Paper to be presented at the DRUID Academy Conference 2017 at University of Southern Denmark, Odense, Denmark on January 18-20, 2017

Technology management of technology-based nonprofits

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Abstract

State of the Art Technology-based nonprofits are a class of social ventures that have recently emerged due to diffusion of digital technologies. These organizations aim to achieve social objectives (e.g. reduce extreme poverty, provide affordable healthcare and education) through the use of digital technologies (e.g. smartphones, 3D printers, web applications, et al.). Such firms may face challenges in acquiring the resources needed to develop their technology and grow (e.g. traditional VC funds are unlikely to invest in nonprofits). However, being nonprofit may also provide them with some advantages (e.g. charitable foundations may provide funding; skilled individuals may offer their time and expertise for free). Research Gap There is little published research on the growth of technology-based nonprofits. The literature review reveals that academic research on the growth of technology-based organizations has been predominantly focused on for-profit organizations. Additionally, the phenomenon of technology-based nonprofits was only recently enabled by the advancement and widespread diffusion of digital technologies. This leads to a research gap, which merits attention to enrich academic understanding of how technology-based nonprofits acquire resources to grow, and to develop their technologies. Theoretical Arguments The resource-based theory views the firm as a bundle of resources (Penrose, 1959; Wernerfelt, 1984). The theory is suitable to explore the growth process of firms since the change of resources can be observed. Garnsey and Heffernan (2005) have adapted the resource-based theory to research on the growth process of high-technology firms. The adapted theory will be used as a theoretical basis for analysis of technology-based nonprofits. Methodology The method to research the phenomenon was conducted in two parts. Firstly, a case study of a local technology-based nonprofit was undertaken, and data from this case study applied to the Garnsey and Heffernan (2005) framework to reveal new insight. The case study used was that of Cambridge-based technology-based nonprofit, Simprints (selected from the results of preliminary interviews with local practitioners involved in social ventures). Primary data was captured using two methods: (1) interviews were conducted with core Simprints staff members and managers from organizations supporting Simprints; (2) the author undertook participant observation at

Simprints by volunteering expertise in software and hardware development to participate in their technology development process. The experience was documented in the form of field notes. Secondary data from relevant news articles online were also reviewed and documented. The data were subsequently codified based on recurring themes and structured using Garnsey and Heffernan (2005)'s framework. Results The results revealed that Simprints as a nonprofit had certain advantages over for-profit organizations in accessing resources. Simprints' use of volunteers and strategic partnerships with many organizations to grow the venture revealed new insights to how technology-based organizations overcome their resource constraints. These findings were not able to be fully explained by Garnsey and Heffernan (2005)'s framework. Modifications to the framework were made in order to include the new elements, the generalisability of which will be explored through further qualitative and quantitative research on a broader sample of technology-based nonprofits. References Garnsey, E., & Heffernan, P. (2005). High-technology clustering through spin-out and attraction: The Cambridge case. Regional Studies, 39(8), 1127-1144. doi:10.1080/00343400500328289 Penrose, E. (1959). Theory of the Growth of the Firm. Wernerfelt, B. (1984). A resource-based view of the firm. Strategic Management Journal, 5(2), 171-180.

Jelcodes:M10,O32

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1.0 Introduction

Technology-based nonprofit firms are a class of technology firms that aim to use digital technologies (e.g. smartphones, 3D printers, web applications, *et al.*) to achieve social objectives (e.g. reduce extreme poverty, provide affordable healthcare and education, *et al.*). The number of such firms has increased in recent years due to the rapid diffusion of digital technologies (Coren, 2016). The phenomenon can also be observed by proxy through the formation of incubators and accelerators that provide support for the setup and growth of technology-based nonprofit firms (e.g. FastForward Accelerator[1] in the US, Center for Acceleration of Social Technology (CAST)[2] in the UK), as well as established for-profit technology accelerators (e.g. Y Combinator) broadening their scope to include nonprofits (Graham, 2013).

Technology-based nonprofit firms may face particular challenges in acquiring the resources needed to develop their technology and support growth. For most technology-based new firms, technology development is a resource intensive endeavor typically requiring external investment. For non-profit startups, many sources of investment typically available to for-profit start-ups may not be available. For example, mainstream venture capitalists will find it difficult to justify investing in a nonprofit venture which will not generate the financial returns that the such funds require (Desa, 2012). Other specific challenges that a technology-based nonprofit may face include talent recruitment (Landles-Cobb, Kramer, & Milway, 2015) and avoiding mission drift (Ebrahim, Battilana, & Mair, 2014).

[1] Fast Forward Accelerator for Technology Nonprofits (http://www.ffwd.org/)
[2] Center for Acceleration of Social Technology (http://www.wearecast.org.uk/)

On the other hand, the nonprofit status and social inclination of a technology-based nonprofit may also enable advantages that may not be available to purely for-profit firms. Such advantages could include access to specific types of partnerships and philanthropic grants (Meyskens & Carsrud, 2011).

This paper aims to explore how technology-based nonprofit firms can overcome challenges to acquiring the resources they need. We start with a literature review on resource acquisition by technology firms and nonprofit management. From the resource-based view literature, we extract a conceptual framework for the analysis of our data. We then describe the methodology used to conduct the research. Next, we present our single exploratory case study of a UK-based technology-based nonprofit firm, Simprints. We then analyse their early-stage growth using our conceptual framework to shed light upon particular challenges they faced in resource acquisition, and how these were overcome. We then draw our key conclusions and make suggestions for further work.

