



Youth and Technology

A desk review of the makerspace phenomenon and its potential to enhance youth employment and empowerment

Susan Njambi-Szlapka
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Contents

1 Introduction	6
1.1 Background on makerspaces	6
1.2 Review of Methodology	9
2 Key findings on outcomes	11
2.1 Effects on employment	11
2.1.1 Employment: Enablers	12
2.1.2 Employment: limitations	14
2.2 Effects on broader empowerment	14
2.3 Broader social effects – social inclusion and education	15
2.4 Secondary-level (indirect outcome) effects	18
2.5 Wider Challenges	19
2.5.1 Financial sustainability	20
2.5.2 Scalability	22
2.5.3 Access to hardware	23
2.5.4 The regulatory environment	23
2.5.5 Education	22
2.5.6 Limited inclusivity	22
3 Youth involvement in makerspaces	22
3.1 Enablers of the UNICEF Innovation Lab Kosovo	27
4 Conclusions and recommendations	26

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Executive summary

Background

The maker movement is a growing and dynamic phenomenon worldwide with new spaces being created and others being dissolved. Makerspaces are spaces for collaborative working, learning by doing (otherwise known as the DIY-movement), innovation and invention. They include FabLabs, co-working spaces, hackerspaces, hubs and other similar spaces and while these terms may be used synonymously there are some differences in their respective foci. This desk review looks at the effects of these spaces on three youth outcomes: employment, empowerment and inclusion. Its findings will inform the design of Terre des hommes' humanitarian FabLabs by drawing on key lessons from the literature.

Effects on youth outcomes

There is little evidence on youth outcomes such as youth employment, inclusion or empowerment. This is in part a result of the lack of clearly defined objectives and theories of change for makerspaces. More rigorous evaluations are needed as well as suitable evaluation and learning methods catered to the unique facilitative nature of makerspaces. However, some key findings are:

- **Employment:** Makerspaces can help increase self-employment by addressing information asymmetries between entrepreneurs and investors. However, there is little evidence on the use of makerspaces by marginalised young people.
- **Empowerment through education:** Makerspaces teach skills where other formal education providers fail. Finding ways to formally recognise the skills acquired by users will help young people access formal employment opportunities.
- **Indirect effects:** Makerspaces enhance youth employment, inclusion and empowerment by creating spaces that stimulate problem solving. Youth in makerspaces have brought digital education to other young people, created career counselling sites, and even apps to report gendered violence.
- **Youth accessibility:** makerspaces for youth employment must be accessible to marginalised youth. This means thinking carefully about appropriate geographical and institutional homes, as well as outreach approaches. In order to increase youth access makerspace organisations should involve youth in the design of the makerspace. They should take a human-centred design approach— involving young people from diverse backgrounds and both male and female in their design—rather than relying on experts alone to shape these spaces. To implement this human-centred approach and respond to needs, makerspaces need flexibility and autonomy. They also need to conduct outreach activities and use digital platforms to target those who have access to internet.

Makerspaces and hubs still face challenges which hinder the extent to which they can have wider impacts on youth employment, empowerment and inclusion. These include financial sustainability, regulatory challenges and limited inclusivity with respect to marginalised youth.

To maximise their impact on youth employment, inclusion and empowerment, makerspaces should implement the following recommendations:

Recommendations

1. Be clear about the longer-term objectives and feasibility of supporting makerspaces. Involve young people in designing makerspaces to support these objectives

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2. Be clear which groups the makerspace would like to engage with, and develop pro-active outreach activities to support these aims
 3. Consider the wider infrastructure for the makerspace and any spin-offs
 4. Encourage scaling and spin-offs that relate to the objectives of each makerspace
 5. Consider whether the makerspace could be permanent, temporary, physical and/or virtual, and think from the outset how available funding matches these goals
 6. Understand the relationship between makerspaces and formal training and education provision, and seek to strengthen these linkages, especially provision of recognised qualifications.
 7. Manage makerspaces, generate learning and assess their impact using non-traditional approaches, mixed research methods (quantitative surveys and more in-depth qualitative research) and where possible generate longitudinal data to understand not just short-term but also longer-term legacy effects of programme investments.

Introduction

The world is experiencing a youth bulge. Agenda for Humanity estimates that half of the 1.4 billion people living in countries affected by fragility and crises are under the age of 20¹. However, in these humanitarian contexts—where people suffer from conflict, deprivation, displacement—youth as a population group has not been sufficiently prioritised. Youth unemployment is high: in sub-Saharan Africa in 2017, 15.5 per cent of the youth were not in education, employment or training (ILO, 2017). Ensuring that these young people have the capacity, skills and resources to respond to and achieve resilience in the context of humanitarian situations is essential to improving humanitarian effectiveness and fostering resilient communities (Global Compact for Young People in Humanitarian Action).

Against this backdrop, the current study explores an emerging trend in the employment and youth empowerment and inclusion sectors. The maker movement seeks to enable new models of education, manufacturing and collaborative work (Rosa et al., 2018). In Europe, the maker movement aims to find solutions to environmental and sustainability problems (*ibid*). In Africa and the developing world its focus is on finding local solutions to local problems that enhance sustainability whilst also creating employment, improving income generation and enhancing social, economic and political participation (World Bank, 2017; De Beer et al., 2017; Friederici, 2017). While there is some literature that discusses the potential impact of the maker movement on youth employment and inclusion, little has been done to synthesise empirical findings, implementation challenges and enablers. This desk review summarises key findings on how these initiatives can be utilised to enhance youth employment, inclusion and empowerment. It draws out lessons for Tdh Fablabs and other Fablabs in their work with youth.

1.1 Background to makerspaces

Key points

- The maker movement is a growing and dynamic phenomenon worldwide with new spaces being created and others being dissolved.
- Makerspaces are spaces for collaborative working, learning by doing (otherwise known as the DIY-movement), innovation and invention
- They include FabLabs, co-working spaces, hackerspaces, hubs and other similar spaces and while these terms may be used at times synonymously there are some differences in their respective foci.
- Hubs which are hybrids of these spaces are popular in developing countries
- In sub-Saharan Africa, a hybrid model is more common combining features of makerspaces, hackerspaces, co-working spaces and incubators.

1.1.1 What are makerspaces?

The grassroots-driven maker movement refers to a growing number of individuals (“makers”) who use physical or digital forums to produce physical objects and share these with the members of the maker

¹ <https://www.agendaforhumanity.org/initiatives/3829>

community (NYCI, 2018²). Makers are inventing new ways of working and learning while engaging in digital transformation. These new ways of working are characterised by personal fabrication (otherwise known as the Do-It-Yourself movement), collaborative working and sharing on global platforms, and new models of education (learning-by-doing). Makers disrupt the market as they seek to democratise production by shifting away from a market where the players are large existing companies. Instead they create micro-factories where personalised items are produced by individuals with access to 3D printers rather than being mass manufactured in factories. Once individuals produce the personalised products they share the process of production on global platforms for other makers to replicate and adapt these products to their own needs.

1.1.2 Characteristics and aims of makerspaces

Makerspaces provide the facilities, tools and community engagement to enable these shifts. They are community workshops where members and users access tools such as 3D printers or laser cutters to produce (physical) products such as tools for building or welding, toys, artisanal products or software (Van Holm, 2014).

Makerspaces are sometimes referred to as hackerspaces, FabLabs, hubs or co-working spaces, among other terms. They are all spaces for making, collaborating, learning and sharing. They typically include offers of educational programmes including for instance on digital fabrication, robotics, the internet. They are often set up in libraries, universities, community centres, or standalone buildings as well as classrooms. Makerspaces vary between small spaces for communities and big spaces with commercial services (Taylor, 2015). Not all makerspaces have the same goals and aims. However, what they share is the aim to provide open spaces that are accessible to the public to collaborate and engage in design and manufacturing (Friederici, 2017). Finally, they aim to foster a culture of making as opposed to consuming (Hatch, 2014). The varied terms for these spaces are often used synonymously, but there are some differences between them which are summarised in Annex A.

