

The making of a makerspace in Ethiopia: a study of legitimacy using Actor-Network Theory

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Bio
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Abstract
Makerspaces are community-based design and fabrication spaces that enable the development of local solutions. Although the number of makerspaces in Africa is increasing, it is not well understood how these makerspaces deal with legitimacy challenges. This study aims to illuminate the process by which a newly established makerspace in Ethiopia seeks to gain, maintain and defend its legitimacy as a site for local innovation and production. It introduces Actor-Network Theory as a novels lens to study organisational legitimacy. The Actor-Network of BiT Makerspace in Bahir Dar is analysed over a three year period to show how a makerspace can establish itself as an Obligatory Passage Point via a networked legitimization process. This study enriches organizational theory on legitimacy, by introducing a new theoretical perspective that presents a procedural view of legitimacy that is continuous and bi-directional. Practically, this study identifies several strategies to support the legitimacy of makerspaces in Africa.

Keywords
Makerspaces, legitimacy, Actor-Network Theory, networks

1. Introduction

Since Gershenfeld (2012) declared a new revolution in fabrication almost a decade ago, there has been an exponential growth in the number of makerspaces around the world (Gershenfeld et al., 2017). Makerspaces (otherwise known as FabLabs, techshops and hackerspaces) are community-based design and fabrication spaces that can empower marginalized communities with the tools and resources to design and produce solutions that address local problems (Corsini & Moultrie, 2020). These spaces have been praised for their "democratizing" potential, as they open up design and production to unprivileged groups who otherwise lack access to resources (Smith, 2017). Perhaps more importantly, makerspaces can also play a role within the manufacturing industry, as potential sites for localized and re-distributed production (Hennelley et al. 2019). As such, it is believed that these spaces are particularly valuable in regions where manufacturing infrastructure is poor or disrupted (Seo-Zindy & Heeks, 2017).

In Africa, it is currently estimated that there are over fifty makerspaces, however this number is growing (Fablabs.io, 2020). Despite a rapidly growing body of research on makers and makerspaces, there has been little work which specifically examines the African context. Among limited extant research, De Beer et al. (2017) provide an initial analysis of the factors influencing the development of the South African maker ecosystem; Kraemer-Mbula & Armstrong (2017) analyses the drivers of the Maker Movement in Gauteng Province in South Africa; Oladele-Emmanuel et al., (2018) conduct a SWOT analysis of African FabLabs; Dlodlo & Beyers (2009) provide initial evidence that FabLabs can address gender inequality in science and engineering education in South Africa; Schonwetter & Wiele (2018) analyze how open 3D printing technologies can advance entrepreneurship in African makerspaces; Okpala (2016) puts forward a model for setting up a makerspace at a library in Nigeria. Ambole (2020) reflects on the case study of a makerspace in Ghana to show the potential for decolonizing African design. In a similar vein, Nkoudou (2017) calls

for the “Africanization” of the maker movement to secure cognitive justice. Elsewhere Potter et al. (2019) conceptualizes Agbogbloshie makerspace as a type of Afro-Futurism that can play a role in constructing new discourse. Irie et al. (2019) also compares Agbogbloshie makerspace with makerspaces in Singapore, China and the US to elicit shared maker ethics. They emphasize that although maker culture is steeped in Western-centric ideologies, it has the potential to incorporate contextually relevant values.

These works represent a first step towards understanding the phenomenon of African makerspaces. However, it is noted that the majority of research is published as early findings (i.e. as working papers); there is a lack of substantive engagement with theory; and, studies tend to focus on the same case studies or countries. For instance, three papers from different authors report on the Agbogbloshie makerspace in Ghana; there are also a disproportionate number of studies on South Africa. Prior research on tech hubs in Africa has considered makerspaces as part of these hubs (De Beer et al., 2017), however it is argued that these studies do not give adequate attention to the organizational uniqueness of makerspaces. Hubs typically take the form of co-working spaces that foster the development of new (social) innovations; they are “intermediary organizations that work institutional voids to promote entrepreneurship, innovation and affect wider social change” (Littlewood & Kiyumbu, 2018). In contrast, makerspaces are explicitly centered around making (Smith et al., 2013). They provide people with the resources they need to engage with physical prototyping and production, and thus they give rise to a particular set of activities and outcomes that is distinct from hubs.

In the past, researchers have pointed out the unique contextual challenges that organizations face in Africa (Lashitew & Tulder, 2017). For example, Corsini et al. (2019) report that environmental conditions, financial constraints, political instability, and lack of human resources limit the use of digital fabrication tools and infrastructure in low-resource settings. However, legitimacy is an issue that is particularly pertinent to the development of makerspaces in Africa and has hitherto not been addressed in the literature. It is well-accepted that legitimacy enhances both the stability of an organization, as well as its access to resources (Deephouse et al., 2017). In resource-constrained environments, legitimacy is therefore crucial to effectively managing operations. Traditionally makerspaces have faced legitimacy challenges from formal institutions and manufacturing organizations (Corsini et al., 2020; Browder et al., 2021), as they emerged from a subculture antagonistic to “traditional, industrial top-down” manufacturing (Kostakis et al., 2015). For instance, makers have been characterized as non-professional “tinkerers” (Peppler et al., 2016) which has limited their contribution to solving local challenges. Despite this, there have been recent endorsements of makerspaces. For instance, millions of USD have been invested in South China as part of China’s “mass makerspace” initiative (Lindtner et al., 2016). More recently during the pandemic, makerspaces have been celebrated from producing crisis-critical items (Corsini et al., 2020). The question remains, however, how does a new makerspace in Africa gain, maintain and defend its organizational legitimacy in order to fulfil its goals?

In this paper, legitimacy formation and its challenges are explored in a newly established makerspace in Ethiopia, the Bahir Dar Institute of Technology (BiT) Makerspace. Actor-Network Theory provides a conceptual lens in order to identify the key strategies that a makerspace in Africa can use to gain, maintain and defend its legitimacy. The paper is

structured as follows. First, the case study is briefly set out to introduce the reader to the key case study actors. Second, a theoretical context is outlined. Literature on legitimacy is presented before introducing Actor-Network Theory and the concept of the Obligatory Passage Point. Next, the development of BiT Makerspace's Actor-Network, and its related legitimization process is described. Finally, theoretical and practical contributions are discussed, and areas for further research are highlighted.

1.1 Case study context: Bahir Dar Institute of Technology (BiT) Makerspace

This study focuses on the single case study of the BiT Makerspace, which aims to foster inclusive and sustainable growth in Ethiopia. The makerspace is situated in the urban center of Bahir Dar, the capital of the Amhara Region, a relatively underdeveloped region of Ethiopia. Ethiopia has both the second largest population and the fastest growing economy in Africa (The World Bank, n.d.). To this extent, BiT Makerspace offers an accelerated view of the development of a makerspace in Africa.

BiT Makerspace was first established at the end of 2019 with the support of Bahir Dar University (BDU), the Centre for Global Equality (a UK based non-profit organization) and a private foundation, herein referred to as "XYZ Foundation". The makerspace itself is equipped with a range of non-digital and digital fabrication tools, including 3D printers, laser cutters and CNC milling machines, that enable rapid prototyping and small-scale production. BiT Makerspace is a first of-its-kind in Ethiopia, as the only active makerspace in the country.

Since its inception, BiT Makerspace has established multiple design engineering projects with support from national and international partners, including JedCCDO, a community based organization in Ethiopia, as well as international universities such as the University of Cambridge and the University of Wisconsin. It has also been supported by local government ministries and agencies e.g. the Ministry of Science and Higher Education and the Ministry of Innovation and Technology. The author actively engaged with BiT Makerspace for 16 months during its initial operations, and was primarily involved in design and innovation projects with BiT Makerspace as part of a research team from the University of Cambridge between January-November 2020.

Through a range of partnerships, BiT Makerspace have developed several innovations that respond to local health and food security challenges. For instance, the makerspace worked on the development of a low-cost oxygen concentrator, protective personal equipment (PPE) and an oximeter during the COVID-19 pandemic. More recently, BiT Makerspace have started developing agricultural innovations to support small-holder farmers in the region.