2.0 Literature review

There is extensive literature on the management of technological innovation by commercial organizations. However, there is little published research on technological innovation in nonprofit organizations. As the focus of our research is on how non-profit firms acquire the resources needed to develop their technology, our review focuses on the literature on resource-based theories for technology ventures and nonprofit management.

Resource-based theories for technology firms

The original conception of the resource-based theory was used to explain the growth of firms through their internal resources, capabilities, and the ability to adapt their existing capabilities to changing market conditions (Penrose, 1959). The subsequent development of the theory have focused on the characteristics of the resources which contributes to obtaining sustained competitive advantage (Barney, 1991; Wernerfelt, 1984). This is in contrast with earlier

expositions of the resource-based theory of the firm which emphasized the importance of the interactions of a firm's resources with its environment (Penrose, 1959). Recent development of the resource-based theories has sought to integrate the concept of business ecosystems (Lubik, Garnsey, Minshall, & Platts, 2013) and business models (Lubik & Garnsey, 2015) with traditional resource-based theories.

In addition to the integration of ecosystems and business models, recent development has also interpreted resource-based theories in the context of new firms (Garnsey, 1998; Garnsey & Heffernan, 2005). The original theory was more relevant to established firms which had established resources and capabilities (Penrose, 1959). However, at its core, resource-based theories are essentially concerned with building a resource base that can be used to realize opportunities by generating value (Garnsey, 1998).

The process of building the resource base to realize opportunities through value generation draws parallels to the entrepreneurial process. Figure 1 shows a simplified version of the entrepreneurial process as summarized by Garnsey, Dee, and Ford (2006). The process explains the cycle of how a firm goes from having an initial business idea to building their productive base and creating value for their customers and capturing the resulting returns.

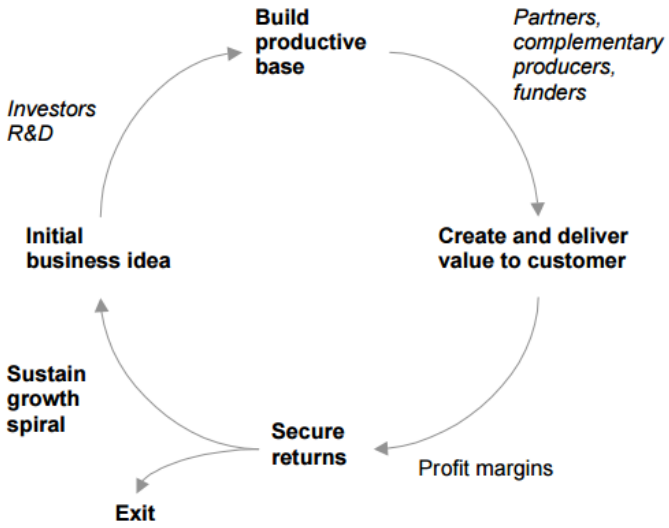

Figure 1 Entrepreneurial process of value creation and capture (Garnsey et al., 2006)

The process of going from an initial business idea to building a productive base typically requires investment and research and development (R&D). While it is possible for some business ideas to be entirely self-financed, typically the scale involved with technology firms requires outside investment to be acquired before and after the productive base is operating (Gill, Minshall, Pickering, & Rigby, 2007). Such investors will typically have a major impact on the new firm, enabling a greater scope with the additional resources provided to the firm, but also restraining their decision-making flexibility.

Most technology firms are required to build a productive base for commercialization of their technologies. This can be achieved through a variety of ways, through in-house production, outsourcing of key activities to third party provides, licensing, or direct acquisition of the technology (Mortara, 2012). The process of building a resource base may also include partnerships between firms. The partnerships forged may vary from informal, to contractual, from equity agreements to joint ventures (Pekar & Margulis, 2003). Partnerships are typically forged with expectation that firms working together may produce synergy (Dyer & Singh, 1998). The role of partnerships is generally acknowledged to be critically important especially to high-tech firms (Bidault & Cummings, 1994; Stuart, 2000). Resources which technology firms may require include capital, development know-how, technological capabilities and facilities. In certain cases, such as university spinouts, additional complementary resources such as market information or market access is required (Maine & Garnsey, 2006). In addition to tangible resources, partnerships formed with other firms may also provide reputational resources by improving credibility of start-ups (Maine & Ashby, 2002; Niosi, 2003). While the partnerships between corporate firms and startups have received some attention (Minshall, Mortara, Valli, & Probert, 2010), the potential contribution of other partners are less well known (Davidsson, Low, & Wright, 2001).

Technology firms create commercial value for their customers by commercializing their R&D through product sales, licensing royalties, and/or contract services (Maine, Lubik, & Garnsey, 2013). The value creation ability of technology firms is influenced by internal resources and

capabilities (Barney, 1991; Penrose, 1959), the application targeted (Niosi, 2003), partnership strategy (Teece, 1986), and location chosen (Gill & Minshall, 2013). There have been many ways in which value creation by technology firms are measured. One of the most common measures used is the number and importance of patents (Jaffe & Trajtenberg, 2002; Lim, 2004; Porter & Stern, 2001). However, while patents are indicators of successful R&D practices, they are insufficient as indicators for successful commercialization strategies (Maine et al., 2013). Instead, revenue generation and revenue growth are the preferred value creation proxies for technology firms (Almus & Nerlinger, 1999; Maine, Shapiro, & Vining, 2010; Utterback, Meyer, Roberts, & Reitberger, 1988).

The profit that is captured as a result of a healthy revenue generation will contribute to the value capture by the firm. This surplus can then be added to the firm's resource base or used to provide a return on investment for investors who expect a quick return. Alternatively, the firm can exit by being acquired by larger firms.