Within the makerspace and workspace family, FabLabs serve a particular function. FabLabs are governed by a foundation (the Fablab Foundation, Fablab.io) which has a charter and specific rules. Founded in the Massachusetts Institute of Technology's Centre for Bits and Atoms, FabLabs started as an education facility following the pedagogical principles of learning by doing before they became an entrepreneurial tool (Bilkstein, 2013). They provide access to fabrication hardware and software along with training, workshops and other service to enable their users to create, prototype and test products. FabLabs cater to early stage development of innovations, after which users are encouraged to produce and sell their products outside of the FabLab. This is to allow other users to use the facilities and prevent the commercialisation of the spaces.

In sub-Saharan Africa and Asia, technology hubs (tech hubs) or innovation hubs are more common. These are typically hybrids of makerspaces, incubators, accelerators, co-working spaces, FabLabs, hackerspaces, and other innovation centres (Littlewood et al., 2017). Hubs typically also house other makerspaces, as is the case with iHub which houses mLab, Nailab and others. A study of makerspaces in the global south therefore must include a discussion of "hubs".

In 2016 there were 442 hubs in sub-Saharan Africa (Bayen and Giuliani, 2018). The majority were concentrated in South Africa with 59 active hubs Nigeria (55), Egypt (33), and Kenya (31). Examples include the iHub in Nairobi, the Kumasi Hive in Ghana, kLab in Uganda and jHub in South Sudan. It also includes the mLab in Nairobi: this was established with World Bank support (through InfoDev) by

²<http://www.youth.ie/sites/youth.ie/files/Guide%20to%20setting%20up%20makerspaces%20in%20youth%20work%20organisations%282%29.pdf>

EastAfrica3, and is run by a consortium of stakeholders., including (eMobilis), an academic organization (University of Nairobi), an NGO (World Wide Web Foundation) and a Tech Hub (iHub).

In South and South East Asia where there were 565 hubs, more than 50% were found in India (250), Indonesia (51) Malaysia (39), Thailand (38), and Vietnam (37) (GSMA, 20183). According to the World Bank's 2016 mapping (Kelly and Firestone, 2016) , the majority of these spaces were civil society led (68%) while the rest were either led by government (6.4%), academic institutions (9.2%) or were a hybrid (16,1%).⁴ The civil society model refers to hubs which are run by NGOs, foundations, and private sector firms that are not affiliated with government or academic institutions (*ibid*).

These spaces are characterised by high dynamism: at the time of this report, around 400 new hubs had been opened and around 80 closed within a period of 18 months (Bayen and Giuliani, 2018). For instance, the Uganda Space Hub, iLab in Liberia, JHub in South Sudan or the South African 88MPH have (maybe temporarily) shut down (*ibid*).

Overall, the investment in these spaces appears to be less concentrated in Africa and mostly in Europe and North America. Mappings of these spaces suggest there is comparatively low investment in makerspaces in Africa compared to Europe and North America⁵⁶.

1.1.3 Who uses makerspaces?

Much of the literature on youth and makerspaces focuses either on the youth in developed countries or young students or graduates in developing countries. The large majority of users of these spaces are younger than 35 years with some spaces having an even younger user-based between 6-16 years old (Schonwetter and Wiele 2018). There is some indication that spaces concentrated in the global north have a older userbase -e.g the Impact Hubs in the global north have a user base of 20-40 years old (Wittmayer et al., 2015). The users of makerspaces are typically early adopter young males who recently graduated university with a creative and IT background (Taylor et al, 2015; Bramann, 2016). According to Taylor et al (*ibid*) this is because many of these makerspaces have grown out of software clubs which have tended to be male-dominated. Furthermore, as many makerspaces are housed within universities users of makerspaces will tend to be students of those universities (Barrett et al., 2016; Wong et al., 2016). Generally, nearby educational institutions strongly affect the userbase (Schonwetter and Wiele,2018). However, users also vary depending on location, what the makerspaces offer and how they communicate those offers, as discussed further below. Some initiatives have started to reach out to young women to encourage them to participate in tech or STEAM subjects (Science, Technology, Engineering, Arts and design, and Maths) such as the “Tech Needs Girls” initiative in Ghana⁷. Students from Soronko Academy act as mentors who train the 6 to 18-year old girls at the space⁸. The Terre des hommes pilot FabLabs in Greece found that 54% of the visitors were female and 14% of those from the host community.

³ <https://www.gsma.com/mobilefordevelopment/programme/ecosystem-accelerator/1000-tech-hubs-are-powering-ecosystems-in-asia-pacific-and-africa/>

⁴ <http://pubdocs.worldbank.org/en/765531472059967675/AFC42460-081716.pdf>

⁵ <https://www.atlasofinnovation.com/map/>

⁶ <http://themakermap.com/>

⁷ http://wiki.p2pfoundation.net/Makerspaces_in_Africa

⁸ <https://circumspecte.com/2018/11/co-working-spaces-tech-hubs-ghana/>

A note on incubators and hubs

Because many hubs including the iHub include incubation in their portfolios of services, discussions about hubs often use the word ‘hubs’ as synonymous with ‘incubators’ and ‘accelerators’ (Friederici, 2019). Hubs seek to make skills development opportunities and resources accessible to wider public and thus grow a country's pool of ideators (Kelly and Firestone, 2016). Though they often include components of accelerator or incubator activities, hubs typically do not have the structured programme and engagement with private firms that incubator and accelerator initiatives have and are not exclusively tailored to ventures in particular stages of development (Littlewood et al., 2017). Incubators, which traditionally aim to increase the survival rate of young companies and start-ups share this aim with hubs. This means that similar metrics of success are used for both incubators and hubs (*ibid*). Evidence suggests that start-ups who participate in an incubator program are 23% more likely to receive external investment (de Beer, 2017).

Incubators and accelerators typically offer seed funding for promising entrepreneurs in return for an equity stake (Kelly and Firestone, 2016). Investors in these spaces look for big ideas in tech to secure a share in the market. This means that incubators act as idea-spotting spaces for investors keen to identify promising ventures: they are less about offering inclusive eco-system development than they are about talent-picking. While there are significant differences in aims of incubators and hubs they can offer complementarities.

Synergies can be built between tech hubs and incubators to allow idea-spotting, the propping up of promising ventures, development among less advanced entrepreneurs and ecosystem development. In Senegal, the Africa-Living Living Lab, Jokkolabs Dakar, and Jiguene Tech act funnel their high performers towards Dakar-based incubators like CTIC (Kelly and Firestone, 2016). In Nigeria the incubator 400.NG works with eco-system focused hubs like Hub16 to foster high performing entrepreneurs; while L5Lab fosters graduate incubatees (*ibid*). The mLab and iHub which have a similarly symbiotic relationship between hub (ecosystem fostering) and incubator (talent picking). Tech hubs, incubators and accelerators can thus offer synergistic services to young entrepreneurs at different levels of development while fostering an eco-system for idea development (e.g providing the space and equipment for collaboration, learning , and networking).

1.2 Review methodology

Following an initial review of documents on FabLabs, this review looked at documents from makerspaces and hubs to identify key characteristics, successes, challenges and enablers. Case studies were selected from existing literature on makerspaces which discussed one or more of the following outcomes: youth employment, inclusion and/or empowerment. The documents identified included descriptions about the makerspaces (primarily from the “About” sections of their websites) as well as secondary research about these makerspaces.

The next section of the review looks more closely at different types of makerspaces and their respective aims. This will help to place FabLabs in the wider ecosystem of makerspaces and to inform discussion on the extent to which lessons learned from these spaces are transferable to FabLabs.

Use of technology among youth

An important aspect of understanding the potential impact makerspaces have on youth is understanding their use of technology. Much of the literature has focused on youth's use of digital technology, internet and mobile devices (Caribou, 2018; ITU, 2017; Herbert, 2017). The increase of technology and use of internet globally is driven by young people between 15 and 24 years old (ITU, 2017).

Uptake and coverage: Youth aged 15-24 are at the forefront of internet adoption: in developing countries 67% of youth in this age group use internet (ITU, 2017). While this number is high and increasing, it is significantly lower than the number of people in the same age group accessing internet in developed countries (94%). In least developed countries the coverage is only 30%. Young men use the internet more than young women. There is a close correlation between the use of internet among young women and gender parity in enrolment in tertiary education; suggesting an association with education levels. Furthermore, young people living in rural areas are less likely to own a mobile phone and access internet. The increase in mobile phone devices therefore ensures that young people no longer have to go to cyber cafes, universities and other public spaces or own a computer to access internet (Bailur et al., 2015).

