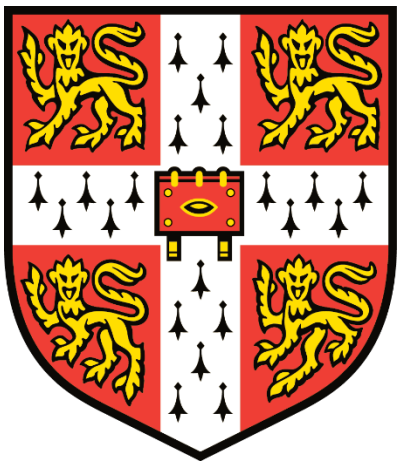
Growth of technology-based social enterprises in the manufacturing sector



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This thesis is submitted for the degree of Doctor of Philosophy

This thesis is dedicated to my parents, Fong Lai Fong and Yong Hai Choy.

Declaration

This thesis is the result of my own work and includes nothing which is the outcome of work done in collaboration except as declared in the preface and specified in the text.

It is not substantially the same as any work that has already been submitted before for any degree or other qualification except as declared in the preface and specified in the text.

It does not exceed the prescribed word limit of 65,000 for the Department of Engineering Degree Committee.

Yong Bang Ming

Cambridge, July 2021

Abstract

Growth of technology-based social enterprises in the manufacturing sector
by Yong Bang Ming

The recent intersection of two entrepreneurship streams – technology and social – has given rise to the emergence of technology-based social enterprises (TSEs). TSEs are of particular interest to many stakeholders as they have the potential to provide scalable solutions from a technological perspective to address diverse social challenges in the world. However, a review of the literature revealed a gap in knowledge on the growth process of TSEs because: (1) TSEs are an emerging phenomenon; (2) existing research on technology enterprises has predominantly focused on issues related to profit and value maximization; (3) existing research on social enterprises and non-profits typically do not have a technology focus.

To address the gap in knowledge, in-depth case studies were conducted on five prominent TSEs based in Cambridge, United Kingdom – Raspberry Pi, Simprints, WaterScope, Solaware, and Blue Tap. The case studies were conducted in two stages – Stage 1 was structured around an initial resource-based conceptual framework derived from the literature; Stage 2 was structured around a legitimacy-based framework derived from literature. Findings from Stage 1 revealed the similarities and differences of growth between TSEs and commercial technology enterprises or traditional non-profits. The findings from Stage 1 also indicated that legitimacy as a resource has significance for the growth of TSEs, which led to the implementation of the legitimacy-based Stage 2 to provide further analysis. The findings from both stages were subsequently used to modify and enhance the initial resource-based conceptual framework.

This study provides contributions to theory through the development of a conceptual framework to describe the growth process of TSEs. The study also revealed the strategic use of legitimacy as a resource by TSEs to grow. This study also contributes to practice by providing empirical findings on the resource acquisition process of TSEs. The findings highlight the importance of specific resources accessible by TSEs, such as the use of skill-based volunteers and pro bono resources, which are unconventional to both commercial technology-based enterprises and traditional non-profits. The study also revealed that the environment plays a crucial role in facilitating resource acquisition by TSEs. An environment such as Cambridge that has a rich ecosystem of individuals and organizations to support technology-based organizations has been found to be conducive for the growth of TSEs.

Publications

Conference papers

Yong, B. M., Minshall, T., (2017). Technology management of technology-based nonprofit firms. In *DRUID Academy Conference 2017,* Denmark.

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i Because no single adjective that currently exist in the English dictionary can do justice to describe her.
ii ±500 km.
iii The sun is fairly consistent in Malaysia, goes to work at 7am, goes off at around 7pm. In the UK, rather temperamental, and can sometimes suddenly disappear in the middle of the afternoon.

Leyla, remedied this and provided me with an extended family in this new and foreign land. Cold and dark winters have since been replaced with hot chocolate, buffet of food[iv], and competitive games of Exploding Kittens.

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iv In reference to no longer being physically thin, Geraldine, with her constant delicious home-cooked meals, is partly to blame.
v Pascal and I did a lot more than just watch livestreams together, we also worked on a lot of cool and fun projects together.
vi Merely an exaggeration of expression. Marc is without a doubt, an incredibly responsible and competent pilot.
vii Unfortunately, not an exaggeration of expression. George is truly a rare and loyal friend.

Although I may not have listed all your names (because there are too many!), please know that I remember and appreciate your teachings.

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Jasa anda akan sentiasa dikenang.

Yong Bang Ming

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List of abbreviations

ARM	Advanced RISC Machines
BGV	Bethnal Green Ventures
CAST	Centre for Acceleration of Social Technology
CEO	Chief Executive Officer
CGE	Centre for Global Equality
CIC	Community Interest Company
CRM	Customer Relationship Management
CSR	Corporate Social Responsibility
CUE	Cambridge University Entrepreneurs
CUTEC	Cambridge University Technology and Enterprise Club
DTI	Department for Trade and Industry
EPOC	Entrepreneurial Postdocs of Cambridge
EPSRC	Engineering and Physical Sciences Research Council
FOSH	Free and Open-Source Hardware
FOSS	Free and Open-source Software
GCRF	Global Challenges Research Fund
GIIN	Global Impact Investing Network framework
HGF	high-growth firms
HIF	Humanitarian Innovation Fund
IfM	Institute for Manufacturing
IP	intellectual property
ITIC	Impact Through Innovation Cambridge
JHU	John Hopkins University
LED	light-emitting diode
MIT	Massachusetts Institute of Technology
NGO	non-governmental organization
NPD	new product development
POS	productive opportunity set
R&D	research and development
RBT	resource-based theory
RBV	resource-based view
SDG	Sustainable Development Goals
SME	small medium enterprises
SROI	Social Return of Investment
TMT	top-management team
TSE	technology-based social enterprise
TSV	technology social ventures

Chapter 1 Introduction

1.1 Phenomenon of interest – technology-based social enterprises

Technological advancement has largely done wonders for improving humanity's quality of life. An integral enabler of continuous technological advancement at scale is the commercialization of those technological advancement through enterprise, typically in the form of corporations. Due to the capital and knowledge intensive nature of developing and commercializing new technology, there is typically a strong emphasis on prioritizing large financial returns to recoup the investments made and to reward those who have taken the risks and/or create the most value. This implies a focus on markets that would bring the most financial profits for the enterprise.

Most organizations that are not focused on commercial activities such as non-profits are typically unable to engage in technology-based activities (that requires research and development). This is due to the relatively high level of risks involved in investing in capital and knowledge intensive activities – not to mention, for a market segment which may not bring much financial returns to recoup investments (if otherwise, commercial technology-based enterprises would have already entered the market). As a result, these "bottom billion" (Prahalad, 2012) market segments that are mainly in developing countries, are left out of many life-improving technological solutions (Radjou & Prabhu, 2015). However, the emergence of a new phenomenon – "technology-based social enterprises" (TSEs) – indicates that there is a way for organizations to organise resources to enable them to engage in technology-based activities for markets which may not be financially lucrative. The key motivation for the research topic in this thesis stems from the desire to understand the process of how TSEs from Cambridge were able to engage in capital and knowledge intensive activities such as technology development and manufacturing, yet not focused on markets which will maximise financial returns. To provide context, conceptual developments leading to the emergence of TSEs will be briefly discussed.

In the old and narrow view of capitalism, corporations contribute to society by making a profit to support job creation, wages, and investments. This view dates back all the way to Adam Smith's theory of the "invisible hand", which states that private individuals acting on behalf of their own self-interest in a free market will make a positive impact on an economy (Smith, 1776/2007). This gave rise to a huge interest in entrepreneurship (across various stakeholders such as governments, investors, individuals), since it involves the creation of new corporations which will, in combination, taking Smith's perspective, create positive impact on an economy and society (Hisrich, 1988).

In the 60's, the rise of the concept of Corporate Social Responsibility (CSR) presented a shift in the approach of corporations (Bosch-Badia et al., 2013). Many corporations realized that profit maximization may lead to undesirable results, causing negative externalities in the form of environmental pollution or wealth inequality. This led them to adopt the approach of contributing to society directly beyond just profit maximization in the form of CSR activities.

Friedman (1970) has argued persuasively that CSR is not an effective way for a corporation to contribute back to society. He argued that a corporation allocating resources to social causes would be doing so at the expense of the corporation's stakeholders (namely employees, owners, customers). This would lead to inefficiencies in the process since that is not what the corporation was created to do. He postulated that some corporations may be hypocritical when executing CSR and may do this as means to "cloak" their potentially negatively perceived actions and to generate goodwill. He ultimately claims that the social responsibility of a business is to increase its profits.

Whether the intentions are genuine or not, there is some evidence that CSR positively affects firm performance when measured through financial and non-financial indicators (Burke & Logsdon, 1996; Reverte et al., 2016). Scholars adopting the resource-based perspective posits that engaging in CSR activities may positively benefit firms internally or externally (Branco & Rodrigues, 2006). Internal benefits of CSR may come from investments helping a firm develop internal new resources and capabilities. External benefits of CSR may come from its effect on corporate reputation as an intangible resource which may enable the firm to attract better employees or customers. This causes the practice to still be adopted today.

One of the biggest recent criticisms of CSR is that social impact is pushed to the periphery of a corporation's activities rather than at its core since financial profit will always be the most important bottom line (Yunus et al., 2010). This led leading business scholars to suggest new ways of organizing business to create social impact. Porter and Kramer (2011) suggested that businesses should adopt a new approach of creating shared value to replace or to "supersede" CSR. Although their primary recommendation was for corporations to rethink their approach to creating social impact, they also highlighted that existing corporations are "not the only players in the space of looking for profitable solutions to social problems" (Porter & Kramer, 2011, p. 10). They note a noticeable rise in new forms of hybrid organizations which blur the line between traditional non-profit and for-profit organizations. The hybrid organization they refer to is more commonly known as "social enterprise"[1].

A social enterprise is not a distinct legal structure. It is generally hybrid in nature and may take on many forms, depending on location and interpretation (Alter, 2007; Kerlin, 2006). One constant about social enterprises is the primary focus of the organization on creating social impact and achieving that through enterprise (i.e., commercial) means. Some scholars view social enterprises to be a superior successor to both traditional businesses and social organizations such as charities and non-profits (hereon collectively referred as "non-profits") with regards to creating social impact (Yunus et al., 2010). The rationale for the perceived superiority of such organizations is because social impact is put at their core (as opposed to the periphery in traditional corporations) and may be more scalable and sustainable compared to traditional non-profits. This interest gave rise to the conceptualization of "social entrepreneurship" (Dees, 1998), a subset of mainstream entrepreneurship.

In parallel, industrial transformations and acceleration of the development and diffusion of technologies have led to the conceptualization of another subset of mainstream entrepreneurship – "technology entrepreneurship". Technology entrepreneurship is entrepreneurship with a focus on innovation based on science and engineering (Beckman et al., 2012). The creation and growth of early-stage technology-based firms (hereon referred to as "technology-based start-ups") are of

1 Other variants are "social business", "social ventures". These terms are interchangeable.

great interest to multiple stakeholders, arguably even more than regular corporations due to their potentially scalable and disruptive nature (ibid.).

More specifically, technology-based start-ups operating in the domain of "digital technologies" (Nambisan, 2017), which is the focus of this thesis, have been identified to be relatively scalable in nature (Huang et al., 2017). Nambisan (2017) postulated that digital technologies in the realm of entrepreneurship can be conceptualized as three distinct but related elements, namely digital artifacts, digital platforms, digital infrastructures.

A digital artifact is defined as "a digital component, application, or media content that is part of a new product (or service) and offers a specific functionality or value to the end-user" (Nambisan, 2017, p. 1031). Its examples are apps present in mobile phones, or from digitally connected "smart" devices[2] (such as Nike+ activity tracker, Oral-B's connected toothbrush, or Nest's learning thermostat). These artifacts need to be hosted on shared services or operating systems, such as Apple's iOS platform and Google's Android platform, to allow end users to interact with the artifacts through hardware like mobile phones. These are digital platforms, "a shared, common set of services and architecture that serves to host complementary offerings, including digital artifacts" (Nambisan, 2017, p. 1032). Tools such as 3D-printers and virtual reality headsets, or systems such as cloud computing, enable the creation and support of digital artifacts and digital platforms. They are examples of digital infrastructures, "digital technology tools and systems that offer communication, collaboration, and/or computing capabilities to support innovation and entrepreneurship" (Nambisan, 2017, p. 1032).

The scalable nature of digital technologies (Huang et al., 2017) provides technology-based start-ups with the potential for exponential growth and wealth creation. Under Smith's view of capitalism, this would then translate to exponential societal benefit (although as a "by-product of economic value" (Mair & Martí, 2006, p. 39)) in the form of job creation, wages, and investments.

2 Digitally connected "smart" devices are also commonly associated with the Internet of Things (IoT).

Since 2010, the two entrepreneurship streams (technology and social) began to intersect, leading to the emergence of a new phenomenon – the rise of TSEs[3]. TSEs are of particular interest to many stakeholders as they have the potential to create social impact at scale. One of the reasons for the rise of TSEs is due to the lowered barrier to entry to engage in activities based on digital technologies. Moore's Law has greatly improved the economics of electronics (and general purpose computers by extension), enabling a larger population to access the technology (Mack, 2011). Digital technologies such as cloud computing (Grossman, 2009) and 3D-printing (Shahrubudin et al., 2019) have enabled small organizations to access previously inaccessible activities such as large scale software deployment or manufacturing.

The interest in TSEs can be observed by the numerous organizations that have emerged in recent times with a specific focus to support TSEs, as well as a thematic shift in established organizations. The emergence of support organizations specifically for TSEs (e.g., Centre for Acceleration of Social Technology (CAST), Bethnal Green Ventures, Social Tech Trust – previously known as Nominet Trust, Fast Forward Accelerator, Benetech, DotForge) reflects the growing interest in TSEs. A thematic shift can also be seen in some university-based technology transfer activities such as the language used by the organizations to focus on social benefits as well as financial returns. For example, MIT's technology incubator spinoff, The Engine[4], states on its website that "The Engine's defining principle is to support start-ups that seek to create material positive impact on society [by] prioritizing breakthrough ideas over early profit…". Another example, in the past few years, the Institute for Manufacturing (IfM) at University of Cambridge has adopted a new theme of "Manufacturing a Better World"[5] to incorporate in its teaching and research activities, a greater emphasis on creating positive social benefits along with economic benefits.

The interest in TSEs is due to their potential to address important social problems from a technological perspective. As an example, Simprints, a case study researched in this thesis, is addressing the problem of providing formal identification to people in developing countries using fingerprinting technologies. Simprints claimed that more than 1.5 billion people do not have access to formal identification (Storisteanu et al., 2016). This prevents the unidentified people

3 Other variants are "social technology business", "technology social ventures". These terms are interchangeable.
4 MIT's The Engine is a technology incubator that provides support for "Tough Tech" (technologies that may bring a lot of positive benefits to society but require patient capital) (https://www.engine.xyz/about-us/our-story/).
5 IfM's "Manufacture a Better World" theme (https://www.ifm.eng.cam.ac.uk/insights/manufacturing-a-better-world/manufacturing-a-better-world/).

from accessing medical and financial services, which significantly lowers the quality of life. Raspberry Pi, another case study in this thesis, is providing access to computer literacy globally through its innovative low-cost but powerful computers. Their technology enables rural areas in developing countries like Kenya to have access to modern computing education for children and adults[6]. The fact that Raspberry Pi is claimed to be "third best-selling computer of all time"[7] and have sold more than 37 million units after only starting operations in 2011 is testament to how the company's product is accepted by the market[8]. These examples illustrate the importance of supporting the development of TSE because the solutions they are providing can be important in helping address diverse social challenges, including those arising from the widening inequality between developed and developing nations in the world. Such TSEs face a particular set of challenges, beyond those faced by purely commercially focused technology-based start-ups, and those faced by traditional non-profits.

In order to succeed, TSEs first need to survive beyond inception and grow. The emergence of support organizations specifically for TSEs mentioned earlier indicates that TSEs have different needs that are not already addressed by existing support organizations such as technology-based start-ups "accelerators" and "incubators". TSEs inherit characteristics of both technology-based start-ups and non-profits. Unfortunately, this leads to challenges because some of the characteristics seem to be at odds with each other – high risk, high returns nature of technology-based start-ups versus risk averse, low or zero commercial returns nature of non-profits. Although barriers to accessing technology have reduced in recent times as described earlier, engaging in technological development is still relatively capital and knowledge intensive (or in other words – resource intensive) and high risk when compared to the activities of traditional non-profits. The market segments that TSEs address are typically not financially lucrative[9] and would not be attractive to many traditional investors. Thus, there are challenges to acquire financial resources (Desa, 2012), recruit talent (Landles-Cobb et al., 2015), and avoiding "mission drift" (Ebrahim et al., 2014). However, due to their social inclination, TSE may also encounter

6 Forbes article on how Raspberry Pi revolutionized education in rural Kenya (https://www.forbes.com/sites/devinthorpe/2014/11/05/rotarian-hopes-to-revolutionize-education-in-rural-kenya-with-rachel-and-raspberry-pi/#5e33e4bc6405).
7 Report on Raspberry Pi's high sales (https://magpi.raspberrypi.org/articles/raspberry-pi-sales).
8 Raspberry Pi blog post, dated 21 Jan 2021(https://www.raspberrypi.org/blog/raspberry-pi-silicon-pico-now-on-sale/). See also report on Raspberry Pi devices sold in 2019 (https://blog.adafruit.com/2019/03/15/25-million-raspberry-pi-computers-sold-raspberry_pi-raspberrypi/).
9 Raspberry Pi as the fastest growing computer company with relatively high turnovers is an exception and will be discussed in later chapters.

additional benefits that might not be available to purely for-profit ventures such as specific types of partnerships and philanthropic grants (Meyskens & Carsrud, 2011).

This leads to the question of how can TSEs reconcile the differences in their characteristics to manage resources? How can TSEs attract talented people to develop their technologies when they are competing against leading technology companies paying high salaries? How can TSEs attract funding to support the venture in the first place? Phrased in another way, "*how do TSEs acquire and manage resources to grow the venture, and develop their technologies?"*

In the following chapters of this thesis, an attempt to answer these questions based on the analysis of specific case studies will be presented.

1.2 Research question and gap

The research question that this thesis is addressing is:

> *"How do technology-based social enterprises acquire and manage resources to grow the venture, and develop their technologies?"*

The gap in existing knowledge can be summarised as follows:

1. **Technology-based social enterprises are an emerging phenomenon;**
   The study of TSEs lies in the intersection of technology enterprises and social enterprises. Neither stream of literature adequately explains the phenomenon. It can be observed that only recently, scholars have begun to research TSE as a separate and specific entity (Arena et al., 2018; Desa, 2012). However, such authors point out that there are still multiple unexplored avenues for research into the phenomenon.

2. **Much of research on technology enterprises has focused on issues related to profit and value maximization;**
   The extant literature and related conceptual models on growth of technology enterprises is not an appropriate fit to explain the phenomenon of TSE. This is primarily because technology enterprises are nearly always researched in the context of maximizing financial profits and the creation and capture of financial value for specific stakeholders. From a business model point of view, all the actors interacting with the technology enterprise in an ecosystem are doing so in order to create and capture value for themselves. Similarly, from a resource-based point of view, transfer of resources from resource providers (or partners) to the technology firm are always done with the resource provider's own interest in mind. For example, equity investors invest in technology enterprises for the potential to capture significant returns on their investments (either for themselves or their own investors). Partnerships may be formed between large corporations and smaller technology enterprises because the partnerships could be a means to access a new market segment for the large corporation or it would be cost efficient for them to acquire new technologies or innovations (Weiblen & Chesbrough, 2015). And generally, since the target markets of technology enterprises are always potentially financially lucrative, talented people are almost always acquired at or above market rate (whether directly or as

a promise of future value through shares) (Hall, 2004). Therefore, this stream of literature does not adequately explain what happens when the conditions in which TSEs operates are different (e.g., limited returns from target markets, TSEs may not have much to give back to large corporations, or limited resources to acquire talent through market rates). The literature also does not account for support provided to TSE by resource providers due to altruism and volunteering.

3. **Much of the research on social enterprises and non-profits do not have a technology focus.**

   Although the literature on social enterprises and non-profits explain to an extent, support due to altruism and volunteering, these studies have not focused on organizations that actively engage in technology development. Technology development requires specific resources such as technical know-how and typically large amounts of capital and would be different from the types of resources provided by resource providers to non-profits. Resources provided through goodwill exercises (such as CSR) by resource providers are almost always under the assumptions that it will ultimately improve their own firm's performance, especially on their own corporate reputation. This does not sufficiently explain what happens when the organization receiving the resources is hybrid in nature and is actively engaging in enterprise activities similar to commercial-focused technology enterprises.

1.3 Research approach

This section will provide an overview of the research approach taken in this thesis. A full description is provided in Chapters 3.

The case study method (Eisenhardt, 1989; Yin, 2014) was used to investigate and provide answers to the research question. The case study method was selected because it is suitable to "investigate a contemporary phenomenon" (Yin, 2014, p. 16) where the "boundaries between phenomenon and context may not be clearly evident" (Yin, 2014, p. 16). Five case studies based on prominent TSEs located in Cambridge, United Kingdom were completed (Raspberry Pi, Simprints, WaterScope, Solaware, Blue Tap). The selected TSEs are at different stages in their business life cycle to investigate the process of growth. Cambridge as a geographic focus was selected because of several reasons: (1) to maintain a homogenous environment for the cases; (2) Cambridge is the birthplace of globally leading TSEs (e.g., Raspberry Pi and Simprints); (3) Cambridge is a notable technology innovation cluster which means that competition for resources (e.g., talent, technology, and funding) may be more intense, but also available in abundance.

The research approach was structured into two stages. Stage 1 took the Resource-Based View (RBV) (Garnsey, 1998; Penrose, 1959/1995) to investigate the phenomenon through the development of a conceptual framework from literature (which combines theories from both for-profit commercial technology enterprises and non-profits). Primary data was collected through semi-structured interviews and multi-organization workshops with key people from the TSE and their resource providers. Secondary data was collected from online articles and internal company documents (e.g., email threads, internal reports, and business plans).

Findings from the case studies using the resource-based framework revealed a promising avenue for further research, Stage 2 – the use of legitimacy as a resource for TSE to grow. A legitimacy-based framework was subsequently developed from literature and used to gather additional primary data. Analysis using the legitimacy-based framework was performed on the new and existing data (both primary and secondary).

1.4 Structure of thesis

The structure of this thesis is illustrated in **Figure 1.1**.

Chapter 2 (Literature review) reviews relevant literature to explain the state-of-the-art with regards to TSEs and validate the gap in literature.

Chapter 3 (Methodology) describes the research approach taken in this thesis. It describes the philosophical stance adopted for this thesis, the research design, procedures to select cases, data collection and data analysis protocols. The chapter also describes the development of the resource-based conceptual framework from literature that is used as the theoretical lens to guide data collection and provide structure for the analysis.

Chapter 4 (Case study findings) presents the main results of Stage 1 and Stage 2 of the research. The individual case studies are presented in a descriptive manner, based on data collected and analysed using the resource-based framework. Results from the cross-case comparative analysis are also presented in this chapter.

Chapter 5 (Discussion of Stage 1 and Stage 2 analysis) discusses and interprets the Stage 1 and Stage 2 findings with regards to the state-of-the-art in extant literature. The analysis from Stages 1 and 2 are then brought together to modify and enhance the initial TSE conceptual framework developed in Chapter 3.

Chapter 6 (Conclusion) presents a summary of key contributions to theory and practice arising from Stages 1 and 2, limitations of the study, and avenues for further research.

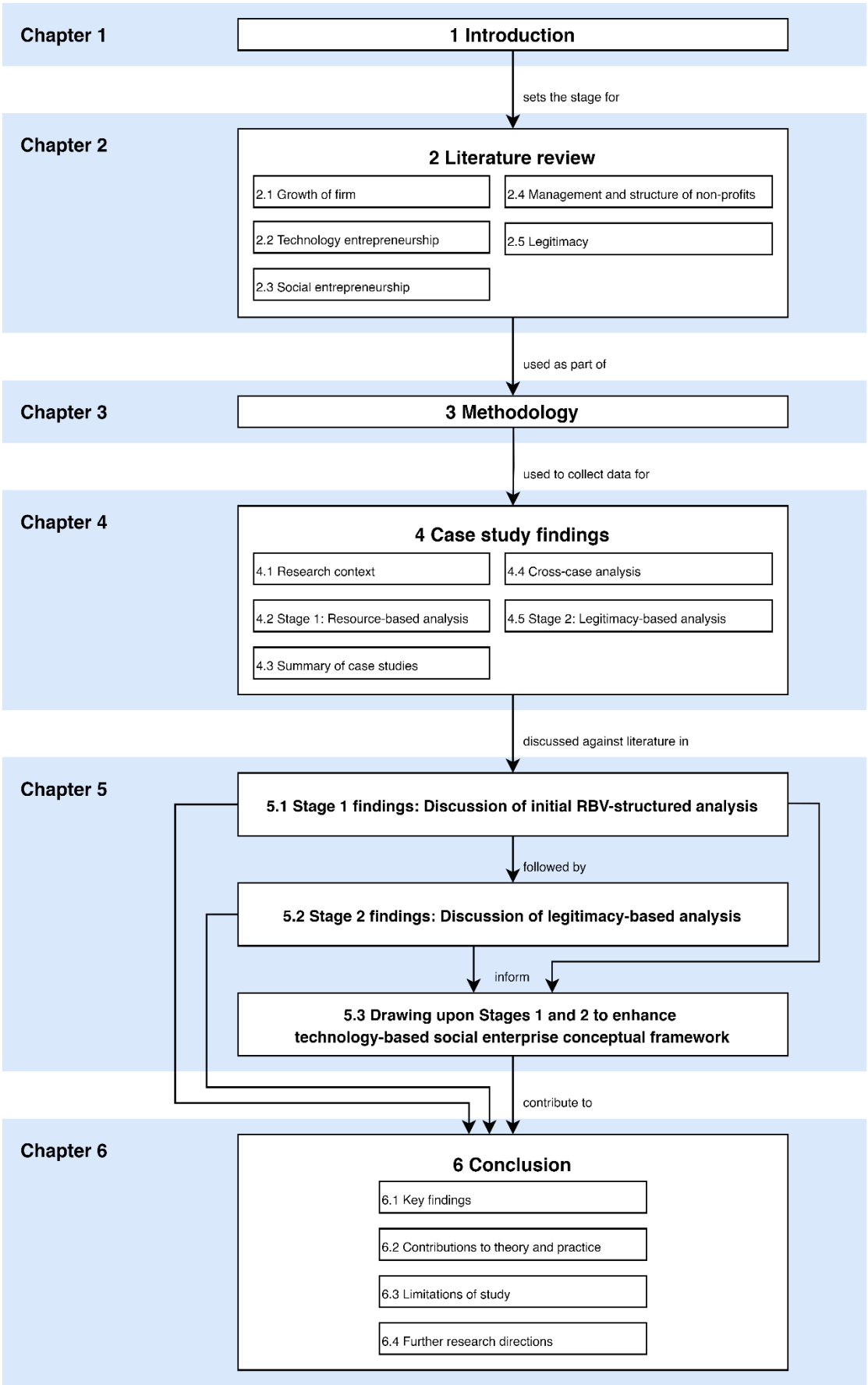


Figure 1.1. Structure of thesis.

Chapter 2 Literature review

This chapter reviews the literature in five sections: (1) growth of firm; (2) technology entrepreneurship; (3) social entrepreneurship; (4) management and structure of non-profits; and (5) legitimacy. The review positions the research question and provides the conceptual foundations for addressing the research question. The chapter concludes with a summary, and articulation of the research gap.

2.1 Growth of firm

The main research question of the thesis concerns with the growth of TSEs. The starting point for the literature review is to review the firm growth literature. This is because the "enterprise" component of "technology-based social enterprise" implies that TSEs conduct businesses and could be treated as if they were firms. Firm growth has been the subject of interest for many stakeholders due to the potential socio-economic benefits which arises from thriving business firms (Coad et al., 2014). As a result of this interest, the firm growth literature is long and varied with different approaches and perspectives adopted by various scholars (Davidsson et al., 2010; Zupic & Giudici, 2018).

What exactly is "growth of the firm"? Penrose's "The Theory of the Growth of the Firm" (1959/1995) serves as an excellent point of reference to discuss this. In her seminal work, Penrose (1959/1995, p. 1) characterizes growth as follows:

> *"The term 'growth' is used in ordinary discourse with two different connotations. It sometimes denotes merely increase in amount; for example, when one speaks of 'growth' in output, export, and sales. At other times, however, it is used in its primary meaning implying an increase in size or improvement in quality as a result of a process of development, akin to natural biological processes in which an interacting series of internal changes leads to increases in size accompanied by changes in the characteristics of the growing object."*

Essentially, this means that growth can be characterizes either as an "increase in amount" (of size or resources), or a continuous process "akin to biological processes" (ibid.). Other scholars have pointed out in their reviews that research has largely focused on explaining the differences in the amount of growth and neglected other aspects of the process of growth (Davidsson et al., 2010). Most research on small firm growth "takes growth-related measures as dependent variables to explain growth as increase in amount" (ibid.).

As the literature on firm growth is wide and varied, it is important to narrow down the scope of review to that which is most relevant to the study of TSEs – namely new venture and small firm stream of firm growth literature. Small firms and new ventures are most relevant to TSEs in the context of this thesis because TSEs in general are comparably newer and smaller than other types of technology organizations. The new venture firm growth literature can be classified into four sub-streams (Zupic & Giudici, 2018): (1) research on high-growth firms; (2) research on factors driving firm growth; (3) research on the process of growth; and (4) measures of growth. Each of these sub-streams will be considered in turn.

2.1.1 Research on high-growth firms

The stream of literature on high-growth firms (HGFs) is largely empirical and typically uses large-scale secondary databases to quantitatively draw conclusions on high-growth new venture populations and their effect on the economy (with regards to GDP growth and employment rate) (Zupic & Giudici, 2018). According to Zupic and Giudici (2018), HGFs are usually identified in two ways, as either a percentage of firms recording the highest growth (e.g., top 5% of fastest growing firms), or as firms surpassing an annual predetermined level (e.g., all firms growing 20% annually in a three-year period). The interest in HGF is mainly due to the recognition that a small number of firms generate a large number of jobs (Birch, 1979; Coad et al., 2014; Henrekson & Johansson, 2010). There is a common perception that HGFs are synonymous with so-called "high technology firms"[10], but this is not empirically supported as research shows that HGFs come from all sectors (Henrekson & Johansson, 2010). However, it has been recognized that

10 "High technology firm(s)" (or "high tech firm(s)") is a phrase commonly used to describe firms that are heavily involved in science-based research and development activities. However, the phrase is not a term of art and has various interpretations across different stakeholders (Lécuyer & Brock, 2009). The phrase is used in this thesis to maintain the original choice of words used by scholars. This thesis adopts Butchart's (1987) definition of "technology firms" (elaborated in Section 2.2) and does not distinguish "high technology firms" as a distinct class of "technology firms".

different measures of growth are weakly correlated, therefore causing most HGFs to only be considered as high growth depending on the measurement criterion used (Davidsson et al., 2010; Zupic & Giudici, 2018). This limits the applicability of the findings to help policymakers support HGFs as scholars have pointed out methodological and political biases in impact assessment of HGFs on the economy (Nightingale & Coad, 2013; Zupic & Giudici, 2018).

2.1.2 Research on factors driving growth

Research on factors driving growth (or the antecedents of growth) looks at how different factors (e.g., human capital, social capital, finance, strategy) affect new venture growth. This is one of the most researched streams in the firm growth literature and uses a mix of qualitative and quantitative methods (Davidsson et al., 2010). Growth determinants that have been researched in the past can be classified as internal or external determinants (ibid.).

Internal determinants are those that relate to the entrepreneur, the structural characteristics of the firm, firm resources, and strategy. Research into the motivations of entrepreneurs towards growth have revealed that ambitions and intention for growth are important drivers of firm growth (Baum et al., 2001). This means that the intention to grow is very important since not all firm owners desire growth, and some may be content to stay small. Some research has investigated relationship of the top-management team (TMT) characteristics and growth. Past experience of the TMT in a similar industry is strongly correlated with growth (Colombo & Grilli, 2005). Structural characteristics of the firm are factors such as the legal structure or firm age and size. Firms with limited company status have been found to experience higher levels of growth since the status provided "credibility" (Storey, 1994) to the business and indicated that the business was "serious" (Freedman & Godwin, 1992).