2. Theoretical context

2.1 Legitimacy

It has already been highlighted that makerspaces face legitimacy challenges from different actors, including formal institutions (e.g. regulators), manufacturing organizations and product beneficiaries. According to Freeman et al. (1983) legitimacy challenges are heightened in a context where a particular organizational type is uncommon or emergent.

For these reasons, it is particularly important to investigate the legitimacy deficits and strategies relevant to makerspaces in Africa.

In this study, legitimacy is considered as "a generalized perception or assumption that the actions of an entity are proper or appropriate within some socially constructed system of norms, values, beliefs, and definitions." (Suchman, 1995). Put simply, legitimacy affirms the right to exist for a particular organization. Conversely when organizations are not perceived as legitimate, they will not be accepted and their right to exist is threatened (Knoke, 1985). Whether an organization is deemed "proper" or "appropriate" clearly has implications for its long term stability (Meyer & Rowan, 1977). In addition, legitimate organizations are better placed to access resources (Brown & Deegan, 1998) they are perceived as trustworthy (Suchman, 1995) and their social and financial capital is greater (Parsons, 1960).

To date, organizational legitimacy has been considered from different perspectives. On one hand, strategic-legitimacy literature views legitimacy as a resource to be extracted from sources (i.e. stakeholders) thus emphasizing the perspectives of the focal organization. On the other hand, institutional perspectives view legitimacy as a set of constitutive belief that are constructed (Suchman, 1988). As Zimmerman & Zeitz (2002) put it: "legitimacy ultimately exists in the eye of the beholder". In other words, institutional legitimacy is primarily focused on the collective beliefs of the stakeholder field or sector (DiMaggio & Powell, 1983). Notably, Castello et al. (2017) report that both of these approaches fail to consider legitimacy as a bi-directional relationship between the focal organization and its stakeholders; such an approach would help to overcome the respective blind spots of institutional and strategic perspectives.

The legitimacy literature also debates whether legitimacy is continuous or dichotomous. Deephouse & Suchman (2008) argue for a binary view of legitimacy i.e. an organization is either legitimate or not. However, other work prefers a dynamic view of legitimacy whereby it is continuous in nature i.e. an organization can be more or less legitimate (Ashforth & Gibbs, 1990; Brinkerhoff, 2005). For instance in earlier work, Suchman (1995) poses that legitimacy demands are higher for organizations that require active support from its stakeholders, which implies a continuous scale.

Alongside these differing perspectives is the reality that the process of legitimization remains poorly understood (Deephouse et al., 2017). Ashforth & Gibbs (1990) and Suchman (1995) focus on the process of gaining and maintain legitimacy, as well as responding to legitimacy challenges. However these processes of gaining, maintaining and defending legitimacy are "black boxes" in the literature. Bitektine (2011) propose that comprehensibility is a key strategy for gaining legitimacy, whilst Deephouse et al., (2017) emphasize the importance of differentiation. Meyer & Rowan (1997) draws attention to institutional isomorphism as way to gain legitimacy. Yet, the internal workings of these ongoing processes are not readily understood. According to Lawrence (2008), power relations are also largely undervalued in the process of legitimization. The following study will explore the evolving Actor-Network of BiT Makerspace, in order to examine how makerspaces face legitimacy challenges and how they can develop mitigating strategies to build and defend their legitimacy.

2.2 Actor-Network Theory

In the previous section, it was established that legitimacy is crucial for organizations, yet there exist different interpretations of legitimacy found in the literature. Specifically, the process by which organizations gain and maintain legitimacy, and also refute legitimacy challenges is not well understood. Thus, this study turns to Actor-Network Theory to shed a light on the concept of legitimacy and how power relationships affect the gain, maintenance and defense of legitimacy.

Actor-Network Theory is a post-structuralist perspective that was initially developed by Michel Callon, Bruno Latour and Johnson Law to deal with socio-technical "imbroglios" (Latour, 1994). Actor-Network Theory is perhaps most famous for its inclusion of human and non-human actors within networks as "participants in the course of action" (Latour, 2005, p. 70). That is not to assume parity between human and non-human actors, but to recognize that they collectively constitute a network that leads to particular outcomes (Law, 1984). What this means for legitimacy is that the organizational context cannot be separated from the organization itself, and any legitimacy challenges must be reflected in the Actor-Network.

Unlike earlier structuralist network theories, which primarily focus on how the relationships in a network affect its behavior, Actor-Network Theory shifts the focus back to the individual actors in the network (Coulon, 2005; Özman, 2017). Actor-Network Theory argues that individual actors do hold agency (i.e. an ability to act independently); it contends that a system's behavior is just the result of the momentary interactions between actors in the network. As Latour (2005 p. 65) explains: "Actor-Network Theory is the name of a type of momentary associations which is characterized by the way it gathers together into new shapes". This perspective implies that the process of legitimization is continuously ongoing, and that legitimacy itself is dynamic.

Actor-Network Theory is also largely critical of the "social force" model which prevails in the social sciences. Latour (2005) claims that attempts to explain the causes of phenomena using social forces (e.g. power, the markets) fail to unpack their constituent parts and the networks that constitute them. Rather, Actor-Network Theory acknowledges a relational or diffused conception of power that is aligned with Foucault's (1979, p. 307) conceptualization of power as: "not a network of forces, … [but] a strategic distribution of elements of different natures and levels." Latour's (2005, p.64) view that: "Power, like society, is the result of a process and not a reservoir, a stock or a capital" mirrors the view that legitimacy cannot be possessed or exchanged (Scott, 1995). Instead it suggests that legitimacy is constructed through the Actor-Network, implying a bi-directional view of legitimacy that integrates both organizational and stakeholder perspectives.

In this study, the concept of the Obligatory Passage Point developed by Callon (1984) as part of Actor-Network Theory is specifically used to illuminate how organizations can build and develop their legitimacy. An Obligatory Passage Point is a feature of Actor-Networks that emerges when actors must negotiate their goals through a common node in the network. An Obligatory Passage Point is a single locus that shapes and mobilizes the network in such a way that it cannot be bypassed (Bijker & Law, 1994).

Callon (1984) outlines four main phases in a process called “translation” that lead to the development of an Actor-Network and an Obligatory Passage Point (see Figure 1). First, in the “problematization” phase, an actor must define their identity such that they establish themselves as indispensable to the network; in other words they configure themselves as an Obligatory Passage Point in the network of relationships. Second, in the “interessement” phase, this actor attempts to stabilize the identities of other actors involved in problematization. Actions are taken to lock other actors into place. Third, in “enrolment” the various roles of other actors are defined and interrelated, leading to the development of alliances. Finally, in “mobilization” the alliance is examined to assess whether it is representative of the actors’ interests. If agreed upon, the Actor-Network and the Obligatory Passage Point become stabilized.

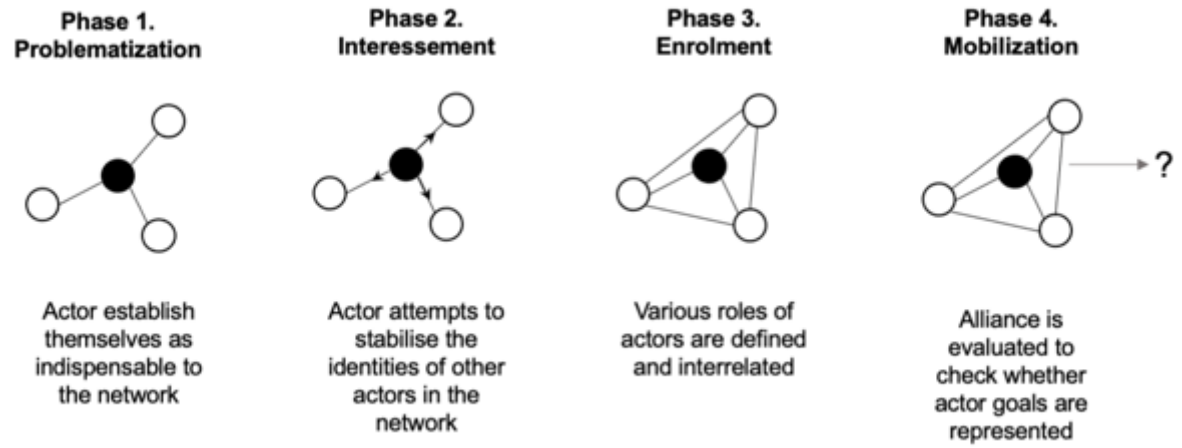


Figure 1. The formation phases of an Obligatory Passage Point

In this paper, it is put forward that the process of translation and the formation of an Obligatory Passage Point can be paralleled with the legitimization process. In other words, in an Actor-Network the translation process creates a type of relational or networked legitimacy.