Barriers to access: Part of the explanation for these differences in access to internet is the lack of fixed broadband at home. Young internet users typically access internet at work, schools, universities or other places with shared connections. However, shared connections in these spaces rely on fixed broadband, which is less affordable in developing countries than mobile broadband. This makes it difficult for people (especially those living in rural areas) to access the internet in shared spaces. Young people therefore depend on mobile phones and public spaces for internet access. The second common barrier to accessing internet apart is illiteracy. This is prominent across rural and marginalised groups, including youth, which makes it difficult for them to access text-based internet content (Herbert, 2017).

Usage: A study of young people's usage of mobile phone devices in Kenya, Uganda and Ghana finds that youth use these devices for instrumental and non-instrumental purposes (Bailur et al., 2015). The former refers to political engagement, finding jobs, buying and selling products, advancing education and income generation. The latter (which is most common) refers to entertainment such as gaming and social networking for example through Facebook. Typically, these uses are intertwined: youth use Facebook to socialise, to read news and to find out what is going on in their communities. WhatsApp was the most commonly used medium for sharing job details and accessing job advertisements. Young people also used WhatsApp to share notes and soft copies of books and used YouTube, Wikipedia and other similar platforms to learn new skills on their mobile phones. Self-learning was particularly common among young women.

The challenges of accessing reliable internet in developing countries, and the increased use of technology and internet (e.g. for accessing jobs and market opportunities), explains to some extent the expansion of hubs and makerspaces as an avenue for accessing internet and technology.

2 Key findings

This section focuses on the effects of makerspaces on three key outcomes youth employment, inclusion and empowerment. Drawing on different examples of makerspaces and hubs, it offers lessons for how they operate, what effects they have had on the three outcomes and which factors enabled them to have these effects. While the findings in this section are not specifically focused on youth (due to the lack of disaggregated data and rigorous evaluations), the users in these spaces as previously mentioned are typically young men. Overall, there is little documentation of makerspaces, their theories of change are not well articulated and there is little rigorous measurement of their impact. Much of the literature focuses on ethnographic accounts of user behaviour and the management of these spaces, using anecdotal evidence. Due to this shortage of research-based evidence the main sources of detailed information on these spaces are still “grey” literature such as blog posts, consultancy reports and white papers (de Beer et al., 2017). This is also in part due to the fact that it may take several years for start-ups or makerspaces to succeed (*ibid*).

Key points

- **Employment:** Makerspaces can help increase self-employment by addressing information asymmetries between entrepreneurs and investors. However, there is little evidence on the use of makerspaces by marginalised young people.
- **Empowerment through education:** Makerspaces teach skills where other formal education providers fail. Finding ways to formally recognise the skills acquired by users would help them access formal employment opportunities.
- **Indirect effects:** Makerspaces enhance youth employment, inclusion and empowerment by creating spaces that stimulate problem solving. Youth in makerspaces have brought digital education to other young people, created career counselling sites, and even apps to report gendered violence.
- **Youth accessibility:** makerspaces for youth employment must be accessible to marginalised youth. This means thinking carefully about appropriate geographical and institutional homes, as well as outreach approaches. More research is needed on demand-side barriers such as perception among youth.

2.1 Effects on employment

Generally, employment opportunities resulting from makerspaces tended to emanate from 1) self-employment through start-up support; 2) skills developed in these spaces that enable young people to find employment.

In its study on the impact of mLabs, the World Bank (2016) considers outcomes at two levels, namely the creation of start-ups and employment (i.e. the target population levels) and benefits for communities. There is clear evidence on job creation and increase in the number of start-ups created, only very few of which discontinue. The number of new start-ups created and discontinued appears to be strongly

influenced by the rules around member selection. For example the mLab in West Africa has a very high survival score but at the same time new entrepreneurs are expected to have secured revenue. This suggests that mLab's success is due to the process of selecting entrepreneurs rather than the support provided by the mLab to entrepreneurs. Where support is geared towards start-ups that already have funding (e.g. mLab West Africa) survival rates are highest, but at the expense of reaching marginalised young people.

The World Bank evaluation also measures the extent to which mLabs have created jobs and found that there were two main ways. The first is direct job creation as mLab firms become established and grow. The second is by developing and expanding markets. Using these two measurements, the researchers find that mLab East Africa created 212 jobs between 2014 and 2016 (*ibid*). Benefits include access to capital and investors.

Case example 1: mLab

Background: mLabs were launched in 2010 by the government of Finland and Nokia “to derive and test new approaches to advancing innovation and entrepreneurship in developing countries” (World Bank, 2016: ii). It has been described both as a hub and an incubator. There are several mLabs on the African continent that are nested within a larger incubator: the Enterprise Incubation Foundation in Armenia, the iHub in Kenya, the Innovation Hub in South Africa, and the Croissance des technologies de l’information et de la communication (CTIC) in Senegal.

How it works: mLab is a mobile technology accelerator which aims to support start-ups creating mobile apps. It provides space a for working, networking, training opportunities and courses, supporting skills development through code academies and partnerships with industry and the public sector. The space, located in the iHub, allows users to experiment and test concepts before they can scale or pilot their apps on app stores. It targets young entrepreneurs and (university) students.

How it is funded: mLabs were supported by public-private consortia and followed similar program structures. Each mLab was geographically distributed, each had regional coverage, and each had largely similar objectives and activities.

Outcomes: The World Bank evaluation of mLab East Africa found that it had created 212 jobs between 2014 and 2016 (*ibid*). Benefits include access to capital and investors. The mLab had positive effects on the maturation and survival rate of young start-ups, helping them to progress from early-stage start-ups to mature businesses. The factor that was cited most frequently for bringing about these results was the opportunities that the mLab provided to work with other entrepreneurs and other high quality business resources.

Source: World Bank, InfoDev (2016)

2.1.1 Employment: enablers

Government involvement and regulations

It is unclear what prompted the growth of makerspaces in Kenya. While some argue that it was directly due to Kenyan government support (including its focus on ICT and tech hubs for the country's 2030 vision), others believe they grew in spite of governments picking winners and hosting entrepreneurship centres.

Yet others argue that they grew as a result of overall economic growth and the lack of centralised guidance which could have “stunted growth in smaller, more resource poor and politically risky economies, such as Jordan and its conflict-affected neighbours, and Rwanda and its risk of violent spill-over from the Congo” (World Bank, 2016: ii).

Enablers of Kenya's iHub

Geographical location and take-up

This intermediary and market-correcting role is demonstrated by the iHub in Nairobi. The iHub has often been credited with having started the innovation and tech hub movement in Africa. It is the most established tech hub in Africa with around 150 companies and over 13,000 online and physical members (Banga and de Vet, 2018; de Beer, et al., 2017; Graham, 2013).

An important enabler for the iHub is its location in the heart of Nairobi, which meant that makers in Nairobi were better connected/networked externally (Littlewood et al., 2017). These networks allowed users to access opportunities that they might otherwise not have been aware of or able to access.

Location is also important to ensure access of marginalised communities. Relatedly, interaction and engagement from private sectors and investors was strongly dependent on the costs such as travel, or time required. Investors and mentors only interacted with the entrepreneurs if these costs were low (Friederici, 2017). This has implications for hubs and makerspaces as the areas where the most marginalised reside are in rural and other hard to reach areas, thus adding to the challenge of these groups' access to such investors and mentors.

Another enabler is the iHub brand which has given it convening power and helped to facilitate connections with the stakeholders in industry, academia, international corporations, investors and venture capitalist (Moraa and Mwangi, 2012). It has also formed partnerships with universities and corporations and has relations with the Kenya ICT Board.

Governments can also assist by creating an enabling environment, for example by reducing the costs of doing business and burdensome taxes on imports of ICT components (*ibid*). Furthermore, reducing barriers to forming legal entities, enabling easier access to financial services (which is especially challenging for youth—see (Demirguc-Kunt et al., 2014) and awarding employment permits to skilled workers can be beneficial (World Bank, 2016).