The entrepreneurial framework in Figure 1 is subsequently expanded to form the conceptual framework in Figure 2. The expanded conceptual framework will be used as a theoretical basis for analysis of technology-based nonprofits.

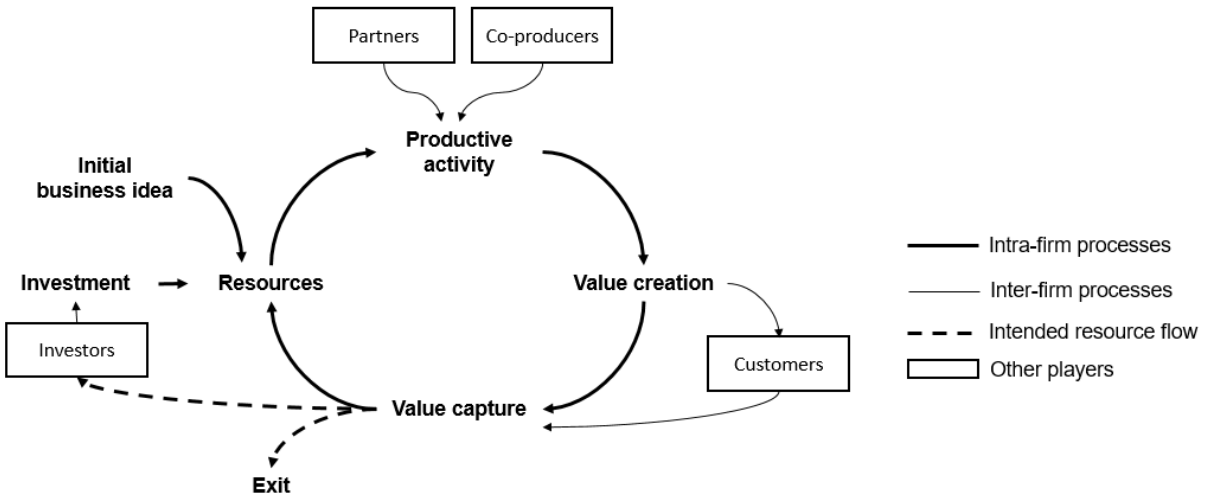

Figure 2 Conceptual framework of entrepreneurial process of value creation and capture, adapted from Garnsey et al. (2006)

The literature review reveals that academic research on the growth of technology-based firms has been predominantly focused on for-profit firms. Differences between growth processes of for-profit and nonprofit technology-based firms are not well understood. This leads to a research gap that this paper aims to explore to enrich understanding of how technology-based nonprofits acquire resources to grow, and to develop their technologies.

Nonprofit management

Our review of the nonprofit management literature encompasses organizational structures, volunteer management, and use of technology.

There are indications that the nonprofit sector is experiencing growth globally. For example, the rate of nonprofit firm formation between 1987 to 1997 has even exceeded the rate of new business formation (Austin, Stevenson, & Wei-Skillern, 2006). Due to changes in government policies, nonprofit firms are needing to take on more of the operational characteristics of for-profit firms such as revenue generation to achieve sustainability (Maier, Meyer, & Steinbereithner, 2016).

Weisbrod (1998) has outlined the key differences between nonprofit firms and for-profit firms in terms of the organizational structure and constraints that they face. Some commonly used legal structures for nonprofit firms (e.g. 501c3 in the US or charity in the UK[3]) have a "nondistribution constraint" (Hansmann, 1980), i.e., a legal restriction on managerial compensation. This constraint causes challenges for nonprofit firms to offer competitive pay compensation and professional development opportunities (Landles-Cobb et al., 2015). The consumer demand experienced by nonprofit firms may also be different from for-profit firms since some people may be willing to pay a higher price for a social cause (Weisbrod, 1998). Some nonprofit firms have also been noted to have changed their legal structure in order to maximize opportunities to form new partnerships (Haigh, Kennedy, & Walker, 2015). Some nonprofit firms have even adopted a dual structure in order for the organization to improve

[3] "Building a Social Enterprise: The Legal Landscape" (http://www.simprints.com/wp-content/uploads/2016/04/Building-a-Social-Enterprise-The-Legal-Landscape-2015.pdf)

their commercialization potential and deliver greater social impact. An example of such an organization is Embrace Global[4], a technology-based nonprofit firm making low-cost baby warmers that has spun off a for-profit counterpart, Embrace Innovation, to improve commercialization and better focus on their social mission (Chen, 2013). However, there are few empirical studies on nonprofits with a technology focus adopting dual structures.

There is a growing body of research on the management of volunteers within the nonprofit management literature (Studer, 2016). However, most empirical research on volunteer management does not focus on product development (Locke, Ellis, & Smith, 2003; Studer, 2016; Waikayi, 2012).

There is little published research on technology development in nonprofit firms. Most published research focuses on the adoption of existing technology such as Customer Relationship Management (CRM) tools or social media by nonprofit firms (Attouni & Mustaffa, 2014; Bürger, 2015; Curtis et al., 2010; Miranda, Farias, de Araújo Schwartz, & de Almeida, 2016). To our knowledge, technology development by nonprofits are not addressed in the literature. Recently, a technology-based nonprofit, SpaceIL[5] made headlines for being the top contender for the Google Lunar X Prize, a competition that aims to land a rover on the moon (Whittington, 2016). SpaceIL is a nonprofit that has managed to raise funding from philanthropic funds as well as attract dozens of volunteers to assist with the research and development of their 'moon rover'. Despite the small number of such well-publicized examples, research on the strategies of leveraging resources in a technology nonprofit is very limited. However, the emergence of incubators focused on technology nonprofits (such as Fast Forward in the US and Centre for Acceleration of Social Technologies (CAST) in the UK) indicates that there is growing practical interest in providing support to technology-based nonprofits.