3. Methods

This paper focuses on the single case study of BiT Makerspace in Ethiopia. Single case studies are a valuable way of gathering data about a relatively unknown phenomenon (Eisenhart, 1989), especially when it cannot be easily separated from its context of study (Yin, 2018). In this research, BiT Makerspace represents both an extreme and revelatory case as the first makerspace in Ethiopia, in the relatively underdeveloped Amhara region. Yin (2018, p. 50) explains that a revelatory case exists when a researcher is able to study a phenomenon which was previously inaccessible. In this instance, the researcher was able to actively engage with BiT Makerspace for 16 months between July 2019 – November 2020, from its inception to its establishment to its development.

The researcher acted as both a participant and observer whilst undertaking the case study research. The study was conducted entirely remotely by the British researcher due to travel restrictions during the COVID-19 pandemic. The British researcher’s role (external to the

local context) was examined as a potential source of bias that could affect the data collection and analysis. The researcher takes a pragmatic philosophical position that any research is inevitably from a particular perspective, but to the extent possible, action has been taken to mitigate sources of bias. First, multiple interviews were conducted with different actors in the networks to enable a holistic perspective of the case study. Second, multiple sources of data were used to build up a rich narrative and to help triangulate the data (Mathison, 1988). The findings of this study were also shared with the actors in the project to help validate insights. Table 2 shows an overview of the different data collected in this study.

Table 2. Data sources collected in the study

Data sources
Interviews and workshops: Actor-Network mapping workshop with employees at BiT Makerspace (July 2020); interview with CEO, Centre for Global Equality and five interviews on "legitimacy and Actor-Networks" with employees at BiT makerspace (May – November 2020);
Private communications: 147 emails, WhatsApp Group chat with employees at BiT Makerspace, (including 16 photos, 2 videos, 3 links, 1 document), six meetings with employees at BiT makerspace (March – September 2020)
Field notes: Researcher's reflections from meetings with BiT Makerspace and stakeholders between March – August 2020
XYZ Foundation related documents: grant application, final grant report November 2020, progress reports (1st June 2019, 28th April, 30th June 2020)
Cambridge-Africa related documents: grant application, progress report (November 2020)
Gates Open Research on BiT Makespace: Allen et al., 2020; Mower et al., 2019

As a participant, the researcher was primarily involved in design and innovation projects with BiT Makerspace between January-November 2020. Namely, they were involved in involved in planning for a healthcare "makeathon" event and a circular economy plastics workshop, which were both subsequently postponed due to travel disruption resulting from COVID-19. The researcher was also involved in the delivery of a COVID-19 project to produce PPE at BiT Makerspace, which resulted in the distribution of over 3000 face shields and 2000 face shields to front line workers in Ethiopia. The researcher's involvement in the development of the makerspace and its projects, allowed them to build up a detailed understanding of BiT makerspace, its activities, partners and the broader innovation ecosystem in Bahir Dar. It provided them with access to rich temporal data that would have otherwise been very difficult to collect. For example, they were able to access private communications, grant proposals and documents that helped to build up a timeline of events. In addition, the researcher's contributions helped to build up trust with employees and other stakeholders, which was especially important whilst collecting data remotely due to travel restrictions.

As an observer, the researcher facilitated Actor-Network workshops and interviews with employees at BiT makerspace. The Actor-Network workshops were conducted remotely over two sessions with two employees at BiT Makerspace, using Miro as an online collaborative whiteboard tool. All the interviews were conducted in English due to the fluency of stakeholders. The aim of these workshops was to document how the Actor-Network of BiT Makerspace evolved over time, and the related process of legitimization. A template was prepared in advance of the workshops, which was used to help identify and

map the Actor-Networks of BiT Makerspace. First, participants were asked to identify the actors related to BiT Makerspace for each stakeholder type (i.e. third sector; government and political actors; media; research and science; users; industry). Second, participants were asked to explain the relationships between these actors and the makerspace, using lines to visualize these relationships. The researcher asked questions to elicit a view of how these relationships had developed over time. Third, participants were asked to reflect on the various aims of the actors, and how the Actor-Network enabled them to achieve their various goals.

Semi-structured interviews were also conducted with employees at BiT Makerspace at regular intervals between May – November 2020. These interviews were conducted in two main parts. The first part served as a reflective session, where the researcher and interviewee reflected generally on the makerspace's progress and its roadblocks. The second part of the interview was used to explore the concept of legitimacy. The interview protocol focused on asking questions related to the following: (1) the perceived legitimacy of BiT Makerspace; (2) strategies for building legitimacy; (3) challenges to legitimacy; and, (4) strategies to maintain and defend legitimacy. An in-depth interview was also conducted with the CEO of the Centre for Global Equality (a key partner in setting up BiT Makerspace) to triangulate the case study data. Interviewee details are shown in Appendix Table 1. All the interviews and workshops were audio recorded with the participants' consent and transcribed using automatic transcription software (Otter.ai). These transcripts were then adjusted for accuracy by the researcher.

The data analysis consisted of different stages. The first involved carefully analyzing different sources of data to build an "event history database" as per Garud & Rappa (1994). This narrative helped the researcher to develop a detailed view of what had transpired during BiT Makerspace's formation and development. Second, this data was compared with the four stages of translation by Callon (1984) to identify how the evolution of BiT Makerspace related to the stages of problematization, interessement, enrolment and mobilization. Third, the data (including interviews and workshop recordings, and secondary data) was cross-checked to identify all the actors involved in the BiT Makerspace, and their relationships. This helped to construct an Actor-Network for each translation stage of BiT makerspace, whereby each actor (e.g. an organization, person, event etc.) was identified as a node or "element" in the network, and the relationships between these actors were represented as edges or "connections". Kumu, a web-based network analysis software, was selected to help visualize these networks. Kumu allows network maps to be shared publicly using a unique hyperlink, and thus responds to calls for researchers to "give back" network data to participants (Borgatti & Molina, 2005). The Actor-Networks for BiT Makerspace for the four stages of translation are shown in Appendix Figures 1-4, and can also be viewed interactively using the hyperlinks shown in Appendix Table 2. The following section will describe each of these Actor-Networks, and analyses how BiT Makerspace establishes itself as an Obligatory Passage Point in the network. This analysis documents the process of networked legitimization, helping to shed light on how a makerspace in Africa can gain, maintain and defend its legitimacy.

4. A case study of networked legitimization: Bahir Dar Institute of Technology (BiT) Makerspace

4.1 Problematization phase: Laying the groundwork (March 2017 – March 2019)

Although BiT makerspace did not officially open its doors until the end of 2019, the underpinnings of this initiative date back two years prior. In the early stages of 2017, the Centre for Global Equality, a non-profit organization based in Cambridge, UK was connected with the Bahir Dar Institute of Technology (BiT) in Ethiopia, via one of their partner organizations: a community-based organisation called JedCCDO. The Centre for Global Equality convenes a network of non-profit, academic and civil society actors who seek to mobilize frontier technologies for international development. At the time, the Centre for Global Equality were actively searching for a partner with whom they could improve technology transfer from the University of Cambridge, to support a more inclusive innovation approach "for, with and by the rising billions". Following several promising meetings between Centre for Global Equality and BiT, a "Bahir-Dar-Cambridge Relationship Building Workshop" was held in Bahir Dar in March 2018, which was co-hosted by BiT, the Centre for Global Equality and JedCCDO. The workshop brought together over sixty researchers from Ethiopia and the UK, in an effort to identify collaborative research projects related to water, food, energy, waste, health, work and livelihoods. This workshop helped to identify several promising areas for collaboration between BiT and the University of Cambridge.