2.1.2 Employment: limitations

The findings above suggest that hubs and makerspaces can directly address youth unemployment by fostering start-up creation among young people. However, their impact is limited as hubs can only support a small number of start-ups simultaneously. The Muzinda Hub in Zimbabwe realised that it could not reach enough young people to significantly reduce youth unemployment, and decided to turn the hub into an educational and skills training centre (Friederici, 2016).

While start-ups may not employ many young people directly and immediately, in the long run youth start-ups could employ more young people. More evidence is needed on how many of the incubated start-ups create significant employment, but this will require longer-term follow-up evaluations. Overall, apart from the mLab evaluation discussed here, there is little rigorous evidence on the direct impact of such spaces on youth employment. A qualitative study conducted in the UK found that a number of spaces took on young unemployed youth in work experience roles. One makerspace was funded by the nuclear industry which was a major employer in the area: it used the makerspace to develop skills and enthusiasm for science and technology in local young people who could become potential employees in the energy sector (Taylor et al, 2016). However, a follow-up evaluation is needed to see the extent to which those youth found employment in that sector.

Adopting the iHub model in other contexts: Muzinda Hub

iHub's creation has inspired an upsurge of hubs in other countries on the continent, including the Muzinda Hub in Harare, Zimbabwe.

The initial implementation of Muzinda Hub saw little up-take in the local population, with only 2 businesses incubated which had developed their products independently of the hub. Given that the hub was meant to catalyse employment of a large number of young people, this model soon proved to be non-scalable.

As a result, the founders of Muzinda Hub decided to turn the hub into a mass-oriented skill building program that would provide training for 1000 graduates in software development and entrepreneurship (Friederici, 2016). These young graduates were envisioned to subsequently develop software applications for projects outsourced by firms which would in turn generate revenue for the hub. The hub also relocated to be closer to the university.

In the new model, Muzinda Hub was to act as a training centre and an outsourcing firm with a social purpose and therefore arguably not a hub in the strict sense (Friederici, 2016).

Some of the reasons found for Muzinda Hub's failures included:

- The location in a residential neighbourhood which was detached from public transport, thus making it difficult to access
- The external perception of the initiative including for instance that the entrepreneurs projects would be taken over rather than nurtured as independent projects
- The hub idea was not developed in detail. It was envisioned to be a place for entrepreneurs to meet and collaborate, use the office space and bandwidth (*ibid*).

2.2 Effects on empowerment

While there is little quantitative evidence on the impact of hubs and makerspaces on youth employment, there are a number of qualitative studies that suggest they create employment through empowerment. Friederici (2017; 2016) finds hubs do not generate socio-economic outcomes but instead allow economic actors to reconfigure their relationship with individual entrepreneurs. This allows young people to gain access to opportunities such as angel investors. In other words, they provide a network infrastructure for entrepreneurs and start-ups (Friederici, 2019). Makerspaces also produce entrepreneurs by creating diverse networks to create new ideas (Van Holm, 2015). They are also envisioned to produce entrepreneurs by making it cheaper to prototype and test ideas (*ibid*). Makerspaces are therefore best seen as facilitators rather than interventions and should be judged as such. Networks are also formed with other users and new entrepreneurs. However, once study finds that the interaction between users in these spaces varies significantly from one makerspace to another with some showing almost no user-to-user interaction (Jimenez and Zheng., 2016; 2017).

Qualitative studies suggest that supportive structures create impact as they act as a first point of contact between foreign actors and novice entrepreneurs (Hui and Gerber, 2017). Therefore, as intermediaries, hubs facilitate business activity, entrepreneurship, and technology development. As a result it is argued that hubs and makerspaces enables job creation rather than directly creating jobs⁹ and this needs to be reflected in the measurement of impacts.

⁹<https://includeplatform.net/wp-content/uploads/2016/09/ICTs-Job-creation-Kenya.pdf>

2.3 Broader social effects – social inclusion and education

In contexts where youth education is often lacking practical applications for employment (British Council, 2017), the practical hands-on experience provided by makerspaces and hubs can be a crucial instrument for providing youth with labour market relevant skills. Likewise, where tertiary and higher education are hard to access makerspaces and hubs can act as important alternatives (ITU, 2018). Two examples of how makerspaces provide education are given below.

Case study 3: Kumasi Hive

Founded in 2016, this is a tech and collaborative hub to provide a platform for young innovative entrepreneurs using a multi-space sustainable model.

How it works: The Hive provides meeting and co-working space, training space, shared costs and maker space for quick-prototyping of ideas. It offers business development support including financial literacy programmes, investment readiness training, mentorship and co-learning support to foster youth entrepreneurship. It also offers incubation and accelerator services for promising early stage startups, helping them move from idea to prototyping and to a business.

Outcomes: The Hive has created 3D printers and 3D printing services that are manufactured from electronic waste or e-waste including from discarded computers, electronic equipment and other waste material. Electronic material that has been traditionally imported from China is now being substituted with material manufactured with the 3D printers. The Hive's activities have also been associated with a decrease of the price for 3D printers as is the cost of prototyping products and bringing them to the market. Currently, Kumasi Hive houses 25 start-ups who are using the co-working spaces and over 100 start-ups network members utilising the business development support along with is incubating 9 start-ups ; 4 hardware start-ups that are prototyping their early stage products before introducing it to the market Of the 1066 young people who had accessed its training and education services, the majority were between 18 and 30 years old, but only 168 of them were women (Gbande, 2018).

Enablers: while other spaces in Ghana such as Hub Accra or iSpace specialise in digital technology, Kumasi Hive focuses on hardware. It helps businesses by providing a manufacturing space, equipment, training in hardware engineering, coding, digital fabrication, skills development and the Internet of Things. Training curriculum also includes robotics, artificial intelligence, 3D printing and blockchain technology. In addition to offering training and manufacturing space, it also incubates by offering support at different stages of business development including conceptualisation of ideas, modules to develop the appropriate skills, networking opportunities and support with finding funding. The Hive is receiving assistance from a UK charity called TechforTrade.

Challenges: The 3D printer which is a central part of its offer, can only print small items so the manufacturing of bigger objects such as handbags is still very limited. Challenges persist also in terms of access to quality electronics , the high shipping costs and the limited demand for 3D printers as therethir is a lack of education and awareness around their potential benefits and uses in the local population. The Hive users also face challenges with accessing loans as currently local bank loans are targeted towards manufacturing start-ups instead of facilitators and ecosystem enablers such as the Kumasi Hive.

Source: Banga and te Velde, 2018

Given that makerspaces are not typically formal educational institutions, organisations should find innovative ways to ensure the certified recognition of the skills acquired in makerspaces for youth who want to move on to formal education. Further research is required on how the skills young people learn can be accredited and recognised on the formal job market.

Many offer workshops for students and young people to make up for lack of equipment at universities or to facilitate the professional integration especially of young women and marginalised groups (ID4D, 2019). Babylab in Cote d'Ivoire which operates in poor neighbourhoods seeks to be a driver of social change and education; Blolab in Benin promotes digital literacy among youth and professionals like farmers or artisans and has facilitated the development of an application that reports gendered violence¹⁰. More broadly makerspaces are seen as “informational commons” as they “develop digital knowledge and share it within communities as well as conserve it on web platforms” (*ibid*). Luminus Education, a TVET programme, received funding from the European Union to foster work preparedness and job skills among young Jordanians and Syrian refugees through hands-on vocational education in makerspaces¹¹. Another example is the South Africa Gauteng maker movement.

Case study 4: the Gauteng maker movement

A maker movement is gradually emerging in South Africa, particularly in Gauteng Province. These include a number of community-based collectives, which began with a space called House4Hack. As a not-for-profit, self-funded, community initiative, the movement holds values of openness and sharing, rather than a focus on commercialisation of products.

How they work: Hack4House started offering a workspace in a residential house, belonging to one of the co-founders, in 2011. This space spawned two off-shoots, called BinarySpace and Makerlabs, by former House4Hack participants who wanted to have spaces closer to home. All three are organised on a volunteer basis by its unpaid members, some of whom provided equipment, free-of-charge, to the space. Beyond these contributions, House4Hack ran training courses for which it charged small fees and renting out some of the space to small businesses.