[4] Embrace Global, a nonprofit firm which is developing low-cost baby warmers (http://embraceglobal.org/)
[5] SpaceIL-Israel-based nonprofit that is the current leading contender for the Google Lunar X Prize competition, a competition for privately funded organizations to land a rover on the moon (http://lunar.xprize.org/teams/team-spaceil)

3.0 Methodology

The method to research the phenomenon was conducted in two parts. Firstly, a single case study was conducted on Simprints, a technology-based nonprofit located in Cambridge (UK). Simprints was identified as a suitable case following a series of exploratory interviews with stakeholders within the Cambridge start-up business ecosystem. Secondly, the data from the case study was applied to the conceptual framework derived from the literature to reveal new insight.

Primary data was captured using two methods: (1) interviews were conducted with core Simprints staff members and managers from organizations supporting Simprints; (2) one of the authors of this paper undertook participant observation at Simprints by volunteering expertise in software and hardware development to participate in their technology development process. The experience was documented in the form of field notes.

Secondary data from relevant news articles online were also reviewed and documented. The data were subsequently codified based on recurring themes and structured using the conceptual framework.

4.0 Results

This section contains two sub-sections. The first subsection presents the results of the case study conducted on Simprints. The second subsection presents the results of analyzing the data using our conceptual framework.

Simprints Case Study

Simprints Technology Ltd. is a technology-based nonprofit organization which was incorporated in August 2014 in Cambridge (UK). Simprints aims to develop a low-cost, ruggedized fingerprint sensor to provide access to identification for citizens in developing countries (Storisteanu, Norman, Grigore, & Norman, 2015). Some citizens in developing countries such as Nepal and Bangladesh lack access to any system of personal identification. This is because conventional means of identity (e.g. name record in a database) are not effective enough since it is prone to

error due to illiteracy. This lack of identification is a big problem as it can inhibit access to essential services such as financial and medical services.

Simprints was founded by graduate students from the University of Cambridge who participated in business plan competitions with the idea for a low cost fingerprint technology prior to incorporation of the firm. One of the earliest high profile competitions which Simprints won was the Saving Lives at Birth Grand Challenge[6], a competition which promotes innovation in reducing infant mortalities. The competition was supported by prominent organizations such as the Bill & Melinda Gates Foundation, USAID, UKAID, Grand Challenge Canada, Norwegian Ministry of Foreign Affairs, and the Korea International Cooperation Agency and provides seed money to the winners to launch their organization.

Simprints proposed to develop a low-cost fingerprint sensor to enable health workers to easily identify pregnant mothers who visit them for scheduled prenatal checkups. The competition judges found this a compelling idea and Simprints was among the twenty-six teams selected to receive seed grants from the competition. Simprints received a grant of UK£250,000 from the Bill & Melinda Gates Foundation[7]. The grant was matched by ARM Foundation[8] later in the month as part of their corporate social responsibility, leading Simprints to receive a total of £500,000 in seed funding. Winning these grants also attracted partnership with the Johns Hopkins University Global mHealth Initiative[9] and with BRAC[10], the world's largest NGO, to use the seed grants to optimise their fingerprint system and conduct a pilot study in Bangladesh. Simprints also went on to receive an addtional £150,000 grant from the Global Innovation Fund (GIF), a nonprofit innovation fund which invests in social innovations that aims to improves the lives and opportunities of millions of people in the developing world [11]. The reasons cited for GIF's investment were that the problem Simprints was trying to solve affects GIF's target

[6] Saving Lives at Birth Grad Challenge (https://savinglivesatbirth.net/)
[7] Bill and Melinda Gates Foundation (http://www.gatesfoundation.org/)
[8] ARM Technology Corporate Responsibility Profile (https://www.arm.com/about/company-profile/corporate-responsibility/index.php)
[9] John Hopkins University mHealth Initiative (http://www.jhumhealth.org/)
[10] BRAC (http://www.brac.net/)
[11] Global Innovation Fund grant to Simprints (http://www.globalinnovation.fund/investments/simprints)

beneficiaries, the product Simprints was developing showed promising commercial traction, and that Simprints had a strong and committed team.

Simprints subsequently received pro bono consultation from a local law firm, Taylor Vinters, to assess the various legal structures for social enterprises and determine the most suitable one. As a result of the consultation, Simprints officially incorporated as Simprints Technology Ltd., a company limited by shares but with an asset lock embedded in the Articles of Association of the company to ensure that the company remains nonprofit.

In order to overcome resource constraints to develop their technology, Simprints operated from Makespace[12], a community-run space with tools and equipment for manufacturing, prototyping and making. The space promotes members to meet, work, build, and socialize. It is accessible to members who pay a monthly subscription fee, for which they get 24/7 access to the space and equipment to work on their projects. According to one of Simprints' co-founders, the community at Makespace were mostly technology enthusiasts[13] who had full time jobs as engineers at Cambridge. They were very willing to assist Simprints with their prototyping efforts. Eventually, when Simprints moved out of Makespace and into their own building, they continued to leverage on volunteer expertise through weekly meetings (called 'Hack Nights') to recruit volunteers to continue to help develop Simprints' core technologies. One of the authors of this paper volunteered his electronic engineering expertise to assist Simprints, while collecting data through participant observation.