The effect of firm age and size on growth has been researched extensively, most likely as consequence of what has been labelled "Gibrat's law" (Daunfeldt & Elert, 2013; Gibrat, 1931), the law of proportionate effect. Gibrat's law states that "firm size and growth rate are independent, and that growth has no correlation through time" (Zupic & Giudici, 2018). This implies that firm growth is a stochastic (i.e., random) process. Recent studies, however, have rejected the theory, at least for smaller firms (e.g., Derbyshire & Garnsey, 2015). Although the theory still seems to hold true for larger organizations (Zupic & Giudici, 2018). The relationship

between firm age and growth appears to be more important than the relationship between firm size and growth (Haltiwanger et al., 2013). Essentially, this means that young firms, rather than small firms, grow.

Much of the research on the effects of firm resources and strategy towards firm growth can be traced back to Penrose's "The Theory of the Growth of the Firm" (1959/1995). A central thesis of Penrose's work is the managerial limits to firm growth. The managerial constraint stems from limited capacity of existing management to focus on growth. This upper limit on the rate of firm growth is dubbed the "Penrose Effect". Another important aspect of Penrose's theory is the productive opportunity set (POS) facing the firm. The POS is affected by resources and knowledge accessible by a firm and the know-how of managers to recombine them to develop new products and services. The legacy of Penrose's work is subsequently developed within the resource-based view (RBV) (Barney, 2001b; Wernerfelt, 1984). In the resource-based view, resources that are "valuable, rare, inimitable, and non-substitutable" are considered to be sources of competitive advantage for firms (Barney, 2001b). Acquiring and mobilizing resources thus becomes important for firm success and growth.

Many types of resources have been researched in the extant growth literature, but among the most researched resources are human, financial, and social capital (i.e., networks) (Zupic & Giudici, 2018). The human and financial resources available to a new venture at start-up have been found to significantly affect performance (Cooper et al., 1994). Human capital usually refers to either the founders or the employees of the firm, and are considered to be a source of competitive advantage according to RBV (Ganotakis, 2012; Zhuang & Lederer, 2006). Fast growth usually requires access to increasing amounts of financial capital which can be obtained from customers (through sales), banks (through loans), or venture capitals (through equity investments) (Chittenden et al., 1996). Studies on the role of venture capitals on firm growth have found that firms backed by venture capitals experience higher growth (Davila et al., 2003; Inderst & Mueller, 2009). However, recent studies by Rosenbusch et al. (2013) challenges this notion and found that after controlling for industry selection, the effect of venture capitals on firm growth is minimal (Zupic & Giudici, 2018). In spite of that, the venture capitals industry is still considered an integral part of the technology entrepreneurial ecosystem (Grilli, 2014). Social capital is another highly researched topic in firm growth literature (Zupic & Giudici, 2018). Social capital research usually looks at the network aspect of the entrepreneurial team or the firm and have been found to have positive effect on firm growth (Davidsson & Honig, 2003). Network of

the entrepreneurial team usually refers to the personal network of the founders while network of the firm refers to strategic alliances and partnerships formed with other firms. Social capital essentially enables new ventures to access other forms of capitals (e.g., human or financial) that they do not possess. Apart from human, financial, and social capitals, legitimacy is another kind of resource that have been found to affect new venture growth. In order to overcome the liability of newness, Khaire (2010) have found that new ventures mimic the structures and ceremonial activities as well as affiliate themselves with established organizations. Khaire's (2010) work is interesting because it explains how resource-constrained new ventures (when compared to established firms) can overcome financial limitations to grow. However, the study was conducted on the advertising industry and Khaire notes that the findings may not be applicable to firms in more capital-intensive industries such as "high-tech firms" (ibid.). Some resources such as technology, are specific to certain industries (such as the so-called "high-tech" industries). This will be discussed separately in Section 2.2.2.

External determinants are those that relate to the environment of the firm. This stream of research takes the view that external forces play a large role in determining the firm's growth, as suggested by the population ecology perspective (Hannan & Freeman, 1977). With regards to resources, environments can be viewed to affect organizations by either making available or withholding resources (Aldrich, 1979). Delmar et al. (2003) have shown that the growth paths of clusters of high-growth firms differ according to their industry affiliation. Fast growing firms have been found to be more prolific in industries and regions that are more dynamic (Carroll & Hannan, 2000). Therefore, the evidence suggests that firm growth is externally determined to an extent.

When considering both internal and external determinants of growth that have been researched, an obvious conclusion that can be drawn is that growth is considerably affected by the willingness and skills of the firm to grow, but at the same time, the fundamental facilitators and obstacles in the environment cannot be disregarded (Davidsson et al., 2010). It is notable that most of the firms in which the factors driving growth are researched, share a characteristic – they are commercial organizations which is predominantly focused on profit and value maximisation objectives. The blend of social and commercial objectives of TSEs presents a unique context which encourages the revisitation of the various factors driving growth. For example, access to financial resources through capital markets to support fast growth (Chittenden et al., 1996) might be limited or not available to TSEs due to their focus on non-commercial objectives.

2.1.3 Research on the process of growth

Research on the process of growth are dominated by the "stages-of-growth models" or also known as "life-cycle models" (e.g., Churchill & Lewis, 1983; Greiner, 1997; Hanks et al., 1994). Hanks et al. (1994, p. 7) defined "life cycle" as "a unique configuration of variables related to organization context and structure". A key assumption of the stages-of-growth model is that there are certain number of stages that an organization go through, and all firms move through these stages – akin to how organisms undergo natural biological processes. One of the earliest and most prominent stages-of-growth model appeared in the early 1970s with Greiner's (1997) (first published in 1972 and reprinted in 1997) influential five stage growth model (**Figure 2.1**). Greiner's (1997) model illustrates the various phases an organization goes through as it matures and increases in size. The model was subsequently expanded by Churchill and Lewis (1983) and other scholars. Since then, a lot more models were designed by researchers up until the early 1990s.

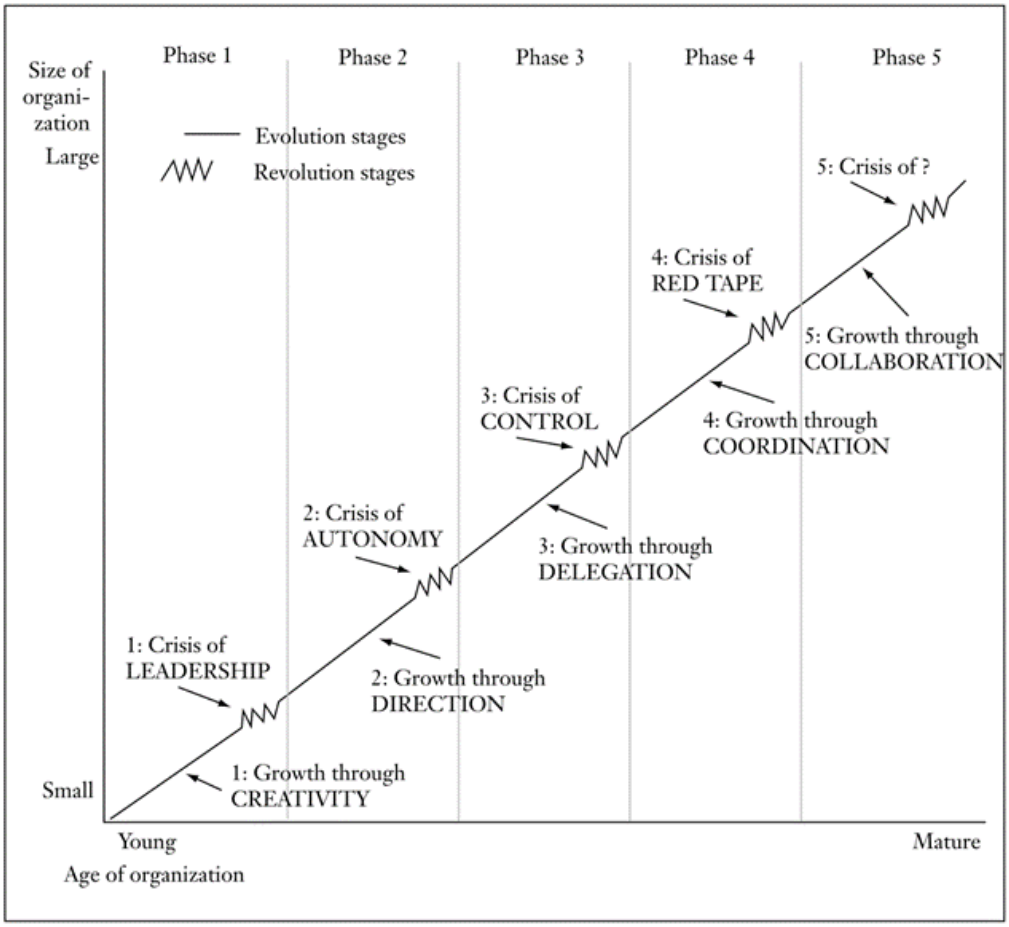


Figure 2.1. Greiner's (1997) five stage growth model.

The number of stages that have been identified by scholars varies greatly. In a review of over 100 scholarly publications of stages-of-growth models, Levie and Lichtenstein (2010) identified that most models are between three to five stages. Davidsson et al. (2010, p. 123) concluded from their review of various models that "all models start with an initial stage which is typically characterized by a simple organizational structure, direct supervision, and particular importance is attributed to the founder or entrepreneur" (e.g., Greiner's (1997) "creativity stage"; Churchill and Lewis's (1983) "entrepreneurial stage"). The initial stage is followed by a stage where the firm achieves initial success (e.g., Greiner's (1997) "direction stage"; Churchill and Lewis's (1983) "success stage"; Garnsey's (1998) "resource generation stage"). Subsequent stages are typically characterized by an increased bureaucratization of the organization (e.g., Churchill and Lewis's (1983) "resource maturity stage"). Some scholars like Garnsey (1998), included "growth reversal stage" and "stability stage" as alternative growth paths for organizations.

The stages-of-growth models were popular because they had a high perceived face validity for practitioners (Davidsson et al., 2010; Zupic & Giudici, 2018), i.e., entrepreneurs can use the models to identify the stage of their company at a certain point in time and respond to the real-world challenges that are discussed in those stages. For example, Eggers et al. (1994) reported that 100% of the entrepreneurs in their study were able to unambiguously identify their company with one of the five defined stages.

However, one of the major criticisms with stages-of-growth models is the overly deterministic nature of the models (Levie & Lichtenstein, 2010). Some have pointed out that there is no agreement in the literature on what constitutes a stage, and most definitions are "used only by a handful of authors without wide-reaching consensus" (Zupic & Giudici, 2018, p. 201). In addition, another problem is the lack of systematic empirical evidence to support most models (Davidsson et al., 2010). These criticisms are the reason that research interest in stages-of-growth models have waned. Levie and Lichtenstein (2010) even concluded that stages-of-growth models are a "dead end".

Frustration comes from the fact that all the different models do not fit together which implies limited utility of the models. This is unfortunate because findings from growth process research can have high practical relevance for firms, e.g., as Davidsson et al. (2010, p. 126) have pointed out:

"Process knowledge can make entrepreneurs aware of possible crises and solutions, and researchers should be able to present better alternatives to the portrayals of inevitable growth problems and universally applicable snake oil cures that one finds in the non-research-based management literature."

Even if the models are not universal, research shows that they should not be dismissed completely as that would be akin to "throwing the baby out with the bathwater". If the criticisms are addressed properly, the stages-of-growth models can be made relevant again since they are an excellent way to reveal internal firm dynamics (Garnsey, Stam, et al., 2006). This sentiment is reflected in recent calls by scholars to revive this stream of research (Davidsson et al., 2010; Zupic & Giudici, 2018). The calls also asked to take on board Levie and Lichtenstein's (2010) criticisms and suggestions regarding fundamental assumptions that underlie the research.

Levie and Lichtenstein (2010) has presented an alternative "dynamic states model of entrepreneurial change" to overcome the criticisms of the stages-of-growth model. The dynamic states model approach addresses two core propositions in the stages-of-growth model that have been found to be unsupported by evidence, (1) businesses develop through a specific number of stages; (2) the stages represent an immanent program of development. A summary of difference between the stages-of-growth model and the dynamic states model is shown in **Table 2.1**.

Table 2.1. Differences between 'stages-of-growth model' and 'dynamic states model', recreated from Levie and Lichtenstein (2010, p. 335).

	Stages-of-growth model	**Dynamic states model**
Assumption	**Organizations grow as if they were organisms**	**Each state represents management's attempts to most efficiently/effectively match internal organizing capacity with the external market/customer demand**
Proposition: What	Configuration of structural variables and management problems	Configuration of structural variables and organizational activities (aspirations)
Proposition: How	• **A specific number of progressive stages** • Sequence and order is predictable • Incremental and punctuated transitions	• **Any number of states** • Sequence and order may be predictable depending on context • Incremental and punctuated transitions, and emergence
Proposition: Why	• **Immanent program of development** • Prefigured rules of development • "Regulated" by environment	• **Adaptive process of retaining the sustainability of a business model** • Interdependent rules for development • Driven by market change and opportunity creation

Note. Major difference highlighted in bold.

The dynamic states model does not necessarily invalidate all stages-of-growth models that came before it. This is because the main changes are to the assumptions and propositions surrounding the stages-of-growth model. It is quite likely that constructs discovered in existing stages-of-growth models can be adapted to fit the dynamic states model approach. For example, Greiner's (1997) famous five stage growth model is still valid using the dynamic states approach as long as the assertions surrounding the model are modified. Assertions must be modified to not have the assumption that all organizations undergo those five stages definitively. Instead, those same five stages are five possible states which businesses may find themselves in and that there could well be more states depending on the different context of the organization.

Methodologically, scholars (Davidsson et al., 2010; Zupic & Giudici, 2018) have recommended conducting more qualitative-based case study research on process of growth studies since quantitative approaches may not capture the full picture due to the complex nature of growth. Specific indicators measured quantitatively may not reflect the actual underlying situation of the firm since they are constantly affected by time. This is not to say that process of growth cannot be researched quantitatively. It is still possible, but it would require considerable resources and continuous access by the researchers (Davidsson et al., 2010). A brief review of indicators used in growth research will be described in the following section.

2.1.4 Measures of growth

Many indicators of growth have been used in the extant literature such as sales growth, employment growth, asset growth, profit growth. Among all the indicators, sales (or turnover) growth and employment growth are the two most utilized indicators in existing growth research since they apply more generally to all firms (Chandler et al., 2009; Zupic & Giudici, 2018). However, all the indicators have been found to be weakly correlated (even between sales and employment), suggesting that no single indicator is adequate (Davidsson et al., 2010; Garnsey, 1998; Zupic & Giudici, 2018).

The choice of growth indicator is important because it has different implications for different stakeholders. For example, entrepreneurs typically do not grow their business for the purpose of expanding employment numbers. Employment growth is typically a means to an end, and not the end itself. On the other hand, generating employment is of importance to policymakers. Hence,

policymakers would be more likely to use employment growth measures as an indicator for research. Sales growth may appear to be universal, but it is possible that the business is not (yet) profitable (Davidsson & Gordon, 2009). For early-stage ventures, it is quite likely that sales or employment growth may not be available due to the age of the firm. In such cases, a possible indicator would be the investment that has been raised by the firm. Though it can be argued that investments raised by firms is an input to the firm to achieve growth. This gives the perception of the problem where to achieve growth, a firm just need to raise more investment. Obviously, raising investment is a means to an end, and not the end itself – this is not unlike the earlier discussed employment growth indicator. Scrutinizing the indicator further will lead to a recursive problem. Although not perfect, in early-stage ventures, investments raised is a good proxy for growth since it is an enabler for subsequent growth of employment and sales. The indicator is popular in research on early-stage high-tech firms, though usually it comes in the form of firm valuations (which is affected by investments raised) (Achtenhagen et al., 2010).

Scholars recommend using more than one indicator when possible in order to better capture the phenomenon of growth (Davidsson et al., 2010).

2.1.5 Summary and conclusion

The resource-based view was selected as a starting point for the review on growth of firm literature due to its long and rich history in the research of firm growth. Narrowing the literature to focus on new venture firm growth revealed three research sub-streams: (1) research on high-growth firms; (2) research on factors driving firm growth; (3) research on the process of growth. The review revealed that factors driving firm growth and process of growth are promising avenues to research growth of TSEs. Recent calls by scholars to research process of firm growth (e.g., Davidsson et al., 2010; Zupic & Giudici, 2018) indicate that there is interest to further the understanding of internal firm dynamics and its relation to firm growth. The stages-of-growth (or life cycle) models were also identified to be a suitable approach to operationalize the research of the process of firm growth as it has been used by many scholars (e.g., Churchill & Lewis, 1983; Garnsey, 1998; Greiner, 1997; Hanks et al., 1994). In spite of recent criticisms of the stages-of-growth models (Levie & Lichtenstein, 2010), scholars have called to revisit and expand the research on stages-of-growth models (Davidsson et al., 2010; Zupic & Giudici, 2018). The unique context surrounding the dual nature (social and commercial) of TSEs also revealed to present an

opportunity to revisit the research on factors driving firm growth. Scholars also recommended using multiple indicators when possible since no single indicator is sufficiently adequate on its own to capture the complex nature of firm growth (Davidsson et al., 2010). In addition, it is also due to the complex nature of firm growth, that scholars have recommended the use of predominantly qualitative methods (Davidsson et al., 2010). In conclusion, the review on growth of firm literature revealed that qualitative-based research combining factors driving firm growth and process of growth would be a promising path to explore the growth of TSEs. In fact, scholars have adopted a similar approach to explore growth in various emerging industries (e.g., Garnsey, Dee, et al., 2006; Stam & Garnsey, 2006). This will be elaborated in greater detail in Chapter 3.

2.2 Technology entrepreneurship

Research on the entrepreneurship phenomenon can be defined as the study of the emergence and creation of new firms (Bygrave & Hofer, 1992). Technology entrepreneurship is a subset of mainstream entrepreneurship with a focus on innovations from science and engineering (Beckman et al., 2012). Over the last few decades, a core part of technology policy worldwide has focused on fostering the formation and growth of new technology-based enterprises (Almus & Nerlinger, 1999; Brown & Mason, 2014). Although technology-based enterprises comprise only a small portion (about 15%) of the entire population of small medium enterprises (SME), policymakers have the view that these firms are an essential part of their entrepreneurial ecosystems because of the potential for high growth (Mason & Brown, 2013; OECD, 2000).

Butchart's (1987) definition has been widely used to define technology-based enterprises. The definition emphasizes: (1) above average expenditure on research and development (R&D) relative to turnover; (2) employ proportionately more 'qualified scientists and engineers' than other sectors; (3) science-based. These defining points have resulted in distinguishing characteristics of technology-based enterprises such as higher rate of growths (in employment, sales, and assets) (Storey & Tether, 1998), higher concentration of firms in clusters of innovation (Garnsey & Heffernan, 2005), innovative business models (Velu, 2015), a more open approach to innovation (Ahn et al., 2015).

2.2.1 Growth of technology-based enterprises

The growth of technology-based enterprises is of great interest to many policymakers worldwide because of its potential to bring economic benefits and create employment (Storey & Tether, 1998). Technology-based enterprises exhibit different growth patterns due to their knowledge and resource intensive nature (Garnsey & Heffernan, 2005). As described in the last section, there are different perspectives to evaluate growth of firms. The process of growth approach has been recommended as a promising avenue to further explore the internal dynamics of firm growth (Davidsson et al., 2010; Garnsey, Stam, et al., 2006; Zupic & Giudici, 2018). As such, the review in this section will focus on the process of growth perspective for technology enterprises.

The resource-based perspective and the process of growth perspective go hand in hand (considering the academic lineage of both streams can be traced back to Penrose). Garnsey's (1998) work has been cited by scholars (Davidsson et al., 2010) as an interesting and relatively recent work to expand on process of growth studies. In Garnsey's (1998) "Theory of the Early Growth of the Firm", she extended Penrose's theory to look specifically at the early growth of firms (Penrose's work focused on established firms). A conceptual model grounded in the resource-based perspective was proposed to explain how early technology firms grow. This will be discussed in more details in the Chapter 3 on development of the conceptual framework.

2.2.2 Technology as a resource

One of the key resources specific to technology enterprises is the technology itself (Garnsey & Heffernan, 2005). Technology as a resource can be managed by organizations through multiple aspects such as identification, selection, acquisition, protection, and exploitation (Gregory, 1995).

Identification involves developing an awareness of all the technologies which may be important to the business. Selection involves deciding on the choice of technologies that should be supported and promoted within the organization. Many terminologies had been used to describe the systematic process to acquire, assess, and communicate the information on technological trends such as technology monitoring, technology assessment, technology forecasting, and more recently – technology intelligence (Lichtenthaler, 2004). The emergence of this stream of literature can be traced back to the 1970s as scholars called for a more systematic approach to

observe changing technological trends to support better decision-making (Ansoff, 1975; Cooper & Schendel, 1976; Utterback & Brown, 1972). Technology intelligence has been identified to be critical to the success of technology-based enterprises (Savioz & Tschirky, 2004). Scholars have developed many approaches to facilitate technology intelligence process by technology enterprises such as roadmapping techniques (Phaal et al., 2004), patent analysis (Abbas et al., 2014), and more recently – web-based horizon scanning approaches (Palomino Marco et al., 2012). According to a review by Savioz and Tschirky (2004, p. 224), there are factors which dictate the suitability of specific approaches to firms such as the technology strategy of the firm (Gerybadze, 1994, p. 136), the complexity and uncertainty of the industry (Balachandra, 1980, p. 164), and available time (Reger et al., 1998). Due to the relatively resource-intensive nature caused by those factors, technology intelligence activities are usually conducted by resource-endowed mature organizations (Lichtenthaler, 2007) compared to start-ups with limited resources and higher urgency to get their products to market.

Acquisition involves making decisions to acquire technologies and embed it within the organization in an effective manner. There are many strategies that have been identified for technology-based enterprises to acquire technology such as licensing, partnership, through university or corporate spinoffs (Mortara & Ford, 2012), or through mergers and acquisitions (Cefis & Marsili, 2015; Makri et al., 2010). These external technology acquisition strategies were developed mainly to enable mature corporations to maintain competitiveness in the face of rapidly changing technological trends (Arora et al., 2016; Lambe & Spekman, 1997). Technology acquisition is typically initiated to acquire tacit, socially complex, and idiosyncratic technical knowledge, but there is a risk that the knowledge might not survive the acquisition process due to its tacit and socially complex nature (Ranft & Lord, 2002). Hence, scholars have developed various models to manage the relatively complex nature of the technology acquisition process (e.g., Durrani et al., 1998; Ranft & Lord, 2002).

Protection is mainly concerned with preservation of the knowledge and expertise of the technology within an organization. One of the approaches to achieve this is through the use of intellectual property (IP) and patent protection strategies (Kanwar & Evenson, 2003). There is some evidence that stronger protection of patent rights facilitates the access of additional financial capital to increase R&D intensities in patent-intensive manufacturing industries (Maskus et al., 2019). Patent protection has been regarded as one of the best ways for a firm to protect new innovations and ideas (Baran & Zhumabaeva, 2018). However, high protection costs,

complicated IP regulations, lengthy waiting time for a patent, and lack of awareness, makes patent protection less accessible to start-ups with limited resources (ibid.).

Exploitation is concerned with the conversion of technologies into marketable products. This is usually done through the process of new product development (NPD) (Brown & Eisenhardt, 1995; Wheelwright & Clark, 1992). In the seminal review by Brown and Eisenhardt (1995), one of their main claim is that process efficiency (i.e., the speed and productivity of product development) and product effectiveness (i.e., how well the product fits with firm competences and market needs) are heavily influenced by "agents", including team members, project leaders, senior managers, customers, and suppliers. In other words, the performance (i.e., effectiveness and efficiency) of NPD process is influenced by many different actors, both internal (e.g., team members, project leaders, senior managers) and external (e.g., customers and suppliers) to the firm. Verona (1999) subsequently proposed a model which suggested that the performance of NPD process is affected by the interactions between agents and the organizational capabilities of the firm (Amit & Schoemaker, 1993; Teece et al., 1997). This combination of agents and capabilities essentially highlights the importance of human capital resource in the exploitation of technologies. In addition to NPD, the business model (see DaSilva & Trkman, 2014 for a detailed discourse on the use of the terminology) is also central to the success of the exploitation process (Chesbrough, 2007). In fact, Chesbrough (2007, p. 12) claimed that "a better business model often will beat a better idea or technology". This highlights the importance he places upon business models in successfully converting technologies into marketable products.

The review revealed that management of technology as a resource can be a resource-intensive endeavour (consuming other types of resources such as financial and human capital). Extant literature also revealed that most studies had been conducted in the context of relatively mature organizations with access to resources (e.g., Arora et al., 2016; Lambe & Spekman, 1997; Lichtenthaler, 2007; Maskus et al., 2019; Verona, 1999). Hence, technology management under limited resources in the context of start-ups is a promising avenue for further research as evidenced by relatively recent studies (e.g., Baran & Zhumabaeva, 2018; Still et al., 2017). In addition, the context of TSEs, which has relatively even lesser resources (considering their predominantly non-profit and primarily social nature) than commercial start-ups call for further investigation.

2.2.3 Business incubation

Business incubation provides a range of support to businesses in the form of networking, access to funding, mentorship, technical resources, among others (Scillitoe & Chakrabarti, 2010). Some evidence shows that business incubation can be effective in increasing the success of entrepreneurship in specific situations (Autio & Rannikko, 2016) and, in recent decades, business incubation has become a popular policy instrument to promote and foster entrepreneurship, innovation, and regional development (OECD, 1997). Incubation is essentially a type of resource which the technology enterprise may access in an ecosystem.

The challenges which a firm face varies according to the industry sector which they operate as well as the stages of the firm's growth (Dee et al., 2008). As a result, business incubation models have adapted to accommodate for the differences among firms (Pauwels et al., 2016). In the past few decades, business incubation has predominantly focused on for-profit enterprises both in practice and in academia (Hackett & Dilts, 2004). However, there is some recent research that highlights the emergence of new models of incubation focused on stimulating welfare (i.e., social) or a hybrid combination of both welfare and commercial (Pauwels et al., 2016). There is little published research on the operations of the new models since they are a recent phenomenon. Incubation to stimulate welfare and the hybrid model are especially interesting since it is not clear how the incubated firms sustain revenue generation while pursuing social objectives (Pauwels et al., 2016). Business incubation for for-profit enterprises is typically grounded in market-oriented benefits. This may still be the case for social enterprises (especially for-profit social enterprises). However, in the case where financial gain is not the primary goal of an incubator, such an incubator may be considered more of a support organization. This is a potential differentiator for incubators in the social enterprise context (i.e., support organizations) from commercial business incubators. The nature of the interactions between support organizations and social enterprises is a promising avenue for further research since it would explain how social enterprises can access support organizations as a resource.

2.2.4 Summary and conclusion

Technology-based enterprises are of interest to many policymakers due to their potential for high growth (Mason & Brown, 2013; OECD, 2000). Butchart's (1987) definition of technology-based enterprises is adopted for this thesis. Management of technology as a resource is reviewed through Gregory's (1995) framework of identification, selection, acquisition, protection, and exploitation. The reviews revealed that existing research has largely focused on mature organization with access to resources. The resource-limited context of start-ups, and by extension, TSEs (with relatively even lesser resources), is a promising avenue for further research on technology management. Business incubation was found to have some impact in increasing the success of start-ups under specific conditions (Autio & Rannikko, 2016). However, the literature is predominantly focused on support for-profit organizations (Hackett & Dilts, 2004). The impact of incubation and support for hybrid organizations (combining social and commercial objectives) such as social enterprises are less clear and warrants further research (Pauwels et al., 2016).

2.3 Social entrepreneurship

The interest in social entrepreneurship among practitioners, policymakers, and academics has increased over the last three decades. This can be observed from the recognition and scale of support given by leading foundations such as Ashoka, Skoll Foundation, Schwab Foundation to practitioners annually (Dacin et al., 2011). Policymakers globally have enacted various policies to support social entrepreneurship, such as the United Nations Social Impact Fund and European Union Social Business Initiative. Universities such as Harvard, Stanford, Oxford, Cambridge have set up their own research centres for social entrepreneurship, and new scientific journals on social entrepreneurship have been launched (e.g., Journal of Social Entrepreneurship, International Journal of Social Entrepreneurship and Innovation, Social Enterprise Journal).

In the academic literature, there is a lack of a unified definition (Choi & Majumdar, 2014; Short et al., 2009). It may refer to corporations innovating in the social sector (Austin & Reficco, 2009), non-profits adopting an earned income strategy (Dees, 1998), or for-profit ventures with social objectives (Dees & Anderson, 2003) among other definitions. However, common to most definitions and interpretations of social entrepreneurship is the primacy of social value creation

with an economic component as opposed to purely economic value creation (Austin et al., 2006; Mair & Martí, 2006; Moss et al., 2008; Weerawardena & Mort, 2006). Emphasis on social value creation is important to help distinguish social entrepreneurship from commercial entrepreneurship (Austin et al., 2006). For this research, Mair and Martí's (2006) definition of social entrepreneurship is adopted to allow inclusion for a wider range of social activities:

> *"a process involving the innovative use and combination of resources to pursue opportunities to catalyze social change and/or address social needs."*

Similar to commercial entrepreneurship, social entrepreneurship research can be conducted on different levels of analysis such as the individual (social entrepreneur) (e.g., Beugré, 2014; Christopoulos & Vogl, 2015; Germak & Robinson, 2014; Yitshaki & Kropp, 2016), the organization (social enterprise) (e.g., Bull, 2008; Moizer & Tracey, 2010; Spear et al., 2009), or the ecosystem (social entrepreneurship ecosystem) (e.g., Goyal & Sergi, 2015; Mendoza-Abarca et al., 2015). For this research, the emphasis is at the organizational level, i.e., the social enterprise. Therefore, the literature on social enterprises will be reviewed in greater depth compared to the other aspects of social entrepreneurship.

2.3.1 Defining social enterprises

A review of recent social enterprise literature revealed two dominant streams of studies (Liu et al., 2014). The first stream focuses on defining social enterprises (Austin et al., 2006; Choi & Majumdar, 2014; Mair & Martí, 2006; Teasdale, 2012). The second stream focuses on the social enterprise business model, which investigates structural tensions of maintaining both social and commercial components and the legitimacy of commercial involvement (e.g., Battilana & Lee, 2014; Cooney, 2006; Doherty et al., 2014; Haigh, Kennedy, et al., 2015; Meyskens & Carsrud, 2011; Moizer & Tracey, 2010; Santos et al., 2015).

Social enterprises are the organizational manifestation of social entrepreneurship (Choi & Majumdar, 2014). They are interpreted differently by different groups of people across time and region (Defourny & Nyssens, 2010; Kerlin, 2006; Teasdale, 2012) due to the unique historical and socioeconomic context of different locations (Kerlin, 2010). Analogous to the broadly defined concept of social entrepreneurship, there is no single legal or organizational form that defines

social enterprises. Social enterprises can include cooperatives, non-profits, for-profit enterprises, nongovernmental organizations, among other definitions (Teasdale, 2012).

There was an upsurge in interest in social enterprises in the United Kingdom beginning in the late 1990s. This was in part due to the policy approach of the New Labour government to push forward the third sector (Haugh & Kitson, 2007). The third sector comprises of organizations (e.g., non-profit organizations, charities, community groups and voluntary associations) that aim to deliver social and environmental benefits, that are neither part of the profit making (private) nor statutory (public) sectors. A new Social Enterprise Unit was formed under the then Department for Trade and Industry (DTI) which defined a social enterprise as follows (DTI, 2002):

> *"A social enterprise is a business with primarily social objectives, whose surpluses are principally reinvested for that purpose in the business or in the community, rather than being driven by the need to maximise profit for shareholders and owners."*

There are three key elements in the definition by DTI (2002) as analysed by (Teasdale, 2012). Firstly, the term "business" differentiates social enterprises with traditional charities by the implication of trade. Secondly, the phrase "primarily social objectives" differentiates social enterprises with commercial enterprises with the focus on social objectives. Thirdly, the phrase "surpluses are principally reinvested for that purpose" implies limited profit distribution and a means to further differentiate social enterprises with commercial enterprises. While the definition provides some clues to identifying social enterprises, it is still relatively vague for classification of social enterprises. Teasdale (2012) argued that this vagueness in definition by the UK government was intentional for political expediency. This is because a vague definition allows for greater inclusiveness of organizational forms (e.g., cooperatives, non-profits, for-profits) and subsequently allows the government to claim greater collective benefit from social enterprises.