Outcomes and successes: All three spaces are committed to providing training, skills and innovation space to its members and to do this outside of a “scarcity mentality”. As a result, many of its participants see themselves as “process makers” rather than “product makers”, meaning that the focus is on the process of designing, learning, and problem-solving rather than making products that can be commercialised. That said, it has a number of successful innovations to its name, including a low-cost 3D printer, which can print most of the parts needed to replicate itself. Several of them are specifically targeting unemployed youth such as the Employable Nations Project (which is part of Workspace), eKasi Lab Ga-Rankuwa, eKasi Lab Soweto, Geekulcha Makers in order to build their employability skills.

Keys to success: participants and leaders in the spaces identified their interpersonal networks with like-minded individuals and a “strong ethic of innovation” as key to making their spaces work. The collectives had put a great deal of effort into outreach work, both online and offline – holding weekly meetings, convening innovation competitions or hackathons, and running training courses alongside online advertising. Many argued that South Africans needed the maker movement more than other places, but could also take it forward, because poverty has long made innovation a necessity.

Challenges: the collectives struggled to attract individuals from socio-economic and racial groups outside of their own due, in part, to South Africa’s history. In addition, as is the case in many other similar spaces, they struggled to attract women and the small number who used the space regularly did not have the time or inclination to engage in outreach work.

Source: Kramer-Mbula and Armstrong, 2017

These examples provide evidence that makerspaces are more commonly used as facilitators of empowerment and inclusion through education especially in contexts where formal education and skills training is poor or lacking. Other empowerment effects include a feeling among makerspaces users of contributing the community which was a finding among Impact Hub users (Bramann, 2015). More research is needed on this.

¹⁰ ID4D, <https://ideas4development.org/en/fablabs-digital-africa/>

¹¹ <http://www.openair.org.za/north-africa-dss-al-safadi-makerspaces-and-employment/>

Enablers of the Gauteng and Kumasi Hive makerspaces

Geographic location

As in the iHub and Muzinda hub case, the physical location has significantly contributed to the use of the Gauteng maker spaces. Here research (De Beer et al., 2017) suggests that the physical location was strongly associated with the types of groups that were participating as well as the kind of funding that was available to the makerspaces.

Programmatic location

The institutional location is as important as the geographic location. Makerspaces who are embedded within a government institution can benefit from in-kind support as well as the ability to channel their activities through government run activities. On the other hand embedding makerspaces in government institutions might result in them being perceived as government agents. Makerspaces therefore might struggle to position themselves as community-driven, community-accessible entities.

One case found that makerspaces benefit from a design where institutional embeddedness within the Gauteng Provincial government supported the Hub in Pretoria but most of the activities were run at locations outside the hub and in partnership with schools, universities, provincial and local governments (De Beer et al, 2017; Kramer-Mbula, and Armstrong, 2017).

Other spaces are embedded within universities such as University of Pretoria Makerspace or Tinker Space at University of Johannesburg have benefitted from in-kind and financial support from the universities. While locating these spaces in universities can help the spaces benefit from universities' in-kind and financial support, they can also strongly influence the type of users that access them and exclude others in the process (De Beer et al, 2017).

2.4 Secondary-level (indirect outcome) effects

Hubs and makerspaces also measure their impact and success by the start-ups that have emerged from their users, for example if a user of a makerspace or hub creates a social business that increases digital education of other young people. These effects are more difficult to attribute to innovation hubs and makerspaces as they are a result of the activities of the users rather than a direct result of the support provided by makerspaces and hubs. Arguably, the facilitation and supporting functions can create an enabling environment to allow users to test their ideas. Some examples include:

- In Uganda the MobiStation or Digital School in a Drum was created in the UNICEF Uganda Innovation Hub. Its objective was to bring digital education to young people in remote areas to counteract the effects of high teacher absenteeism¹².
- Illuminium Glass Houses and Child care improvement through the mLabs (see box below).

¹² <http://unicefstories.org/2014/07/17/unicef-brings-together-bright-minds-in-uganda-to-tackle-tough-problems/>

- UNICEF’s UPSHIFT programme in Kosovo which has enabled young people to develop projects like optical health awareness campaigns, information sites on education opportunities, or career choice counselling sites which in turn empower other youth in the communities.”¹³

mLab-supported innovations

Illuminum Greenhouses is a Kenyan company providing smallholder farmers with access to low cost farming technology to increase production using digital technologies. Assistance from mLab came mainly in the form of getting attention from the market as well as identifying business partners.

Outcomes: In 2016 over 300 greenhouses had been constructed by Illuminum Greenhouses which served over 1,500 farmers and increase their incomes by average of 155 US a month which is the equivalent of 2.7 million annually.

A second enterprise that arose out of the mLab support structures is Kidogo, a social enterprise to improve access to high-quality affordable childcare and education among low-income communities. Kidogo also seeks to empower women entrepreneurs with sustainable business models.

Outcomes: In November 2016 Kidogo had two centres, 250 children, 1,000 family members benefitting from the services along with five “mamapreneurs”. Using a “hub” model, these centres provide social-franchising programmes, training, resources and mentorship programmes to women who want to grow a childcare micro-business.

Source: InfoDev, World Bank, 2017

2.5 Wider challenges

Key points

- **Financial sustainability:** Makerspace strategies include seeking government funding, charging small membership fees, charging for rental spaces and courses etc. Key is diversification of income.
- **Scalability:** Makerspaces can help youth entrepreneurs generate means to scale up production by helping them apply for funding, connecting them with investors etc. However, makerspaces need to be careful not to lose their social value by focusing too much on commercialisation. In using makerspaces as an approach to foster youth empowerment and employment scalability model of makerspaces is very limited.
- **Limited inclusivity:** Users tend to be well educated young males which is in part related to the ICT skills requirements as well as other accessibility barriers.
- **Regulatory challenges:** high safeguarding standards might create difficulties for innovators to get their products on the market. Other regulatory barriers include taxation burden, access to financial services for youth and supply chain barriers

While the challenges faced by the makerspaces will depend on the context within which they are operating, there are some common challenges. One study found that typical challenges include slow connectivity, limitations in staff capacity, lack of access to sustainable funding, limited space, lack of investment, lack of skills, poor connections to strategic partners, poor quality assurance and infrastructure (Githege and Moraa, 2013).

¹³ <http://kosovoinnovations.org/srpski-building-change-from-below-the-story-of-innovations-lab-kosovo/>

2.5.1 Financial sustainability

The cases described above vary significantly with respect to their funding sources.

A mapping of South Africa's and Gauteng makerspaces finds that they use a wide range of funding generation models as well as in-kind support for their activities. Some of these include member donations, charging membership fees, fees for courses and events, charging for rental spaces, commercial activities, government funding, combined university-government-industry funding, and project-based partnerships with governments or donors (De Beer, 2017).

In Kenya, iHub was initially funded by institutions like Hivos, Omidyar Network, Ushaidi and Zuku and is currently connected to big corporations such as Microsoft and Intel (Wambeti, 2014). Similarly, global Impact Hub relies on a combination of membership fees, renting out spaces, training, education and consultancy to generate funding (Wittmayer, 2015). The funding model is largely related to the locality of the individual makerspace: the Ga-Rankuwa eKasi Lab is located in an under-resourced community and almost entirely government-funded; House4Hack is located in a better-off community and is funded by the contributions of its members (including a private home as a premise for the space); and the UP Makerspace is a part of the University of Pretoria and is sustained by funding from the university (De Beer et al., 2017). Although funding from government can provide some sustainability, government-funded hubs often face challenges in justifying their funding and existence (Friederici, 2017).

Other makerspaces use a consulting approach where after providing training, some of the young people working in the hub are contracted by private firms to provide software development services and develop applications for projects in return for payment. This was one of the revenue generation strategies envisioned by Muzinda hub which saw this as an opportunity to give participants applicable skills to prepare them for jobs in the technology sector or start their own companies, while generating income for the hub (Friederici, 2016). These spaces have sometimes become popular places for employers to recruit software developers which is the case for instance with kLab (*ibid*). Similarly, in Sao Paulo the Impact Hub provides consulting services to banks and industry including for instance co-designing spaces for creative work as well as offering lectures and workshops to managers (Wittmayer, 2015).