The increased number of volunteers provided much needed support to compensate for the lack of human resources. However, they also came with their own set of management challenges. For instance, the volunteers who showed up to Hack Nights were not always the same ones: some were one off participants, some came every week, some came from time-to-time. This meant time spent by Simprints team members to brief new volunteers who did not return was to some extent wasted (though even one-off inputs were valuable). In addition, joint hardware or software development by volunteers proved to be challenging since the working styles

[12] Makespace, a community-run space with tools and equipment for manufacturing, prototyping and making (http://makespace.org/)
[13] Profile of recurring Hack Night volunteers (https://www.simprints.com/about/)

between volunteers differed. The short period of time spent at Hack Night (four hours per week) meant that there was little contact time or opportunity to integrate and streamline volunteers to ensure they understand the larger scope of the project pipeline beyond the projects which they work on a weekly basis. Conscious efforts to document the development activities and processes were taken to ensure continuity but not all volunteers adhered to proper documentation requirements. This caused disruption to development when a particular volunteer was not present and the undocumented activities they had been working on was taken on by another volunteer. As a result of such problems the Simprints management team decided to limit new intakes of volunteers to the frequency of once per month (as opposed to being open for every Hack Night) and also introduce a potential screening process for interest and skills. However, there was concern that the new rules might deter new volunteers from participating.

In order to mitigate risk of putting volunteers in charge of the critical path of the development process, Simprints decided to hire experienced staff members to monitor the hardware development as well as manufacturing in order to help ensure that the project could continue even without volunteers. The experienced staff accepted salaries close but slightly less than market rates for their services because of Simprints' social cause.

The support and partnership with ARM (a market-leading Cambridge-based microprocessor technology licensing firm) helped to enhance the legitimacy of Simprints. As a result, this attracted partnerships with other technology enterprises operating in Cambridge. One of the partners, SEARAN, which develops Bluetooth software stacks compatible with ARM chips, offered their product to Simprints at no cost. Additionally, many organizations also offered pro bono services to Simprints due to the status as a nonprofit social enterprise. For example, SMART Design, a London-based product design company provided services to optimize user interface and user experience of Simprints' device (a total 35 designer days). A local software company, Redgate, offered the services of 12 Redgate developers to spend a total of 60 developer days to improve the speed and accuracy of Simprints' matching algorithm. This was conducted as part of an annual corporate event (dubbed 'Down Tools Week') where Redgate developers get to spend the week working on inspirational projects. The Redgate event was

highly successful and even received coverage from BBC[14]. London School of Business offered 9 Masters student to conduct pro bono studies to explore potential commercialization and pricing strategies for Simprints. However, the partnership with some of the companies also prohibited Simprints from open sourcing their fingerprint sensor. This is because some of the proprietary codes were supplied to Simprints in good faith as a nonprofit social enterprise, but open sourcing these codes could jeopardize some of their partners' commercial interests.

As of August 2016, Simprints have begun manufacturing and shipping commercial batches of their fingerprint devices to paying customers, a few of which are nonprofit charities operating to provide aid in developing countries. The nonprofit status of Simprints provided leverage to negotiate better rates with manufacturing contractors and component suppliers.

Analysis of Simprints Case Study through Conceptual Framework

We now analyse the Simprints case using the expanded conceptual framework in the previous section (Figure 2).

Initial business idea

The business idea for Simprints emerged from graduate students participating in the Saving Lives at Birth Grand Challenge. Winning the competition provided Simprints with credibility and seed money.

Investors/Investment

Bill and Melinda Gates Foundation which was supporting the Saving Lives at Birth Grand Challenge competition provided a seed grant of £250,000 to Simprints. The grant was subsequently matched by ARM Foundation as part of their corporate social responsibility. The Global Innovation Fund also provided a grant of £150,000 to Simprints.

[14] BBC: Simprints & Redgate Down Tools Weeks (https://vimeo.com/145614508)

Resources

The resources of Simprints include capital, development know-how, technological capabilities, facilities, among others. Simprints have acquired financial capital from prize money won from business competitions and seed grants from philanthropic foundations (such as Bill and Melinda Gates Foundation and ARM Foundation). Development know-how and technological capabilities were initially gained from leveraging on community support at Makespace. Simprints leveraged on community workshops and co-working space such as IdeaSpace to access facilities. As part of the human resources, Simprints managed to attract volunteers to contribute their time and expertise for negligible costs (food and beverages).

Productive activity

The productive activity conducted by Simprints was R&D to prototype and develop their low-cost, ruggedized fingerprint sensor. The R&D process involves development of both software and hardware. In addition, Simprints is also continuoulsy trying to develop and refine the business plan for their firm in order to be sustainable.

Partners/co-producers

Simprints formed many partnerships with organizations in different sectors. Simprints partnered with nongovernmental organizations such as BRAC (to work with their health and research teams on biometric-empowered mobile healthcare projects in Dhaka, Bangladesh) and Centre for Global Equality (which provided network support to Simprints in the early stages). Simprints also received support from universities such as University of Cambridge (which contributed to resources such as network, an office building at a discounted rate, among others), John Hopkins University (as part of their mHealth initiative which supports development of mobile technologies to improve global health), and London School of Business (which provided Masters students to work on developing alternative commercial models for Simprints).

Simprints also attracted corporate partnerships such as with ARM who provided seed funding and embedded engineers to help them develop the fingerprint collection platform that was used to

collect 120,000 fingerprint images in 2015. Simprints and ARM also co-authored a chapter for the World Economic Forum Report[15]. SEARAN is another corporate partner of Simprints, which provides Bluetooth stack for low cost and low power embedded devices as their commercial offering. SEARAN provided the Bluetooth software stack to Simprints at no cost in order to support Simprints. Smart Design and RedGate Software are corporate partners which have provided engineers to work on improving Simprints' device. Simprints also received support in the form of pro bono consultancy from Fen Technology Ltd. and Therefore Product Consultants as part of their corporate partnership.

