innovation (with rather loose KTIs)

enables to rapidly deliver social impact. Also, similarly to Eftekhari and Boger (2015), the results of this study show that policies that facilitate open innovation among startups (which CMITs are) help increasing their chances of survival.

Yet, this study also illustrates some limits of open social innovation. Whereas Residential CMITs are probably those who would generate the most (targeted) social impact, they are also the ones who face the greatest challenges. In contrast, Educational and Industry CMITs appear more scalable and sustainable, but are possibly fulfilling only partially the objectives of the CMIT programme.

A second contribution of this research relates more specifically to fab labs and makerspaces. In particular, this study provides the founders and managers of fab labs and makerspaces with a roadmap to make these entities sustainable and in some cases even profitable. Most challenges encountered by the CMIT founders are the same as those experienced by fab lab founders everywhere else in the world: necessity to adapt to the local environment, trial and error at prototyping stage, difficulty to sustain and to scale and diffuse. Indeed, the study can provide fab lab and makerspace founders and managers with guidance in relation to team building, use of external resources, striking the right balance between paid and free-of-charge activities, and finding external sources of income. At a time when historical fab labs have closed because of lack of sustainable business model, the CMIT experience could provide valuable information on how to find a sustainable path for non-subsidised fab labs and makerspaces.

Upon completion of this first exploratory study of the CMIT network, several avenues for further research come to mind. A first one would be to confirm these qualitative findings by carrying out a survey of the other CMITs. Also, since this network enables to observe open social innovation at three different levels – macro level (the national programme), meso level (the fab labs, makerspaces and their founders) and the micro level (open social innovation carried out by CMIT members) – it would be interesting to investigate the interactions between these three levels. Finally, it would be interesting to replicate this study with fab labs and makerspaces located outside of the CMIT network in order to gain further insights about the open social innovation processes in fab labs and makerspaces in general.

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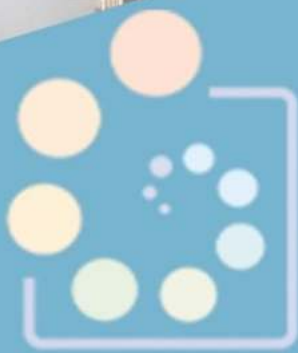
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Notes

1. A link, albeit indirect, between social innovation and open innovation was beforehand established in the case of Corporate Social Responsibility (Holmes and Smart, 2009).
2. <http://www.fabfoundation.org/index.php/about-fab-foundation/index.html>
3. Some CMITs have signed the Fab Charter, others have not.
4. Which means that schools, universities, local administrations, etc., are not eligible.
5. Population is not listed in the table to protect anonymity.
6. http://www.socioprognoz.ru/files/File/publ/Inkzernerno_technicheckoe.pdf
7. <https://ria.ru/society/20150316/1052833237.html>
8. Students enrolled in the college are 14–19 years old and receive technical education.
9. V1 is now in a techno park, but was originally located in a business incubator.
10. For instance, the CMIT team might be very knowledgeable in digital manufacturing but not in design, robotics and Internet of Things.

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