Some have argued that all forms of enterprises are social enterprises because they generate some form of social value either through innovation (e.g., economic benefit from the cell phone innovation) or new job creation (Schramm, 2010). However, defining social enterprises as such will discount the unique challenges faced by social enterprises (Bornstein & Davis, 2010). Most interpretations of social enterprises in the literature generally accept that social enterprises are

distinct from commercial enterprises with the emphasis on pursuing social objectives (Mair & Martí, 2006).

The UK is also perceived by some as having one of the most developed institutional support structures for social enterprises in the world (Nicholls, 2010). This is because "whilst policy focus in other regions in the world has typically focused on developing new approaches to welfare via innovation in the social economy, UK policy has typically addressed the development of the social enterprise sector per se as its key objective" (ibid.). The creation of the Community Interest Company (CIC) legal form in 2005, the first new legal form of incorporation in over a century, represents a significant manifestation in this sector-focused public policy agenda. The number of social enterprises present in UK was reported by various national surveys to be approximately 62,000 in year 2007, an exponential increase from 5,300 in year 2003 (Teasdale et al., 2013). This implied an exponential growth in the phenomena and attracted a lot of research interest in the academic community. The growth figures were widely cited by academics since it legitimizes the increasing importance of social enterprises (Chell et al., 2010; Haugh & Kitson, 2007; Spear et al., 2009). However, Teasdale et al. (2013) revealed that inconsistent interpretations of the social enterprise definitions (leading to the inclusion of more enterprises) may be the reason behind the perceived exponential growth.

In the United States, interest in social enterprises led to the creation of the Office of Social Innovation and Civic Participation under the Obama administration[11]. Similar to the UK, the term social enterprises in the US also refers to multiple legal forms such as non-profits or for-profit enterprises (Short et al., 2009). However, in the US, there is a greater tendency to refer to social enterprises as non-profits applying business practices in its activities outside of academia (also known as 501(c)(3) tax exempt organizations) (Kerlin, 2006). This is because a decrease in government funding for non-profits during the 1980s led non-profits to seek alternative methods to fund their projects (Defourny & Nyssens, 2010; Kerlin, 2006).

Apart from the US and UK, social enterprises also have prominence in many parts of the world. European countries such as Germany, France, Belgium, and Ireland, social enterprises usually refer to non-profits operating in the field of social services which are financed and regulated by

11 Archived website of the Office of Social Innovation and Civic Participation (https://obamawhitehouse.archives.gov/administration/eop/sicp)

public bodies (Salamon et al., 1999). There is also a tendency among practitioners and researchers to associate social enterprises with the UN's Sustainable Development Goals (SDG)[12] (Rahdari et al., 2016; Ramani et al., 2017). This is understandable since the SDGs are globally considered as important social objectives to strive towards.

The difference in defining social enterprises reiterates the notion that there is no single definition for social enterprises. Practitioners tend to adopt Justice Potter Stewart's "I know it when I see it" approach in defining social enterprises. This approach might be convenient for practitioners but unfortunately untenable in a formal academic inquiry. Thus, the relatively inclusive definition of social enterprise based on the DTI's (2002) definition will be adopted to allow for a more comprehensive inspection of the phenomena: "A social enterprise is a business with primarily social objectives, whose surpluses are principally reinvested for that purpose in the business or in the community, rather than being driven by the need to maximise profit for shareholders and owners." An operational definition of social enterprises to identify and select cases is elaborated in Chapter 3.

2.3.2 Business model of social enterprises/hybrid organizations

Social enterprise business models are another point of interest in the literature since conventional theories developed from for-profits may not be applicable to social enterprises (Bocken et al., 2014; Santos et al., 2015; Wilson & Post, 2013; Yunus et al., 2012). Within the social enterprise domain, there are also different conceptualizations of the social enterprise business model. For example, Yunus et al. (2010) proposed the concept of "social business model" which requires the organization to reinvest all of its profits into the social mission without rewarding shareholders financially. Some other scholars interpret social enterprise business models to be hybrid business models which combine social and commercial components while permitting financial rewards to shareholders (Battilana & Lee, 2014; Haigh, Walker, et al., 2015).

Scholars have identified that the dual components of social and commercial in a hybrid organization such as a social enterprise holds interesting research potential (Doherty et al., 2014; Pache & Santos, 2013; Wilson & Post, 2013). Some has focused on the potential misalignment in

12 UN's Sustainable Development Goals (https://sdgs.un.org/goals).

the dual components since the components may be competing logics in nature (Pache & Santos, 2013). Others have focused on the effects of social and business activities on the hybrid organization's construct. However, the specifics on how hybrid activity actually occur in social enterprises (e.g., the operationalizing of dual components) are not clearly understood and requires more research (Wilson & Post, 2013).

Scholars have also attempted to analyse social enterprises business model through strategic management theories. For example, Meyskens, Robb–Post, et al. (2010) conducted research on Ashoka[13] organizations (a social entrepreneurship network) and discovered that there is some evidence that traditional resource-based view theories (Wernerfelt, 1984) are also applicable to social enterprises. However, some scholars remain sceptical on the applicability due to the inherent differences between social enterprises and for-profit organizations and suggests for more research to be conducted on the new social enterprise organizational form (Zeyen et al., 2013).

The call for more research on modifying existing entrepreneurship theories such as resource-based view for social enterprises may be justified since the differences can be observed from the literature. For example, Muñoz and Kimmitt (2019) found that the social mission of social enterprises can be a source of competitive advantage for the firms. In another example, Proximity Designs, a non-profit social enterprise managed to significantly reduced R&D costs by recruiting low-cost, highly motivated design fellows and interns as a result of their organizational form (Osberg & Martin, 2015). These examples indicate that resource acquisition may be different in social enterprises due to their social inclination. A survey of social entrepreneurs and impact investors shows that the lack of early-stage capital was revealed as a top challenge to the industry's growth (GIIN, 2016). Although access to early-stage capital is likely to be desirable in all venture forms, the issue is much more pronounced among social enterprises since the relatively limited profit is less attractive to traditional funders.

The legal structure of a social enterprise has been shown to affect the range and types of partnerships available to the organizations (Haigh, Kennedy, et al., 2015). This causes some social enterprises to alter their structure from for-profit to non-profit and vice versa to maximize opportunities for partnerships (ibid.). The change need not occur in the legal form and could be

13 Ashoka (https://www.ashoka.org/).

as a change in impression. Social enterprises have been labelled by some as multi-faceted organizations which can present a different impression to different stakeholders (Teasdale, 2010). This seemingly 'fluid' nature is interesting as it presents opportunity for new research to understand the conditions that facilitate this shift in social enterprise structure.

2.3.3 Technology-based social enterprises

There is limited research that investigates specifically on TSEs. Desa (2012) is one of the earliest works that specifically focus on "technology social ventures" (TSV). Desa used a combination of in-depth case study method and quantitative regression models to investigate resource mobilizations by TSVs. The case studies were selected from projects that were under incubation in a "US-based social tech incubator", Benetech Labs. The results were subsequently tested against a larger database of TSV from the Technology Museum of Innovation in San Jose, California (Desa, 2012).

More recently, other scholars have also begun to publish research on TSEs. Arena et al. (2018) published their work on how "social tech start-ups" may be able to access different financial instruments at different stages of the organization's inception. There is little published research on technology development by social enterprises. However, scholars have noted the interest and potential for research in a related area of research, technology innovation by social enterprises (Short et al., 2009).

2.3.4 Growth of social enterprises

The growth literature reviewed earlier is based on commercial businesses. Literature focusing specifically on growth of social enterprises is much more limited – which is unsurprising considering social enterprises as a distinct phenomenon, only emerged relatively recently in the literature. There are a few published works on growth of social enterprises that will reviewed briefly (Hynes, 2009; Katre & Salipante, 2012; Lyon & Fernandez, 2012; Steiner & Teasdale, 2016; Vickers & Lyon, 2014).

The literature reviewed predominantly used a qualitative approach to research growth of social enterprises with a focus on strategies and factors affecting growth. Hynes (2009) found that there is a tendency for social enterprises to prioritize non-financial measures over financial measures when evaluating growth. This is consistent with the findings of Austin et al. (2006) which found that social entrepreneurs in their study relied on subjective ad hoc measures determined by their stakeholders rather than common financial measures to evaluate success of their business. The adoption of subjective non-financial measures is likely due to two reasons: (1) the social mission of a social enterprise; (2) lack of a common framework for evaluating social benefits.

A key distinguishing feature of social enterprises over commercial enterprises is the prioritization of social benefits over financial benefits. Social entrepreneurs typically start social enterprises to make a difference in the sector that they are involved in (Yitshaki & Kropp, 2016). The business component is usually to ensure financial sustainability of the enterprise. However, it can be argued that some social enterprises may choose to prioritize financial sustainability purely to ensure that it can compete and survive in the market, and not rely on charitable grants and donations. The thin line between social and commercial objectives is a source of confusion for practitioners and researchers to distinguish between social enterprises and commercial enterprises (will be discussed in a later section in this chapter) (Doherty et al., 2014). The relative operational priority given to social and commercial objectives may vary among social enterprises, but the main point is the existence of both financial and non-financial components. A social enterprise which only focuses on financial objectives and not social objectives would likely not be considered as one by stakeholders.

The lack of a common framework for evaluating social benefits is another reason for social enterprises to adopt subjective ad hoc measures. Tuan (2008, p. 19) in a report commissioned by Bill and Melinda Gates Foundation on evaluating social impact, states that:

> *"Even the very best methodology cannot compensate for the lack of common measures, as each intervention is measuring its results differently."*

There are attempts such as the Global Impact Investing Network framework (GIIN)[14] and the Social Return of Investment (SROI)[15]. These frameworks may be useful for some practitioners but there is still a level of subjectivity associated with the difficulties of measuring intangible social benefits (Arvidson et al., 2013). Therefore, there are no consensus among practitioners and researchers on using the frameworks. Organizations adopt the frameworks based on their specific needs. For example, New Philanthropy Capital stated in a publication that the "the most common reason for charities to undertake an SROI is to attract funding" (NPC, 2010).

2.3.5 Summary and conclusion

There are two dominant streams of research on social enterprises: (1) defining social enterprises; (2) social enterprise business model. There is a lack of consensus on defining social enterprises in the literature (Austin et al., 2006; Choi & Majumdar, 2014; Mair & Martí, 2006; Teasdale, 2012). DTI's (2002) definition of social enterprises is adopted for the thesis after reviewing the definitional discourse. Social enterprise business models are of interest for further research since conventional theories developed from for-profits may not be applicable to social enterprises (Bocken et al., 2014; Santos et al., 2015; Wilson & Post, 2013; Yunus et al., 2012). Scholars have called for further research to be conducted on understand the hybrid nature of social enterprises since the specifics on how hybrid activity occur in social enterprises (e.g., the operationalizing of dual components) are not clearly understood (Wilson & Post, 2013; Zeyen et al., 2013). The research on TSEs is comparatively more limited.

However, recent studies (e.g., Arena et al., 2018; Desa, 2012; Short et al., 2009) indicate that this domain is an emerging area for further research. The review on growth of social enterprises also revealed that subjective non-financial measures are typically used to measure growth (Austin et al., 2006) due to the prioritization of the social mission and a lack of a common framework for evaluating social benefits. In conclusion, the extant literature on social entrepreneurship revealed that the extant literature does not adequately provide answers to how TSEs grow. The hybrid nature of TSEs with a prioritization on social (i.e., non-financial) objectives comes in contrast

14 Global Impact Investing Network framework (https://thegiin.org/research/publication/impact-investing-a-framework-for-decision-making).
15 Social Return on Investment Guide was originally written by the UK Cabinet Office in 2009 (http://www.socialvalueuk.org/resource/a-guide-to-social-return-on-investment-2012/).

with the nature of commercial technology-based enterprises (reviewed in the last section) which are typically focused on profit and value maximisation objectives. This calls for further research on the topic.

2.4 Management and structure of non-profits

Since social enterprises encompasses a range of organizational forms (i.e., for-profit and non-profit), social enterprises may experience benefits enjoyed by non-profits. Therefore, the literature on the management and structure of non-profits is reviewed below.

There are indications that the non-profit sector has experienced substantial growth over various measured time periods. For example, the rate of non-profits formation between 1987 to 1997 exceeded the rate of new business formation (Austin et al., 2006). Due to changes in government policies, non-profits organizations are increasingly becoming "business-like" (Maier et al., 2014). The scope of literature reviewed covers the following topics: (1) organizational structure of non-profits; (2) volunteer management; and (3) role of technology in non-profits.

2.4.1 Organizational structure of non-profits

Weisbrod (1998) has outlined the key differences between non-profits and for-profits in terms of the organizational structure and the constraints that they face. Some legal structure of non-profits (such as the 501c3 in the US or charity structure in the UK) have a "non-distribution constraint" (Hansmann, 1980) which is essentially a legal restriction on managerial compensation. The constraint was primarily put in place to prevent private inurement and abuse of the status since non-profits status usually brings considerable tax exemption benefits (Arnsberger et al., 2008). However, the constraint also causes challenges for non-profits to offer competitive pay compensation and professional development opportunities when compared to their commercial counterparts (Landles-Cobb et al., 2015). This disadvantage of non-profits is offset by having a different consumer profile from those of for-profits. Consumers of non-profits goods have been found to be willing to pay a higher price for goods and services for a social cause (Weisbrod, 1998). This behaviour of consumers causes some non-profits organizations to engage in "cross-subsidization" as a common business model strategy (James, 1983). Cross-subsidization by non-

profits is the practice of taking on profit-making activities to cover the deficit incurred in other activities (these are typically activities related to the social mission of the non-profit) (ibid.).

Research shows how some non-profits have changed their legal structure in order to maximize opportunities to form new partnerships (Haigh, Kennedy, et al., 2015). Some non-profits have even adopted a dual structure (i.e., part for-profit, part non-profit) for the organization to improve their commercialization potential and deliver greater social impact. An example of such an organization is Embrace Global, a technology-based non-profit 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). Chen (2013) stated that the fundamental difference between adopting a non-profit or for-profit legal structure is the sources of capital which are available to the organization. However, there are insufficient empirical studies on technology-based non-profits adopting dual structures to draw any generalisable conclusions from this observed phenomenon.

2.4.2 Volunteer management

There is a growing body of volunteer management research within the non-profits management literature because volunteers are generally considered to be a specific resource that non-profits can access (Studer, 2016). The UN estimated in 2017 that the value of volunteer work globally is at USD 1.348 trillion or 2.4% of the entire global economy[16]. A brief discourse on the definition of volunteers, based on Overgaard (2019), is presented below before reviewing the management aspects of volunteers.

Volunteers are often simply defined as people who conduct the act of "volunteering" (Overgaard, 2019). An often-cited definition of "volunteering" by Wilson (2000, p. 215) is as follows:

> *"Volunteering means any activity in which time is given freely to benefit another person, group, or organization."*

16 UN Volunteers statistics (https://www.unv.org/swvr/volunteers-count-their-work-deserves-be-counted).

Wilson (2000, p. 233) has warned that this rather generic definition of "volunteering" can be problematic as it "embraces a vast array of quite disparate activities." Nevertheless, many scholars have largely ignored this warning and have treated "volunteering" as the organizing theme to study its object as opposed to focusing on a specific form of work (Overgaard, 2019, p. 130). As a result, all forms of volunteering are lumped together even though the nature of the work is vastly different (ibid.). Overgaard (2019, p. 130) stated as an example that it is not immediately obvious that volunteering in the domain of care work, soccer coaching, firefighting, conservation work, union activism, have much in common. In fact, some of these domains can have very different characteristics, e.g., care work is a highly regulated domain as opposed to soccer coaching. Overgaard (2019) subsequently proposed a conceptual rethinking of volunteering as a form of unpaid work under formal and informal capacity (an example in care work domain is illustrated in **Table 2.2**).

Table 2.2. Example of care work categorized using Overgaard's (2019) framework.

Forms of work	Formal	Informal
Paid	e.g., paid care assistant	e.g., occasional paid babysitting of younger siblings
Unpaid	e.g., unpaid care assistant working in a hospice every Monday	e.g., unpaid care for sick or elderly neighbour or relative

Essentially, this conceptual rethinking calls for greater scrutiny in the research of volunteers, especially via clarity of defining the volunteering context. This also suggests that studying volunteering as a form of unpaid work and comparing it against its paid work counterpart, under specific work domains, is an avenue for further research.

In the context of non-profits that are producing goods and services, effective management of volunteers can reduce the average unit cost of labour and allow the non-profit(s) to offer products and services below market rate (Menchik & Weisbrod, 1987). While the impact of volunteers on non-profits is generally positive, volunteers may also have an adverse effect on non-profits as they introduce an overhead into managing the process (ibid.).

Volunteer management can be viewed from two perspectives, from the perspective of the organization intending to access volunteers as a resource, and from the perspective of the volunteers themselves. From the perspective of organizations intending to access volunteers, volunteer management research is mainly focused on recruitment and retainment of volunteers (Studer, 2016). From the perspective of volunteers, research has mainly been focused on the

motivations of volunteers. One seminal work with this regard is Clary's "Volunteer Functions Inventory" which describes a framework on volunteer motivations (Clary et al., 1992).

Within those two perspectives, management of volunteers can be further categorized into duration of engagement and capability requirements. Duration of engagement refer to whether volunteers are engaged on an ongoing, long-term basis (e.g., registered and processed via volunteer organizations such as the Red Cross) or sudden, short-term basis (e.g., volunteers that turn up in response to sudden disaster relief). Volunteers on a sudden short-term basis have been labelled by scholars as "spontaneous volunteers" (Paciarotti et al., 2018). Drawing from the literature on volunteers in emergencies and disaster reliefs, "spontaneous volunteers" have been characterized as volunteers who "seek to contribute on impulse and offer assistance following a disaster but are not previously affiliated with recognised volunteer agencies and may or may not have relevant training, skills, or experience" (Paciarotti et al., 2018, p. 261). "Convergence"[17] is a terminology that is also associated with spontaneous volunteers in the disaster relief domain, it refers to the mass convergence of people towards a disaster site (der Heide, 2003; Fernandez et al., 2006). Despite the well-intention of volunteers, when the sudden convergence of people is not properly managed, it has been reported to cause more problems than support to official responders (e.g., causing traffic jams or phone line congestions) (Fritz & Mathewson, 1956; Paciarotti et al., 2018). As such, scholars have proposed management strategies to deal with spontaneous volunteers specifically in the domain of disaster relief (Fernandez et al., 2006; Paciarotti et al., 2018).

In addition to duration of engagement, another dimension of volunteers is the capability requirement. Using an example of volunteering at a soup kitchen, capability requirement refers to volunteers that do not require specific skills or capabilities (e.g., serving soups) or volunteers that do require specific skills or capabilities (e.g., cooking and preparation of soup for a large number of people). Most research conducted in the domain of volunteer management are based on the former category of volunteers (no capabilities required) (e.g., Locke et al., 2003; Studer, 2016; Waikayi et al., 2012). The latter category of volunteers (capabilities required) has been labelled by scholars as "skills-based volunteer" and has only been recently identified as a distinct form of volunteers (Letts & Holly, 2017; Steimel, 2018). Skills-based volunteering has been defined as

17 A classic description of the phenomenon was first published in a report by the National Academy of Sciences in 1956 (Fritz & Mathewson, 1956).

"the practice of using work-related knowledge and expertise in a volunteer opportunity" (Corporation for National and Community Service cited in Steimel (2018)). As skills-based volunteers has only recently been distinguished as a distinct class of volunteers, scholars have called for more research to be conducted on understanding the management of such volunteers (Letts & Holly, 2017; Steimel, 2018).

In the context of technology development, there are some literature on volunteer management in the domain of Free and Open-source Software (FOSS) (Lerner & Tirole, 2002; von Krogh & von Hippel, 2003, 2006) and more recently Free and Open-Source Hardware (FOSH) (Hausberg & Spaeth, 2020). Parallels can be observed with volunteering in non-technology domains such as from the perspective of organizations engaging open-source contributors (e.g., West & Gallagher, 2006), or from the perspective of open-source volunteers[18] (e.g., motivations to contribute) (Hars & Ou, 2002; Hausberg & Spaeth, 2020; Lakhani & Wolf, 2005; Lerner & Tirole, 2002).

Open-source volunteers are viewed as contributing to "public good" (Lerner & Tirole, 2002). The context of "good" here is that open-source products is a publicly available good for the masses, as opposed to "good" in the philanthropic betterment of society (i.e., public). Although there may be overlaps (e.g., well-known technology non-profits such as Mozilla Foundation[19] and Wikimedia Foundation[20] have developed technologies using open-source volunteers for the "good" of society), the literature on open-source volunteers (whether FOSS or FOSH) are generally distinct from the literature on volunteers in the traditional non-profit domain. For example, FOSS and FOSH literature are generally more focused on technology-based enterprises and innovation activities (Lerner & Tirole, 2002; von Krogh & von Hippel, 2003, 2006). This revealed a gap in knowledge on the characteristics and management of volunteers in the context of technology-based non-profits (as part of TSEs, the main subject of interest in this thesis) that are more closely aligned with traditional non-profits.

18 Also commonly labelled as "open-source contributors".
19 Mozilla Foundation (https://foundation.mozilla.org/en/).
20 Wikimedia Foundation (https://wikimediafoundation.org/).

2.4.3 Role of technology in non-profits

The literature on the intersection between technology and traditional non-profits is very limited. Most research focuses on the adoption of off-the-shelf technology by non-profits such as Customer Relationship Management (CRM) tools or social media by non-profits to further the objectives of the non-profits (e.g. Curtis et al., 2010; McNutt et al., 2018; Miranda et al., 2016). Apart from non-profits in the context of FOSS and FOSH (discussed in the last section), the literature on technology development (in the sense of resource-intensive activities of technology-based enterprises described in Section 2.2, as opposed to resource-light activities such as website development) by traditional non-profits are almost non-existent.

2.4.4 Summary and conclusion

The review revealed that the organizational structure adopted by non-profits have shown to have an impact on various operational aspects such as regulatory constraints (Hansmann, 1980), tax exemption benefits (Arnsberger et al., 2008), or consumer behaviour (Weisbrod, 1998). This led some non-profits to adopt different organizational structures (e.g., cross-subsidization via dual structures) to maximise available opportunities (Chen, 2013; Haigh, Kennedy, et al., 2015; James, 1983). The review also revealed that volunteers – a specific resource that are available to non-profits – have been largely lumped together in the literature on volunteer management (Overgaard, 2019). This suggests that studying volunteers as a form of unpaid labour and comparing it against its paid work counterpart, under specific work domains, is an avenue for further research. Lastly, the review also revealed a gap in knowledge on characteristics of skills-based volunteers (and the organizations intending to access them) in the domain of technology development and non-profits.

2.5 Legitimacy

Legitimacy plays an important role in the acquisition of resources by organizations (Zimmerman & Zeitz, 2002). However, as legitimacy is intangible in nature, scholars have proposed various theoretical perspectives on the concept of legitimacy. Those various perspectives of legitimacy by scholars (Scott, 1995; Suchman, 1995; Suddaby et al., 2017; Überbacher, 2014) will be reviewed in

the following section, with a focus on perspectives which are most relevant for this thesis (e.g., legitimacy-as-property perspective). Subsequently, the literature on legitimacy in the context of new ventures will be reviewed to identify a suitable conceptual framework for legitimacy which be used for this research.

2.5.1 Legitimacy perspectives

The concept of legitimacy has been described to be at the core of an intellectual transformation which viewed organizations as having boundaries that are porous and problematic as opposed to tightly bounded entities separated from its environment (Suchman, 1995). More specifically, legitimacy is used to conceptualize normative and cognitive forces that affect the actions of organizational actors in an environment such as exchange of resources (Zimmerman & Zeitz, 2002).

As the subject of extensive research in organization studies over the past few decades, the concept of legitimacy has generated many different perspectives. In a seminal paper to consolidate conceptualizations in literature, Suchman (1995, p. 574) defined legitimacy as:

> *"a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions."*

This definition implies that legitimacy is socially constructed within the psyches of social actors and is possessed objectively. Since then, there has been many more attempts to refine construct clarity of legitimacy to enable better discourse on the topic (Deephouse et al., 2017; Suddaby et al., 2017; Überbacher, 2014).

Suchman (1995) stated that literature on legitimacy up until his seminal paper was largely divided between two perspectives – strategic or institutional. The strategic perspective (Dowling & Pfeffer, 1975; Pfeffer & Salancik, 1978) adopts a managerial perspective to legitimacy and focuses on how organizations can manipulate their actions and deploy evocative symbols to gain societal support. In contrast, the institutional perspective (DiMaggio & Powell, 1983; Meyer & Rowan, 1977) views legitimacy as being driven by sector-wide structuration dynamics which is beyond any organization's purposive control.

Überbacher (2014) subsequently extends the perspectives to five in his review of the literature, viz. impression management, institutional, cultural entrepreneurship, ecological, social movement. While he does not mention the strategic perspective explicitly, the three perspectives – impression management, cultural entrepreneurship, and social movement – clearly stems from the strategic perspective as they are actor centred and regard the organization (new ventures seeking legitimacy) as controlling the legitimation process. The other two perspectives, institutional and ecological are more audience centred and view the organization as having very little influence over the legitimation process.

Suddaby et al. (2017) provided yet another perspective on legitimacy research, grouping prior studies into three distinct configurations of how they view legitimacy – legitimacy-as-property, legitimacy-as-process, legitimacy-as-perception. Legitimacy-as-property which is also the dominant view in legitimacy research, views legitimacy as an intangible asset or resource (Dowling & Pfeffer, 1975; Suchman, 1995; Zimmerman & Zeitz, 2002) that can be possessed or acquired in some measurable quantity. In this view, legitimacy is seen to occur between the organization (which is seeking legitimacy) and its environment. Legitimacy-as-process on the other hand views legitimacy as an ongoing communicative process rather than being comprised of essential properties. Legitimacy-as-perception explores the perceptual and subjective components of legitimacy, focusing on the role of the individual in the social construction of legitimacy. These studies build on findings from related disciplines such as cognitive psychology (Bandura, 1986; Sherif & Hovland, 1961) and microsociology (Berger et al., 1998). Under this perspective, legitimacy "resides in the eye of the beholder" (Ashforth & Gibbs, 1990, p. 177) and research typically adopts a constructivist approach.

The many different perspectives of legitimacy by various scholars are not necessarily incompatible with one another and in fact share overlaps. For example, three out of five perspectives espoused by Überbacher (2014) can be viewed as an extension to the strategic perspective mentioned by Suchman (1995). In the conceptualization by Suddaby et al. (2017), Suchman's (1995) perspective is viewed as a subset of one of his perspectives (i.e. legitimacy-as-property). It is important to note that within the legitimacy literature reviewed above, various typologies of legitimacy have been proposed. These typologies may vary according to the legitimacy perspective subscribed. An all-encompassing review and discussion of typologies within all perspectives of legitimacy is not necessary as the scope of the thesis is already constrained by a chosen perspective. The specific typologies of legitimacy adopted within this

thesis will be described and discussed after a brief explanation is provided on the selection process of the legitimacy perspective and its implications.

The adoption of a legitimacy perspective is influenced by the epistemological position of the researcher and the research domain of interest. A researcher with a positivist-leaning position will be more inclined to view legitimacy as something that can be objectively measured or identified. In addition, research situated within the business and management domain will gravitate towards a legitimacy perspective that may reveal actionable managerial findings. Therefore, this thesis predominantly adopts the perspective of legitimacy-as-property by Suddaby et al. (2017) because it is consistent with the resource-based view of the firm adopted in earlier parts of the thesis in which resources contribute to the survival and growth of the firm. As described earlier, the legitimacy-as-property perspective essentially views legitimacy as an intangible resource that can be acquired (Suchman, 1995; Suddaby et al., 2017; Zimmerman & Zeitz, 2002). Both the legitimacy-as-property perspective and resource-based view are situated comfortably within the same broader strategic management perspective of the firm under the business and management research domain.

The main implications of choosing one legitimacy perspective over another are the conclusions that could be drawn on the construct as well as the methods in which it is operationalized. To the best of the researcher's knowledge, all prior works reviewed (irrespective of perspective) conceptualized legitimacy as being not directly observable. However, the question of whether legitimacy can be measured by proxy to a certain degree is dependent on the adopted perspective. The legitimacy-as-property perspective views legitimacy as "a thing" (Suddaby et al., 2017) that can be measured by proxy. The choice of proxy measures to operationalize measurement of legitimacy depends on the typology of legitimacy and the specific context of interest (Zimmerman & Zeitz, 2002).

The typology of legitimacy perhaps can be best described as being synonymous with the source of legitimacy from which an organization draws (when viewed in the legitimacy-as-property perspective). Suchman's (1995) typology is one of the most influential and widely cited work on legitimacy. He proposed three broad categories of legitimacy – pragmatic, moral, and cognitive. Pragmatic legitimacy refers to an organization's capacity to achieve practical outcomes in its immediate environment. Cognitive legitimacy refers to a degree of congruence between the normative expectations of the organization and its environment at such a high level that it is

unquestioned or "taken-for-granted" (Suchman, 1995). Moral legitimacy refers to the degree of congruence between a focal firm's behaviours and characteristics and the normative expectations in the cultural meaning system of the other organizations that surround it.

Scott (1995) in another influential work, proposed three categories of legitimacy – cognitive, regulative, and normative. When compared to Suchman's (1995) typology, cognitive legitimacy maps quite closely to the same term, while normative legitimacy maps quite closely to moral legitimacy. Regulative legitimacy refers to the extent in which an organization complies with "explicit regulative processes – rule setting, monitoring and sanctioning activities" (Scott, 1995, p. 42). Zimmerman and Zeitz (2002) proposed the industry as a source of legitimacy, explaining that it refers to the degree of acceptance of a particular industry stemming from the collective action of industry members. A summary of the sources of legitimacy is provided in **Table 2.3**.

Table 2.3. Sources of legitimacy.

Source	Definition
Pragmatic legitimacy	Refers to an organization's capacity to achieve practical outcomes in its immediate environment (Suchman, 1995)
Sociopolitical regulatory legitimacy	Refers to the extent in which an organization complies with "explicit regulative processes—rule setting, monitoring and sanctioning activities" (Scott, 1995, p. 42)
Sociopolitical normative legitimacy	"Refers to the degree of congruence between a focal firm's behaviours and characteristics and the normative expectations in the cultural meaning system of the other organizations that surround it" (Suddaby et al., 2017)
Cognitive legitimacy	An extension of sociopolitical normative legitimacy where the degree of congruence between the normative expectations of the organization and its environment is at such a high level that it is unquestioned or 'taken-for-granted' (Suchman, 1995)
Industry	Refers to the degree of acceptance of a particular industry stemming from the collective action of industry members (Zimmerman & Zeitz, 2002)

There are some common approaches for measuring legitimacy based upon the sources mentioned above – population ecology, media accounts, regulator's authorization (Suddaby et al., 2017). The population ecology approach (Hannan & Carroll, 1992; Hannan & Freeman, 1977) counts organizations adopting an organizational form or practice that are assumed to possess legitimacy. The proxy measure termed population density assumes that the more legitimate an organizational form or practice, the higher the frequency of appearance of the form or practice in the population. Another approach to measuring legitimacy is based on media accounts, counting the frequency of conversation about an organizational form or practice that appears in the media. The media content is most analysed using content analytic techniques (Deephouse, 1996;

Deephouse & Carter, 2005; Ruef & Scott, 1998). Another approach to measuring legitimacy is observing if a firm has obtained regulator's authorization. Having received authorization is an important cue for legitimacy (Tost, 2011). Other methods that have been used to measure legitimacy include surveys (Foreman & Whetten, 2002; Glynn & Abzug, 2002; Kennedy & Fiss, 2009) and semi-structured interviews (Elsbach & Sutton, 1992; Human & Provan, 2000; Low & Johnston, 2008; Rutherford & Buller, 2007).