During this problematization phase, one of the key individuals supporting the nascent partnership between BiT and the University of Cambridge was promoted to Director of BiT. One of the priorities for his tenure was to support entrepreneurship as youth unemployment is a major challenge in Ethiopia. It soon became apparent that a prototyping space was urgently needed to support this vision as local entrepreneurs lacked the tools and resources to materialize their ideas; with this in mind the concept of the BiT Makerspace was formed. In March 2019, BiT and the Centre for Global Equality successfully applied for a grant from XYZ Foundation, to establish the makerspace. It was noted that XYZ Foundation, an international foundation with headquarters based in the US, requested to not be named in public communications about the BiT Makerspace; it was felt that the XYZ Foundation wished the makerspace to be viewed as a stand-alone initiative. Whilst this was initially considered to be counter-intuitive to the makerspace's reputation building, it was speculated that this actually helped the makerspace to gain legitimacy within the African makerspace network, and to legitimize their efforts to boost entrepreneurship and innovation in Ethiopia. According to stakeholders from BiT Makerspace and the Centre for Global Equality, the XYZ Foundation adopted a mostly hands-off approach, allowing the project to be locally-driven by the stakeholders on the ground.

Although just a concept at this stage, BiT Makerspace already began to position itself as an Obligatory Passage Point for the various actors to achieve their goals (see Figure 1). A shared "problematization" was realized in the makerspace, which helped to legitimize the concept from the outset. Specifically, for XYZ Foundation, the initiative supported their vision for sustainable development in Africa. For the Centre for Global Equality, BiT Makerspace offered an infrastructure for enabling inclusive innovation projects between BiT and the University of Cambridge. For the Bahir Dar Institute of Technology, the makerspace

offered the possibility to cultivate (and restore) their reputation as an innovation leader in Ethiopia, among other research institutions and public bodies:

> In previous times, BiT was known for innovative ideas, new problem solving, public projects. But at some point, this became a little bit hidden. Most of the projects that we were doing were not as significant as they used to be. So having this kind of space would establish back that name. – 02-01

At this stage, the actors involved began to reinforce the identity of BiT Makerspace by differentiating it from other initiatives in Ethiopia. Language that emphasized novelty (e.g. "first-of-its-kind") was regularly used in communications to signal the possible new opportunities that could emerge from the makerspace. However, the novelty of the concept also created some initial legitimacy challenges. To begin with, the makerspace concept was not well understood by some decision-makers at BiT, the host institution. Here, the Centre for Global Equality played a key role in helping to raise their level of awareness, by drawing on their relationships with other makerspaces in East Africa. Showcasing success stories helped to build cognitive legitimacy around the makerspace concept i.e. it became comprehensible and understood by key stakeholders at BiT. Through this process, the BiT Makerspace concept began to establish legitimacy; stakeholders considered the makerspace concept to be a feasible and appropriate solution for tackling sustainable development goals in Ethiopia.

Although BiT Makerspace was only at the concept stage in this phase, it became an important passage point through which BiT, the Centre for Global Equality and the XYZ Foundation began to develop a relationship. According to the stakeholders involved, collaborating on a shared initiative helped to build trust, which created further buy-in for the makerspace concept. Figure 2 summarizes how BiT Makerspace began to position itself as an important node in the network, by helping the main actors to achieve their goals.

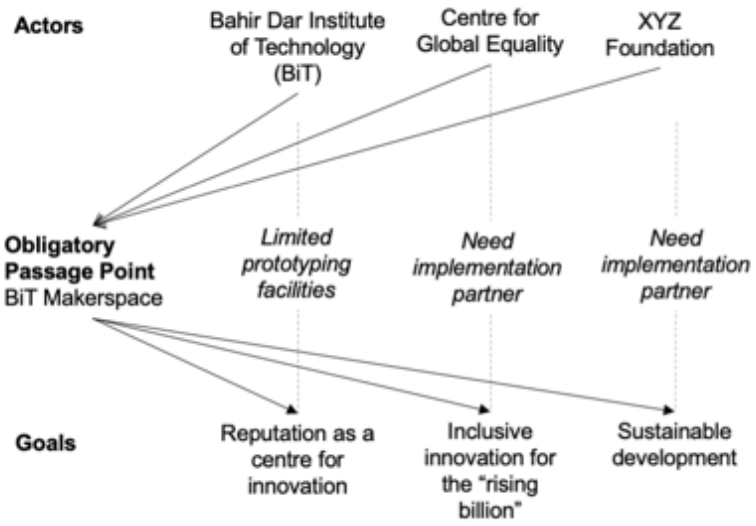


Figure 2. BiT Makerspace positions itself as an important node in the network

4.2 Interessement phase: Establishment and initial operations (April 2019 – March 2020)

In the previous phase, the initial concept of the BiT Makerspace was conceived through a shared “problematization” of key stakeholders. Although not yet realized, the BiT Makerspace had already succeeded in making itself indispensable to these actors.

Once funding had been secured to set up BiT Makerspace, it took several months for the makerspace to be fully operational. Initially, several procurement challenges and related University policies meant that it was difficult to secure equipment which needed to be imported to the makerspace. Whilst waiting for the equipment to arrive, the organization of the makerspace and its programs were prioritized. In particular, efforts were made to build relationships between BiT Makerspace and other well-established makerspaces in Africa. For example, the manager of BiT Makerspace visited Nairobi Makerspace in Kenya, Kumasi Hive in Ghana, and also attended the Africa Makerspace Gathering in Accra in November 2019. Attending these events helped to expose BiT Makerspace to community norms and practices, as well as strengthening the makerspace’s legitimacy as perceived by other actors.

During this stage of the makerspace’s development, the researcher based at the University of Cambridge was connected with the makerspace via the Centre for Global Equality. As part of an initiative to tackle health challenges, the researcher began collaborating with BiT Makerspace to plan a healthcare Makeathon that could support the development of local health innovations in Ethiopia. This project helped BiT Makerspace to communicate the value of its space through targeting the specific sustainable development goal of health and wellbeing. Being able to demonstrate expertise in a particular area was seen as an advantage for persuading partners to support BiT Makerspace and to enable its legitimacy building.

By December 2019, the first shipment of 3D printers and fabrication tools arrived at BiT Makerspace, supported by the Centre for Global Equality. BiT had allocated the makerspace a room and an office to set up the space on its campus free of charge. In this way, the makerspace effectively “locked in” BiT as an institutional partner, and strengthened its position as an Obligatory Passage Point. A partnership was also formed between BiT Makerspace and the Business Incubation and Techno-Entrepreneurship Centre (BiTec) based at the Bahir Dar University. This increased the community’s awareness of the makerspace and helped to initially strengthen the makerspace’s agenda as a capability for fostering local innovation. For BiTec, the existence of the makerspace provided a much-needed prototyping and production facility for local entrepreneurs, thus enabling BiTec to also materialize their goals of advancing entrepreneurship.