Diversifying income sources in makerspaces in South Africa and Ghana

A key factor for financial sustainability found in a mapping of South Africa's makerspaces is diversification. Another factor that researchers identified as crucial for financial sustainability was the maker communities' ability to develop a niche, along with positive reputations and a brand (De Beer et al., 2018). The development of niches and brand seemed to be most successful when paired with targeting to the locality. For example, the Employable Nation makerspace offered skills relevant to youth in the poor Hout area (*ibid*). Developing these niche areas and brands can help these spaces to attract participants, partners, and funding/in-kind support.

A similar diversification approach has been applied to the Kumasi Hive where funding is provided through: charging modest fees for using the co-working spaces; charging for some of its training courses; renting out training space; offering services to private companies against a fee; incubating potentially successful start-ups.

While different maker spaces and hubs use various means of generating revenue, what they share is diversification. Although funding from government might appear to be an obvious solution for financial sustainability, this has repercussions both in terms of management of the spaces, their accountability

and their flexibility to be adaptive. If governments need these spaces to demonstrate their value, they might resort to using proxy measures of impact described above (such as number of users or start-ups incubated) and limit organisers' ability to adapt to the needs of their users. They might also be seen to be agents of the government which could influence the take-up and use of these spaces among marginalised youth. The table below summarises the funding sources used by the case studies described above:

Makerspace	Funding sources
Kumasi hive ¹⁴	<ul style="list-style-type: none"> charging fees for co-working space^[17] running and charging for training courses as well as plenty of free ones^[17] renting out training room and event space; charging companies for work done for them in the makerspace; taking stakes in the startups incubated at hub
mLab	World Bank/Info Dev
iHub	the iHub is 70 per cent self-funded from its operations through the different consulting services it offers (Research, Consulting, UX Lab). The remaining 30 per cent was brought in through its corporate partnerships and events ¹⁵ .
Gauteng makerspaces	<ul style="list-style-type: none"> Member donations, fees from course offerings, fees from corporate partnerships membership fees, funded by university-owned company (Tinker Space at University of Johannesburg), project partnerships with governments (foreign, national, provincial, local), private sector, universities, schools (Geekulcha Makers), University funds (for university based spaces like University of Pretoria Makerspace, Vaal University of technology tech hub) , sale of consumables, (Made in Workshop) proceeds from Makers Village (design and production services craft sales, restaurant, entertainment venue), (I Make Makerslab), space rental fees (Kluys Makerspace), government funds (Craft and Desing Institue, eKasi Lab Soweto), start-up funding from the British Council's Maker Library Network (MLN), project partnerships with local NGOs(Workspace) <p><i>Source: De Beer et al. (2017)</i></p>

2.5.2 Scalability

Funding is also critical for ensuring that entrepreneurs have the means to take their products to scale after piloting and testing. Beyond its own financial sustainability, an innovation hub or makerspace should be able to ensure that the entrepreneurs continue to secure funding and financial sustainability to sell their product. Assistance can take the form of providing information about funding opportunities, mentoring, networking or direct funding assistance (Verity and Whipkey, 2016). They should be encouraged to look broadly for different options from grant to loans, crowdfunding, investors, donors or other channels.

¹⁴ <https://www.kickstarter.com/projects/kumasihive/kumasi-hive-a-makerspace-for-entrepreneurs-in-ghan>

¹⁵ <http://disrupt-africa.com/2016/03/kenyas-ihub-raises-funding-to-scale-operations/>

In the case of the UNICEF Innovation Lab (described in the next section), the scaling and sustainability models of each of the youth-led initiatives developed in the Lab vary significantly. Many of them are continued by NGOs which proceed to scale them up, while others receive more institutional support to scale them on their own. Some benefit from built-in revenue generated from consumers¹⁶ and others have won prizes from organisations supporting similar initiatives such as the Yunus Social Business initiative (Verity and Whipkey, 2016).

Makerspace organisations can help users attain sustainability beyond the initial funding received by directing them to funding sources and helping them apply for them (*ibid*). UN-OCHA’s Innovation Exchange for instance provides a platform for sharing knowledge on funding opportunities and assistance with proposals and applications (Bloom and Faulkner, 2015). A similar platform is also offered by USAID.

While financial sustainability and scaling are crucial to ensure the sustained impact of makerspace and innovation hubs, some suggest that hubs and spaces need to be careful not to make this the only measurement of success. Scaling in tech or innovation spaces as well as in makerspaces is often understood as creating a profitable business and is therefore primarily associated with commercial goals (De Beer, 2017). In South Africa, a mapping of makerspaces found that scaling goals are often defined as ‘scaling of socioeconomic benefit’ and include scaling the innovations into commercial enterprises as well as skills development, educational achievement and empowerment without commercial goals. The authors argue that simply scaling in the traditional sense—that is, turning the innovation into a business—might undermine the equitable benefit-sharing and inclusion goals of these innovations due to the winner-take-all mentality of businesses (*ibid*). Defining scalability in these narrow terms significantly limits makerspaces’ ability to address youth employment and empowerment.

2.5.3 Access to hardware

While there has been a rapid proliferation of tech hubs in Africa which are often oriented towards software development and web development start-up communities, the hardware start-up businesses often struggle to scale up. This is the result of either costs of materials or lack of access to materials and machines necessary for prototyping and fabrication. Often these hardware materials have to be imported from China or India; costs that most start-ups cannot cover. Makerspaces focusing on hardware development have been set up to address some of these issues including initiatives to develop machines that make machines or produce machines locally. For example, AB3D Designs produces 3D printers from electronic waste and sells them at a fraction of the commercially available price (Schonwetter and Wiele 2018). One such space which has been discussed is the Kumasi Hive. There is some expectation that a proliferation of these spaces in Africa will lead to more of this hardware being produced on the continent and adapted to the African market.

2.5.4 The regulatory environment

EU consumer policy safeguards often pose a challenge to open source DIY toolkits developed in makerspaces. This is likely to become a challenge for makers in the global south. As mentioned above, one of the core elements of the maker movement is the sharing of practices and processes in the global community. Makers who do not meet the safeguard requirements might lack credibility and be unable to compete on the market when they go to scale. Other regulatory challenges for start-ups and young businesses include high tax burden and start-up formalities (see e.g. Doing Business, World Bank, 2019) and lack of access to financial services such as affordable credit among youth. The lack of access to finance also forces young entrepreneurs to work on the side to generate funds which impairs their ability to focus on building their enterprise (Bramann, 2016). This challenge is exacerbated by the lack of angel investing culture for instance for makers in Kenya (*ibid*).

¹⁶ <https://goodpracticessite.files.wordpress.com/2016/03/innovations-lab-kosovo-civic-engagement.pdf>

2.5.5 Education

There are a number of challenges associated with education. Makerspaces are often used as informal education facilities to: make up for the lack of equipment in TVET institutions (ITU, 2017), build employability skills among youth who do not have access to formal education and address the mismatch between skills development at formal educational facilities and the labour market demands (Smith et al., 2017). While the hands-on practical skills young people acquire in makerspaces are valuable skills for the labour market, they often do not issue formal certification or recognition of these skills. This can significantly limit the impact of skills development programmes in makerspaces on youth who are seeking formal employment. Furthermore, lack of adequate ICT and entrepreneurship skills among users of these spaces means that makerspace organisations have to invest time and resources to build these skills among users so they can benefit from makerspaces. (Bramann, 2016).

2.5.6 Limited inclusivity

Another challenge that makerspaces face is the limited inclusivity of female and marginalised youth. A 2012 survey conducted at iHub found that of the young hub members, only 16% were women (Moraa and Mwangi, 2012). Moreover, as mentioned above, many of the users tend to be young male university graduates with IT or creative skills background. Furthermore, in Gauteng, the collectives struggled to attract individuals from socio-economic and racial groups outside of their own due, in part, to South Africa's history (Kramer-Mbula and Armstrong, 2017). Furthermore, spaces which charge membership fees to all users are excluding those population groups who cannot afford those fees (Wittmayer, 2015). Finally, the location of spaces in townships or in universities made them less accessible to youth living in rural areas or youth who were not part of the the universities respectively (Schonwetter and Wiele, 2018). Organisations need to take active steps to ensure inclusivity which should include active outreach to marginalised youth populations as well as education on ICT for people with very low education levels. The next section outlines an example of such actions from the UNICEF Innovation Lab in Kosovo.