Another dimension on legitimacy worth noting is the fact that some scholars conceptualize legitimacy as being dichotomous (Deephouse & Suchman, 2008) where an organization either have or does not have legitimacy, or on a continuum (Dowling & Pfeffer, 1975) where an organization can have more or less legitimacy compared to other organizations. The central argument in conceptualizing legitimacy as dichotomous is a distinction between legitimacy and the concepts of status (Washington & Zajac, 2005, p. 284) and reputation (Washington & Zajac, 2005, p. 284). In the model proposed by Deephouse and Suchman (2008), organizations that receive resources from stakeholder are grouped in various classes and ranking orders. Organizations are in either legitimate or illegitimate classes and within it, ranked according to its status and reputation to determine the preference in receiving resources from stakeholders. This thesis adopts the view of legitimacy as being on a continuum. This is predominantly because empirically, the boundaries between status, reputation, and legitimacy may not be easily distinguishable to resource providers.

Deephouse and Suchman (2008) recommended that researchers should "attend more closely to the workings of various sources of legitimacy" as the sources and subjects of legitimacy are situated within a complex network of social influence and communication. They provided an example of how certain sources of legitimacy such as regulatory approval of a new pharmaceutical may have greater impact compared to other sources such as publication of a non-refereed study funded by the drug's developer. Similarly, Überbacher (2014) stated that in earlier legitimacy studies, audiences that grant legitimacy are 'theoretically and empirically collapsed into the aggregate concept of "organizational environment"'. He recommended future research to look at how different types of audiences (consumers, investors, etc.) make legitimacy judgements and resource allocation decisions. This implies that the impact of various sources of legitimacy towards a firm's resource acquisition efforts may differ and would be worthwhile investigating. Understanding the impact of a source of legitimacy would have managerial implications for the

firm since it would be able to strategize and prioritize attainment of a particular source of legitimacy.

Suchman (1995) in his recommendation on further legitimacy research stated that little is known on how legitimacy differs under different empirical context (e.g., from public and private organizations, from new to old sectors, at various points of the organization's lifecycle) and would be of interest to explore. Subsequent researchers have since taken up this recommendation and explored the concept of legitimacy under different empirical context. For example, legitimacy has been researched in the context of multinational enterprise (Kostova & Zaheer, 1999), new ventures (Zimmerman & Zeitz, 2002), voluntary services (Singh et al., 1986), high-tech ventures (Deeds et al., 2004).

In the context of TSEs, legitimacy research is sparse since it is an emerging phenomenon. Consistent with the overarching research question of the thesis (understanding growth and survivability of technology-based social ventures), the scope of review would be further confined to articles exploring legitimacy in the context of new ventures.

2.5.2 Legitimacy in context of new ventures

The attainment of legitimacy as a resource by a new venture facilitates gaining other essential resources such as "capital, technology, personnel, customer goodwill, and networks" (Zimmerman & Zeitz, 2002). This resource is especially important in the early stages of the organization's lifecycle as it is required to overcome the "liability of newness" (Stinchcombe, 1965) to achieve survivability and growth (Singh et al., 1986; Zimmerman & Zeitz, 2002).

Deeds et al. (2004) have studied the influence of legitimacy on resource flows in the high-tech sector, concluding that "sociopolitical and cognitive legitimacy at both the firm and industry levels have significant impact on a biotechnology venture's access to resources". They operationalized legitimacy by considering the background of the founders and management team (firm's sociopolitical legitimacy), the amount of press coverage received by a biotech venture (firm's cognitive legitimacy), the number of biotech centres available in the US and drugs approved (industry's sociopolitical legitimacy), total number of biotech firms in existence and the amount of press coverage received by the biotech industry (industries' cognitive legitimacy).

Legitimacy research situated within the strategic management perspective naturally implies that there are actionable strategies for a firm to gain legitimacy. Scholars have used different terminologies to refer to these strategies such as "strategic legitimation" (Zimmerman & Zeitz, 2002), "legitimation strategies" (Suchman, 1995), "legitimation mechanisms" (Fisher et al., 2017).

One way to conceptualize these different strategies is to view it in two levels. At the higher level (**Table 2.4**), legitimation strategies (Suchman, 1995; Zimmerman & Zeitz, 2002) revolves around the rules and norms in the industry or environment which a firm seeking legitimacy operates. At this level, firms can strategize to attain legitimacy by either conforming to existing rules and norms in an industry (conformance), selecting a different industry with different rules and norms (selection), changing existing rules and norms to their advantage (manipulation), or creating new rules and norms (creation). The rules and norms in question can also be viewed as institutional logics. This is because institutional logics are defined as "socially constructed, historical patterns of material practices, assumptions, values, belief, and rules by which individuals produce and reproduce their material subsistence, organize time and space, and provide meaning to their social reality" (Thornton & Ocasio, 1999, p. 804).

Table 2.4. Legitimation strategies (Suchman, 1995; Zimmerman & Zeitz, 2002).

Strategic legitimation	Description
Conformance	Complying to accepted rules and norms in the industry which the firm operates
Selection	Selecting the environment of the firm to compete in
Manipulation	Altering the accepted rules and norms
Creation	Creating new rules and norms

Within a selected institutional logic (or rules and norms of an industry or environment), the subsequent level of legitimation strategies involves the specifics of how the firm can take actions to gain legitimacy. Fisher et al. (2017) labelled legitimation strategies on this level as 'legitimation mechanisms' and grouped various strategies described in the extant literature into three categories – identity mechanisms, associative mechanisms, organizational mechanisms. Identity mechanisms revolve around the use of cultural tools and identity claims such as images, symbols, and language to gain legitimacy. Associative mechanism revolves around the relationships and connections forged by the firm to gain and manage legitimacy. Organizational mechanism revolves around the attributes of the firm such as structure or organizational achievement and success to gain legitimacy. Within those broad categorizations, there are further narrow categorizations drawn from relevant extant literature as shown in **Table 2.5**.

Table 2.5. Legitimation mechanisms (Fisher et al., 2017).

Legitimacy mechanisms	Narrow categorizations
Identity	Storytelling; sensegiving; impression management; analogies and arguments; cultural agency; collective framing; symbolic actions
Associative	Organizational ties; top management ties; individual ties
Organizational	Internal milestones or structures; leaders background; external validation
Other	Factors beyond the control of the venture e.g., population density, country characteristics, population homogeneity, industry subsidies etc.

A key contribution of Fisher et al. (2017) is their exploration of the relationship between a firm's legitimacy and their audiences with different institutional logics in resource provisions. They proposed a new venture legitimation framework which categorizes resource providers of new technology-based ventures according to different institutional logics (i.e., community logic, state logic, market logic, professional logic, corporate logic) and relates them to different legitimacy mechanisms. These categorizations of institutional logics are an extension to the categorization by Pahnke et al. (2015) in the context of technology-based ventures.

The framework by Fisher et al. (2017) is useful in consolidating the different theories that have been associated with how new ventures may enhance and manage legitimacy. As such, Fisher's framework will be used to analyse the data from a legitimacy perspective. However, it is important to note that the analysis will not include Fisher's incorporation of institutional logic theory. This is because the institutional logics of resource providers used in Fisher et al. (2017) may not be applicable to the context of social enterprises as they were originally developed for the context of technology-based ventures.

2.5.3 Summary and conclusion

Various dominant theoretical perspectives on legitimacy that have been proposed by scholars (Scott, 1995; Suchman, 1995; Suddaby et al., 2017; Überbacher, 2014) were reviewed. Many of the various perspectives were found to share overlaps and were compatible with one another. The legitimacy-as-property perspective by Suddaby et al. (2017), which views legitimacy as an intangible resource that can be acquired, was adopted as the theoretical perspective for this thesis due to its compatibility with the resource-based view. The review also revealed that the research on legitimacy in the specific context of TSEs is an avenue for further research as scholars have previously explored legitimacy under different empirical context (Deeds et al., 2004; Kostova & Zaheer, 1999; Singh et al., 1986; Suchman, 1995; Zimmerman & Zeitz, 2002). Lastly, the

conceptual framework by Fisher et al. (2017) has been identified as a useful framework to analyse legitimacy of TSEs.

2.6 Summary and research gap

The review was undertaken to shed light on existing knowledge to answer the research question of *"how do technology-based social enterprises acquire and manage resources to grow the venture, and develop their technologies?"*. After reviewing five main domains of literature: (1) growth of firm; (2) technology entrepreneurship; (3) social entrepreneurship; (4) management and structure of non-profits; and (5) legitimacy, it is revealed that in every domain, there is a gap in existing knowledge to adequately explain the phenomenon of TSEs.

The review on growth of firm literature revealed a promising theoretical foundation to base the inquiry of the research question – through resource-based view and growth process of firms. The review on technology entrepreneurship revealed that existing studies have predominantly focused on mature corporations that are endowed with resources. While the literature focusing on the resource-limited context of technology-based start-ups are growing, this still does not adequately explain the context of TSEs which may be even more constrained in resources (Desa, 2012). The review on social entrepreneurship revealed that the hybrid nature of social enterprises warrants further research. The review also suggests that there is a lack of common framework to evaluate social benefits which fits different types of social enterprises (Tuan, 2008). As such, is common for social enterprises to resort to adopting subjective ad hoc measures to evaluate social benefits generated by their organizations. The review on management and structure of non-profits revealed that non-profits have been known to change their organizational structures to maximise available opportunities (Chen, 2013; Haigh, Kennedy, et al., 2015; James, 1983). The organizational scope of TSEs provides a suitable context to investigate the effects and opportunities to the organization. In addition, the review also revealed that there is a gap in knowledge on the use of volunteers in a technology development context. The extent of using volunteers as a resource by TSEs for the purpose of technology development is currently unclear. Lastly, the review on legitimacy revealed that the context of TSEs is a suitable avenue for further research on how legitimacy functions under a different empirical context.

The literature of the five domains reviewed in this chapter will used as the theoretical foundation in the design of the conceptual framework in Chapter 3. Some elements reviewed such as the definitions of technology and social enterprises, and evaluation of social measures, will also be used in the same chapter to suitably identify cases.

Chapter 3 Methodology

This chapter explains the approach taken for this empirical research to address the gap identified in the literature review. It begins with a statement of philosophical positioning of the researcher. Subsequently, the research strategy is explained and justifications for the chosen case study research method are provided. The design of the case study and its associated data collection and analysis protocols are described and explained in detail. The chapter ends by addressing issues concerning qualitative rigour.

3.1 Philosophical positioning

Prior to embarking on any research project, it is important to clarify the ontological and epistemological positioning of the researcher. This serves to provide an explanation for the researcher's interpretation of the underlying relationship between data and theory as it may have impact on the study. A brief summary of major philosophical positions is described in the following paragraphs before stating the researcher's own positioning.

Ontology concerns with the nature of reality and existence. There are three main ontological positions along a continuum that are espoused by scholars in the field – viz. realism, relativism, nominalism (Blaikie, 2007; Easterby-Smith et al., 2018). The labels for these three positions may differ from scholar to scholar but the underlying concepts remains largely the same. For example, what some scholars describe as "nominalist position" (or nominalism) (Easterby-Smith et al., 2018) has been described as an "idealist position" (Blaikie, 2007), but these two labels essentially refers to a very similar ontological position that reality is created by humans and does not exist independently of our perceptions. Going further to describe the other major ontological positions, the "relativist position" (or relativism) refers to an ontological position that social concepts are defined by different actors and multiple truths may exist depending on the viewpoint of the observer or as Collins (1983, p. 88) puts it – "what counts for the truth can vary from place to place and time to time". Moving beyond the "relativist position" on the continuum is the "realist position" (or realism) which refers to an ontological position that reality exists

independently of human perceptions (Blaikie, 2007; Burell & Morgan, 1979). These positions are summarized in **Table 3.1**, which has been adapted from Easterby-Smith et al. (2018).

Table 3.1. Contrasting three different ontological positions, adapted from Easterby-Smith et al. (2018).

	Realism	**Relativism**	**Nominalism**
Truth	Single truth	Many "truths"	No truth
Facts	Exists and can be revealed	Depends on viewpoint of observer	Are creations of the human mind

Epistemology concerns with the theory of knowledge and how to inquire the nature of the world. The two main epistemological positions along a continuum are positivism and social constructionism (Easterby-Smith et al., 2018). Similar to ontological positions described above, scholars may use different labels to describe epistemological positions that essentially have similar underlying concepts. For example, a "social constructionist position" (Berger & Luckman, 1966; Easterby-Smith et al., 2018) may also be referred to as an "interpretivist position" by different scholars (Blaikie, 2007), but these labels describe a similar position which focuses on a socially constructed reality. Hence, emphasis is given to making sense of meaning that people give to a situation based on their experiences and views. This contrasts with a "positivist position" (Comte, 1853) which describes a position where the social world exists externally and can be measured objectively. These positions are summarized in **Table 3.2**, which has been adapted from (Easterby-Smith et al., 2018).

Table 3.2. Contrasting two different epistemological positions, adapted from Easterby-Smith et al. (2018).

	Positivism	**Social constructionism**
Researchers	must be independent	is part of what is observed
Human interests	should be irrelevant	are the main drivers of science
Explanations	must demonstrate causality	aim to increase general understanding of the situation
Research progresses through	hypotheses and deductions	gathering rich data from which ideas are induced
Concepts	need to be defined so that they can be measured	should incorporate stakeholder perspectives
Unit of analysis	should be reduced to the simplest terms	may include the complexity of 'whole' situations
Generalization through	statistical probability	theoretical abstraction
Sampling requires	large numbers selected randomly	small numbers of cases chosen for specific reasons

A researcher may adopt any of the above combinations of ontological and epistemological positions. Although given the underlying nature of certain positions, certain ontological positions align better with certain epistemological positions (i.e., realism and positivism, nominalism with social constructionism). Fundamentally, adoption of a philosophical position by the researcher

boils down to the paradigm in which he/she subscribes. The paradigm may be viewed as a set of basic beliefs that must be "accepted simply on faith (however well argued)" (Guba & Lincoln, 1994, p. 107) and cannot be resolved through further reasoning. However, rather than staunchly holding onto philosophical positions as a core belief system, a more pragmatic approach to adoption of philosophical positions would be to take into consideration the topic that is being researched in addition to the researcher's own worldview. This is because not all worldviews are compatible with all topics under research. As an example, Richard Dawkins famously said, "even the most dedicated relativist does not believe, when flying 40,000 feet in a Boeing 747, that the laws of physics that hold the jet in the air are mere constructs of the imagination" (Irwin, 1994 cited by Easterby-Smith et al., 2018, p. 65).

The topic that is being researched in this thesis (i.e., growth of TSEs) exists independently of this research, but the facts and truths are susceptible to some degree of subjective, yet valid interpretations of the actors involved in the study. In addition to that, the study requires that the complexity of the whole situation be taken into consideration (i.e., ecosystem in which TSEs and actors interact) rather than isolating it.

Hence, given the above considerations, the researcher identifies with "relativist" ontological position and weak "social constructionist" epistemological position for this thesis.

3.2 Research strategy and method

Blaikie (2007) listed four major research strategies that are used in social science research – inductive, deductive, retroductive, and abductive – each with its own merits and weaknesses. Given the philosophical positioning of the researcher and the research context, the researcher has decided to adopt an abductive reasoning approach for this research. Since scholars have successfully researched growth of technology enterprises in Cambridge based on conceptual frameworks developed by Garnsey and her colleagues, the researcher has opted to take a similar approach to develop a preliminary conceptual framework from the literature as a theoretical lens. As a result, the preconceptions of the researcher rule out pure inductive grounded theory as laid out by Glaser and Strauss (1999). Deductive and retroductive research strategies are also not appropriate due to their focus on regularities (in contrast to the complex research context of real-world firms). The iterative theory matching process of the abductive research strategy is most

appropriate as it enables the researcher to understand data and literature in a new way and "from the perspective of a new conceptual framework" (Kovács & Spens, 2005, p. 138).

Yin (2014) suggests a few criteria to evaluate suitability of different research methods for a research project – a) type of research question, b) extent of control required over behavioural events, c) degree of focus on contemporary events. These are summarized in **Table 3.3**.

Table 3.3. Contrasting different research methods, adapted from Yin (2014).

Method	Form of Research Question	Requires Control of Behavioral Events	Focuses on Contemporary Events?
Archival analysis	Who, what, where, how many, how much?	No	Yes/No
History	How, why?	No	No
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Case Study	How, why?	No	Yes

In order to determine an appropriate research method for this thesis, we must revisit the research question and key elements of the research context. The main research question that this thesis seeks to investigate is, *"how do technology-based social enterprises acquire and manage resources to grow the venture, and develop their technologies?"*. TSEs are an emerging phenomenon that has only become prevalent in the recent decade which means historical data archives are limited in existence. This fact coupled with a need to focus on contemporary events rules out archival analysis and historical methods. Experimental methods are also inappropriate because the research holds no control or influence over the firms and their decision making.

Hence, we are left with two probable methods to investigate the research question of "how", survey method and case study method, which we will look at in turn. The survey method has been used by scholars to research TSEs (Del Giudice et al., 2019; Desa, 2012). However, a limitation of previous survey-based studies is the lack of a clear and consistent definition of "social enterprise" (and "technology-based social enterprise" by extension) which limits applicability of the findings. Buckingham et al. (2012, p. 83) pointed out that it is "difficult to trace and measure SE [social enterprises] when the object of study is ambiguous and inconstant and the total population unknown". Although it is within the researcher's purview to clearly define "social enterprises" for the purpose of the survey to reduce ambiguity, the recipients of the survey may interpret it differently (as they have an interest to self-identify with the terminology "social enterprises") and thus, affecting the findings. This problem is exacerbated

when the object of study is an even newer subset of social enterprises, i.e., TSEs, which further blurs the line of what is a "technology-based social enterprise". One cause of ambiguity among TSEs is the difficulty in differentiating for-profit TSEs with regular commercial technology-based enterprises (**Figure 4.1**). This differentiation is important and needs to be addressed because incorporation of regular commercial technology-based enterprises into the survey sample may dilute the sample and limit the conclusions that can be drawn on TSEs.

The problem can be addressed if more attributes are taken into consideration when designing the survey. However, as the field is still new, many distinguishing attributes are still unknown, preventing the implementation of a simple inclusion-exclusion criterion into the design of the survey. This is essentially a sampling problem and a limitation of the survey method (Visser et al., 2000). Many existing survey-based studies on social enterprises do not address this sampling problem sufficiently. For example, in the survey conducted by Desa (2012, p. 735) on resource mobilization of technology-based social ventures, the sampling frame consists of "all ventures in the TSV [Technology Social Venture] Database maintained by the Technology Museum of Innovation (TMI) in San Jose, CA". The criteria for inclusion into the TSV Database in the first place is not made clear, therefore rendering the sampling to be one of "haphazard sampling" (Visser et al., 2000) and due to convenience rather than theoretical significance. Of course, this is merely one example meant to illustrate the problem and not to dismiss all survey-based studies on social enterprises. Some scholars have addressed this sampling problem by drawing conclusions after considering and triangulating from different sets of social enterprise definitions used in multiple surveys (Buckingham et al., 2012). This approach of administering surveys with different definitions would not be feasible within the timeframe and budget of the research for this thesis. Therefore, given the considerations, the survey method is not the most appropriate method to develop answers to the research question.

It would seem as though the only method left which fulfils the criteria set out by Yin (2014) is the case study method. However, justifications for the case study method to answer the research questions of this thesis go beyond a simple selection by process of elimination. Firstly, the case study method is very suitable to investigate questions of "how" and also draw causal links and explain "why" this happens (Yin, 2014). The method is able to incorporate the real-world context when assessing cases (which overcomes shortcomings of survey method) and is especially important when the "boundaries between phenomenon and context are not clearly evident" (Yin, 2014, p. 16). This is clearly the case with TSEs. Secondly, no control is needed on behavioural

events as the cases are assessed without interventions from the researcher. Thirdly, the case study method is very suitable to investigate contemporary events that have newly emerged such as TSEs.

3.3 Case study research design

The chosen case study method is not without criticisms. Some common concerns of the case study method are the level of rigour, generalizability of findings, and comparative advantage over other methods (Yin, 2014) – among others. These concerns can be addressed by understanding the strengths and weaknesses of the case study method and by having a proper design. For starters, rigour can be established through a proper design of the case study protocols (as will be described in the following sections). To address concerns of generalizability, it is important to understand that the aim of the case study method is not to generalize statistical results from a small sample to a larger population, but rather to gain an in-depth understanding of a complex phenomenon to draw conclusions in the form of a framework, model, typology, or theory (Gioia et al., 2010; Thorngate, 1976). Comparative advantages of the case study method against other methods have been discussed briefly in the previous section. The research context Given the research context, it is clear that the case study method is the most appropriate to investigate this new phenomenon of TSEs.

The research implements an in-depth multiple-case design with a theoretical replication logic (Yin, 2014). As the main interest is on understanding "growth", firms (TSEs) representing various stages of growth are selected as cases.

Figure 3.1 presents an overview of the following sections which describes the design of the case study and its protocols.

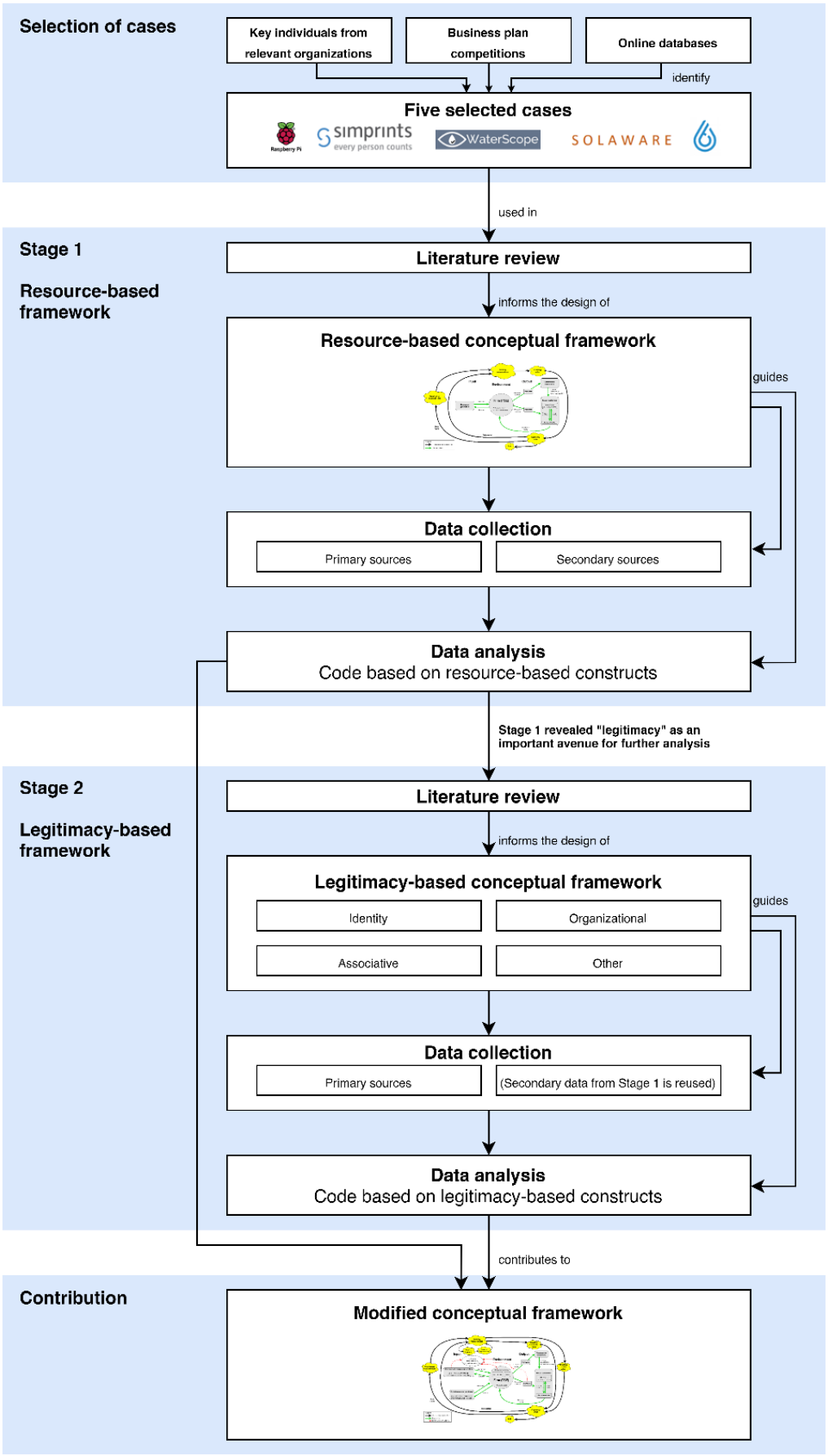


Figure 3.1. Overview of case study design.

3.3.1 Selection of cases

In order to select representative cases for the research, it is very important to first define what constitutes a case (Yin, 2014, p. 31). This definition can be achieved by developing a list of selection criteria to ensure that the cases can inform the "understanding of the nature and form of [a] phenomenon" (Ritchie et al., 2014, p. 116). This section will describe the definitions of the case (and its accompanying justifications), the sources used to identify cases, and the selected cases. The research context in which the selected cases are situated will be elaborated in detail in Section 4.1.

3.3.1.1 Defining growth (of technology-based social enterprises)

A review of the literature on growth in the previous chapter has shown that there are many ways to evaluate growth of a firm. As of the writing of this thesis, no consensus could be found in the literature on specific criteria to evaluate growth of social enterprises.

For the purpose of this thesis, the researcher has decided to adapt the European Commission's (2015, p. 4)[21] guide to defining SME (Small-medium Enterprises) to define the size of the "enterprise" portion of social enterprises. This is because the firms of interests to the research are somewhat comparable in size (according to SME definition) with SMEs. In the guide, the European Commission states that "size" and "accessible resources" of the firm will be used to evaluate SME status. Size refers to "number of employees", "turnover", and "balance sheet total". Accessible resources refer to "ownership", "partnerships", and "linkages". Although further guidance is provided in the guide on the threshold to those criteria to classify SMEs into micro, small, medium-sized categories, these are not used for this research. The specific categories of TSEs are defined by the researcher and described towards the end of this section.

While there are numerous ways to evaluate the "social" portion of social enterprises (see Tuan (2008) for a full review), a problem which persists is the lack of common measures for evaluating social impact in the social sector. Tuan (2008, p. 19) states in her report that "Even the very best methodology cannot compensate for the lack of common measures, as each intervention is measuring its results differently" and draws analogy of comparing apples to oranges when

21 When the research was conducted, the UK was still part of EU with ongoing Brexit negotiations.

evaluating social impact across different social programs (which is applicable to firms as well). As the intent of this thesis is not to have a comprehensive evaluation of social impact growth, the researcher has decided to take a more simplified, but pragmatic approach to defining growth of social impact. The criterion is simply to define social impact by the "social measure" which the firm claims as opposed to having a common measure for all. For example, if a firm seeks to help increase the number of whales in the ocean, the social measure would be "number of whales increased". If the firm seeks to provide access to identification for people in developing countries, then the social measure would be "number of people benefited". The social measure is defined according to the firm if the information is readily available, otherwise the assessment on most appropriate social measure is made by the researcher.

These criteria are summarized in **Table 3.4**. It is important to note that these criteria are not all the criteria to assess the growth of TSEs in the full case study. At this stage, these criteria were merely used to objectively identify or filter appropriate cases at different stages of growth as the information can be obtained either from Company House or the firm's website. As most of the firms of interests are in the early stages of growth, not all information to fulfil the criteria are available, nor is it required as the partially available information may be sufficient to make assessment and would be evaluated on a case-by-case basis. For example, some early-stage TSE may not have benefited people directly yet as they could still be developing or refining their technologies. However, if the same firm shows a noticeable increase in employees or funding, or have secured high profile partnerships with other firms, then it would be considered to have experienced growth and fits the criteria of a case for this thesis.

Table 3.4. Criteria for growth of social enterprises.

Social	**Enterprise**
• Social measure	**Size** • Number of employees • Turnover • Balance sheet total **Accessible Resources** • Ownership • Partnerships • Linkages

3.3.1.2 Defining technology-based social enterprises

The next most important definition is what is meant by "technology-based social enterprise", or in other words, what kind of firms constitutes a case.

All cases must fulfil the following criteria:

1. **Headquartered in Cambridge;**
   Must originate and continue to be predominantly based in Cambridge to maintain a homogeneous ecosystem in which all selected cases operate.

2. **Social mission of the firm aligns with UN Sustainable Development Goals (SDG);**
   It is arguable that all firms are social to an extent and there are no anti-social firms (apart from criminal ones). Therefore, in order to draw a line to distinguish firms with a social mission for this thesis, the UN SDGs are used as a filtering benchmark. The UN SDGs are chosen because it is accepted worldwide[22] as important social goals to achieve. The social mission of selected cases must fall within one of the 17 SDGs (**Appendix 1**).

3. **Self-identify and/or have been identified by others as a social enterprise;**
   As stated in the research context, social enterprise is a concept and not an explicit legal structure. It is not hard to distinguish the enterprise portion as any organizations engaged in business activities would be considered as such, but the social portion is slightly trickier to distinguish (even if they fulfil criterion 2 listed above). Therefore, not-for-profit firms that engage in business activities would be classified as a social enterprise (even if they do not self-identify with the term) but for-profit social enterprises would have to be evaluated on a case-by-case basis. For-profit social enterprises must self-identify with the term "social enterprise" in its external communications (e.g., website, social media, blog posts) and have been identified as a "social enterprise" by other individuals/organizations.

22 It has been ratified by 193 countries of the UN General Assembly on 25 September 2015.

4. **Involved in design and manufacturing of novel products to address social mission.** This criterion is to define the technology-based portion of the selected cases. The selected firm must be involved in the development of a novel product (that does not already exist) to address its social mission. The product development must involve design and manufacturing of a physical product. However, the firms do not need to already be engaged in manufacturing as early-stage firms could still be in the design and prototyping phase. The manufacturing criterion is mainly to distinguish firms which are involved in developing physical hardware as opposed to software-only firms. This is important because software firms are typically less capital intensive and may exhibit a different pattern of growth (Garnsey & Heffernan, 2005).

3.3.1.3 Sources for identifying cases

After the case has been defined, cases were identified from three sources – recommendation by key individuals in relevant organizations, established business competitions in Cambridge, publicly available online databases. A summary of sources used is shown in **Figure 3.2**.

Key individuals from relevant organizations
- Centre for Global Equality (CGE)
- Makespace
- i-Teams
- Cambridge Enterprise
- ideaSpace
- Future Business Centre
- Centre for Acceleration of Social Technology (CAST)
- Bethnal Green Ventures (BGV)

Business plan competitions
- Cambridge University Entrepreneurs (CUE)
- Entrepreneurial Postdocs of Cambridge (EPOC)

Online databases
- Nominet Trust 100 database
- Fast Forward Tech Nonprofit directory

Figure 3.2. Three sources used to identify cases.

The first source used to identify potential cases was asking key individuals involved in social enterprise support activities. The individuals (**Appendix 2**) were interviewed and asked to suggest firms which fit the defined criteria. All except two organizations are based in Cambridge. The two non-Cambridge organizations that were approached, Centre for Acceleration of Social Technology (CAST)[23] and Bethnal Green Ventures (BGV)[24] are based in London. They were consulted to get suggestions for prominent non-Cambridge[25] TSEs to compare against the

23 Centre for Acceleration of Social Technology (https://www.wearecast.org.uk/).
24 Bethnal Green Ventures (https://bethnalgreenventures.com/).
25 London is one of the most established technology clusters in the UK apart from Cambridge.

defined criteria and other selected Cambridge cases. These non-Cambridge consultations were conducted as a simple sanity check (rather than an exhaustive check) to ensure that there were no cases outside of Cambridge that were glaringly more appropriate to provide answers to the research question.

The second source used was identification through business plan competitions run in Cambridge. Although there are many business plan competitions organized in Cambridge, two competitions stood out as obvious choices to look for cases for this research. Cambridge University Entrepreneurs (CUE), a university society that has been running an annual business plan competition for the past 20 years, has had an explicit Social Enterprise category for the past 10 years. Entrepreneurial Postdocs of Cambridge (EPOC), another university society, also runs a similar business plan competition. Although EPOC has only been operating since the past 5 years and does not have an explicit Social Enterprise category, it was selected because it was backed by Cambridge Enterprise[26] and was recommended by a few individuals (key individuals from relevant organizations) that were interviewed. Participants of both competitions must undergo a rigorous multi-stage judging process. Judges for both competitions are typically a mix of accomplished professionals from industry and university. A list of past winners was compiled through attendance of the researcher at the award ceremonies, the competition organizers' websites, and by contacting members of the competition organizing committee.

The third source used was publicly available online databases of technology-based social organizations. Two databases of global TSEs were selected, Nominet Trust 100[27] and the Fast Forward Tech Nonprofit Directory[28]. The respective organizations that compiled the databases have relatively high profiles operating in the technology-based social innovation sector.