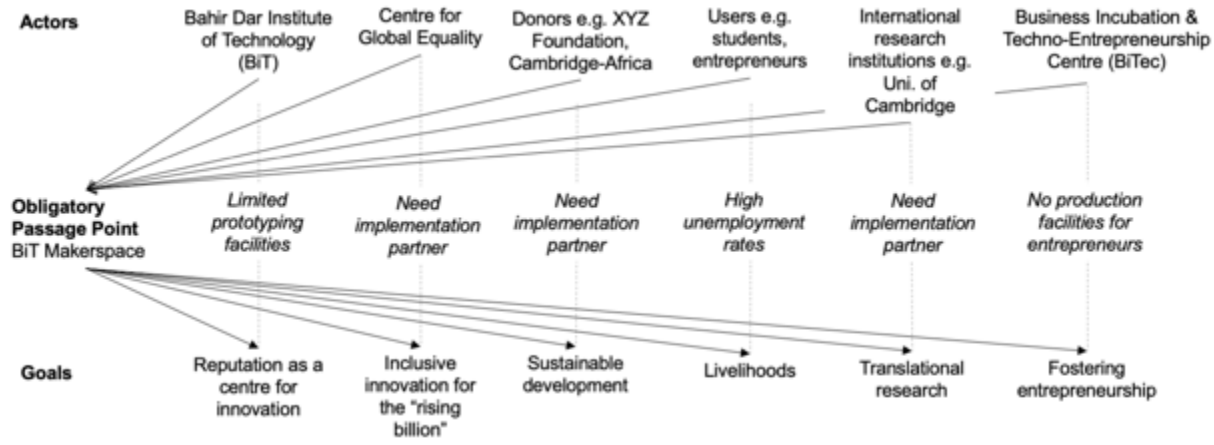
In October 2019, the first workshops were organized at BiT Makerspace. During this time, raising awareness about the makerspace was a key priority for its legitimization. In January, a Bio-Maker Challenge workshop, was co-hosted by the University of Cambridge at BiT Makerspace. Stakeholders at BiT Makerspace reported that by forming this collaboration with a world-ranked university, the makerspace was able to effectively gain legitimacy, both locally and internationally. It also helped to formalize the value of BiT Makerspace among its institutional partners; the makerspace acted as critical infrastructure for implementing translational research. This observation that international partners could help to strengthen legitimacy was reflected upon in light of the earlier proposition that makerspaces could help to decolonize innovation in Africa. Perhaps the reality that African makerspaces (in spite of

being set up as spaces to empower African innovation) would still look for partners in the Global North is not surprising, given that these spaces exist within a broader socio-political context that persistently favors Northern design and technology. During this early stage of legitimacy building, these partnerships were viewed as an asset, and not considered to be in tension with the makerspace's agenda to empower local innovation. However, the researcher speculates that these tensions could potentially emerge in a later stage of the makerspace's development.

Between January and March 2020, 3D printing workshops were also hosted at BiT Makerspace, in which participants learnt how to build self-replicating 3D printers. A subsequent workshop was held to develop a fingerprint identification technology. Importantly, these events established a relationship between BiT Makerspace and its users (i.e. students and young entrepreneurs) and helped to position the makerspace as a resource for them to pursue their ultimate goal of employment (and entrepreneurship). During this phase of the makerspace's development, raising awareness about the space was identified as a key priority. In order to do this, the makerspace sought to evoke the concept of making, thus reinforcing its cultural-cognitive legitimacy.

> People don't know about makerspaces... We need to create an awareness about what a makerspace is, how they can benefit the world, how they can stimulate new ideas… the first thing is to create awareness. – 01-02
> So when we first established it, people were not familiar with the idea of a makerspace, but at least they are familiar with the idea of making – 02-02

In this phase, BiT Makerspace began to strengthen itself as a focal organization by which actors could achieve their various goals (see Figure 3). The makerspace attempted to stabilize the identity of different actors, by forming partnerships that establish each actors' role and contributions.

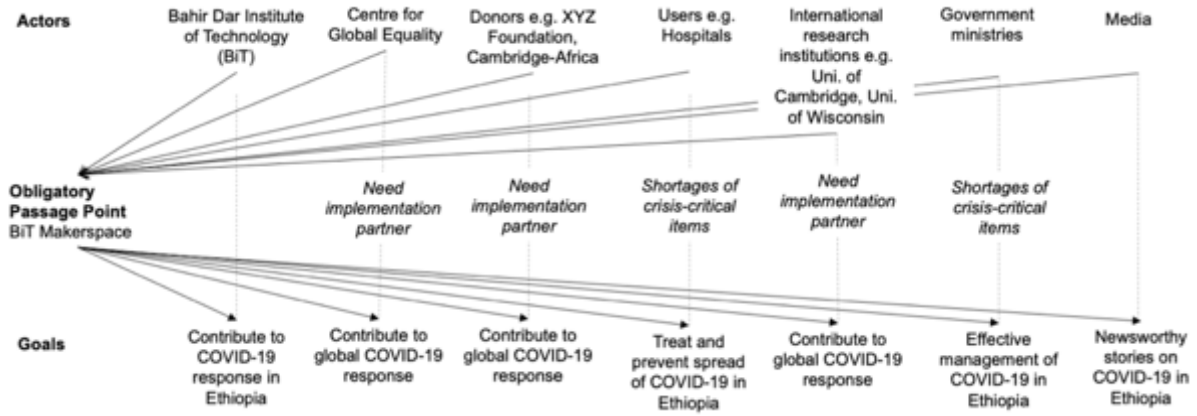


4.3 Enrolment phase: Crisis response (March – September 2020)

In the previous phase of interessement, the Actor-Network of BiT Makerspace evolved in such a way that the identities of other actors stabilized in relation to the makerspace. More precisely, BiT makerspace positioned itself a focal organization for which actors could seek

to achieve their various goals, including: reputation building (BiT); translational research (University of Cambridge); partnership development (Centre for Global Equality); livelihood creation (users); and, providing production facilities to support entrepreneurship (BiTec). In the following stage of enrolment, the overarching goals of these and additional actors align during the COVID-19 pandemic crisis response. The roles and relationships between these actors are further defined and interrelated in such a way that solidifies BiT Makerspace as a focal node, and an essential actor in Ethiopia's crisis response (see Figure 4).

Figure 4. BiT Makerspace as an Obligatory Passage Point during enrolment phase



The first case of coronavirus was declared in Ethiopia on 13th March 2020, which led to subsequent travel restrictions and students being sent home from universities. As a result, several planned activities, including a Health Makeathon coordinated by BiT Makerspace, Nairobi Makerspace and the Centre for Global Equality was cancelled. Although COVID-19 disrupted short-term plans at BiT Makerspace, it also presented an opportunity for the makerspace to clarify its role in the local ecosystem. At a time when there were extreme shortages of critical healthcare items, BiT Makerspace was able to rapidly design and fabricate urgently needed supplies, including: automatic hand-washing systems; a disinfection tunnel; infra-red thermometers; pulse rate oximeters and a remote patient monitoring system. BiT Makerspace also worked with the University of Wisconsin and the University of Cambridge to digitally fabricate face masks and face shields for healthcare workers. During this stage, the researcher collaborated with BiT Makerspace, as part of a team at the University of Cambridge, to rapidly deploy digital fabrication tools (3D printers, laser cutters) to locally produce face masks and face shields for front line workers. These digital fabrication tools became key elements of the Actor-Network that facilitated resource flows between various actors, and helped to materialize the goal of BiT Makerspace to support local innovation. To this extent, these technologies became key devices in the legitimization of the makerspace, by enabling the space to demonstrate its organizational efficacy. Separately, BiT Makerspace collaborated with the Centre for Global Equality and the University of Cambridge to develop a low-cost oxygen concentrator.

> COVID is very awful but in terms of the makerspace it did bring a lot of opportunities… it increased our visibility… we started making a lot of things and I think people began to realize we can actually can do things to help the community. – 02-01

In light of their work during the pandemic, BiT Makerspace has been well-recognized by Ethiopian government ministries and national media. Prominent endorsements were received by the Ministry of Science and Higher Education and the Ministry of Innovation and Technology, who were both invited to visit the makerspace by the Director of BiT. Amhara TV, a mass media television network, subsequently produced a program on 3D printing at BiT Makerspace, and they are now commissioning a series of other programs on the makerspace. To put it clearly, BiT Makerspace made themselves indispensable during the COVID-19 crisis response. To this extent, BiT Makerspace established themselves an Obligatory Passage Point for the government and other actors to tackle the spread and prevention of COVID-19.