3 Youth involvement in makerspaces

Key points

- To ensure the inclusion of all young people, makerspaces must take active steps including outreach activities and involving young people in the design of makerspaces and makerspaces programmes. These activities should also take advantage of digital platforms if the target groups have access to the internet. They should also link users to mentors from similar backgrounds.
- Organisations should involve young people in the design of the spaces and what they offer instead of relying purely on experts. To implement this human-centred approach and respond to needs, makerspaces need flexibility and autonomy.
- Organisations running makerspaces within wider youth engagement strategies have to balance the autonomy of makerspaces with embeddedness within these wider strategies to prevent siloed work approaches.

As highlighted above, the literature suggests that users of these spaces are young, predominantly male university students or graduates. It is assumed that users have some ICT skills and meet other requirements (education, infrastructural access to the spaces etc) to take advantage of makerspaces. An example of how a makerspace has been adapted to ensure the inclusion and participation of youth is given in the box below.

3.1 Enablers of youth involvement in makerspaces

Several factors contributed to how well makerspaces involve and empower young people.

3.1.1 Geographic location and outreach

As previously discussed, the physical location of makerspaces and hubs is likely to determine the number of people as well as the demographic characteristics of users. One way of building in flexibility and end-user agility is by building in physical mobility. Some have done so by employing remote staff to visit marginalised populations located in remote areas. As these populations are also the ones who often lack access to internet, mobile and transient labs or spaces enables flexible and deeper engagement with these communities (Bloom and Faulkner, 2015). The UNICEF Kosovo Innovation Lab described below is an example.

Kosovo UNICEF Innovations Lab

The context: Kosovo has the youngest population in Europe. It has also high youth unemployment and few opportunities for youth civic participation. About 54% of the who are below 25 years old, and 75% of people aged 17-25 are unemployed (UNICEF)¹.

Aims and objectives: Founded in 2010, the Lab's focus on youth was only incorporated in 2013 to help marginalised youth innovate on problems that at grassroots level (Whipkey and Verity, 2016). It shifted towards social programmes to enable marginalised youth to participate in designing solutions instead of simply focusing on incubating advanced ideas from more privileged members of the society. The lab acts as an intermediary between young people, insurgents and authorities to translate needs and priorities and capacities to authorities. Originally, inclusion and accessibility was ensured through an open space; inviting young people to walk into the lab and share their concerns. This has changed over time and young people's input now goes through the online and digital space. Lab staff also conduct outreach activities to rural areas where large part of the marginalised population lives and where access to internet is limited. They also engage with community leaders who have a better understanding of culturally sensitive ways to reach marginalised communities.

How it works: It is a structured programme for testing and prototyping projects which be approved by a program manager. It also acts as a resource for Community Outreach to teach youth marketable skills and facilitate active engagement with community. It offers and facilitates development of youth through innovative project designs and creates open-source technological platforms.

Implemented with a local NGO (Peer Educators Network), the Lab seeks to serve young people through three pillars or components:

- Youth for Youth is a mentorship program which offers guidance to youth participants and grants to young people whose project idea has been approved. One of the criteria for approval includes the extent to which the project seeks to make a difference in the communities.
- Youth Advocacy Platform partners with key consultants and experts to provide guidance for young people in how to advocate for their cause and project. It works by matching youth entrepreneurs with relevant experts to help the young people develop sustainable-web-based app.
- The Design Centre combines their technical expertise with expertise from collaborators in academia, and communications technology to create an open-source technology hub for the region

Other important aspects of the innovation include social media outreach which invites other youth participants to participate; the blog which is run by UNICEF and includes information on accepted projects, project statuses and descriptions of activities; internship opportunities for university students to gain valuable practical experience while receiving university credit for their work through partnering with the University of Prishtina; innovation cafes where team members share ideas as well as engagement with wider community including NGO's, teachers and professors, student groups, or community volunteers. The internship project allows students to get academic credit for work done at the lab. Some of the success it has achieved include the following:

- More than 130 youth-led projects involving over 3,600 youth
- Some of these projects have turned into NGOs or social ventures that aim to address a wide range of problems in their communities.
- Projects developed in the Lab have gone on to secure funding for scaling
- The lab has also initiated satellite labs that have broadened their impact into a national scale. (UNICEF Innovation Labs DIY-guide).

(Source: Faulkner and Bloom, 2015, 2013; UNICEF 2012, 2013; Whipke and Verity, 2016)

The Lab employs mobile staff as a way to engage and centralise youth in programme design (*ibid*). Other initiatives have made the space itself mobile e.g. through the use of temporary physical spaces (e.g. Maker Faire). The Tech Needs Girls initiative used a similar approach.

The Tech Needs Girls makerspace has also successfully engaged a marginalised community – girls. It grew out of the iSpace hub in Ghana and focuses on addressing barriers to computer programming and IT education for marginalised girls. It holds “Ruby on Rails workshops” where female mentors teach young girls to create technology content that is relevant to their own realities. The initiative has also created satellite organisations throughout Ghana to reach girls in remote areas¹.

Ultimately, the nature and location of the physical space should depend on the objectives of the lab (Bloom and Faulkner, 2015). An initiative that seeks to incubate student-driven innovations might be better able to do so by locating the space in a university (*ibid*). If the space is intended to bring together communities or parties that are in tension with each other such as activists and governments, need to ensure that the physical location is neutral (*ibid*). The nature of the lab whether permanent or temporary, physical or virtual, should be driven by the question of what would best enable it to serve the needs of its end-users and should be constantly re-evaluated (*ibid*).

3.1.2 Implementing a human centred approach

Another important enabler is putting people at the centre of the innovation and involving them in the design of the programme which has been critical for both by iHub and UNICEF Innovation Lab. UNICEF Innovation Lab in Kosovo found that the initial design of the programmes by experts rather than community members was a primary reason for its failure to achieve uptake (Whipkey and Verity, 2016). Instead what was required for success was the involvement of a critical mass of the right people along with the right leadership (*ibid*).

Research also suggest that to enable this human-centred design, innovations spaces and makerspaces must have sufficient autonomy and flexibility in the management of these spaces (Faulkner and Bloom, 2015). In terms of the institutions within which these spaces are embedded, autonomy of the spaces and management of them is crucial for allowing them to engage with marginalised group and ensure their inclusion (*ibid*). This autonomy is what allowed the UNICEF Innovation Lab to reach more adolescents and young people in the most marginalised areas and families (*ibid*). The human-centred approach is much more limited where departments such as UNICEF’s Innovation Lab have to follow strict strategic plans and bureaucracy (*ibid*).

3.1.3 Embedding innovations in wider organisation structure

An important factor for organisations setting up hubs or makerspaces is embedding the space or hub within the organisation. Organisations must strike a balance between ensuring that these innovation spaces are not siloed while at the same time allowing them the autonomy to implement a human-centred approach(Carou-jones, (2017).. Embedding them prevents them from having to translate their work into the language and form of the wider organisation such as UNICEF. A study comparing the UNICEF Innovation Lab to other similar spaces within the UN system showed that it can appear as a break from the organisation’s culture. The authors found that the “existence of labs may siphon innovation work off into ‘silos’ of activity, which could be counterproductive to the aim of changing the wider organisation mindset, and also be detrimental to defining how the wider organisation may work closer to communities on the ground beyond the space of the lab.” (Bloom and Faulkner, 2015:27).

4 Conclusions and recommendations

Makerspaces show promise for improving youth engagement in business development and innovation. Hacking externally-sourced technologies to adapt them to local needs and local markets is a new and potentially important source of innovation in developing countries (Essegbey & Fu, 2014). While still nascent, the literature on makerspaces suggest a number of lessons and recommendations on how to help makerspaces and FabLabs help youth employment, inclusion and empowerment.

Be clear about the longer-term objectives and feasibility of supporting makerspaces.