From the three sources, five firms that met the criteria defined for the research were identified. These five firms were frequently mentioned or identified by numerous sources as being exemplary technology-based enterprises with a social mission (shown in **Table 3.5**). These firms

26 Commercialization arm of University of Cambridge.
27 Nominet Trust 100 database is no longer accessible online at the writing of this thesis. The Nominet Trust organization has also since been renamed to Social Tech Trust (https://socialtechtrust.org/).
28 Fast Forward Tech Nonprofit Directory (https://www.ffwd.org/tech-nonprofits/).

were all based in Cambridge (as it is one of the criteria) and were selected as cases for the research.

Table 3.5. Five firms that were identified through various sources.

	Raspberry Pi	**Simprints**	**WaterScope**	**Solaware**	**Blue Tap**
Key individuals from relevant organizations	• i-Teams	• CGE • Makespace • ideaSpace • i-Teams	• CGE • Cambridge Enterprise • i-Teams	• CGE • Cambridge Enterprise	• CGE
Business plan competitions		• CUE winner	• CUE winner • EPOC winner	• CUE winner • EPOC winner (Runner-up)	• CUE winner
Online databases	• Nominet 100	• Nominet 100 • Fast Forward	• Nominet 100		

3.3.1.4 Selected cases

A brief description and the legal structures of the five selected cases are provided in **Table 3.6**.

Table 3.6. Cases selected for the research.

Firms	Description	Year Founded	Legal structure
Raspberry Pi* (Raspberry Pi Foundation & Raspberry Pi Trading Limited) 	Raspberry Pi designs and manufactures low-cost, high-performance computers to promote computing literacy and education among adults and children.	Foundation (2008)** Trading (2012)	Charity with a wholly owned for-profit subsidiary
Simprints Technology Limited 	Simprints designs and manufactures low-cost fingerprint scanner devices to provide access to identification for people in developing countries.	2014	Not-for-profit company limited by share
WaterScope Limited 	WaterScope designs low-cost 3D-printed microscopes to detect water sanitation levels in developing countries.	2015	For-profit company limited by share***
Solaware Limited 	Solaware designs wearable solar-powered LED devices to be used as a light source in developing countries.	2016	For-profit company limited by share
Blue Tap CIC 	Blue Tap designs 3D-printed chlorine injector valves to be attached to water taps in developing countries to sanitize the water.	2018	Community Interest Company

***Note.** Although Raspberry Pi consists of two separate organizations, it is considered as a single firm since the Foundation wholly owns the Trading subsidiary.
****Note.** The Foundation was relatively inactive after its incorporation in 2008 and remained so until 2011.
*****Note.** WaterScope Limited transitioned from a not-for-profit to for-profit legal structure during the course of the research.

Based on the criteria for growth described earlier, the five selected cases are categorized according to various stages of growth. The latest available information (as of the writing of this thesis) based on the criteria for growth are compiled from the firms' website, social media posts, and Company House database and shown in **Table 3.7**. The researcher recognizes that in order to properly represent growth, a change in measure over time is required as opposed to the snapshot shown in **Table 3.7**. This is not necessary since **Table 3.7** is only meant to illustrate the relative size of the firms, which has essentially remained the same[29] since the inception of the firms.

29 For clarification, this means that the size of the firms has maintained in the same positions since their inceptions with Raspberry Pi being the largest in size, followed by Simprints, WaterScope. Solaware and Blue Tap are both at very early stages and are considered the same in size but much smaller than the three firms.

Table 3.7. Snapshot of growth for selected cases.

Firms	Measure of social impact (actual or anticipated)	No. of employees (full-time)	Turnover	Balance sheet total	Prominent Partnerships/ Linkages
Raspberry Pi (Taken from trading subsidiary)	Number of people that have access to low-cost, programmable hardware and free software for computing and digital making[30]	2018 – 48 2017 – 36	2018 £ 27,963,197	(as at 31 Dec 2018) £ 9,904,041	• ARM • Cambridge Angels
Simprints	Number of beneficiaries identified using the Simprints platform[31]	2018 – 21 2017 – 13	2018 £ 629,694	(as at 31 Dec 2018) £ 337,961	• ARM • Bill & Melinda Gates Foundation
WaterScope*	Number of low-cost water testing kits distributed[32]	2018 – 1	N/A	(as at 31 Jul 2018) -£ 9,615	• ARM • Cambridge Enterprise
Solaware	Number of people that have access to healthy, safe, and affordable lighting[33]	N/A	N/A	(as at 31 Jul 2018) -£ 1,521	• Cambridge Centre for Gallium Nitride
Blue Tap	Number of chlorine injectors distributed[34]	N/A	N/A	(as at 30 Apr 2019) £ 12,959	• National Geographic Foundation

***Note.** Although the balance sheet total is lesser than Solaware or Blue Tap, WaterScope is considered to be larger in size due to the strong partnerships it has formed as well as having sufficient funds to employ a full-time employee.

The five cases are categorized in accordance with Garnsey's (1998, p. 530) "phases of growth" (which is the same as "stages of growth") and size as defined by the researcher (**Table 3.8**).

Table 3.8. Growth stage and firm size of selected cases.

Firms	Growth stage	Firm size*
Raspberry Pi	Growth reinforcement	Large
Simprints	Resource generation	Medium
WaterScope	Resource mobilization	Small
Solaware	Resource access	Very small
Blue Tap	Resource access	Very small

***Note.** The firm sizes are meant to illustrate the relative size of the firms. They were not based on established benchmarks as there are none for TSEs.

30 From Raspberry Pi Foundation Theory of Change 2019 Report.
31 From Simprints Annual Impact Report 2017.
32 From WaterScope Business Plan 2016.
33 From Solaware Business Plan 2017.
34 From Blue Tap Business Plan 2018.

3.3.2 Unit of analysis

The main unit of analysis of this research is the "technology-based social enterprise organization". As the focus of the research is on growth of the firm (TSEs) from a resource-based perspective, it is logical to observe and collect data from the firm and its resource providers. Hence, the two units of observations from which data were collected to draw conclusions on the unit of analysis are the "technology-based social enterprises" and their "resource providers".

3.3.3 Data collection protocol

This section described the sources of data used in this research and the process undertaken to collect it. Data was collected in two stages using different conceptual frameworks as guides. Stage 1 data collection was guided by a resource-based conceptual framework which is broader and considers a larger scope of resources. Upon data analysis of Stage 1, it was revealed that a legitimacy-based framework would be appropriate to reveal further insights. This led to Stage 2 data collection that was guided by a legitimacy-based framework.

3.3.3.1 Sources of data

Yin (2014) described six possible sources of data, each with its strengths and weaknesses. As the research question is focused on understanding how the firms grew, an account of how the firm developed in its early days was required. It was necessary to collect this data to investigate the issue from primary sources by conducting interviews, complemented by secondary sources such as internal company documents and online articles. Primary sources were imperative whenever such data was not readily available from secondary sources. Data sources are summarized in **Table 3.9**.

Table 3.9. Data sources used for this research.

	Primary	Secondary
Internal (TSEs)	Interviews; multi-participant workshops	Internal company documents; online news articles, publications, and videos
External (resource providers)	Interviews	Online news articles, publications, and videos

3.3.3.2 Stage 1 – Using resource-based conceptual framework

Data collection in Stage 1 was guided by a resource-based conceptual framework that was derived from the literature (**Figure 3.16**). The design of the conceptual framework will be elaborated in Section 3.4.

The researcher designed and printed a large banner-sized chart (**Figure 3.3**, reproduced in **Appendix 3**) to be used as a data collection tool to map how resources and technology development of the selected cases changed over time. The chart was designed based on the conceptual framework with the first column printed with constructs from the framework. All subsequent columns moving horizontally across the chart until the end were initially blank and represented progression of time. Five copies of the chart were printed to represent the five selected cases. The charts were subsequently populated over time by the researcher with post-it notes containing data that relates to the construct that was collected from primary and secondary sources. Provisions to capture resources that were not accounted for in the framework were provided in the form of an "Other resources accessed" category.

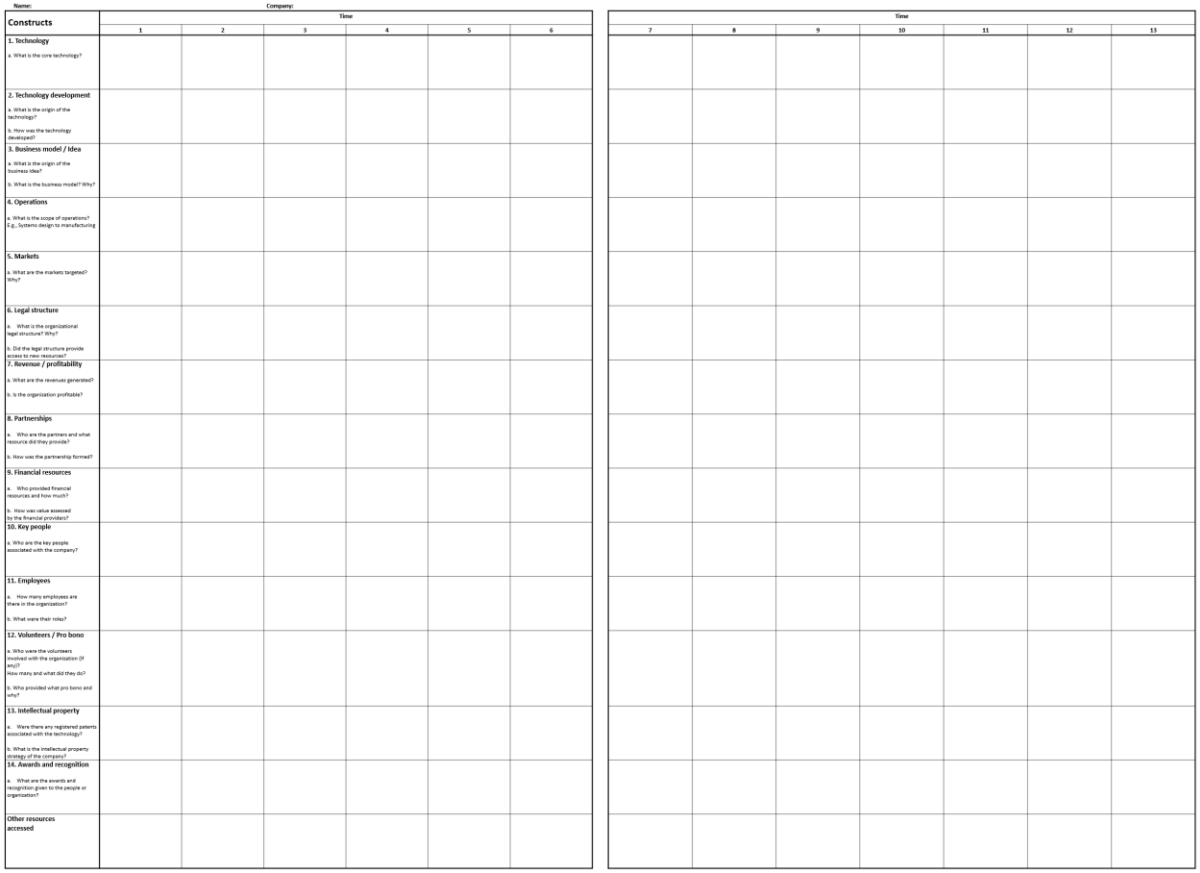


Figure 3.3. Thumbnail of a chart used as a data collection tool.
See Appendix 3 (Full size version: 92cm x 260cm).

Sessions were scheduled with key individuals from the selected case firms to assist with the population of the charts. These individuals were required to have deep knowledge of how the firm progressed over time since its inception with regards to resource acquisition and technology development (typically the CEOs or founders of the firms).

In addition to the charts, primary data were also collected via semi-structured interviews from key individuals from the selected cases and from a limited number of individuals representing resource providers (see **Appendix 4** for full list). The line of questioning at this stage was more focused on extracting a narrative on the firm's development over time. Interviews with key individuals from selected cases were repeated multiple times with a few months gap in between. This was because many of the selected cases (apart from Raspberry Pi) were still in their early stages and was actively experiencing growth as time progressed.

A workshop was also organized to bring together key individuals from a few selected cases to collect data on key challenges and best practices of running a TSE (**Figure 3.4**). The workshop

was also used as an opportunity for the individuals representing selected cases to verify if the existing resource-based charts were populated correctly. A new chart with simplified constructs from the framework was designed and printed (92cm x 260cm) to facilitate the workshop. Participants were required to populate the charts with post-its of their thoughts. The horizontal length of the chart represented the time dimension. The chart design for the workshop is shown in **Figure 3.5** and the populated chart in **Figure 3.6**.

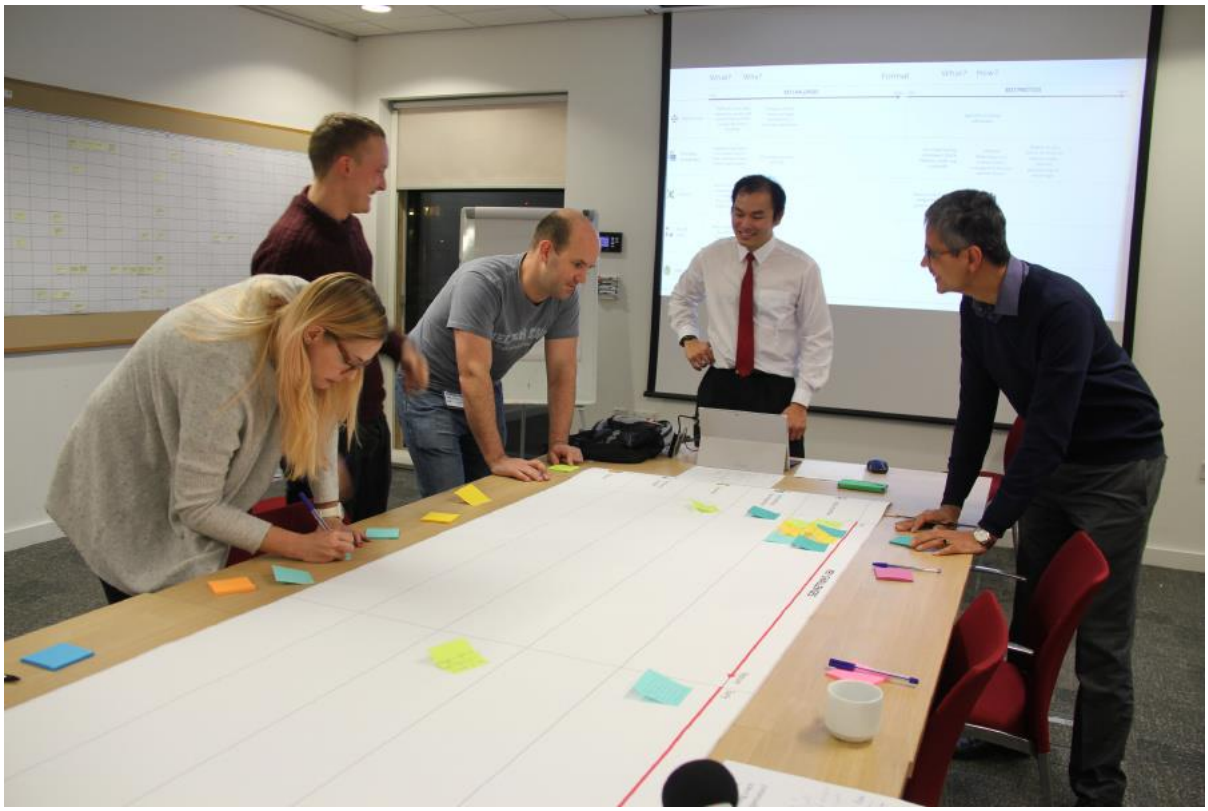


Figure 3.4. Workshop in progress. From left: Helen Lundebye (Simprints), Lewis Beresford (Fodda), Eben Upton (Raspberry Pi), Bang Ming Yong (researcher of the thesis), Nalin Patel (WaterScope).

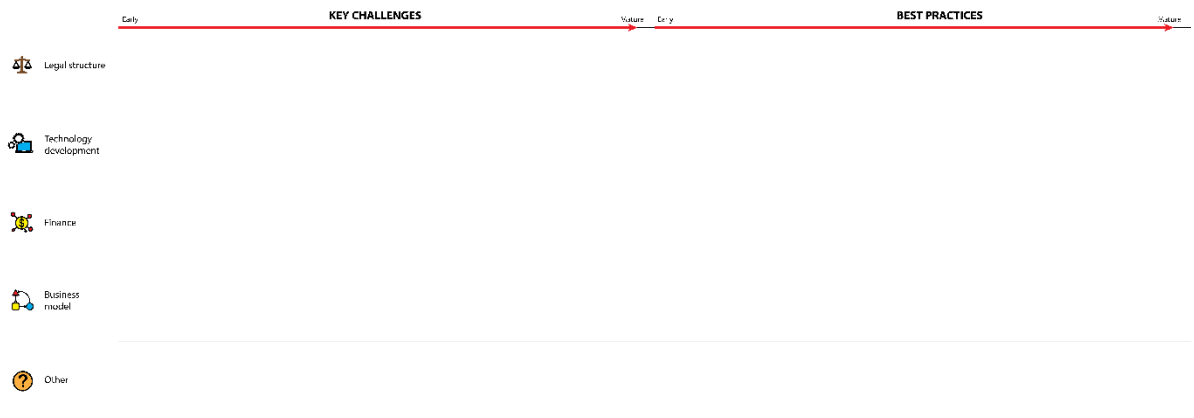


Figure 3.5. Workshop chart design.

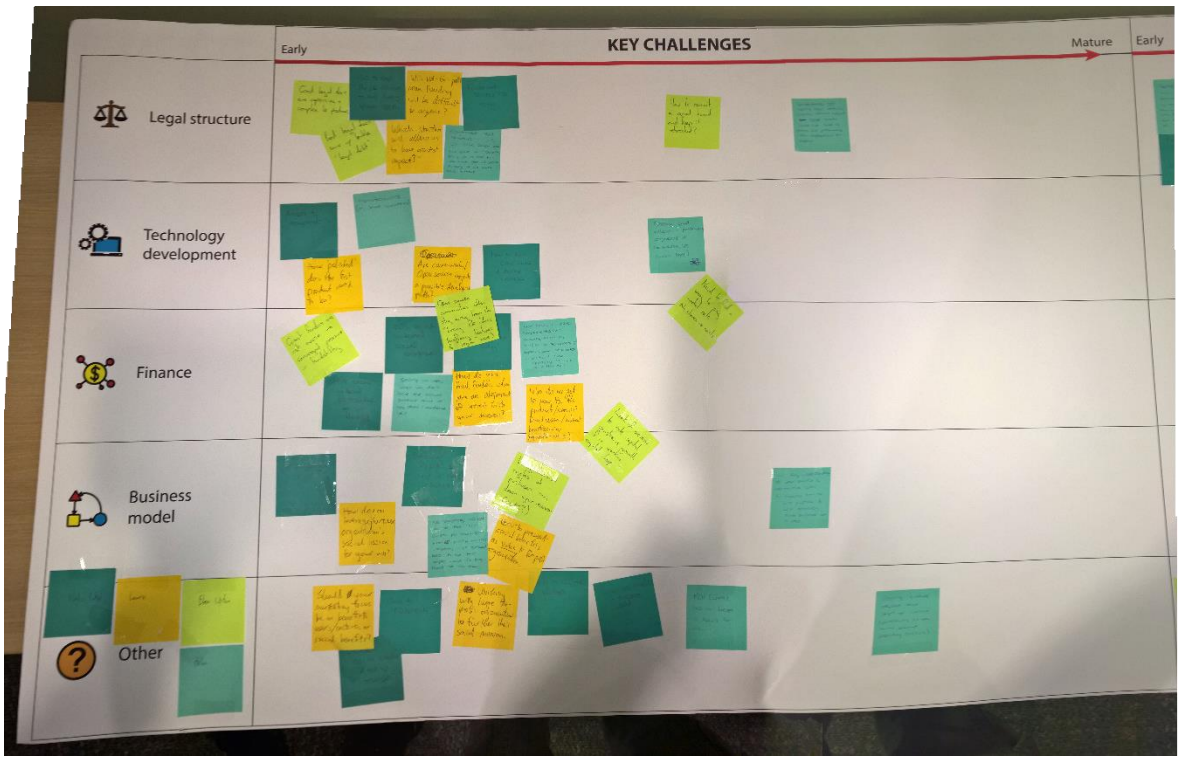


Figure 3.6. Populated workshop chart.

Interviews with resource providers (for all selected cases) were conducted in a relatively limited capacity. This was because at this stage, the researcher was not yet familiar with the cases and was more focused on extracting a narrative for the selected cases and describing what had already happened (or happening). Many key resource providers to the selected cases were high profile individuals[35]. Access to these individuals is very hard to come by and would be wasted if the opportunity were spent extracting information (e.g., what resources they had provided) that could be obtained through other sources rather than extracting the underlying reasons for taking a particular action (e.g., why they decided to provide resources). Therefore, at this stage, the researcher decided to only approach a limited amount of resource providers for interviews, mainly comprised of relatively low-profile resource providers and a few high-profile resource providers to understand why they have decided to provide resources to the selected firms. All interview protocols are described in **Appendix 5**.

Secondary data on the selected cases comprised mainly of news articles and publications and internal documents from the firm. For online news articles and publications, two strategies were

35 Some examples of high-profile resource providers: Rory-Cellan Jones, Technology Correspondent at BBC; David Cleevely, Chairman of Cambridge Angels

used to collect data. First, an automatic Google News alert was setup to notify the researcher when the selected cases appeared as online news items. Second, a list of keywords related to the selected cases (e.g., "Simprints", "WaterScope", "3D-printed microscope") were periodically searched on Google and saved. Relevant videos that were posted online (mainly on Youtube) were also saved. These videos were identified from the Youtube channels maintained by the firms and through a similar keyword search as the new articles. The full list of keywords used is listed in **Appendix 6**. A total of 237 articles and 190 videos were collected. Internal documents that are not publicly available such as business plans, internal reports, email threads were obtained from individuals in the selected cases and from resource providers. These internal documents were provided on the condition that the researcher does not publish them in its entirety and to check with them on permission if certain extracted quotes or information were to be publicly published.

All the collected data were compiled into a case study database within Atlas.ti. The data were then analysed according to the data analysis protocols described in Stage 1 of Section 3.3.4. The analysis from Stage 1 of the case study revealed a promising and underexplored path of inquiry to provide answers for the main research question – the use of legitimacy as a resource to facilitate growth of the firm. Although legitimacy had already been identified as a construct in the resource-based conceptual framework, the existing framework was not capable of investigating the concept in further depth because it was designed to capture and analyse data at a higher level. A new legitimacy-based framework had to be derived from the literature to be used as a theoretical lens to collect new data and analyse existing data.

3.3.3.3 Stage 2 – Using legitimacy-based conceptual framework

An additional legitimacy-based framework based on Fisher et al. (2017) was utilized after reviewing the legitimacy stream of literature. Unlike Stage 1, Stage 2 did not involve a chart as a research tool.

Primary data was collected mainly through interviews with remaining high-profile resource providers and key individuals from selected cases. This time, interviews were conducted with a line of inquiry that reflects the legitimacy-based framework (described in **Appendix 7**). For example, resource providers were asked during the interview on "What characteristics from the

firms gave you confidence to provide resources?". This line of inquiry is different from just asking "Why did you decide to provide resources?" (although the question was asked before focusing on legitimacy) since the terms used ("gave confidence") reflects the notion that legitimacy is a positive perception on the firm (Suchman, 1995). With the new framework in place, the researcher was able to follow up answers from the interviewee (resource provider) with questions to cover other instances of legitimacy to provide a more complete picture. For example, if the interviewee answered that "it was the strong team that gave us the confidence in providing resources", the researcher will first follow up with an inquiry of "why" and once it has been exhausted, move to explore other possible sources of legitimacy with questions such as "What about the legal structure of the firm? Did that affect your decision to provide resources?". Interviews with key individuals from the selected cases were also scheduled with the new legitimacy-based framework in place to find out and understand their strategy to affect perception of resource providers (if any) and if certain decisions that had a positive effect on resource providers' perceptions were intentional.

No new secondary data were collected using the new legitimacy-based framework since the new framework is perception-based and does not alter criteria for collection of secondary data. Instead, the existing secondary data that had been collected in Stage 1 were revisited and analysed using the legitimacy-based framework as a theoretical lens.

3.3.4 Data analysis protocol

To facilitate data analysis, Atlas.ti was used to carefully compile all the collected data into a case study database. Raw data (interviews, internal company documents, online news and publications, videos) were organized and formatted consistently to be filed into data records within the database.

All interview audio data were transcribed verbatim using a 2-step process. The first step, all raw audio data of interviews were initially automatically transcribed using a script developed by the researcher based on Google's Speech-to-Text API[36]. The output of the automatic transcription process was approximately more than 80% accurate but without formatting. For the second step,

36 Google Speech-to-Text API enables automatic transcription of audio to text (https://cloud.google.com/speech-to-text/).

the researcher manually fixed the outputs of all automatic transcriptions by listening to all the raw audio data and correcting the automatically transcribed text. The researcher used ExpressScribe Transcription Software Pro for this step.

Text and images from online news and publications were extracted and stripped of its original formatting. Videos were not transcribed verbatim but had quotes extracted or screenshots taken where it was deemed relevant. Internal company documents were left in its original formatting to avoid inadvertently stripping the context from the data (Mishler, 1979).

The data records (apart from interview data) were then grouped according to events or activities that had occurred. For example, all data records related to Simprints winning the CUE Competition (e.g., business plan entry, news articles and publications reporting the win) were grouped together.

3.3.4.1 Stage 1 – Using resource-based conceptual framework

The data that has been collected in Stage 1 was guided by the resource-based conceptual framework. As described in the last section, data was collected predominantly based on known constructs of resources (from the framework) that had been acquired by the case study firms. Provisions were provided to capture new resources that had not been identified previously. On its own, the collective data simply represents a descriptive account of the activities undertaken by the firms and resources that had been acquired over time. The causal links between activities of the firm and the resources that had been acquired, or the causal links between different acquired resources may not be explicit. The data analysis process is meant to "disassemble" and "reassemble" the data (Yin, 2016) so that causal links can be drawn, interpreted, and concluded, to provide an answer to the research question.

As a first step for the analysis, the researcher looked at the charts of resources acquired over time that had been populated and verified with the firms. Arrows were drawn by the researcher on the charts between different resources that had been populated and spread across the time dimension (i.e., spread horizontally across the chart) to infer possible causal links based on what is known from the literature on those resource constructs.

The data was then qualitatively analysed by adopting the "Gioia method" which consists of multiple rounds of coding (Gioia et al., 2013; Gioia et al., 2010). Primary data (from interview transcripts, notes, and multi-participant workshops) and secondary data (from internal company documents, online news articles, publications, and videos) are thoroughly read through and first-order codes are subsequently highlighted (in line with Glaser and Strauss (1999)) to provide some overview and structure to the data (Gioia et al., 2013; Gioia et al., 2010). The resulting large number of first-order codes are then compared for similarities and differences and reassembled into second-order codes (Yin, 2016). Two examples of the coding process are shown in **Appendix 8**.

The list of first-order codes and their links to second-order codes resulted in a code tree (example shown in **Appendix 9**). Following the abductive approach, the second-order codes are compared with the conceptual framework derived from extant literature and subsequently used to modify and enhance the framework.

The analysis revealed a promising new line of inquiry that the resource-based framework was not capable of exploring in-depth. Therefore, a legitimacy-based framework based on Fisher et al. (2017) was utilized as a theoretical lens to analyse all existing data that had been collected.

3.3.4.2 Stage 2 – Using legitimacy-based conceptual framework

The legitimacy-based framework that had been developed from the literature was used as a theoretical lens to analyse all existing data. Data collected from Stage 1 and Stage 2 were coded according to the new legitimacy-based framework. The qualitative data analysis approach used in Stage 1 (i.e., the Gioia method) was also used in Stage 2.

3.4 Design of resource-based conceptual framework

This section builds upon concepts drawn from the literature review and describes the development of the conceptual framework to analyse TSEs. This section reviews and discusses the resource-based theory and open systems approach to serve as the theoretical foundation for developing the conceptual framework. Subsequently, relevant models that have been used to analyse growth of firms will also be reviewed to draw inspiration for developing the conceptual framework. The conceptual framework that was used to guide data collection and analysis for Stage 1 will be proposed at the end of the section together with an elaboration of the framework components.

3.4.1 Review of relevant theoretical perspectives

The research question that this thesis seeks to address is:

> *"How do technology-based social enterprises acquire and manage resources to grow the venture and develop their technologies?"*

The literature review in the previous chapter identified that qualitative studies on the growth process of organizations are a promising avenue for further research, and that there are many different theoretical perspectives to draw upon.

The classical perspective of organizational theory views the organization as a machine and the employees as cogs to the machine (Taylor, 1947). Firm performance is predominantly linked to improvements in efficiency from within the organization. The resource-based theory (RBT) is one of the theories which looks internally at the organization for attributes or resources which contributes to improved firm performance (Barney, 2001b; Wernerfelt, 1984). Modern organizational theories tend to look beyond just internal firm resources and consider the environment in which the firm operates. Systems theory applied on organizations is a strand of research which takes this approach (Kast & Rosenzweig, 1972; Katz & Kahn, 1966). These theoretical perspectives (RBT and systems theory) have been successfully used by scholars to analyse early-stage technology firms and understand the underlying process of growth (e.g., Garnsey, 1998; Lubik, 2008). As such, both theories will be reviewed and discussed to serve as

the theoretical foundation to develop the conceptual framework for analysing TSEs.

3.4.1.1 Resource-based theory

Penrose's (1959/1995) "The Theory of the Growth of the Firm" was significant as one of the earliest works which contributed to firm growth theories. However, the work was perhaps more known for its contribution as the basis for contemporary resource-based theories (Barney, 2001b; Davidsson et al., 2010; Wernerfelt, 1984). Thus, the resource-based perspective and the process of growth perspective go hand in hand (considering the academic lineage of both streams can be traced back to Penrose (1959/1995)). Resource-based theory views the firm as a bundle of resources, in which the successful organization of resources may lead to a firm gaining sustained competitive advantage (Barney, 2001b; Wernerfelt, 1984). Contemporary resource-based theories present a useful theoretical perspective to study internal firm dynamics. The theory's focus on internal dynamics is a useful complement to other theoretical perspectives on firm performance such as industrial organization theories (Porter, 1979, 1980, 1985) which puts its focus on external factors such as industry structure.

Resource-based theory enables conceptualization of factors (in the form of resources) at the firm level which contributes to a firm's success (Barney, 2001b; Wernerfelt, 1984). Resources may be tangible such as financial or human capital, technology which the firm possess, or even the physical building which the firm resides. Resources could also be intangible in the form of competences (i.e., know-how), capabilities, legitimacy, or reputation. Resources that are tangible may provide competitive advantage but because they could be obtained from the market, the advantage over competitors may not last as long. Intangible resources are considered more difficult to emulate and obtain but would provide better protection for a firm's competitive positioning.

It is notable that Penrose's (1959) theory was originally developed based on her study of relatively established firms. However, in Garnsey's (1998) "Theory of the Early Growth of the Firm", the theory was extended to look specifically at the early growth of firms. A conceptual model (**Figure 3.7**) grounded in the resource-based perspective was proposed to explain how early technology firms grow. Garnsey (1998) theorized that a core activity of early technology firms is to build a resource base. The resource base is important for the firm to conduct productive

activities (e.g., R&D) and generate resources for further growth (Garnsey, Stam, et al., 2006). Five stages have been proposed in the conceptual model – accessing resources, mobilizing resources, generating resources, growth reinforcement, growth reversal.