Value creation

Simprints have generated value by selling their low-cost, ruggedized fingerprint sensor to their customers (charities and NGOs). However, the people who will benefit from the device (beneficiaries) may not be the same as the customers who choose to pay for it.

Customers

Simprints' current customers are charities and NGOs providing aid to developing countries. A few batches of fingerprint sensors have been sold by Simprints to their customers as of the time this paper was written.

Value capture

The surpluses from the sales of the fingerprint sensors are reinvested into the firm. This is because it was determined at the formation of the firm that Simprints as a nonprofit to reinvest all surpluses back into the firm.

Exit

The management team reported that there are currently no plans by Simprints to exit through acquisition.

[15] An online copy of the World Economic Forum Report (http://www3.weforum.org/docs/WEF_Global_IT_Report_2015.pdf)

The analysis of the Simprints case study through the conceptual framework reveals that some of the data do not fit explicitly with certain elements in the framework, i.e. the use of volunteers, the role of philanthropic investors, and value creation for different segments (customers and beneficiaries). This will be discussed in the next section.

5.0 Discussion

The results in the previous section revealed that Simprints as a technology-based nonprofit firm had access to certain resources (such as the use of volunteers, philanthropic investors) which are not currently described by our current understanding of for-profit technology firms. Hence, the conceptual framework is modified to incorporate findings from the Simprints case study (as shown in Figure 3).

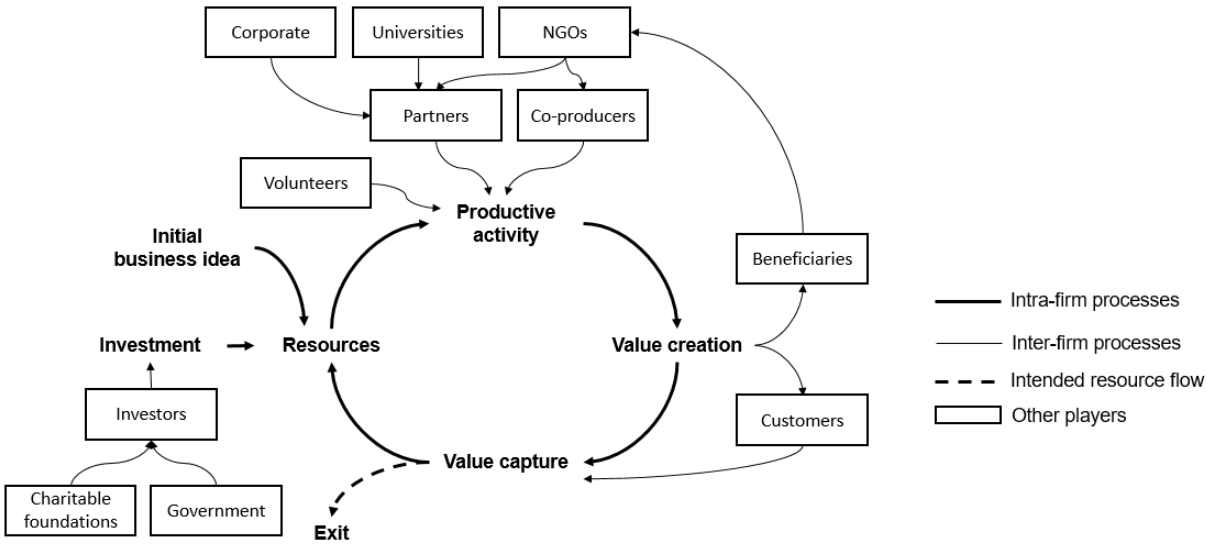

Figure 3 Revised conceptual framework for technology-based nonprofits

The revised framework incorporates the different classes of partners available to a technology-based nonprofit firm, the use of volunteers, philanthropic investments, and different value creation segments.

While the use of volunteers is an innovative way of circumventing the lack of resources, it also brings about its own set of management challenges. Volunteers, unlike employed staffs, are not

contractually bound to work for the firm. This may be challenging considering the technology R&D process is a continuous, evolving activity. Having an inconsistent set of volunteers may disrupt the flow of the project development.

Charitable investments in the form of grants may be useful to bridge the financial capital gap but it also presents its own set of problems for the nonprofit firm. Unlike a traditional technology-based startup, pivoting is not easily achieved by technology-based nonprofit firms. This is because it is much harder to pivot the social objectives (as it is locked into a particular target beneficiaries) rather than commercial objectives. Therefore, if a technology-based nonprofit firm receives charitable grants, it may limit the strategic options of the firm in the short term.

A similar argument can also be made for the support received by corporate partners. By receiving support from certain corporate firms, it may also limit certain strategic options. This was experienced by Simprints who were not able to open source certain parts of their technology because the source code for the technology was provided in good faith to Simprints as a nonprofit firm.