Yet that is not to say that BiT Makerspace did not face legitimacy challenges during this time. In fact, it is reported that there was some initial resistance to items produced at the makerspace because of negative perceptions of manufacturing in Ethiopia. Staff at BiT Makerspace report that in spite of shortages, healthcare providers were initially reluctant to accept face shields that were manufactured locally, due to a preference for imported equipment. Although the makerspace received positive national press for their contributions towards tackling the COVID-19 crisis, negative perceptions towards “made in Ethiopia” persisted among healthcare practitioners at both an individual and institutional level.

> If I give them something without telling them that it was produced here, it’s fine, but if you mention that it is produced here, then you start to have a lot of questions… we're not willing to buy our own domestic products… our perception is always that something which is manufactured abroad is best – 02-02
> I feel there's also that self-doubt, doubting your own production, doubting your own abilities. And I feel it was easy for the government to trust something that has been imported… just because they had been imported. So I think it's also about people embracing their own production and being able to trust in their local abilities. – 02-01

In response to these concerns, BiT focused on establishing adequate quality controls to improve their procedural legitimacy. For instance, they made efforts to engage with the Ethiopian Food and Drug Administration (FDA) in order to certify their products, however did not receive a response. It was pointed out that the novelty of producing healthcare equipment in Ethiopia meant there was an absence of approval pathways for products manufactured in-country. Without confirmation from the Ethiopian FDA on the requisite standards, official certification could not be completed. The distribution of crisis-critical equipment by BiT Makerspace to front line workers was only made possible via emergency product waivers granted by institutional champions (i.e. key decision makers at local hospital/health clinics). It was reported that perceptions of locally manufactured items were more favorable when scarce imported alternatives were available. This highlights how filling a market void can be a key strategy for the legitimization of makerspaces.

In general, it was noted the underdevelopment of the manufacturing sector in Ethiopia was a hinderance to legitimization. Whilst an underdeveloped ecosystem meant the makerspace faced little competitive resistance (e.g. from local manufacturers), it also meant that there were no established pathways for approving healthcare equipment produced in Ethiopia.

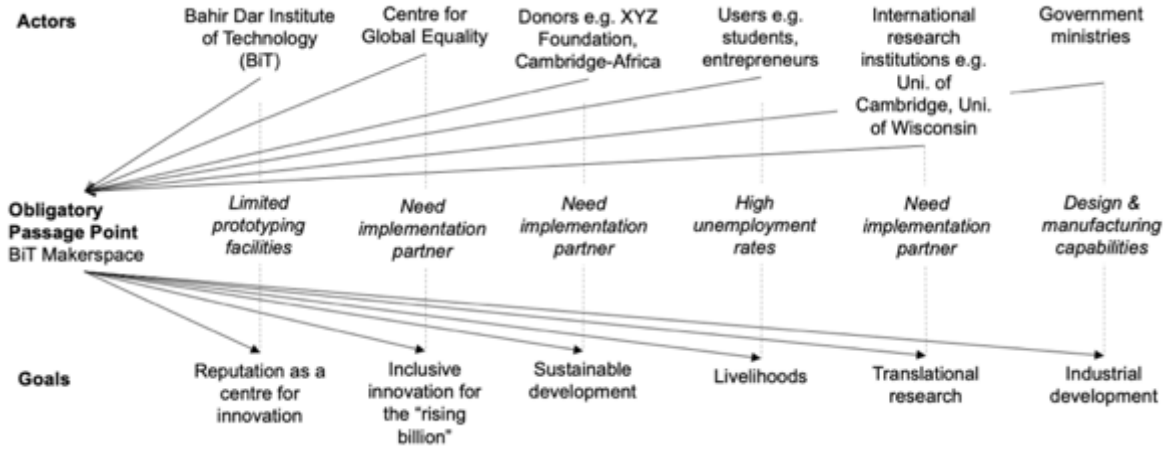
Overall, this highlights how legitimization is constrained by the underdevelopment of the institutional ecosystem.

4.4 Mobilization phase: Recovery and transition (October 2020 –)

In the previous phase of enrolment, the goals of various actors converged around the desire to tackle the spread and prevention of COVID-19. Within this context, BiT Makerspace was able to further gain legitimacy, by stabilizing its position as an Obligatory Passage Point in the Actor-Network. The next mobilization phase represents a critical stage, as BiT Makerspace simultaneously transitions from crisis response to recovery, and its initial grant funding from XYZ Foundation comes to an end. According to Callon (1984) mobilization is a period of reflection, where actors decide whether the Actor-Network and the Obligatory Passage Point is deemed representative (de facto legitimate) or not.

It is too early to assess the outcomes of this stage, however, it is noted that some promising expansions to the network signal the maintenance of BiT Makerspace's legitimacy. For instance, staff members from BiT Makerspace were invited to meet with the Ministry of Innovation and Technology in Addis Ababa, to discuss opportunities for securing further funding from private foundations. BiT also endorsed the efforts of the makerspace, by providing a larger and more prestigious room to house the makerspace on its campus free of charge. Whether BiT Makerspace will inspire other similar initiatives in Ethiopia also remains to be seen. However, initial conversations between the makerspace and the Ministry of Innovation and Technology suggest that there is significant interest in expanding upon and replicating the work of BiT Makerspace in other locations. It is speculated that this could help to reinforce BiT Makerspace's legitimacy by improving awareness of the makerspace concept. However, it could also lead to new legitimacy challenges, particularly related to BiT Makerspace's role as a first-of-its-kind space. These challenges present possible entanglements could even lead to a re-problematization phase, whereby the BiT Makerspace must re-establish its position as an Obligatory Passage Point in an emerging network. This implies that legitimization is not necessarily linear, but a circular and dynamic process.

Figure 2. BiT Makerspace as an Obligatory Passage Point during mobilization phase



5. Discussion

This study has aimed to understand how a newly-established makerspace in Africa can gain, maintain and defend its legitimacy. It has focused on the revelatory case of BiT Makerspace in Ethiopia, tracing the development of this makerspace from its conception to its current operations.

In terms of theory, this paper has enriched current studies of legitimacy by applying Actor-Network Theory as a novel lens. A networked legitimization process is put forward, in which the formation and stabilization of a focal organization as an Obligatory Passage Point is identified as a key legitimacy strategy. Legitimacy challenges are re-framed as controversies (which Callon (1984) also refers to as "betrayals") within the Actor-Network. In relevant work, Castelló et al. (2016) identify the concept of "networked legitimacy" in the context of a pharmaceutical company's social media activities. The current study offers a complementary perspective, placing emphasis on legitimization as process of an Actor-Network's translation.

The introduction of Actor-Network Theory has also helped to bring together differing perspectives on legitimacy found in the literature. Specifically, Actor-Network Theory advocates for a networked view of legitimacy that is bi-directional and co-constructed by the focal organization and its stakeholders; it thus eliminates the possibility of a dichotomy between strategic and institutional legitimacy perspectives. Specifically in this case, the legitimacy of BiT Makerspace evolves according to how they are viewed by other actors, as well as by how they define the roles of these actors in their network. Thus, legitimacy is not constructed "from the outside in", but it is constantly being negotiated in a relational way between BiT Makerspace and each of its stakeholders via multiple bi-directional interactions. Actor-Network Theory also implies that legitimacy is continuously in flux, thus preferring a non-binary view of legitimacy. Finally, the inclusion of human and non-human actors within an Actor-Network implies that context is not something "out there", but it is a part of the network itself and thus must be considered within an analysis of an organization's legitimacy. In early work on Actor-Network Theory, Law (1984) uses the example of how Portuguese colonizers exerted long distance control via the use of documents, devices and trainings. In a similar vein, this study has considered how digital fabrication tools (e.g. 3D printers, laser cutters) become mediating actors that strengthen relationships between geographically dispersed stakeholders and enable the legitimization of BiT Makerspace.