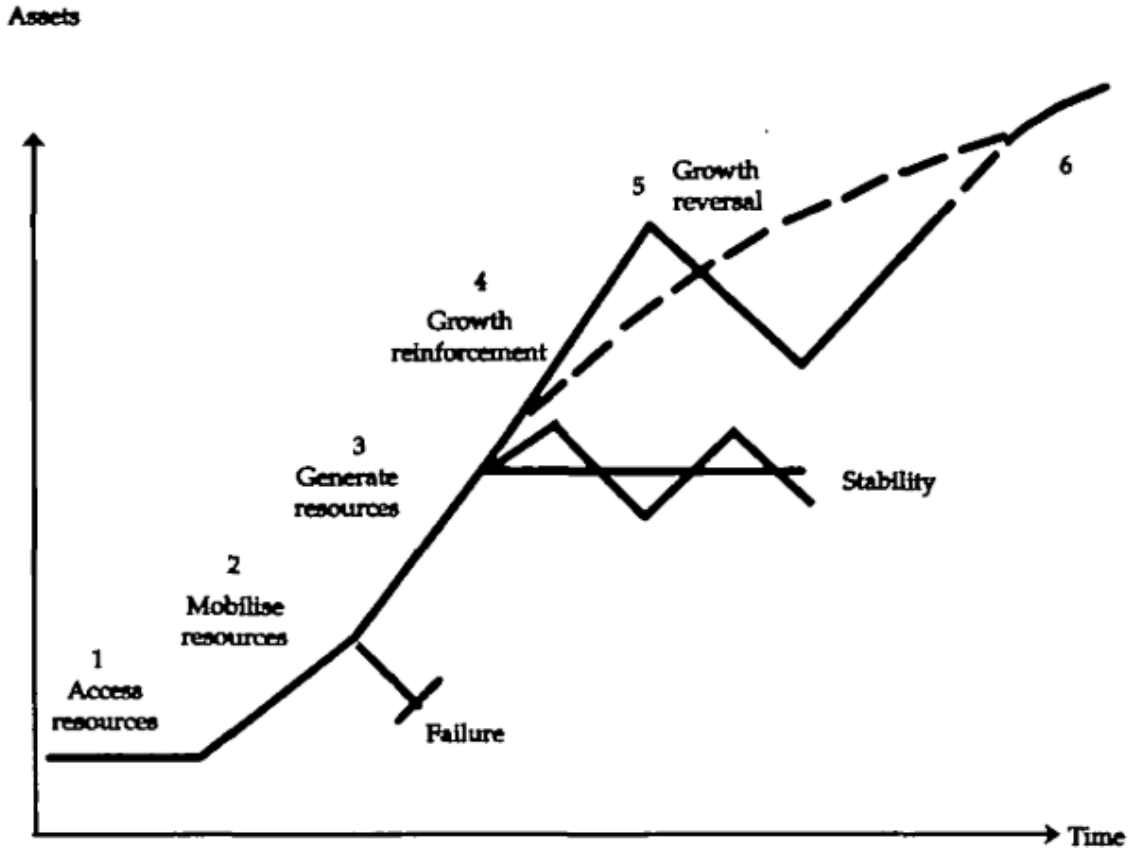


Figure 3.7. Growth paths of early technology firms, reproduced from Garnsey (1998).

Resource-based theory is not without criticisms of its limitations. Priem and Butler (2001) have famously criticized the theory on its limited managerial implications, infinite regress, vagueness of the definitions of resources, among other criticisms. Barney (2001a) has addressed some of those criticisms in which he argues that despite the limitations, the resource-based theory is still a useful theoretical perspective in strategic management. These criticisms have been reviewed and discussed by many scholars (see Kraaijenbrink et al. (2009) for a thorough discussion of the critiques on the resource-based theory).

Some scholars have addressed criticisms of resource-based theory as being overly introspective (Montgomery, 1995; Priem & Butler, 2001) by integrating other theoretical perspectives to consider contributions of firm performance due to external factors from the environment. The environment is important because no firms exist in a vacuum. Open systems theory has been

successfully used by scholars (Garnsey, 1998; Lubik, 2008, 2010) to link the firm to its environment. This will be reviewed and discussed in the next section.

3.4.1.2 Open system theory

General systems theory was proposed by the biologist von Bertalanffy (1968)[37]. The main premise of the theory is that complex systems share organizing principles which can be discovered and modelled. von Bertalanffy (1968, p. 32) stated that:

> *"...there exist models, principles, and laws that apply to generalized systems or their subclasses, irrespective of their particular kind, the nature of their component elements, and the relations or "forces" between them. It seems legitimate to ask for a theory, not of systems of a more or less special kind, but of universal principles applying to systems in general."*

The systems approach has been used in many fields of science such as physics, astronomy, biology, and social science. Katz and Kahn (1966) subsequently applied the systems approach to organizations and considered organizations to be "open systems" (**Figure 3.8**). Open systems theory states that an open system is an arrangement of interrelated parts interacting with its environment.

37 Ideas for systems theory was first proposed by von Bertalanffy in the 1940s.

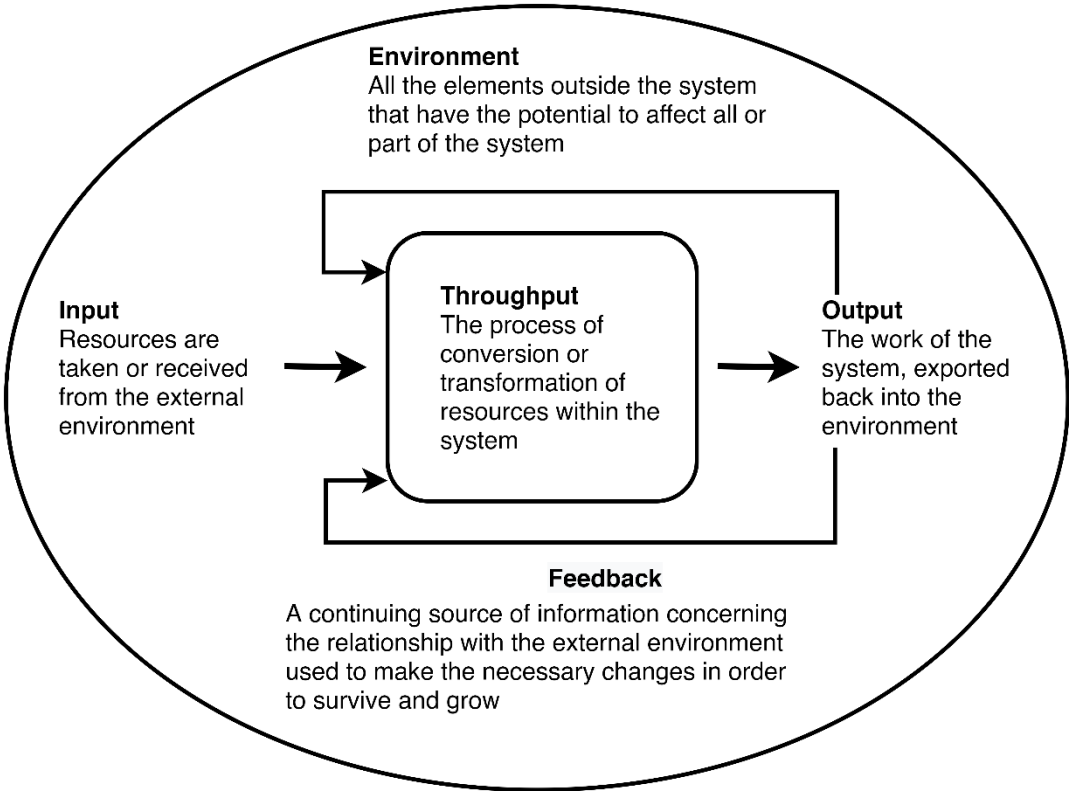


Figure 3.8. Open systems model, recreated from Katz & Kahn (1966).

The open systems approach enables consideration to be given to conditions internal and external to the firm. As Garnsey (1998, p. 526) stated:

> *"An open systems approach can overcome the problem of emphasis on internal conditions to the neglect of external conditions for firm growth or vice versa."*

Garnsey (1998) also proposed that firms can be conceptualized as an input-output system, which draws in resources from its environment as inputs and converts the resources into products and services as outputs. When the open systems approach is applied on development of new firms, the theory enables the study of emergent behaviour (Anderson, 1999).

Adner's (2006) interpretation of the innovation ecosystem takes the systems approach and applies it to a high-tech firm context. Adner (2006) views the innovation ecosystem as a "collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution". This approach considers other organizations downstream and upstream in the network of the primary firm of interest in creating value. This, together with other relevant models will be discussed in the next section.

3.4.1.3 Influence of other conceptual frameworks

Relevant models have been identified from literature and discussed in this section. Garnsey's "A Theory of the Early Growth of the Firm" (Garnsey, 1998) which combined resource-based theory and open systems theory to investigate early firm growth of high-tech ventures, provided a theoretical foundation for many subsequent studies which expanded upon this initial model.

Stam and Garnsey's (2006) model (**Figure 3.9**) and Garnsey, Dee, and Ford's (2006) model (**Figure 3.10**) expanded upon the initial resource-based model. Their models described the process in which new firms develop from their founding to eventually create and capture value. The models described a cycle which may begin from recognizing an opportunity or business idea, followed by building a productive base, creating value, and capturing value.

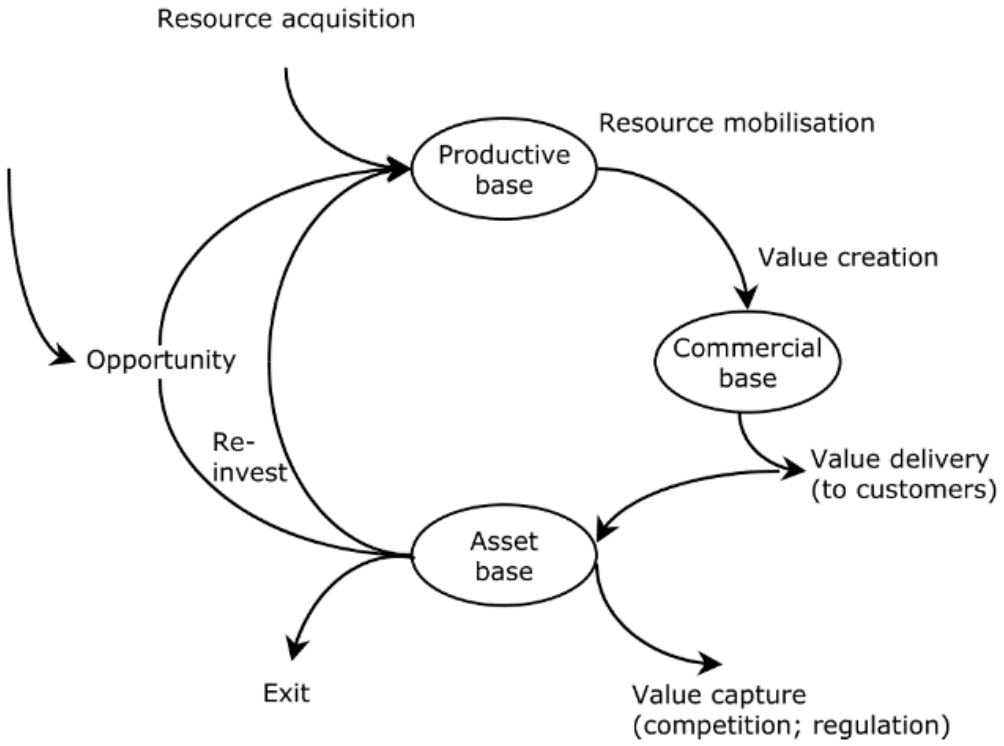


Figure 3.9. Internal and external dynamics of new firm development, reproduced from Stam & Garnsey (2006).

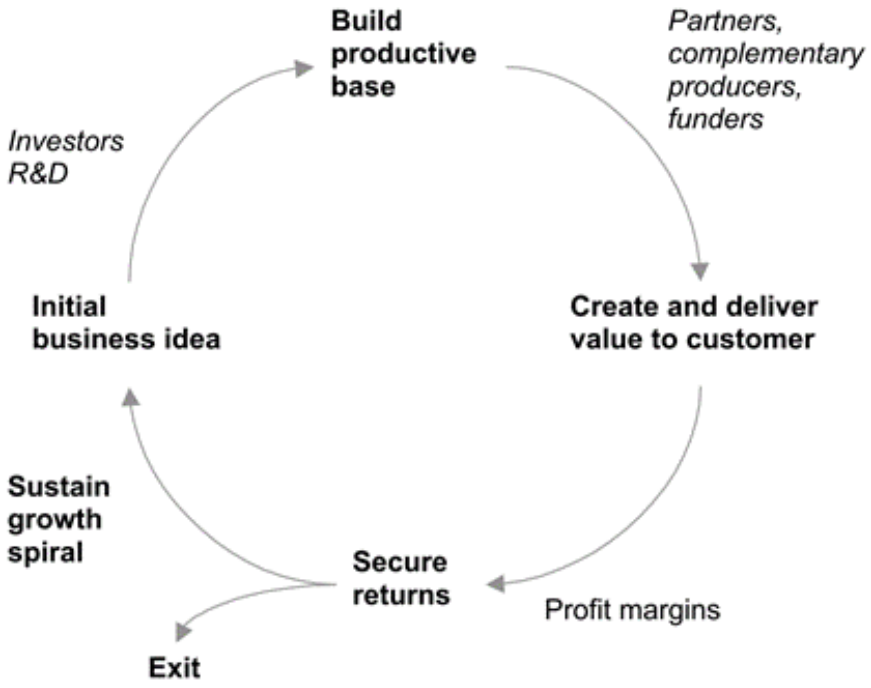


Figure 3.10. The entrepreneurial process of value creation and capture, reproduced from Garnsey, Dee, et al. (2006).

These base models have been successfully adapted to integrate business model concepts (value creation, value capture) and innovation ecosystem concepts to form a more comprehensive resource-based framework to explain the growth process of technology enterprises in different industries. The framework has been used to study "clean tech" ventures (Dee, 2007; Dee et al., 2007), healthcare innovation (Fan Li et al., 2012), biopharma acquisitions (Mohr & Garnsey, 2009), and advanced materials university spinouts (Lubik, 2008, 2010).

It is notable that Garnsey, Dee, et al. (2006) maintain that the starting point in the framework may be non-linear and the cycle can go on for many different iterations until eventual decline of the firm or an exit occurs (through acquisition). For example, entrepreneurs may start the cycle by having a business idea and subsequently working towards building a resource base (and continuing through the cycle by creating and capturing value). However, it could also be possible that the firm starts off by having an inherited resource base (in the case of spinoffs from established firms) and the business idea is developed after it. This addresses one of the criticisms of stages-of-growth approach that all organizations undergo a seemingly linear process (which has been proven to not be the case empirically). This indicates that the authors are aware that the growth process undergone by firms is not linear like those experienced by biological organisms.

Garnsey's framework (1998) has continued to be developed and adapted. For example, Lubik and Garnsey's (2016) framework (**Figure 3.11**) is a recent example of an adapted framework to explain the value creation process of advanced materials university spinouts.

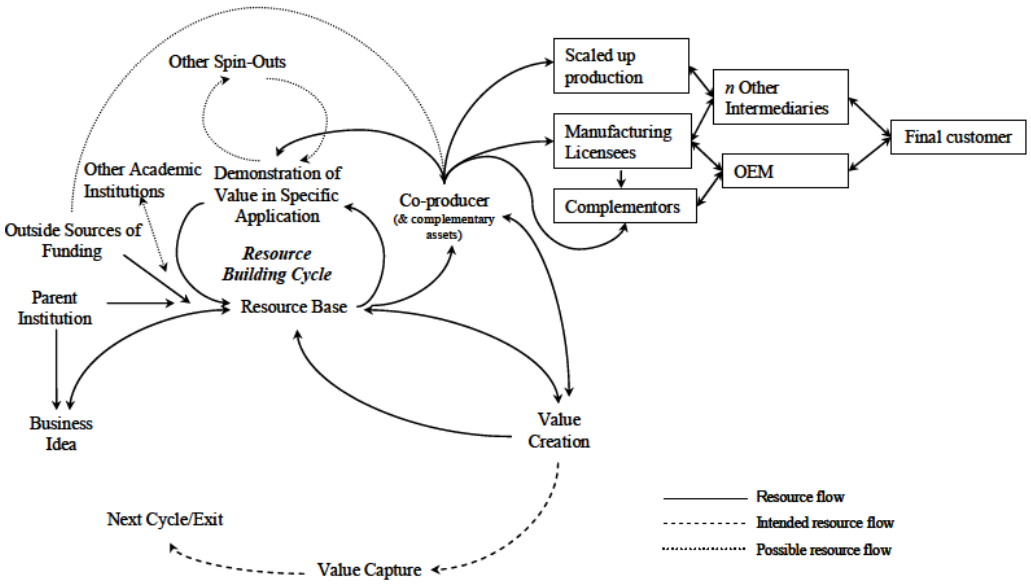


Figure 3.11. Conceptual framework for advanced materials university spinouts, reproduced from Lubik and Garnsey (2016).

Lubik and Garnsey's (2016) framework incorporated Adner and Kapoor's (2010) innovation ecosystem model (**Figure 3.12**) to study how the focal firm interacts with downstream and upstream actors in the network to create value.

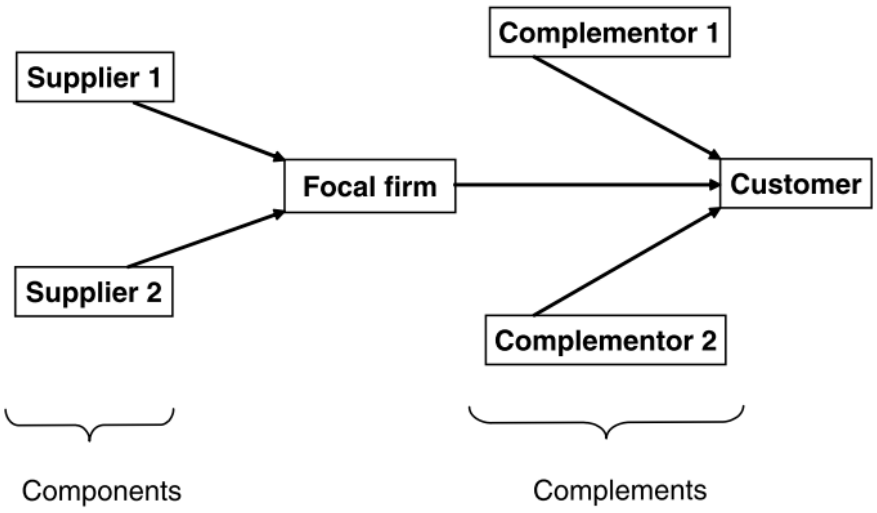


Figure 3.12. Generic schema of an innovation ecosystem, reproduced from (Adner & Kapoor, 2010).

A central component of the frameworks adapted from Garnsey (1998) is the importance of the resource building cycle before value creation or value capture can occur. The frameworks were designed to investigate how this process occurs since value creation and value capture is ultimately necessary for firm growth.

Emerging from the open systems literature, a relevant model specific to social enterprises was proposed by Moizer and Tracey (2010) (**Figure 3.13**). This model separated the revenue generation process from the organizational legitimacy building process. This study will consider the organizational legitimacy as part of the resource base of the firm.

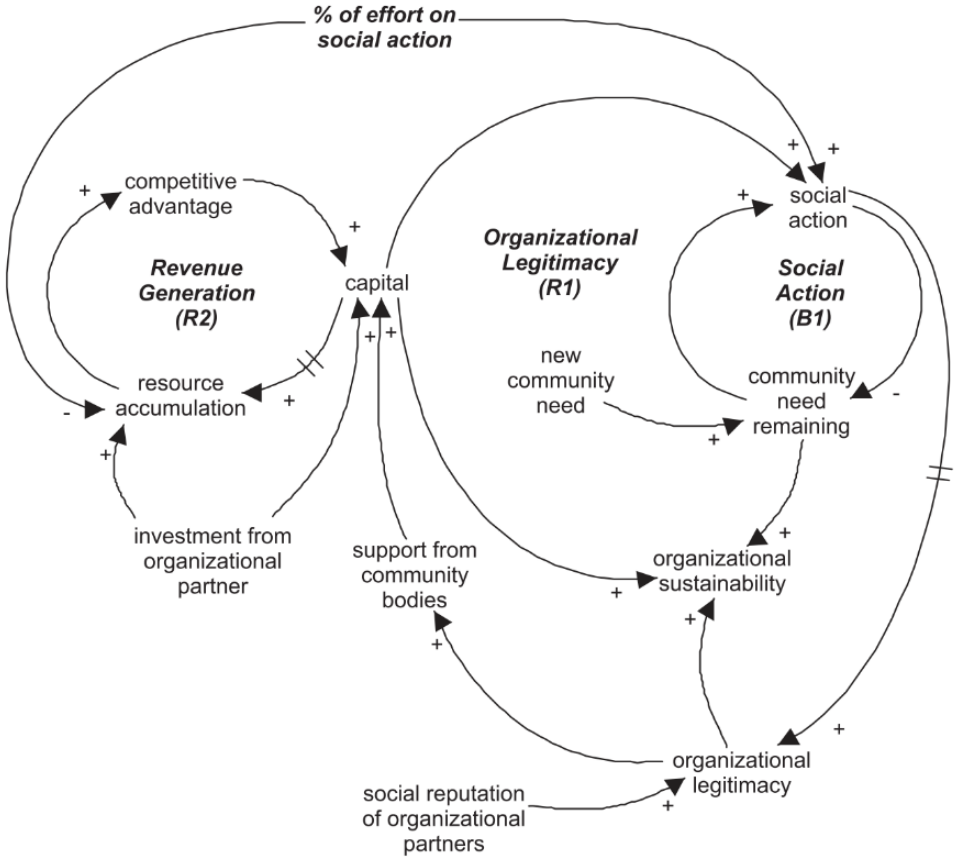


Figure 3.13. Tension between business activity and social action in a social enterprise, reproduced from Moizer and Tracey (2010).

It can be observed that resources are central to the framework presented by Garnsey and her co-authors. Resources, however, are a means to an end. No firms exist purely for the perpetual accumulation of resources. The firm exists to create and capture value for stakeholders of the firm. Thus, integration with business model concepts (of value creation and value capture) is well suited to explain the complete cycle of building a resource base to eventually create and capture

value. Another point of note in the framework is the integration of innovation ecosystem concepts. This is useful to explain how the technology firm interacts with other actors (e.g., other firms & organizations) in the ecosystem to achieve its goals (to build resource base and create value).

To the researcher's knowledge, there are no existing frameworks that have been adapted specifically to explain the growth process of TSEs. Although TSEs share many characteristics with commercial technology enterprises, the hybrid nature (due to the social component) presents interesting opportunities to extend the framework. For example, the social component (which will be reviewed in the next section) may alter the relationship between the firm and other actors in the ecosystem. The interactions of commercial technology enterprises and other actors are always grounded in market-oriented benefits and typically measured in terms of financial gains and economic value maximisation. Customers purchase products and services from a commercial technology firm because they believe they can gain net benefit from their utility after incurring costs (Bowman & Ambrosini, 2000). Similarly, suppliers and co-producers in the ecosystem may exchange resources with the technology enterprise because they believe they can gain a net benefit from the exchange. Social enterprises on the other hand, exists primarily to create social value for its targeted beneficiaries and achieves this by engaging in enterprise activities (i.e., business) (DTI, 2002; Mair & Martí, 2006). A key difference is that the beneficiaries of social enterprises may not be able to afford products and services of technology enterprises in the start-up phase (Arena et al., 2018). This is since customers are likely to pay a premium (whether directly or indirectly) to account for the costs of technology development in the early days of a technology enterprise start-up. In a capitalist market, it is extremely unlikely for business (especially in the context of resource intensive technology enterprises) to be conducted entirely out of goodwill. Thus, this is where the types of actors and interactions present in the ecosystem of a TSE may diverge from those of commercial technology enterprises. This calls for the need to adapt the framework for the context of TSEs to explain successful exchange of resources between actors, and ultimately, the process of growth of TSEs.

3.4.2 Development of conceptual framework

The model developed by Stam and Garnsey (2006) and Garnsey, Dee, et al. (2006) will be adapted in this thesis to study TSEs. In previous studies (such as Lubik and Garnsey (2016)), the entrepreneurial process and flow of resources in the framework is combined. The approach taken in this thesis is to make a clearer separation between the components of the entrepreneurial process (of value creation and capture) and flow of resources into the firm. Both components will be discussed in turn and finally integrated into an overall conceptual framework to study TSEs.

3.4.2.1 Entrepreneurial process of value creation and value capture

A process is a series of actions that are taken to achieve a result. The language used in the entrepreneurial process model by Garnsey, Dee, et al. (2006) is slightly modified to reflect activities that are actionable in general (**Figure 3.14**).

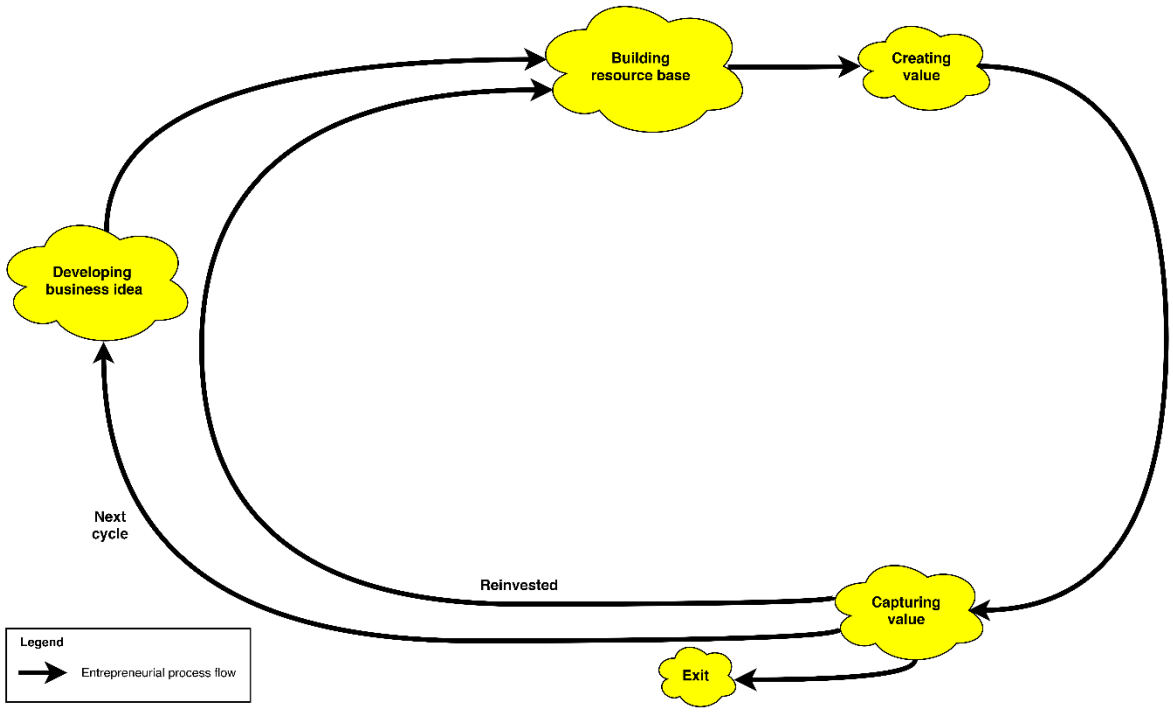


Figure 3.14. Modified entrepreneurial process framework.

The entrepreneurial process typically begins with an opportunity that has been identified and a business idea developed around the opportunity (Garnsey, Dee, et al., 2006). This is represented in the proposed framework as *Developing business idea* which is similarly present in existing

frameworks. Although the main objectives of a social enterprise are social rather than financial, the terminology "business idea" is used instead of "social idea". This is because social ideas cannot be developed artificially by the entrepreneur. Genuine social issues are meant to be discovered or realized (at least in the context of issues recognized globally such as UN's sustainable development goals). The entrepreneur may only develop a business idea around the social issue that has been identified. This construct captures the initial impetus for starting the business. Important to note that in the context of TSEs, the impetus could be due to technological drivers or social drivers. Entrepreneurs starting a TSE could potentially have developed or obtained technologies and looking for ways to apply them to address social problems. Conversely, they could have also first identified a social problem and work to develop or obtain technologies to address it. This is the equivalent of the technology-push and market-pull concepts in commercial technology enterprises (Lubik et al., 2012). This construct will also be used to capture how the founding team of the firm got involved with the firm.

The next step in the process is *Building resource base*. The terminology "productive base" is used instead of "resource base" in earlier versions of existing frameworks. This is because a distinction was made between a firm's productive base, commercial base, and asset base (Stam & Garnsey, 2006). A firm's productive base represents technological competences and R&D expertise. The commercial base represents the means to reach the market. The asset base is the accumulation of assets of the firm. However, it has been recognized that in practice, these different bases are difficult to separate from one another (Dee, 2007). As such, the terminology "resource base" is used instead to collectively represent all the different resources in the firm (Dee, 2007; Lubik & Garnsey, 2016).

After a firm has built up its resource base, it will attempt to create value for its customers – represented in the framework as *Creating value*. Scholars such as Bowman and Ambrosini (2000) have made the distinction between different types of values such as "use value" and "exchange value". Use value of a product or service is a subjective value set by the customers based on the perceived utility of the offering. Exchange value is the amount paid by the customers to the firm for the products and services. Revenue generated is typically used as the proxy for value created (Lubik, 2010; Priem, 2007). However, in the case of TSEs where social objectives are primary, continued usage of the products and services by beneficiaries could also be a proxy indicator for value created.

When surpluses or profits results from revenue generated, value is considered to have been captured by the firm (Bowman & Ambrosini, 2000). This is represented as *Capturing value* in the proposed framework. It has been recognized that in many early-stage technology ventures, firms are unlikely to be at the stage to generate profits (Maine & Garnsey, 2006). In cases where profits have not been realized by the firm, the plans to capture value are used in its place.

After value has been captured, the entrepreneurs may choose to exit through acquisition by a larger organization – labelled as *Exit* in the proposed framework. Similar to *Capturing value,* early-stage ventures may not have reached this stage or that the firm may not have any intentions of exiting. The construct will be used to capture exit plans if they are available.

This model also makes an additional link from *Capturing value* to *Building resource base* to indicate an alternative path where value that has been captured is fed back into the firm's resource base. While this is implicit in the original Garnsey, Dee, et al. (2006) model, the differentiation is made here for clarity. The flow from *Capturing value* to *Developing business idea* will represent the firm's venture into developing new business ideas (which may be new market segments). This differentiation is also reflected in subsequent expansion of the model such as the one proposed by Lubik and Garnsey (2016). This link is considered the *Next cycle* in the entrepreneurial process. In this study, it may be used to represent diversification to new market segments.

3.4.2.2 Flow of resources

The open systems approach stipulates that the system must have inputs, outputs, processes to transform the inputs into outputs, boundaries, feedbacks (Katz & Kahn, 1966). This theoretical approach is applied to the TSEs to model the flow of resources based on literature (**Figure 3.15**).

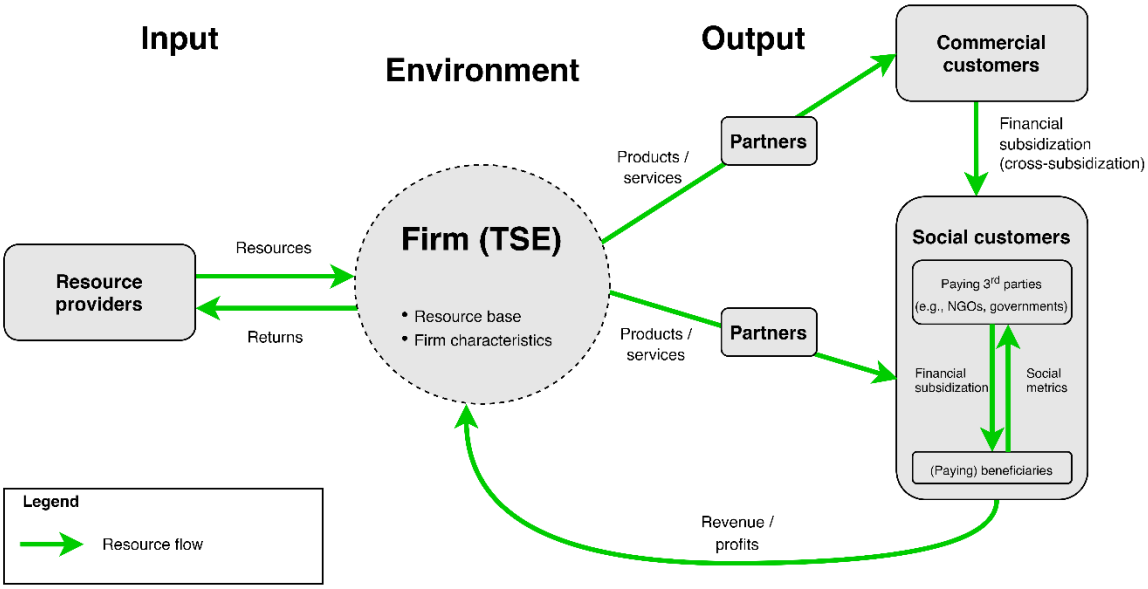


Figure 3.15. Proposed framework for resource flow of TSE.