6.0 Conclusion

After the literature has been reviewed, it was discovered that there is little published research on technology-based nonprofit firms as most of the literature focuses on for-profit firms. A resource-based framework for the entrepreneurial process of technology-based firms was expanded and used for analysis of technology-based nonprofit firms. A case study was conducted on a Cambridge-based technology-based nonprofit firm, Simprints, for the research. The data for the case study was collected through a combination of primary (interviews and participant observation) and secondary sources (web articles). The results of analysis from applying the conceptual framework to the data revealed that some of the data collected do not certain the elements in the framework (such as the use of volunteers and philanthropic sources of investment). The conceptual framework is then revised to incorporate the key findings. The management implications of incorporating the new elements into the framework are discussed. It is discussed that while the alternative path to obtain resources may be a good thing, it also

brings along its own set of management challenges. In conclusion, the results reveal that the growth process of technology-based nonprofits is not well understood and cannot be explained using current resource-based frameworks. This provides an interesting opportunity for further research which will be briefly described in the final section.

Further work

The current research is exploratory in nature with only a single case study conducted. The generalisability of the study can be explored through further qualitative and quantitative research on a broader sample of technology-based nonprofits. There is also indication that the resources accessible to a technology-based nonprofit firm may be different at different stages of the firm growth. For example, Simprints have recently ceased the use of volunteers because they have grown so rapidly in such a short time that it became difficult to manage the volunteers on top of their day-to-day operations.

The next steps in the research are to conduct more case studies on technology-based nonprofit firms based in Cambridge. The reason to focus on Cambridge firms on the planned studies is to minimize the effects of location as a variable on the technology-based nonprofit firm growth. The conceptual framework will be refined with the additional data collected. Subsequently, the framework will be tested on a larger scale by conducting a survey on global technology-based nonprofit firms. The firms which participate in technology-based nonprofit incubators or accelerators (e.g. Fast Forward Accelerator, CAST) will be viewed as a potential source of data as they have enrolled many batches of technology-based nonprofit firms into their program. There is some evidence to support the theory that innovation clusters in different locations may have effects on the growth of particular types of firms (Porter & Stern, 2001). The survey will be designed to investigate if the framework can be generalized beyond Cambridge.

References

Almus, M., & Nerlinger, E. A. (1999). Growth of New Technology-Based Firms: Which Factors Matter? *Small Business Economics, 13*(2), 141-154. doi:10.1023/A:1008138709724

Attouni, M. A. K., & Mustaffa, C. S. (2014). How do Non-profit Organizations in Libya Adopt and Use Social Media to Communicate with The Society. *Procedia - Social and Behavioral Sciences, 155*, 92-97. doi:http://dx.doi.org/10.1016/j.sbspro.2014.10.262

Austin, J., Stevenson, H., & Wei-Skillern, J. (2006). Social and commercial entrepreneurship: Same, different, or both? *Entrepreneurship: Theory and Practice, 30*(1), 1-22. doi:10.1111/j.1540-6520.2006.00107.x

Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management, 17*(1), 99-120. doi:10.1177/014920639101700108

Bidault, F., & Cummings, T. (1994). Innovating through alliances: expectations and limitations. *R&D Management, 24*(1), 033-045. doi:10.1111/j.1467-9310.1994.tb00845.x

Bürger, T. (2015). Use of digital advocacy by German nonprofit foundations on Facebook. *Public Relations Review, 41*(4), 523-525. doi:http://dx.doi.org/10.1016/j.pubrev.2015.07.007

Chen, J. (2013). Should Your Business Be Nonprofit or For-Profit? *Harvard Business Review*.

Coren, M. J. (2016). Silicon Valley wants to save the world by investing in nonprofits as if they were startups. Retrieved from http://qz.com/792685/silicon-valley-wants-to-save-the-world-by-investing-in-nonprofits-like-startups/

Curtis, L., Edwards, C., Fraser, K. L., Gudelsky, S., Holmquist, J., Thornton, K., & Sweetser, K. D. (2010). Adoption of social media for public relations by nonprofit organizations. *Public Relations Review, 36*(1), 90-92.

Davidsson, P., Low, M. B., & Wright, M. (2001). Editor's Introduction: Low and MacMillan Ten Years On: Achievements and Future Directions for Entrepreneurship Research. *Entrepreneurship: Theory & Practice, 25*(4), 5.

Desa, G. (2012). Resource Mobilization in International Social Entrepreneurship: Bricolage as a Mechanism of Institutional Transformation. *Entrepreneurship: Theory and Practice, 36*(4), 727-751. doi:10.1111/j.1540-6520.2010.00430.x

Dyer, J. H., & Singh, H. (1998). The Relational View: Cooperative Strategy and Sources of Interorganizational Competitive Advantage. *The Academy of Management Review, 23*(4), 660-679. doi:10.2307/259056

Ebrahim, A., Battilana, J., & Mair, J. (2014). The governance of social enterprises: Mission drift and accountability challenges in hybrid organizations. *Research in Organizational Behavior, 34*, 81-100. doi:10.1016/j.riob.2014.09.001

Garnsey, E. (1998). A Theory of the Early Growth of the Firm. *Industrial and Corporate Change, 7*(3), 523-556. doi:10.1093/icc/7.3.523

Garnsey, E., Dee, N., & Ford, S. (2006). Clean Technology Ventures and Innovation. *Centre for Technology Management Working Paper Series*.