Makerspaces may have many linked objectives, and the balance between them may change over time as the makerspace matures and becomes embedded within its physical or virtual community. Makerspaces can foster job creation by helping young people self-employ or become job creators themselves. But while job creation may be an overarching objective given the scale of the youth unemployment challenge, other objectives may need to take precedence in the early phase of the makerspace. These would recognise that youth unemployment is as much a social issue as it is an economic one and should include: building specific sets of entrepreneurial skills, improving outreach to disconnected groups, strengthening the supply chain that makerspaces rely on for their technology, and developing the wider infrastructure (such as financing) needed to support small businesses in their start-up phase.

Although the idea of makerspaces rests on issues such as flexibility and innovation, some aspects will take time to change. Clarifying the objectives of each makerspace will indicate whether it should be set up as a physical or virtual entity, where it should be located, what mode of interaction would be encouraged, what types of support technology would be required (fixed or mobile internet, for example), what limitations that would impose, and what sort of scalability is ultimately envisaged.

Be clear which groups the makerspace would like to engage with, and develop proactive outreach activities to support these aims

Adolescent girls and young women as well as young people living in areas with poor internet have been poorly served by makerspaces to date. In South Africa, makerspaces such as House4Hack struggled to engage with socio-economic and racial groups outside those of the original collective. Involving adolescent girls and boys and young men and women from diverse backgrounds in the makerspace movement is as much a social as an economic objective. It requires careful thought about how local norms influence prospects for engagement (both physical and virtual) and the role of local leaders in developing an effective modality for these groups to participate. The Kosovo UNICEF Innovation Lab shows that ensuring the makerspace is youth-led rather than driven by experts, and generally taking a human-centred approach, is a promising way to increase inclusivity. Partnering with organisations who have implemented successful makerspaces, such as the UNICEF Innovation Lab, can be a way to gain access to hard to reach populations. Learning about their gaps and needs could help curate an effective Tdh offer.

Consider the wider infrastructure for the makerspace and any spin-offs

Makerspaces can be self-standing or located in a range of types of organisation such as universities, government or private homes. Each will require different types of investment in infrastructure such as internet access, access to skills training and mentoring, public transport and financing. Some of these will influence the physical location of the makerspace, but the question of future financing is crucial to the sustainability of the makerspace and any businesses that spin off from it. Young people with few resources find it difficult to access finance for business development, and it may take several years for makerspaces and their spin-offs to demonstrate economic returns on up-front investments. Encouraging a diversity of funding sources (including in-kind support) can be key to the financial sustainability of makerspaces. Clarifying the objectives of each makerspace will help identify which aspects of the wider infrastructure should be addressed. One of those options discussed above is partnering with incubators. Tdh could partner for instance with the World Bank who funds incubators like the mLab. This could create future opportunities for Tdh FabLab users with promising products to gain access to funding and incubation support to build viable businesses.

Encourage scaling and spin-offs that relate to the objectives of each makerspace

Relating the scaling goals of makerspaces to their overall objectives will help their own sustainability and the sustainability of the businesses they generate. Focusing too early and too narrowly on business sustainability can undermine the longer-term goals of equitable benefit sharing and social inclusion. A key finding from South Africa and Ghana is that developing a brand and reputation (critical for business sustainability) seems to work best when targeted to the locality and focused on local goals such as supporting artisans in remote communities. Makerspaces in both countries also suggest that having diversified revenue sources is crucial for attaining financial sustainability.

Relatedly, makerspaces should also seek to ensure appropriate networks which will contribute to their sustainability. Networks with the private sector for instance such as manufacturers and the market can help diffuse the products and technologies developed in the makerspaces more widely (Smith et al., 2017). This approach has been used by Kumasi Hive for example. The networks formed should be informed by an understanding of both community needs, youth aspirations and an understanding of markets and value chains. Networks should also be formed with educational institutions, NGOs and public sector. These will not only help sustainability of the makerspaces but also help access marginalised and hard to reach youth. Finally, creation of such networks can help address the mismatch between skills and (labour) market demand which is a common challenge for youth employment.

Consider whether the makerspace could be permanent, temporary, physical and/or virtual: and match funding to setup

There is no single model for makerspaces. Physical and virtual models have both advantages and disadvantages. From the outset it is important to be realistic about the size and shape of the funding envelope. Setting up a makerspace and then exiting could raise and then dash expectations, exacerbating youth vulnerabilities.

Understand the relationship between makerspaces and formal training and education provision seek to strengthen these linkages, especially the provision of recognised qualifications.

By their nature, makerspaces approach learning and training more flexibly than the formal education system. Although many makerspaces provide training in specific topics, much of the learning comes through problem-solving with likeminded people rather than a didactic approach. The makerspace movement does not have a formal system of accreditation and qualification and it is highly unlikely that

it would (or should) develop one. But this means that financiers and other employers may struggle to understand the benefits of participating in a makerspace and why they should offer employment or funding to a makerspace ‘graduate’. Some form of local accreditation could be useful, such as university credits for participating in makerspaces. Partnering with private firms, universities and vocational education providers could help makerspace users access formal accreditation and work placement opportunities.

Manage makerspaces, generate learning and assess their impact using non-traditional approaches and longitudinal data.

Many organisations struggle to measure the effects of makerspaces and have to settle for proxy measures such as number of start-ups incubated, number of members etc. Challenges include both the dynamism of makerspaces as well as the fact that they act as facilitators rather than direct interventions. Makerspace impact also depends on the wider market and value chains within which users are inventing and operating. There are many parallels between the aims and approaches of makerspaces and M4P (making markets work for the poor) programmes. M4P programmes aim for systemic, sustainable and large-scale changes, acting as facilitators and ‘catalysts’ instead of market players or traditional development programme implementers. However, many M4P evaluations struggle to measure and evaluate these concepts. In an evaluation of M4P evaluations (Ruffer et al., 2013), researchers found that the theory-based evaluations were able to capture the sustainability, scale, systemic and unintended outcomes. They include methods such as outcome mapping or outcome harvesting to track intended and unintended outcomes.

The fact that makerspaces are highly dynamic needs to be taken into account when generating evidence and learning. Short-term evaluations will provide little evidence of whether makerspaces contribute to long-term outcomes. Organisations supporting makerspaces will need to invest in mixed methods longitudinal research – following the same cohort of young people who start off in these makerspaces for a period of years – to see if makerspaces really do make a difference to youth employment, empowerment and inclusion.

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ANNEX A

Hackerspaces	Hackerspaces focus on computer and electronics i.e. the digital world and have their origins in hacking software (Van Holm, 2014; Colegrave, 2013).
Co-working spaces	Co-working spaces are hackerspaces for professionals who want to move from hobbyist hackerspace users to professional production (Van Holm, 2014 ; Colegrove, 2013). In recent years they have grown and become spaces for freelancers, contract staff and entrepreneurs to build a network and work with like-minded people as part of a community ¹⁷ (Mitev et al., 2018). These are much more common in developed countries and include for instance We Work18 or Coworking republic ¹⁹ .
FabLabs	Fablabs focus on digital fabrication and are typically equipped with tools such as 3D printers, laser cutters and milling machines to enable their members to engage in production. FabLabs are governed by a foundation (the Fablab Foundation, Fablab.io etc.) which has rules and charters. Examples include FabLab South Africa ²⁰ or gearbox in Nairobi ²¹ .
Makerspaces	The term makerspace refers to community workshops where members use a set of shared tools as professionals or hobbyists (Van Holm, 2014). It is often used in the literature as an umbrella term for hackerspaces, co-working spaces and FabLabs.
Hubs	In sub-Saharan Africa and Asia these spaces often take on a hybrid form referred to as “entrepreneurship hub”, “tech hub” or “innovation hub/lab” or simply “hubs” . These typically combine co-working spaces, internet cafe, coffee shop, training centre, incubator, accelerator, even venues and makerspaces(De Beer, 2017; Giuliani, 2018) ²² .



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203 Blackfriars Road
London SE1 8NJ

+44 (0)20 7922 0300
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²² <https://diode.network/2018/12/17/from-silicon-valley-to-silicon-savannah-tech-hubs-in-the-global-south/>