The inputs into the firm (TSE) are conceptualized as resources provided by *Resource providers* external to the firm. These resource providers provide resources such as financial capital, human capital, or technological capital. Resources that are typically only available to non-profits such as volunteers or pro bono services are also included here. A link from the TSE to resource providers represents resources that are returned to the resource providers such as return on financial investments or fulfilment of social metrics. In practice, resource providers may label themselves (or labelled by the firm) as partners rather than resource providers. This study makes the distinction between organizations that provide support upstream of the firm as *Resource providers* even if they are labelled as partners. Organizations downstream of the firm are labelled as *Partners*. They assist the firm in delivering products and services to the customers.

In the flow of resources, the TSE firm organizes the transformation of inputs into outputs. The accumulated resources form the *Resource base* of the firm (which is consistent with the concept that the firm is essentially a bundle of resources). The resource base may not always start from nothing as the firm could be endowed with resources if it is a spinoff from a larger corporation.

However, in most early-stage technology ventures, it is unlikely for firms to start off with substantial amounts of resource and typically will have to build up its resource base (Garnsey, 1998). Any external actors or organizations that the firm has no control over are considered to be beyond the boundaries of the firm. As such, wholly owned "child" organizations or spinoffs are considered to be part of the firm (within the boundaries) as long as a level of control is maintained by the main organization. Similarly, trading subsidiaries (of non-profits) are also considered to be part of the firm if main organization has a level of control over the activities of the trading subsidiary. Characteristics of the firm such as the legal structure or culture are also captured here.

The output of the firm is represented as products and services that are delivered to customers. A notable differentiation here is the explicit separation between different types of customers. The end-users of the products and services may be different from the customers paying for it (Weisbrod, 1998). This separation between users and paying customers is not exclusive to TSEs. For example, search engine companies (such as Google or Bing) may provide products and services to users who do not pay for it. Advertising companies (among other paying customers) indirectly pay for the products and services on behalf of the users. In the case of TSEs, the priority is to create and deliver value to beneficiaries (users) whom may or may not pay for the services directly (Lyons & Kickul, 2013). For example, governments or non-governmental organizations (NGOs) could be paying for the products and services of the TSEs on behalf of the end users (beneficiaries). This is not always the case as the end users (beneficiaries) themselves could be paying for the products and services.

A typical model used by non-profits engaging in business (or earned-income activities) is the cross-subsidization model (James, 1983). Cross-subsidization is typically characterized by delivering products and services to an entirely different market to pay or subsidize for the primary end users (beneficiaries). This different market is typically much more financially able to pay for products and services to sustain the operations of the charity or social organization. This is typically achieved by delivering a premium version of the products and services or delivering an entirely different set of products and services. Business transaction in the cross-subsidization model is mainly to further the firm's financial objectives. The earlier example provided of NGOs paying on behalf of beneficiaries is not considered to be cross-subsidization because the business transaction is conducted to further the TSE's primary social objectives. In the proposed

framework, the primary customers (beneficiaries and those paying for it) are labelled as *Social customers*. The customers cross-subsidizing the social customers are labelled as *Commercial customers*.

The products and services delivered to both types of customers may be achieved through collaboration and partnership with other organizations downstream. A key contribution of Lubik and Garnsey's (2016) framework is describing the many ways in which the firm engages with partners (labelled as co-producers) to deliver products and services to end users. Similarly, the proposed framework will include *Partners* as components to represent organizations which assist in delivering the products and services to the customers (both financial and social customers).

Resources flow from the customers to the firm typically in the form of revenues. Conceptually, this flow of resources represents the feedback loop of the open systems approach.

All the above exchange of resources between the firm and other organizations occurs in an environment. The environment is a central concept in the open systems approach, which is intuitively labelled as *Environment* in the proposed framework. This is meant to capture contextual factors that enable the exchange of resources to occur. Contextual factors could be due to the geographical location of the firm, or it could go beyond physical presence such as the industry which the firm decides to enter.

Both proposed frameworks (entrepreneurial process and flow of resources) are intertwined. The *Building resource base* step clearly represents the exchange of resources between resource providers and the firm. *Creating value* and *Capturing value* is similarly represented by the exchange of resources between the firm and its customers. As such, it makes sense to integrate both frameworks to produce an overall framework to provide a more holistic answer to the research question. This integrated framework will be described in the following section together with a summary of the framework components.

3.4.2.3 Proposed integrated conceptual framework

The integrated framework of entrepreneurial process and flow of resources in a TSE is shown in **Figure 3.16**.

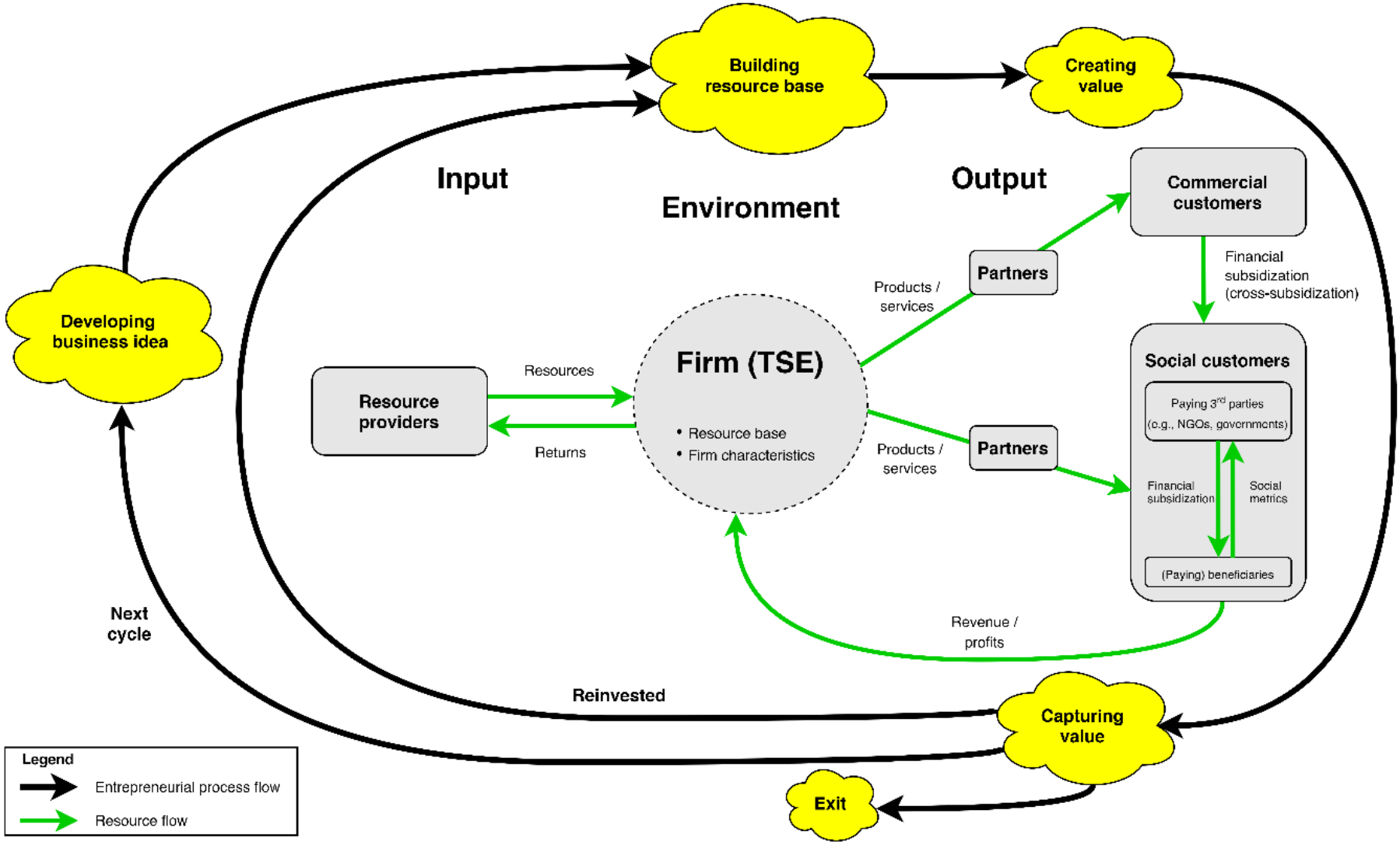


Figure 3.16. Proposed integrated conceptual framework to describe growth process of TSEs.

A summary of the framework components is elaborated in **Table 3.10**.

Table 3.10. Summary of description of framework components.

Framework components	Description
Entrepreneurial process	
Developing business idea	Described by the origin of the business and the founding team.
Building resource base	Described by the process which the firm acquires resources from *resource providers* to build up its *resource base.* Resources includes: • Financial capital • Human capital • Technology development/IP • Pro bono • Volunteers • Organizational legitimacy • Culture • Other resources
Creating value	Measured by revenue generated or users of the firm's products and services.
Capturing value	Measured by profits that have been captured by the firm to sustain its operations.
Exit	Plans to exit the business if available.
Next cycle	Diversification of the firm into new market segments.
Resource flow	
Resource providers	Organizations or individuals upstream of the firm which provides resources to the firm.
Firm characteristics	Described by the legal structure and culture of the firm.
Partners	Organizations downstream of the firm which assists in delivering products or services to the customers.
Commercial customers	Commercial customers are customers in a separate market segment that is mainly to fulfil commercial objectives. This is considered as cross-subsidization if it is present.
Social customers	Social customers are the beneficiaries and third-party organizations which may pay for the products and services on their behalf.
Environment	The contextual factors of the TSEs that are highlighted by the firm or resource providers.

The integrated conceptual framework (**Figure 3.16**) will be used to guide data collection and analysis of TSEs.

3.5 Qualitative rigour

Yin (2014, p. 45) suggests four criteria to judge research design quality of a case study (**Table 3.11**). Although the suggested criteria uses nomenclature that was originally derived in the quantitative domain, Yin's (2014) definitions and suggestions for fulfilment of criteria have already been tailored for the qualitative domain. The objective of fulfilment of the criteria is to establish "trustworthiness" in the research (Lincoln & Guba, 1985). Internal validity, external validity, and reliability have in the qualitative domain have also been referred to as credibility, transferability, and confirmability respectively (ibid.).

Table 3.11. Fulfilling criteria for good research design by Yin (2014).

Criterion	Definition	Fulfilment in this study
Construct validity	Identifying correct operational measures for the concept being studied	• Used multiple sources of evidence • Established a chain of evidence
Internal validity (Credibility)	Seeking to establish a causal relationship, whereby certain conditions are believed to lead to other conditions, as distinguished from spurious relationships	• Addressed rival explanations • Conducted member checks
External validity (Transferability)	Defining the domain to which a study's findings can be generalized	• Retained a homogeneous case setting • Provided a thick description of the phenomenon • Used theoretical replication logic
Reliability (Confirmability)	Demonstrating that operations of a study can be repeated	• Used case study protocols • Developed a case study database

3.6 Summary and conclusion

A summary of the research approach and methodology undertaken for this thesis is presented in **Table 3.12**.

Table 3.12. Summary of research approach and methodology.

Components	**Descriptions**
Ontological position	Relativist
Epistemological position	Weak social constructionist
Context	Cambridge, United Kingdom
Research strategy	Abductive
Research method	Case study
Selected cases	Five – Raspberry Pi, Simprints, WaterScope, Solaware, Blue Tap
Unit of analysis	Technology-based social enterprise organization
Unit of observations	Technology-based social enterprises and their resource providers
Data collection and analysis	Stage 1 – Resource-based framework Stage 2 – Legitimacy-based framework

The following Chapter 4 will present an analysis of the data collected based on the resource-based framework (Stage 1) and legitimacy-based framework (Stage 2). Chapter 5 will subsequently present a discussion of the research implications from both stages of analysis. Chapter 6 will ultimately state this study's contribution to theory and practice and provide conclusions.

Chapter 4 Case study findings

This chapter presents the research context in which the case studies were conducted and a summary of the five case studies – Raspberry Pi, Simprints, WaterScope, Blue Tap, and Solaware, structured around elements of the resource-based conceptual framework (Stage 1) (**Figure 3.16**). This is followed by a cross-case analysis of the cases. This chapter concludes with findings structured around elements of the legitimacy-based framework (Stage 2). More detailed versions of these cases are accessible via:

https://docs.google.com/document/d/1lpy0jl-TJm5OxKjg6pYnSx6DI1knChBPfYD4bc08zHo/edit?usp=sharing
(If link is no longer valid, please email the researcher at yongbm@gmail.com to request access.)

4.1 Research context

TSE is a phenomenon that has emerged over the last decade as a result of two separate fields merging together, viz. technology enterprises (also technology-based enterprises) and social enterprises. Cambridge in the United Kingdom (UK) has been selected as the geographic context of the firms studied in this thesis. The following sections will describe the Cambridge economic, geographic, and social context, and provide justifications on why it is an appropriate context within which to explore the research question.

4.1.1 Technology enterprise context in Cambridge, United Kingdom

Technology enterprises are business firms which has technology at the core of its entrepreneurial activities (Dorf & Byers, 2008). These firms tend to exhibit certain characteristics such as high growth (due to scalable nature of technology) (Siegel et al., 1993), knowledge intensive (Garnsey & Heffernan, 2005), and typically capital intensive (Florida & Kenney, 1988a). The level of intensity of those characteristics varies depending on the sector in which the firm operates and the stage of firm growth. In addition to the industry sector, there is evidence that the locality of the firm also affects the firm's growth due to the presence (or absence) of resources in the environment surrounding the firm (Florida & Kenney, 1988a, 1988b; Garnsey & Heffernan, 2005).

In the case of technology enterprises, there are some well-known locations with a higher-than-average concentration of technology firms such as San Jose (United States), Cambridge, (United Kingdom), Tel Aviv (Israel), Munich (Germany), among others. These locations have been labelled as "innovation clusters" by scholars (Engel, 2015).

Cambridge is a county town of the Cambridgeshire County in the United Kingdom. It is geographically located north-east of London with a 25-mile radius centred on Cambridge. The estimated working population in Cambridge is approximately 365,000. There are an estimated 5,372 technology-based firms in Cambridge with a total turnover of £18bn, employing over 67,000 people[38]. Local firms are active in key technology sectors such as information and communications technology (ICT), advanced electronics and engineering, materials, instrumentation, biotechnology, and technology consultancy (Garnsey & Heffernan, 2005).

Some of UK's most highly valued technology enterprises originated in Cambridge, from Acorn Computers (founded in 1978) to Arm Holdings (founded in 1990), Solexa (founded in 1997), and more recently companies like SwiftKey (founded in 2008), Improbable (founded in 2012), and Darktrace (founded in 2013). Cambridge has been ranked by the European Commission as "excellent for its support of innovative start-ups" (cited in Cambridge Technopole Report v1.5 (Minshall & Gill, 2013)) and highlighted by analysts as one of top three innovation ecosystems globally (Graham, 2013).

The presence of three universities in Cambridge (i.e., University of Cambridge, Anglia Ruskin University, The Open University) has contributed to the high concentration of knowledge-based workers. The University of Cambridge in particular, has been involved in many important scientific discoveries and inventions, as evidenced by the high number of Nobel Laureates affiliated with the prestigious university[39]. The university's encouraging policies[40] for technology transfer has positioned it as a leading institution relative to its peers[41]. Within the university's environment, there are many sub-organizations that exist to encourage entrepreneurship. Examples of such sub-organizations are academic departments such as the Judge Business

38 Data from Cambridge Ahead for 2019-2020, filtering for knowledge-intensive firms (https://www.cambridgeahead.co.uk/cambridge-cluster-insights/).
39 As of 2019, affiliates of University of Cambridge have received more Nobel Prizes than those of any other institution.
40 Starting from 1986, universities in Britain had rights to intellectual property for research funded by the Research Councils. The University of Cambridge was unusual in vesting this entitlement to inventors on its staff (Garnsey & Heffernan, 2005).
41 University of Cambridge Enterprise Annual Review 2018.

School, Institute for Manufacturing; technology transfer organizations such as Cambridge Enterprise; student-led societies such as Cambridge University Entrepreneurs (CUE), Cambridge University Technology and Enterprise Club (CUTEC); accelerators and incubation programmes such as ideaSpace and i-Teams.

Beyond the university, but within Cambridge, there are also numerous organizations in the ecosystem which contributes to entrepreneurship such as equity investments funds and networks (e.g., Amadeus Capital Partners, Cambridge Angels), co-working spaces (e.g., MakeSpace, Bradfield Centre), science parks and incubators (e.g., St. John's Innovation Centre, Future Business Centre, Cambridge Science Park).

Recognizing that there are other geographic clusters within which TSEs could be studied, Cambridge as a leading technology cluster makes it an appropriate choice to study technology-based enterprises. We will now consider the social enterprise context of Cambridge in the next section.

4.1.2 Social enterprise context in Cambridge, United Kingdom

As mentioned in the literature review, the UK is perceived by some as having one of the most developed institutional support structures for social enterprises in the world (Nicholls, 2010). The rapid growth of social enterprises in the UK has made the nation an appropriate choice for many scholars to conduct research on social enterprises[42].

While there is no research to show that Cambridge is a notable cluster for social enterprises in the UK[43], in the recent decade, there has been a noticeable increase in organizations and programmes dedicated to supporting social enterprises in Cambridge. For instance, within the University of Cambridge, Cambridge Enterprise has recently appointed staff to look specifically at how their organization can support social enterprise initiatives in the university[44]. Prominent business plan competitions organized by student societies such as Cambridge University Entrepreneurs (CUE)

42 Even after Teasdale's (2012) criticism of the actual number of social enterprises in the UK are taken into consideration, the number of social enterprises in the UK is still relatively high.
43 To the researcher's knowledge, there has not been any research conducted on geographical clustering of social enterprises across the UK.
44 Cambridge Enterprise has predominantly focused on commercial technology transfer activities of the university.

have had a Social Enterprise category since 2009. There are academic groups dedicated to researching social enterprises such as the Cambridge Centre for Social Innovation[45] (part of the Judge Business School). There are also organizations such as Cambridge Social Ventures which incubates social enterprises in Cambridge.

Beyond the university, there are also many other organizations which provide support to social enterprises. Charities such as the Centre for Global Equality are relatively prominent in the Cambridge social enterprise ecosystem. Allia's Future Business Centre is a co-working space which hosts social enterprises in Cambridge. Even organizations which have not been setup for social enterprises such as Cambridge Wireless have in recent years focused more on supporting social enterprises[46].

The unique intersection of technology and social enterprises in Cambridge has resulted in the formation of notable TSEs such as Raspberry Pi. This makes Cambridge an appropriate choice to provide answers to the research question. However, considering social enterprise is not a legal structure in itself, there is a need to clarify the specific context of TSEs of interest for this study. This will be described in the following section.

4.1.3 Technology-based social enterprise context in Cambridge, United Kingdom

According to the UK government, a social enterprise is defined as a business with primarily social objectives, whose surpluses are principally reinvested for that purpose in the business or in the community, rather than being driven by the need to maximise profit for shareholders and owners (DTI, 2002). This definition is relatively looser compared to the definition adopted by other European countries as it does not include asset lock limiting surplus and asset distribution as part of its definition[47]. As a result of this looser definition, in practice, many practitioners adopt the approach of Judge Potter Stewart's "I know it when I see it" to identify social enterprises[48].

45 Cambridge Centre for Social Innovation (https://www.jbs.cam.ac.uk/faculty-research/centres/social-innovation/).
46 They have organized events to connect local social enterprises with expert members in their network.
47 European Commission's 2019 report, "Social Enterprises and their Ecosystems in Europe: UK Country Report".
48 Based on interviews with relevant individuals involved in the social enterprise space in Cambridge.

TSEs are conceptualized as a subset of technology enterprises in this thesis (illustrated in Figure 4.1). All technology firms which are not-for-profit (but engaging in business) are considered TSEs. A challenging issue is to identify technology for-profit firms as TSEs since they overlap with commercial technology enterprises. The approach taken in this thesis identifies technology for-profit firms as TSEs if they self-identify or has been identified by other organizations as social enterprises.

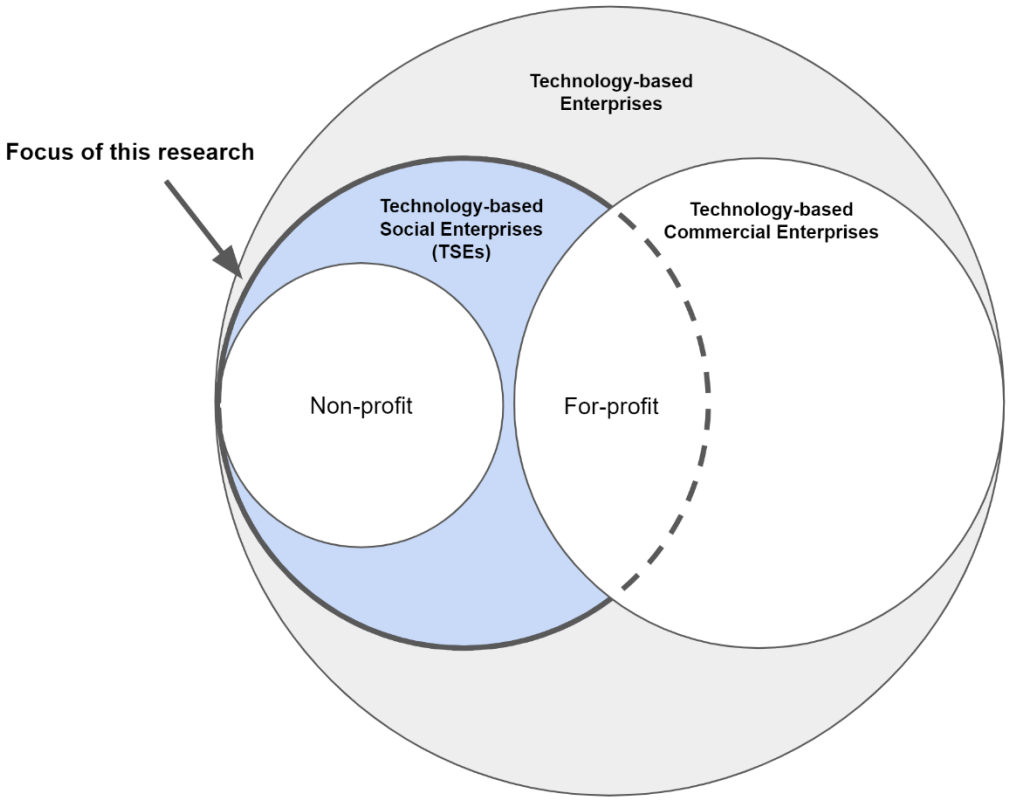


Figure 4.1. Venn diagram to illustrate Technology-based Social Enterprises (TSEs) within the context of all Technology-based Enterprises.

4.2 Stage 1: Resource-based analysis

4.2.1 Raspberry Pi

Raspberry Pi Foundation (hereon referred as the Foundation) was registered as a charity in 2008 with six founding trustees – Eben Upton, Jack Lang, David Braben, Robert Mullins, Professor Alan Mycroft, and Pete Lomas. Many of the founders (all except Pete Lomas) were directly associated with the University of Cambridge. Its charitable mission was to promote computing education by developing low-cost, high-performance computers which costs about the same price as a textbook, £25.

The charity was initially founded to address the problem of declining number of applicants to the University's Computer Science program. The idea of developing a computing device was inspired by the BBC Micro, a home computer device in the 1980s that many of the founders had their first exposure in learning programming. The founders approached BBC in 2011 with a prototype Raspberry Pi device to pitch a partnership to produce the device under BBC, much in the spirit of a modern equivalent of the BBC Micro. Unfortunately, BBC was unable to get involved due to a change in corporate policies. However, the meeting led to a blog post in May 2011 by a seasoned BBC reporter, Rory Cellan-Jones, who made the prototype Raspberry Pi device an overnight online viral sensation which skyrocketed demand.

The founders raised funding from loans (mostly personal loans and a loan from a Cambridge-based investment group, Cambridge Angels) to manufacture the estimated 10,000 units worth of demand. The Foundation manufactured 2,000 units before deciding to seek distribution partnerships to overcome manufacturing challenges. A partnership was subsequently formed in 2012 with two large electronic distributors, RS and Premier Farnell, to manufacture and distribute the devices.

The Foundation's charity status was a key enabler for the technology development of the Raspberry Pi device (by convincing suppliers and volunteers to provide support. The charity status was "useful" (RPI-Upton) to convince many suppliers to supply components at low volume (but high-volume pricing which is lower in cost), which was critical to make the low-cost model work. Most importantly, the charity status enabled the Foundation to secure a supply of BCM2835 microchips (which was the heart of the Raspberry Pi devices) from Broadcom which waived their strict MOQ requirement (millions of units) for commercial engagements.

Additionally, the charity status also enabled the recruitment of volunteer engineers from Broadcom to assist with the development of the device. The designs of the Raspberry Pi devices are open-sourced, but difficulty to access a supply of BCM2835 provided protection from competitors to create knockoffs.

The main target audience of the Foundation, in line with its charitable mission, were people (children and adults) interested to learn how to code. However, the Foundation quickly realized that there were many customers outside of their target audience such as industrial companies who wanted to use Raspberry Pi devices for their applications since it was essentially a low-cost computing device. The opportunity to sell devices to industry was financially lucrative but there was an obstacle as charities can only engage in "primary purpose trading". Trading with industry is generally not considered part of its charitable activities and trading at scale may be prohibited by law.

At the same time, issues rose with regards to resource allocation within the Foundation for development of the next generation of the Raspberry Pi devices. The Foundation's charitable mission was to promote education in computer science, but it does not explicitly state that this must be done through Raspberry Pi devices. One of the founding trustees said,

> "if a charity is interested [in] giving cheap tech and tech education to as many people as possible, while the Raspberry Pi might have founded it and set it off, if we could find some other company like Intel or somebody that said, *'oh, […] we've got this new Mini Intel thing and it is very low power and you could make a Raspberry Pi-like computer with […] twice as much memory and twice the speed and half the price'*, then the Raspberry Pi as a charity probably ought to move into that way. Well, [but] the people working on the tech would say, '*No, no, no. That's our jobs.'"* (RPI-Mycroft).

The tension was between allocating resources to further the charitable mission (such as having more training and educational programs using the existing Raspberry Pi device) and allocating resources to the development of next generation Raspberry Pi devices (such as Raspberry Pi 2 or 3). This tension contributed to the decision to split the Foundation and incorporate a wholly owned trading subsidiary, Raspberry Pi Trading Ltd, on 10 September 2012.

Raspberry Pi Trading (hereon referred as Trading subsidiary) was operated as a commercial company and all profits are donated to the Foundation as a gift. The Trading subsidiary would have autonomy to concentrate on product development and trade, while the Foundation would concentrate on furthering its charitable mission via educational programs and training. The Trading subsidiary then went on to develop multiple versions of the Raspberry Pi, including industrial versions such as the Compute Module.

The Cambridge ecosystem was cited by the founders as a factor which enabled the rapid growth of the organization. The presence of established technology companies such as ARM and Broadcom played an important role in supporting the Foundation at its inception. Additionally, the high concentration of high-profile entrepreneurial individuals in Cambridge (such as Hermann Hauser[49] and David Cleevely[50]) also played an important role to shape the direction of the Foundation in its early days.

The Raspberry Pi organization sold approximately 37 million units of Raspberry Pi devices by 2021[51] (latest model shown in **Figure 4.2**).

Figure 4.2. Raspberry Pi 4 Model B from the side.
(Source: Michael Henzler/Wikimedia Commons/CC BY-SA 4.0)

49 Cambridge-based serial entrepreneur, and investor who co-founded ARM from Acorn in 1990.
50 Chairman of Cambridge Angels.
51 Raspberry Pi blog post, dated 21 Jan 2021(https://www.raspberrypi.org/blog/raspberry-pi-silicon-pico-now-on-sale/).

Key events

Year	Key Events
2008 (November)	Incorporation of Raspberry Pi Foundation.
2011 (May)	Raspberry Pi became viral through the online blog by BBC's Rory Cellan-Jones.
2012 (February)	Official launch of the Raspberry Pi device. Switched to licensing business model and partnered with Premier Farnell and RS Components as distributors.
2012 (September)	Incorporation of Raspberry Pi Trading Limited. Eben Upton was made CEO of both the Foundation and the Trading subsidiary.
2013 (September)	Lance Howarth was appointed as CEO of Raspberry Pi Foundation.
2014 (April)	Launch of Compute Module device.
2014 (October)	David Cleevely was appointed as Chairman of the Board of Trustees for the Foundation.
2015 (February)	Launch of Raspberry Pi 2 device. MagPi is handed over to the Foundation.
2015 (July)	Phillip Colligan is appointed as the new CEO of Raspberry Pi Foundation.
2015 (November)	The Foundation merged with Code Club.
2016 (February)	Launch of Raspberry Pi 3 device.
2017 (February)	Launch of Raspberry Pi Zero device.
2017 (May)	The Foundation merged with CoderDojo Foundation.
2019 (June)	Launch of Raspberry Pi 4 device.

4.2.2 Simprints

The idea for Simprints to address the problem of identification bottlenecks in developing countries was first conceived at a Cambridge hackathon event by Toby Norman and a few other students in 2012. Simprints' solution was to develop an affordable, secure, rugged, open-source fingerprint system that would work in the world's toughest settings where over 1.1 billion people lack formal identification, preventing access to essential services such as finance and medicine. The system would be optimized to deal with scarred, worn, and burned fingerprint profiles which is common among the world's poorest citizens and not currently addressed in the biometrics industry.

Simprints was treated as a student society at its inception by Toby and other student volunteers, many whom were Gates Scholars. In the early days, Simprints won many competitions open to students in Cambridge (such as CUE Business Plan competition) as well as small government grants to sustain operations (such as Technology Strategy Board grant) as a student society. A pivotal moment came when Simprints managed to win the Saving Lives at Birth (SLAB) competition in 2014 with matched funding provided by ARM, for a total of USD$400k. The funding enabled Simprints to incorporate officially as a company limited by shares and for the founders to go fulltime.

After pro bono consultation from a Cambridge-based law firm, Taylor Vinters, Simprints converted into a non-profit in 2015 by amending its Articles of Association to incorporate an asset lock. The non-profit status was essential for Simprints to secure pro bono resources from other companies and recruit volunteers. Even before the official amendment, the founders had already communicated their intention for Simprints to be non-profit, which was important to secure the guarantee of matched funding by ARM in 2014.

Volunteers played a crucial role in the technology development process as it enabled Simprints to recruit highly skilled technical talent without incurring much financial costs (apart from beers and pizzas as refreshments). Experienced engineers from local technology companies such as ARM and Qualcomm, retired software consultants, and graduate students in Cambridge provided a constant pool of technical talent to assist with hardware and software development. At its peak, Simprints was hosting an average of up to twenty volunteers every Monday evening as part of its public volunteering sessions, dubbed Hack Nights (**Figure 4.3**). In the early days, Hack Nights

enabled Simprints to overcome many technical challenges to develop the fingerprint device despite not having a large in-house engineering team. However, as the technology development matured, the overheads of managing volunteers eventually exceeded the returns, which led to Simprints stopping Hack Nights in September 2016. Dan Storisteanu, a co-founder, commented on the challenges of using volunteers over time,

> "It kind of got more and more challenging over time because you know, they're volunteers. No one's mandated to be there. They're incentivized with pizzas and beers, but people would show up and we'd be like, *'okay, we need to come up with a project for these people. What's a project that they could do?'* and then they would not show up the next time or like this project was important but then the person wouldn't show up. Or someone else would show up and they'd be like, *'I want to do this'*, but they weren't very good. And then another person would show up and be like, *'Ah, who can come up with a project, who can like do something with them'* and it ended up requiring so much of our time in the end, and I think as we were growing and increasing our in-house engineering capacity, the benefits were decreasing of having external volunteers. And also, as you know, more and more people came, we had Hack Nights with more than 20 people and preparing for that every Monday night and having projects for everyone and food and everything became more and more of our time. And so at some point, we stopped." (SIM-Storisteanu)

Figure 4.3. Hack Night volunteering session in progress.