Specifically for makerspaces in Africa, this study has identified some key factors that influence the legitimacy of newly established makerspaces. In the case of BiT Makerspace, the organization was successfully able to position itself as a critical node in the network that enabled stakeholders in the broader ecosystem to achieve their overall goals. The findings identify several legitimization strategies that are relevant for practitioners setting up or managing makerspaces in Africa. For instance, during problematization the concept of BiT Makerspace gained moral legitimacy as influential actors (including project donors and research institutions) agreed upon the makerspace's right to exist and its potential to positively benefit the local community. During this phase, building cognitive legitimacy (i.e. building up an understanding of the organization and its purpose) was key to securing

stakeholder buy-in. The makerspace was also granted legitimacy, and to some extent institutional protection, because of its integration into BiT's university campus. Existing relationships between BiT and government ministries led to further endorsements of the makerspace. This support from pre-existing legitimate entities helped to kick start the makerspace's legitimization process in what the author calls a type of "networked legitimacy piggybacking" (see Soublière & Gehman (2016) on legitimacy piggybacking).

Once formed, BiT Makerspace focused on developing its cognitive legitimacy more broadly i.e. making sure that the concept of the makerspace was comprehensible and valued. Even though the concept of a makerspace was relatively unknown in Ethiopia, familiarity with "making" helped to ground the makerspace's identity. This is consistent with the view that in order to gain legitimacy, new organizations must both conform to and manipulate their institutional environments; they should act in a way that differentiates themselves, whilst presenting themselves "broadly enough to encompass existing knowledge and to invoke familiar cognitive categories" (Bitektine, 2011). Developing relationships and collaborating with other well-established makerspaces in Africa helped to legitimize BiT Makerspace within the maker community, as well as reinforcing the idea that the makerspace was part of something bigger to other stakeholders.

This study also signals the possibility for external shocks to accelerate the legitimization process. In the case of BiT Makerspace, the COVID-19 pandemic was viewed as a catalyst for the legitimization of the makerspace. Extreme shortages of crisis-critical items and supply chain disruption meant that products could not be readily imported. In this context, the local production of critical items at BiT Makerspace helped to concretely evidence the value of the makerspace. Thus, one strategy for newly established makerspaces to gain legitimacy is to focus on "quick wins" i.e. products that require minimal resources but demonstrate significant social benefits. To this extent, products developed at makerspaces can serve as "boundary objects" or temporary bridges to create shared meaning and facilitate communication (Star & Griesemer, 1989), thus helping to build cognitive legitimacy.

A key tension that emerged in findings was the observation by members of BiT Makerspace that international partnerships with universities based in the US and UK, helped to strengthen their legitimacy. This runs counter to the discourse on makerspaces being sites for African-driven innovation. In reality, makerspaces (in Africa) must walk a tightrope between being locally rooted and globally open; it is this cosmolocalism that Escobar (2018) argues is needed to cultivate open and resilient communities. The findings emphasize the importance of cultivating an exchange of resources between partners in the Global North and South, as opposed to a linear transfer from North to South. This reciprocity (and resulting flattening of power hierarchies) is key to securing the long-term legitimacy of the makerspace, as a site for African development.

Besides this, the findings suggest that makerspaces in Africa must take extra steps to build and maintain procedural legitimacy through the implementation of best practices and quality assurance. As noted in the findings, there are some negative conceptions about the quality of products made in Africa, which pose a particular legitimacy challenge for makerspaces. To mitigate this, makerspaces must make additional efforts to defend their perceived structural and procedural legitimacy. In reality this remains challenging, especially

within an underdeveloped institutional ecosystem. In particular, the absence of relevant in-country standards and certification processes poses a problem. It is clear that further support is needed from regulators and government bodies to develop robust strategies for the certification of locally manufactured items.

6. Conclusion

Legitimacy is important for organizations to secure their long-term viability and to access resources. The question of how makerspaces in Africa can establish legitimacy is highly relevant, as many makerspaces are pioneers and therefore face particular challenges building and entering a new sector. In this study, Actor-Network Theory was identified as a useful lens to investigate the process of legitimization.

By analyzing multiple sources of data, an Actor-Network of BiT Makerspace was identified during four main stages of Actor-Network translation: problematization, interessement, enrolment and mobilization. Analysis of these Actor-Networks showed how the makerspace effectively established itself as an Obligatory Passage Point i.e. a focal organization that made itself indispensable to the pursuit of other actors' goals. These findings led to the proposal of a networked legitimization process, which can help to illuminate how organizations continually gain, maintain and defend their legitimacy. It was put forward that makerspaces can benefit from "networked legitimacy piggybacking" via direct and indirect relationships to pre-existing legitimate organizations. This study also identified possible areas for further research, particularly with respect to the development of a circular model of legitimization. Specifically, the dynamics of re-problematization could be studied to better understand how established organizations continually defend their legitimacy.

Although this study has contributed to knowledge in several ways, there are some limitations which should be considered. First, this is a single case study, which may limit the generalizability of findings. This study could be replicated in other countries and contextual settings (e.g. urban versus rural). Second, the key informants in the mapping of the Actor-Networks were the staff at the makerspace. Third, the researcher's own position in the network may have obscured or exaggerated certain aspects. Issues of bias due to the researcher's etic position have already been discussed. Although data triangulation (including analysis of documents, reports, communications etc.) was used to mitigate this as much as possible, it is possible that engagement with a broader range of stakeholders would have helped to illuminate other findings or controversies.

Overall, this study has contributed to research on legitimacy, by introducing Actor-Network Theory as a novel lens of study. It has considered the potential of Actor-Network Theory to integrate various accounts in the legitimacy literature. With regards to practice, several practical recommendations for how a makerspace in Africa can gain, maintain and defend legitimacy have been highlighted in this study. We have also revealed how the broader context can manifest as legitimacy challenges or catalysts, drawing attention to the support that is needed within the ecosystem to improve the legitimacy of makerspaces in Africa.

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8. Disclosure statement

No potential competing interest was reported by the author.