Garnsey, E., & Heffernan, P. (2005). Growth setbacks in new firms. *Futures, 37*(7), 675-697. doi:10.1016/j.futures.2004.11.011

Gill, D., & Minshall, T. (2013). *Cambridge Technopole Report: An overview of the UK's leading high-technology business cluster*. Retrieved from

Gill, D., Minshall, T., Pickering, C., & Rigby, M. (2007). *Funding Technology: Britain Fourty Years On*. Retrieved from

Graham, P. (2013). YC Will Now Fund Nonprofits Too. Retrieved from https://www.ycombinator.com/nonprofits/

Haigh, N., Kennedy, E. D., & Walker, J. (2015). Hybrid organizations as shape-shifters: Altering legal structure for strategic gain. *California Management Review, 57*(3), 59-82. doi:10.1525/cmr.2015.57.3.59
Hansmann, H. (1980). The Role of Nonprofit Enterprise. *Yale Law Review*.
Jaffe, A., & Trajtenberg, M. (2002). *Patents, Citations, and Innovations: A Window on the Knowledge Economy*: MIT Press.
Landles-Cobb, L., Kramer, K., & Milway, K. S. (2015). Nonprofits Can't Keep Ignoring Talent Development. *Harvard Business Review*.
Lim, K. (2004). The relationship between research and innovation in the semiconductor and pharmaceutical industries (1981–1997). *Research Policy, 33*(2), 287-321. doi:http://dx.doi.org/10.1016/j.respol.2003.08.001
Locke, M., Ellis, A., & Smith, J. D. (2003). Hold on to what you've got: the volunteer retention literature. *Voluntary Action, 5*(3), 81-99.
Lubik, S., & Garnsey, E. (2015). Early Business Model Evolution in Science-based Ventures: The Case of Advanced Materials. *Long Range Planning*. doi:http://dx.doi.org/10.1016/j.lrp.2015.03.001
Lubik, S., Garnsey, E., Minshall, T., & Platts, K. (2013). Value creation from the innovation environment: partnership strategies in university spin-outs. *R & D Management, 43*(2), 136-150. doi:10.1111/radm.12006
Maier, F., Meyer, M., & Steinbereithner, M. (2016). Nonprofit Organizations Becoming Business-Like: A Systematic Review. *Nonprofit and Voluntary Sector Quarterly, 45*(1), 64-86. doi:10.1177/0899764014561796
Maine, E., & Ashby, M. (2002). An investment methodology for new materials. *Materials and Design, 23*, 297-306.
Maine, E., & Garnsey, E. (2006). Commercializing generic technology: The case of advanced materials ventures. *Research Policy, 35*(3), 375-393. doi:10.1016/j.respol.2005.12.006
Maine, E., Lubik, S., & Garnsey, E. (2013). Value creation strategies for science-based business: A study of advanced materials ventures. *Innovation-Management Policy & Practice, 15*(1), 35-51.
Maine, E., Shapiro, D. M., & Vining, A. R. (2010). The role of clustering in the growth of new technology-based firms. *Small Business Economics, 34*(2), 127-146. doi:10.1007/s11187-008-9104-3
Meyskens, M., & Carsrud, A. L. (2011). Nascent green-technology ventures: a study assessing the role of partnership diversity in firm success. *Small Business Economics, 40*(3), 739-759. doi:10.1007/s11187-011-9400-1
Minshall, T., Mortara, L., Valli, R., & Probert, D. (2010). Making 'asymmetric; partnerships work. *Research-Technology Management, 53*(3), 53-63.
Miranda, M. Q., Farias, J. S., de Araújo Schwartz, C., & de Almeida, J. P. L. (2016). Technology adoption in diffusion of innovations perspective: introduction of an ERP system in a non-profit organization. *RAI Revista de Administração e Inovação, 13*(1), 48-57. doi:http://dx.doi.org/10.1016/j.rai.2016.02.002
Mortara, L. F., S. (2012). *Technology Acquisitions: A guided approach to technology acquisition and protection decisions*: Institute for Manufacturing, University of Cambridge.
Niosi, J. (2003). Alliances are not enough explaining rapid growth in biotechnology firms. *Research Policy, 32*(5), 737-750. doi:http://dx.doi.org/10.1016/S0048-7333(02)00083-5
Pekar, P., & Margulis, M. (2003). Equity Alliances Take Centre Stage. *Business Strategy Review, 14*, 50-62.
Penrose, E. (1959). *Theory of the Growth of the Firm*.
Porter, M., & Stern, S. (2001). Innovation: Location matters. *Sloan Management Review, 42*(4), 28-36.

Storisteanu, D. M. L., Norman, T. L., Grigore, A., & Norman, T. L. (2015). Biometric Fingerprint System to Enable Rapid and Accurate Identification of Beneficiaries. *Global Health: Science and Practice, 3*(1), 135-137. doi:10.9745/ghsp-d-15-00010

Stuart, T. E. (2000). Interorganizational alliances and the performance of firms: a study of growth and innovation rates in a high-technology industry. *Strategic Management Journal, 21*, 791-811. doi:10.1002/1097-0266(200008)21:8<791::AID-SMJ121>3.0.CO;2-K

Studer, S. (2016). Volunteer Management: Responding to the Uniqueness of Volunteers. *Nonprofit and Voluntary Sector Quarterly, 45*(4), 688-714. doi:10.1177/0899764015597786

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy, 15*(6), 285-305. doi:http://dx.doi.org/10.1016/0048-7333(86)90027-2

Utterback, J., Meyer, M., Roberts, E., & Reitberger, G. (1988). Technology and industrial innovation in Sweden: A study of technology-based firms formed between 1965 and 1980. *Research Policy, 17*(1), 15-26.

Waikayi, L. (2012). Volunteer management: an exploratory case study within the British Red Cross. *Management Decision, 50*(3), 349-367. doi:10.1108/00251741211216188

Weisbrod, B. A. (1998). Institutional form and organizational behavior. In W. P. E. Clemens (Ed.), *Private action and the public good* (pp. 69–84). New Haven: Yale University Press.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal, 5*(2), 171-180.

Whittington, M. (2016). Buzz Aldrin pays tribute to Israel's moon shot effort, SpaceIL.