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Appendix

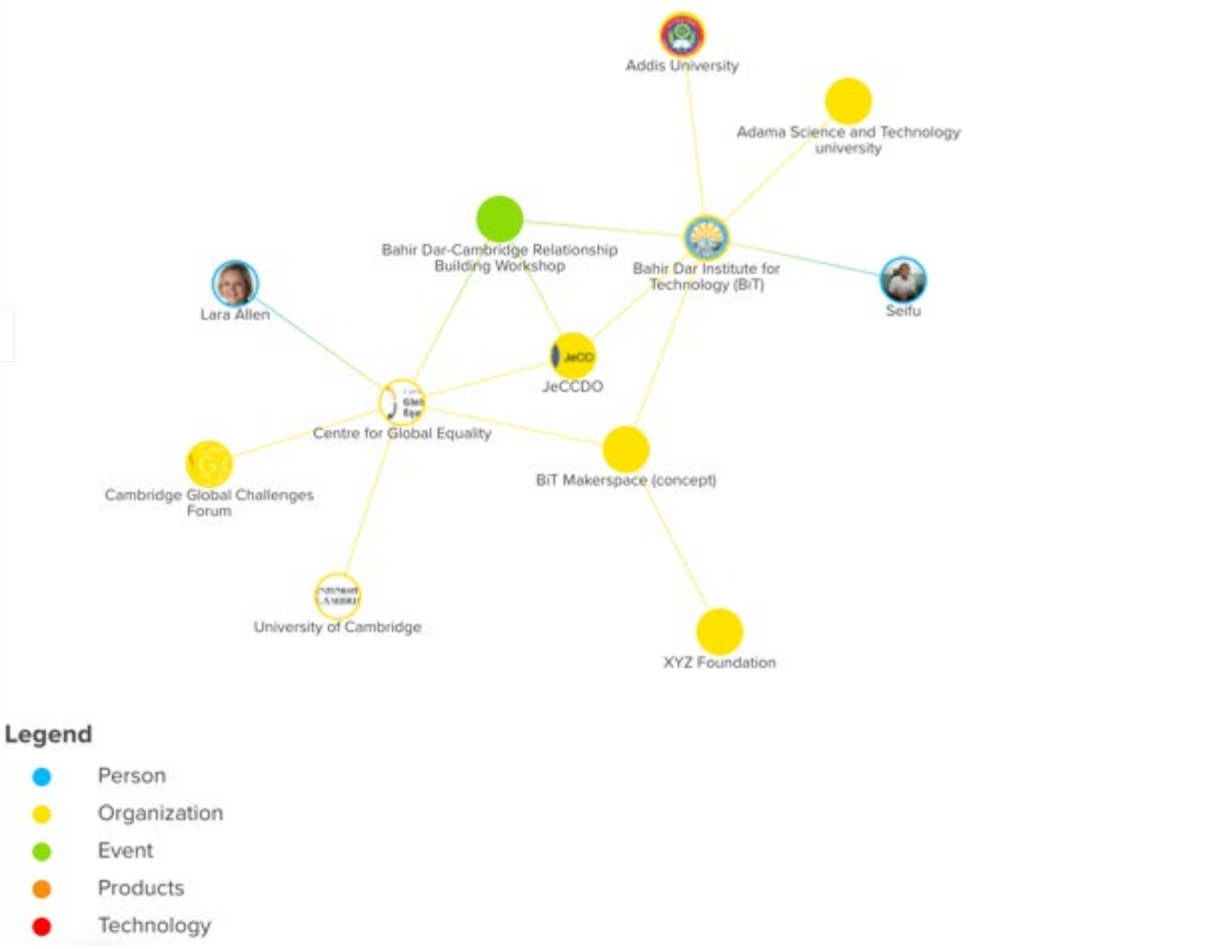
Appendix Table 1. Interviewee details

Role	Interview date	Code
BiT Makerspace manager 1	May 2020	01-01
BiT Makerspace manager 1	August 2020	01-02
BiT Makerspace manager 1	September 2020	01-03
BiT Makerspace manager 2	August 2020	02-01
BiT Makerspace manager 2	November 2020	02-02
Centre for Global Equality, CEO	November 2020	03-01

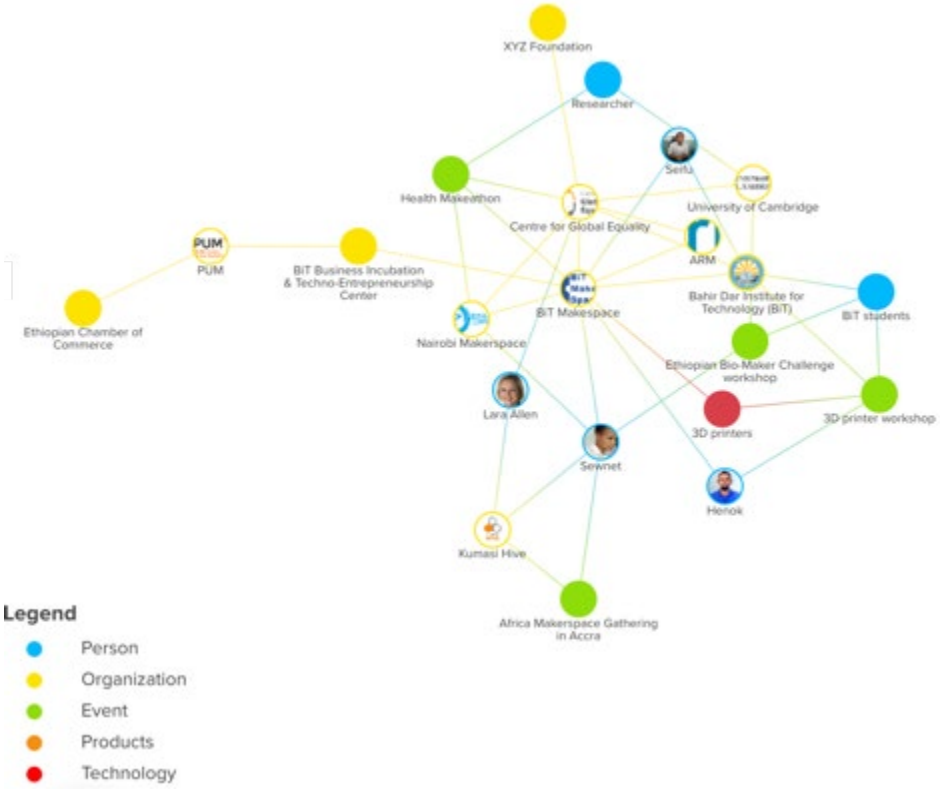
Appendix Table 2. Hyperlinks of Actor-Network of BiT Makerspace during four stages of translation

Actor-Network Phase	Hyperlink to interactive map on Kumu
Problematization	https://embed.kumu.io/1901be1d2bf75cceee451350845af10d
Interessement	https://embed.kumu.io/74781a354ec12d5bb8d3714b4494fd9b
Enrolment	https://embed.kumu.io/5dbb7ccda6bc691d79d3217e9464b066
Mobilization	https://embed.kumu.io/a230b4d52d41215cf12074f75ecc430c

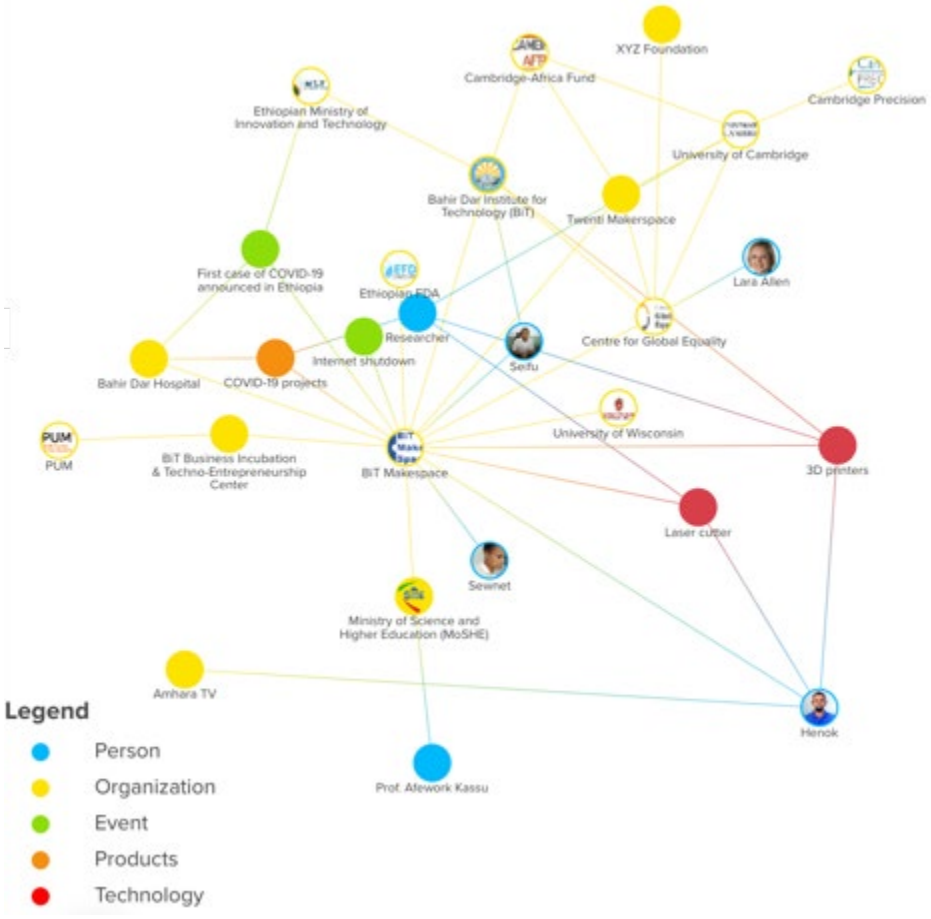
Appendix Figure 1. Actor-Network during problematization phase



Appendix Figure 2. Actor-Network during interessement phase



Appendix Figure 3. Actor-Network during enrolment phase



Appendix Figure 4. Actor-Network during mobilization phase