The Cambridge ecosystem played an important role to support Simprints in its early stages. Local organizations such as Centre for Global Equality (CGE), Makespace, the University, provided resources in the form of office space, business networks, and equipment. Companies such as ARM, Taylor Vinters, and Redgate, which provided resources to Simprints also provided additional credibility when Simprints was at the start-up stage. Many high-profile individuals such as Ken Banks and Professor Alain Labrique also provided support in an advisory capacity due to Simprints' association with the University of Cambridge.

Simprints' identification system (hardware portion shown in **Figure 4.4**) is claimed by them to be 228% more accurate in low-resource settings and 4x more affordable than existing solutions.

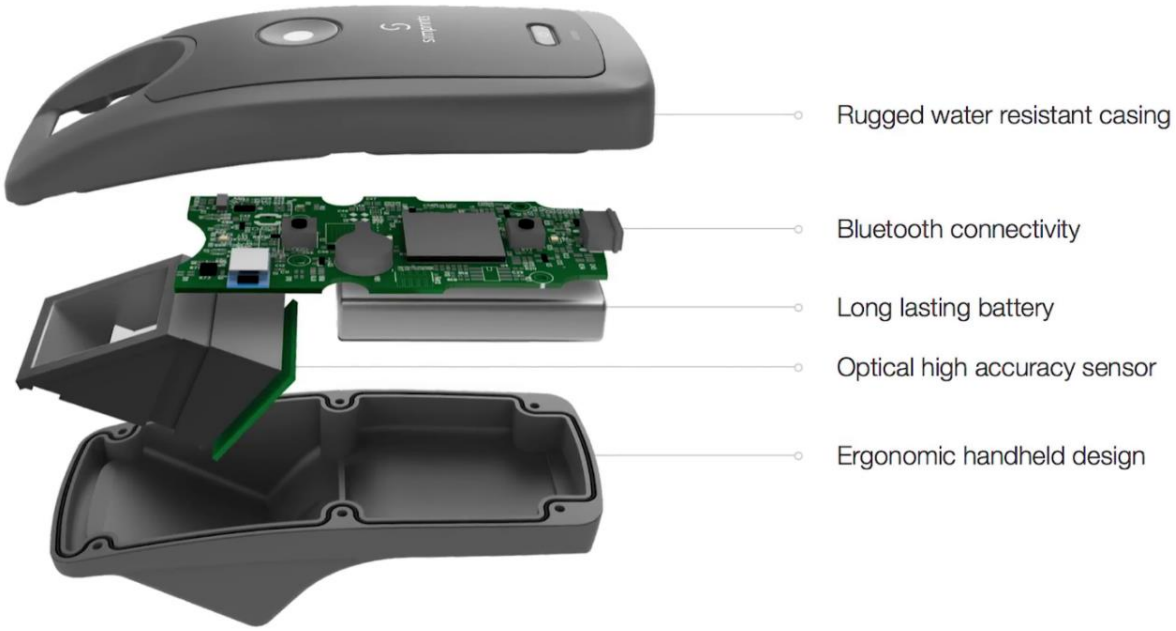


Figure 4.4. Rendering of the Simprints Vero Scanner. (Source: Simprints)

Key events

Year	Key Events
2012 (February)	Conceived the Simprints idea at the Global Health hackathon organized by the Humanitarian Centre.
2013 (July)	Launched an Indiegogo online crowdfunding campaign. Incorporated Simprints as a company limited by shares.
2013 (October)	Recruited Prof. Alain Labrique to join Simprints advisory board. Joined Makespace to start development of the prototype scanner device.
2013 (December)	Awarded the Technology Strategy Board's grant of £15,000.
2014 (January)	Reincorporated Simprints.
2014 (circa Jan-March)	Presented at ARM. Recruited Pawel Moll as a volunteer to assist with technology development.
2014 (March)	Applied for the Saving Lives at Birth competition.
2014 (May)	Organized first field trial to test prototypes
2014 (July)	Secured a commitment of matched funding from ARM on the condition Simprints won the Saving Lives at Birth Competition.
2014 (August)	Presented and won the final stage of the Saving Lives at Birth competition at Washington D.C.
2015 (April)	Amended Articles of Association to include asset lock.
2015 (July)	Moved into the Chesterton Towers.
2016 (September)	Stopped public volunteering sessions, Hack Nights.
2017	Won USD$2m scale-up funding from Saving Lives at Birth 2017.

4.2.3 WaterScope

WaterScope was conceived in 2015 at a Development i-Teams[52] session by Alexander Patto, Nalin Patel, Tianheng Zhao, and Richard Bowman. The aim of the company was to develop an affordable high quality water testing kit that was initially based on an open-source 3D-printed microscope. The main problem statement was the fact that in some developing countries, one in ten people lack access to safe drinking water, and waterborne diseases from bacterial pathogens result in over 2.2 million deaths per year. Conventional water testing kits are typically time-consuming, require a lot of power, and not usable by scientifically unskilled workers. This problem prompted WaterScope to develop their low-cost alternative.

WaterScope was communicated as a non-profit, which convinced key volunteers to provide support for the technology development of the water testing kit (**Figure 4.5**). WaterScope sustained its operations by winning competitions in Cambridge (such as CUE Business Plan competition) and grants from university (such as Global Challenges Research Fund) and charities (such as Humanitarian Innovation Fund (HIF) and CGE). Cecilie Hestbæk, a Senior Innovation Manager at Elrha, stated that Waterscope's partnership with Oxfam was an important factor for the decision to fund Waterscope. She said,

> "As far as I'm aware, they [Waterscope] already had a partnership with Oxfam to test it [water testing kit]. So, we would normally never fund […] an entrepreneurial organization with an idea if they didn't have a partnership with a humanitarian organization because we need to make sure that the understanding of the humanitarian context is there. That the access to testing in the field is there and very importantly, the ethical part of doing humanitarian innovation is there." (WCP-Hestbæk).

However, as the technology development matured, WaterScope decided to switch to for-profit to have more options to secure funding. This switch to for-profit was followed by an exploration to find commercial industrial applications for the water testing technology that had been developed by WaterScope. A key volunteer stated that his involvement with WaterScope prior to the switch to for-profit, made him understand the need to diversify into commercial markets. He stated that it would be unlikely for him to volunteer if WaterScope was first pitched to him as a for-profit

52 Brainstorming sessions hosted to bring people with different skillsets together to provide solutions to problems.

company operating in commercial markets. Waterscope's open position on intellection property also had a positive impression on stakeholders. David Gill, a judge for the CUE Business Plan competition, stated,

> "The question that we asked the team is, *'you haven't sought to protect your intellectual property. Is that going to be a problem?'* and they said, '*No. We would be delighted if millions of people used this to get clean water*' and that to me, that's one of those differentiators between 'tech as commerce' and 'tech as social impact'. It brings out that incredibly fine line about sustainability because if I were a venture investor, and you're saying to me, *'I don't care if people steal my technology'*, I'd be going, I can't invest in you. If what I'm looking for is to relieve the problems of dirty water for millions of people in 50 countries, then you are the pioneers, you are going to have a future. Maybe your financial returns will be lower if people don't copy your technology because social impact is going to be so much better if people DO plagiarize you. And that to me is one of those conundrums that if you're involved in this, well, you seem to have to come to terms with. In a way, the more successful I am, the more vulnerable I am." (WCP-Gill)

The Cambridge ecosystem contributed to WaterScope's growth. Local companies such as ARM and Redgate provided in-kind resources through their engineers. CGE provided small amounts of funding and made important introductions to other organizations in Cambridge, most notably to Simprints. This resulted in Toby Norman from Simprints sitting on the advisory board of WaterScope.

Figure 4.5. An advanced iteration of the WaterScope water testing kit. (Source: WaterScope)

Key events

Year	Key Events
2015 (circa March)	Conceived the WaterScope idea at a Development i-teams session.
2015 (Summer)	Won second prize award at the EPOC Business Plan Competition.
2015 (July)	Incorporated as a company limited by shares on 29 July 2015 on Company House.
2016 (May)	Won the main award in the Social Enterprise category of the CUE Business Plan Competition.
2016 (October)	Redgate provided volunteer engineers as part of their 'Down Tools Week' event.
2016 (December)	Conducted field trials in Tanzania in partnership with Oxfam.
2019 (March)	Switched to for-profit legal structure.

4.2.4 Solaware

Solaware was conceived by James Griffith in 2015 to develop wearable wrist solar-powered lighting devices for developing countries. The idea was prompted by an internal call in James' research group, Centre for Gallium Nitride, to find applications for efficient light-emitting diode (LED) technology that had been developed by their group.

Solaware managed to win a few competitions in Cambridge (such as CUE Business Plan competition) to provide start-up funds to develop their prototype. The initial plan was for Solaware to adopt a cross-subsidization model to sell a premium version of the wearable devices to developed countries and an affordable low-cost version in developing counties (**Figure 4.6**). However, after receiving feedback that their initial product was too expensive for developing countries, Solaware pivoted to develop head torches for cyclists in commercial markets. The initial focus on using patent protected LEDs would also be dropped to use off-the-shelf LEDs which were cheaper. The business model was changed to a donation model where Solaware donated a device to people that "lived in extreme poverty" for every three device that they sold in the UK. Solaware which was initially communicated as a not-for-profit, also pivoted to a for-profit structure to accompany the shift in focus to commercial markets. The for-profit structure enabled Solaware to distribute equity in lieu of salary to hire a fulltime CEO to take over operations in August 2018.

However, the Solaware team eventually found it too challenging to compete in commercial markets and decided to stop their operations in April 2019. Philip Hilton, a business advisor of Solaware, stated that he felt the change in direction to targeting developed markets made it challenging for Solaware to differentiate itself from competitors. He said,

> "They changed the emphasis to developing a product for developed world for cyclists primarily, leisure product which will be head-worn rather than wrist-worn. A torch basically. […] I took some convincing that this was the right way to go. I wasn't happy really because I thought they'd lost sight of the original way of approaching this problem. Now, to be fair, they have not lost their social end. Their objective was to give one, donate one device in developing world for every three sold. […] They still have this big social objective, and they hadn't lost this, but the way they were doing it had changed completely. […] The model to me had changed. […] If you put something on the

> internet, it looks attractive, you'll sell some. But I didn't see that they now were differentiated in the same way, because they were differentiated partly by the product, which was a good product for the developing world, but also by the fact of who they were aiming at and why they were doing it, and their motivation. Although they still have this motivation, it was more of an indirect motivation, and […] now they were selling this developed world product primarily in a market where you can soon be copied. So, although they may have had some initial success, I didn't think it was so sustainable." (SLW-Hilton)

Solaware also managed to access experienced individuals in the Cambridge ecosystem. For example, Philip Hilton and Lara Allen (CGE) both joined the advisory board of Solaware to provide mentorship. Toby Norman from Simprints also provided advice regarding the legal structure and other aspects of running a social enterprise business.

Figure 4.6. Prototype of the Solaware wearable wrist solar-powered lighting device. (Source: Solaware)

Key events

Year	Key Events
2015 (May)	First discussion on solar lighting device
2016 (February)	Cambridge Hub venture for change award £500
2016 (March)	Won the Churchill Enterprise competition. Philip Hilton joins as an advisor. Joined Makespace.
2016 (circa May)	Development of preliminary electronic circuit and prototype product.
2016 (September)	First field testing in Vietnam
2016 (November)	Meeting with patent attorney, develop IP strategy
2017 (January)	Join the CGE cultivator. Won CUE £1k award.
2017 (March)	Won CUE £5k award.
2017 (July)	Registration as a company limited by shares at Company House.
2018 (May)	Amended Articles of Association to limit financial returns.
2018 (August)	Hired Jenny Robinson as the new CEO of Solaware.
2019 (April)	Stopped operations.

4.2.5 Blue Tap

The idea for Blue Tap was first conceived in 2013 after Francesca O'Hanlon did a six-month placement with Engineers without Borders at Mexico City. Francesca worked with a rainwater-harvesting NGO and a supervisor from MIT to develop technology that could automatically inject chlorine into water to sanitize water in developing countries. However, there was no progress beyond the design stage as there had been a "big barrier to prototyping". Blue Tap was only incorporated as a company limited by shares (later switched to CIC in 2019) after Francesca moved to Cambridge to pursue a PhD in 2016.

Blue Tap won competitions (such as CUE Business Plan competition) and grants (most notably National Geographic grant) to sustain operations in the early days. Afrinspire, a Cambridge-based charity which operates in Africa, was one of Blue Tap's main partners. The presence of this partnership has been cited as critical enabler for Blue Tap to secure grant funding.

Cambridge ecosystem played an important role to provide resources to Blue Tap. Local organizations (such as CGE and Allia) provided support in the form of accelerator programmes with access to business mentorship and networks. One of the most notable influences on Blue Tap's ability to secure grant funding was the presence of Simprints in Cambridge. Dan Storisteanu, co-founder of Simprints, whom Francesca met at her college's student orientation event in October 2016 provided important advice on securing funding in Cambridge. Francesca said,

> "I found out what he was doing [at Simprints] and I said, *'Oh I've got this idea'* and then because we were friends, […] I would ask his advice like, *'Hey Dan, we're applying for CUE 10K, like do you have any tips'*. […] They've shared with us a funding document and I put him down as a reference for some funding and stuff. So he's just been really I think the most useful mentorship I've had. Seeing a company or social enterprises [that's] where I want to be in three years with Blue Tap because then you're like, '*Ah, how did you get there?'* Like, you know, you can just track out your future steps. So it's useful." (BT-Francesca)

Additionally, Francesca stated that there was strong support for Cambridge-based companies and was one of the reasons for Blue Tap's emphasis of their Cambridge connection in fund raising attempts. Francesca stated,

"[Cambridge] really what was capitalized on. [They] don't just buy it from someone anonymously from the internet. That's why we've really focused our wholesale sales in Cambridge because you know, people understand this, there's a support for a Cambridge-based organization. And we're going to keep trying to capitalize on that." (BT-Francesca)

Key events

Year	Key Events
2013	First conception of the Blue Tap idea
2016 (November)	Formed Blue Tap team after Francesca attended a student society, Impact Through Innovation Cambridge (ITIC) meetup in Cambridge.
2018 (January)	Won National Geographic grant.
2018 (February)	Registered as a company limited by shares.
2018 (May)	Won CUE Business Plan competition.
2018 (September)	Field trial in Uganda. Funded by CGE's Sandpit funding.
2019 (March)	Changed to a CIC.

4.3 Summary of case studies

Table 4.1. Summary of case studies.

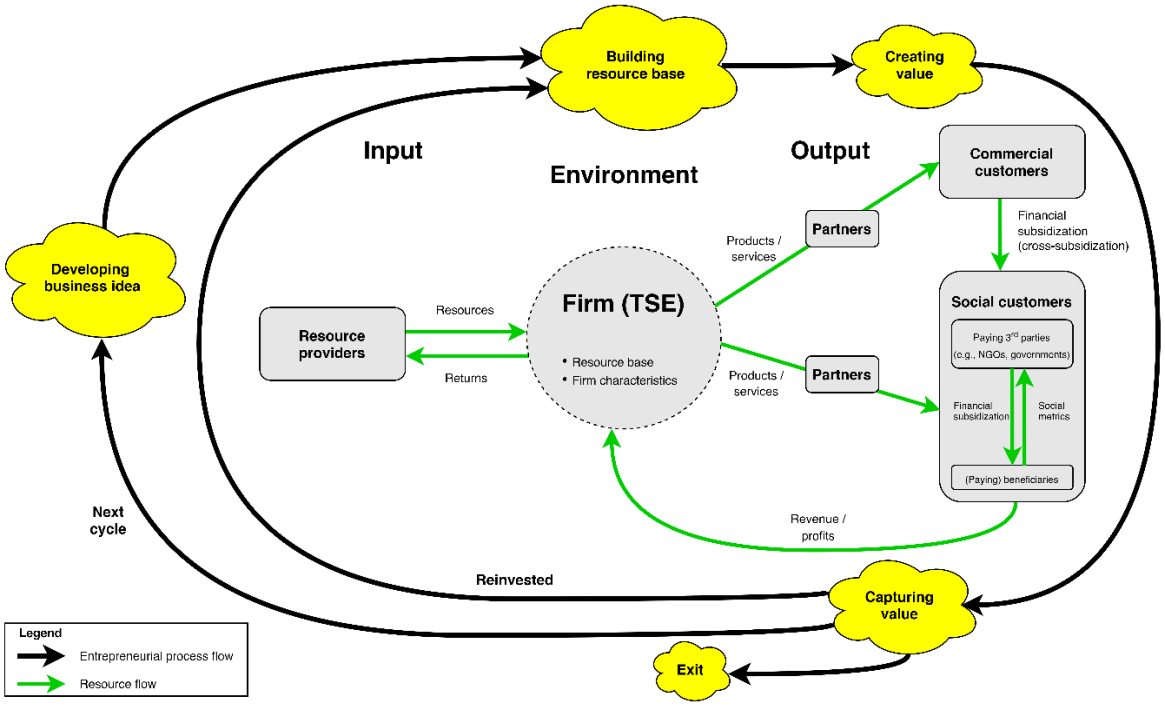
Full case studies are available via

https://docs.google.com/document/d/1lpy0jl-TJm5OxKjg6pYnSx6DI1knChBPfYD4bc08zHo/edit?usp=sharing

	Raspberry Pi	Simprints	WaterScope	Solaware	Blue Tap
Origin	Driven by problem	Driven by problem	Driven by problem	Driven by technology	Driven by problem
Founding team	Experienced individuals (university lecturers and businessmen)	Students	Students and a university staff (Nalin)	Postdoc and students	Students
Financial capital	Self-financed, funding from Cambridge Angels	Grant and university competitions, sales	Grant and university competitions	Grant and university competitions	Grant and university competitions
Human capital	Reached the stage to hire employees.	Reached the stage to hire employees.	Hired Alex Patto as full-time CEO.	Did not reach the stage to hire employees.	Did not reach the stage to hire employees.
Technology development/ intellectual property	Open-source hardware and software designs.	Partially open sourced their designs.	Sought for patent protection of their technology.	Technology was kept as a trade secret.	Technology was kept as a trade secret.
Pro bono	Received pro bono support	Received pro bono support	Received pro bono support	Received minimal pro bono support	Received minimal pro bono support
Volunteers	Moderate use of volunteers. Accessed corporate volunteers from Broadcom.	Heavy use of volunteers. Accessed corporate volunteers from Redgate and ARM.	Moderate use of volunteers. Accessed corporate volunteers from Redgate and ARM.	Minimal use of volunteers.	Minimal use of volunteers.
Creating value	Partnership with Code Club and Coder Dojo.	Partnership with BRAC.	Partnership with Oxfam.	Did not have a partnership with humanitarian organization.	Partnership with Afrinspire.
Capturing value	Earned profits from both commercial and non-commercial customers	Earned profits from non-commercial customers.	Did not earn profits.	Did not earn profits.	Did not earn profits.
Environment	Leveraged resources from the Cambridge ecosystem.				
Legal structure	Started as a charity. Later incorporated a trading subsidiary.	Adopted a hybrid not-for-profit structure of a company limited by shares with an asset lock.	Started as a not-for-profit in name. Later switch to for-profit.	Started as a not-for-profit in name. Later switch to for-profit.	Started as a company limited by shares out of convenience. Later transitioned to CIC.
Organizational culture	Prioritized impact over profits.				
Organizational legitimacy	Received support due to charity status.	Received support due to not-for-profit status.	Received support due to association with University of Cambridge.	Not-for-profit status was used as a strategy to receive support.	Received support due to association with University of Cambridge.
Next cycle	Diversified product lines and business (magazine publishing).	Diversified to develop neonatal fingerprint scanners.	Explored diversification of water testing technology in commercial markets.	Did not diversify but changed main product line (head torches for cyclist).	Did not diversify.
Exit	No plans to exit.	No plans to exit.	Explored opportunities to exit through acquisition.	Explored opportunities to exit through acquisition.	No plans to exit.

4.4 Cross-case analysis

This section describes the comparative analysis between the five case studies, structured around the elements of the conceptual framework, as re-presented below.



4.4.1 Developing business idea

4.4.1.1 Origin

Four cases (all except Solaware) had the inception of the firms driven by a social problem to resolve. Solaware's inception was driven by the desire to apply technology (novel LED technology) to resolve a social problem. Solaware eventually identified a social problem (lack of affordable lighting in developing countries) and continued to address the problem even after moving away from using the novel LED technology. The difference in the cause of inception meant that the four cases (all except Solaware) had their technology and business to be developed around the social problem they were trying to address. In contrast, as Solaware's inception was not driven by a social problem, they had changed their technology and business focus entirely later in the organization's lifecycle. Solaware had decided to change their focus from developing a product primarily for developing countries to developing a product for commercial markets (head torches for cyclists). The social mission of Solaware remained intact as it was still the

intention to distribute lighting devices to developing countries for every few devices sold in commercial markets. However, the nature of the new approach to address the social problem was more "indirect" (according to a business advisor of Solaware). A business advisor thought that Solaware had "lost sight of the original way of approaching this problem." (SLW-Hilton).

4.4.1.2 Founding team

All cases had founders with strong connections to the University of Cambridge. The key founders of all cases were either students or staff of the university when they founded their social enterprises. Only two cases (Raspberry Pi and Simprints) had co-founders that were not directly associated with the university (Pete Lomas and Tristam Norman respectively). The founders' association with the university enabled their firms to access university resources and opportunities (such as grants and competitions). Raspberry Pi also utilized some university resources (such as meeting rooms) but were relatively less reliant on university resources compared to the other four cases. This was likely because the founders of Raspberry Pi were more mature and had more personal resources to put into Raspberry Pi. The founders of the other cases in contrast were mainly students (or postdoc researcher in the case of Solaware).

4.4.2 Building resource base

4.4.2.1 Financial capital

Four cases (all except Raspberry Pi) had accessed sources of funding from the university (competitions and grants) to get started. Raspberry Pi was slightly different in acquiring financial capital for a few reasons. Raspberry Pi had a team of mature co-founders with more business experience. David Braben and Jack Lang are successful entrepreneurs. Eben was a first-time entrepreneur, but he was also the Director of Studies at St John's College and an engineer at Broadcom. The remaining co-founders were either university lecturers (Prof. Alan Mycroft, Robert Mullins) or company director (Pete Lomas). The founders' statuses meant they had the resources to self-finance the cost of Raspberry Pi's initial manufacturing run (of 10k units). Additionally, it was also the reason they were able to access funding from Cambridge Angels because of Jack Lang and David Braben's connections. It is also notable that at the time of Raspberry Pi's inception, there were no university grants or competitions (such as those that

funded the other four cases) that matched the scale of funding that Raspberry Pi required (approximately £75k-£250k for initial manufacturing run). Three cases (Simprints, WaterScope, and Solaware) have considered accessing private investments to fund the venture but did not go through due to a lack of interest from investors. The scale of Raspberry Pi's eventual business meant that it could have been possible to secure private investments. However, private investments were not pursued because Raspberry Pi founders wanted to maintain the organization as a charitable endeavour.

Three cases (Simprints, WaterScope, and Blue Tap) had received sources of funding that were external to the university environment (matched funding from Saving Lives at Birth competition and ARM; HIF funding; O2 and National Geographic respectively). The funding was significant as they allowed the firms to pursue new objectives. For example, Simprints stated that the large, matched funding allowed the founders to go full-time. WaterScope's funding from HIF was also significant as it allowed the founder (Alex Patto) to go full-time. However, the founders of Simprints and WaterScope have cited the importance of winning relatively small amounts of grants and competitions within the university environment to get started initially (such as the CUE and EPOC business plan competitions). The initial sources of funding from the university environment enabled the firms to sustain operations long enough until they can secure external funding. The external funding that Blue Tap received were roughly the same amount as the funding from internal university grants and competitions. Therefore, the importance of both external and internal sources of funding was similar for Blue Tap.

4.4.2.2 Human capital

Founders at Raspberry Pi and Simprints have both stated that the social mission was important to attract talents to their firms. They stated that some experienced hires were even willing to take a salary cut to work at the firms because of the social mission.

The cases also show that they benefited from having experienced advisors providing mentorship and guidance. Raspberry Pi had experienced entrepreneurs such as Hermann Hauser and David Cleevely to provide guidance. Simprints had Prof. Alain Labrique from John Hopkins University on their advisory board. WaterScope had Prof. Jeremy Baumberg from University of Cambridge on their advisory board. Solaware had Philip Hilton to provide guidance. The access to

experienced advisors can be attributed to the Cambridge ecosystem. Many experienced individuals were present within the Cambridge ecosystem to provide support to the firms. It is notable that Prof. Alain Labrique was not from Cambridge, but he cited the connection of Simprints to the university as part of the reason for his support.

4.4.2.3 Technology development/intellectual property

Raspberry Pi and Simprints both relied on volunteers to assist with technology development in the early days of the organization. WaterScope also used volunteers to assist with technology development, but the scale (of volunteers) was considerably smaller compared to Raspberry Pi and Simprints. Raspberry Pi and Simprints were able to utilize a larger number of volunteers to develop their technology likely because they had access to experienced engineers. The volunteers at Raspberry Pi were experienced engineers at Broadcom. Simprints had Pawel Moll, a Principal Engineer at ARM, to support them. This meant that the technology development of the two firms benefitted from having individuals with design experience involved in the process. The remaining three cases (WaterScope, Solaware, Blue Tap) had to develop their technology on a trial-and-error basis with limited technology development experience. This was likely the reason they were not able to emulate Raspberry Pi and Simprints in using a larger number of volunteers to support their technology development.

4.4.2.4 Pro bono resources

All cases received pro bono support from companies. Solaware and Blue Tap received relatively minimal amounts of pro bono support, but this was mainly due to the young age of the firms. Solaware and Blue Tap have not reached the stage to require extensive technology design pro bono services (such as Raspberry Pi and Simprints) or patent protection (such as WaterScope). Three cases (Raspberry Pi, Simprints, WaterScope) received relatively substantial pro bono services from companies. The three firms cited the not-for-profit status as a reason for being able to access the pro bono services.

The founders of all cases managed to access pro bono services partly due to being in the Cambridge ecosystem. The mature co-founders at Raspberry Pi (e.g., Jack Lang, David Braben)

and WaterScope (Nalin Patel) were able to access a lot of pro bono services due to their personal connections in Cambridge. Solaware did not have a mature connection but instead, had the support of an experienced business advisor, Philip Hilton. Philip made key introductions for Solaware to access some pro bono services from patent attorneys. Simprints and Blue Tap did not have mature co-founders or business advisors (at the inception). They were nonetheless able to access pro bono services by forming connections at networking events in Cambridge. It is notable that Simprints did not restrict themselves to pro bono services in Cambridge. Simprints also received substantial pro bono services from firms based in London and the United States. However, the initial pro bono services Simprints received were from Cambridge-based.

4.4.2.5 Volunteers

All cases used volunteers in some capacity, mainly to support technology development. Raspberry Pi were able to access volunteer engineers at Broadcom due to Eben Upton's position as a Broadcom engineer. Among all the cases, Simprints was the most organized in their use of volunteers as they scheduled regular volunteering sessions (e.g., Hack Nights every Monday evening). Apart from Raspberry Pi and Simprints, most of the volunteers for the other cases were student volunteers. Simprints had a fair proportion of volunteers that were experienced individuals. The use of volunteers as categorized using Overgaard's (2019) proposed conceptual rethinking is shown in **Table 4.2**.

Table 4.2. Use of volunteers by TSEs categorized using Overgaard's (2019) framework.

Forms of work	Formal	Informal
Paid	Raspberry Pi, Simprints	Blue Tap
Unpaid	Simprints, WaterScope	Raspberry Pi, Simprints, WaterScope, Solaware, Blue Tap

Two motivations have been cited by volunteers as their reason for volunteering – learning a new skill and the social mission of the firm. Volunteers at Simprints and WaterScope have stated that they were partly driven by the opportunity to learn a new skill by volunteering. Volunteers at Raspberry Pi, Simprints, and WaterScope were also driven by the social mission of the firms. Notably, some volunteers at Simprints and WaterScope have stated that the social mission had a

larger effect on their motivation to volunteer. This was evidenced by their continued volunteering even after acquiring the skills through volunteering.

Two cases (Simprints and Blue Tap) highlighted the challenges of using volunteers to support technology development. A problem with control over volunteers was cited as a challenge. The founder of Blue Tap stated that "there was not much way to assert authority over people who are unpaid" (BT-Francesca). This was similarly echoed by a Simprints co-founder who stated that "they're volunteers" and that "no one is mandated to be there" (SIM-Dan). Simprints faced a unique challenge of having too many volunteers show up at their volunteering sessions as they grew. Three cases (Raspberry Pi, Simprints, WaterScope) eventually moved away from using volunteers as they developed their in-house engineering capabilities. However, this was only possible after they had secured additional sources of funding. It would not have been possible for the firms to rely on in-house engineering capabilities in the beginning because they did not have the necessary funding to hire experienced individuals. Notably, both Raspberry Pi and Simprints have benefited significantly from having experienced volunteers support their technology development (accessing Broadcom and ARM volunteers respectively).

4.4.3 Creating value

The cases suggest a sequence of focusing on non-commercial markets before commercial markets. All cases started their organizations by focusing on non-commercial markets. A co-founder of Raspberry Pi had stated that the support which they received in the beginning could have been different if they were initially focused on commercial markets. Many of the cases had accessed critical sources of funding that were only available to social enterprises focused on non-commercial markets. For example, WaterScope's HIF funding and CUE for the Social Enterprise category. Some volunteers had also commented that they may not be as engaged if the organizations were focused on commercial markets in the beginning.

The case of Solaware indicates that in addition to sequence, consideration should also be given to the timing of entering commercial markets. Solaware had decided to shift their focus to commercial markets relatively quick. Subsequently, it became very challenging for Solaware to compete in commercial markets as they had lost their uniqueness (as a social enterprise).

The cases also suggest the initial need for a partnership that is focused on delivering social impact. A few resource providers have stated that they look for partnerships with a humanitarian organization as a criterion for providing funding (Simprints had BRAC, WaterScope had Oxfam, Blue Tap had Afrinspire). Solaware's did not have a partnership with a humanitarian organization. This likely contributed to the difficulties of securing additional resources. It is notable that Raspberry Pi did not initially have partnership with the equivalent of a humanitarian organization. Raspberry Pi eventually partnered with various organizations (such as Coder Dojo and Code Club) that are focused on supporting their social mission. Raspberry Pi was able to delay in securing the partnerships because they were not reliant on external grants or competitions. The financial sustainability achieved from sales of their products in commercial markets meant that Raspberry Pi did not require the validation from external resource providers.

4.4.4 Capturing value

Financial profits were desirable and necessary to sustain operations of the firm and to take the firm to the next stage. Two cases (Raspberry Pi and Simprints) managed to capture value in the form of financial profits. Raspberry Pi earned a large proportion of profits from sales to commercial non-educational customers (e.g., industrial customers). Simprints earned profits only from sales to non-commercial customers (e.g., NGOs and governments). The difference in the source of profits indicates a difference in the scale of profits achieved. Commercial markets were larger than non-commercial markets. This enabled Raspberry Pi to achieve financial sustainability quicker and move to the next stage of diversifying their product line and expanding the organization. Simprints on the other hand, were still reliant on a combination of grants and sales.

Although profits from commercial markets were desirable, there is a risk of diverting the focus away from the social mission of the firm. Simprints was insistent not to enter commercial markets because they wanted to focus their efforts on creating social impact. In the case of Raspberry Pi, achieving commercial success in commercial markets led to criticisms that they were only focused on serving commercial markets. This indeed appeared to be the case as a lot of resources within the firm was focused on developing new lines of Raspberry Pi devices to serve commercial markets. However, it is notable that Raspberry Pi did not set out to target commercial markets. The pursuit of commercial markets came about inadvertently once the product was launched on the market. This meant Raspberry Pi were not prepared for the scale of

demand from commercial markets for their products in the beginning. This again led to an unbalanced focus of the firm on commercial markets versus non-commercial markets.

4.4.5 Environment

All cases leveraged resources within the Cambridge ecosystem. There was recurring support from organizations towards the different cases. For example, ARM, Redgate, and CGE have provided critical support to multiple firms (e.g., Raspberry Pi, Simprints, WaterScope). The university also provided critical support and resources to firms in all cases. Apart from Raspberry Pi, all four other cases relied on university competitions and grants to provide the funding to get started.

It is also notable that there were overlaps of support between the cases. Simprints have provided mentoring to three other cases (WaterScope, Solaware, Blue Tap) under different circumstances. Toby Norman, the CEO and co-founder of Simprints provided mentorship and advice to WaterScope and Solaware. CGE facilitated the introduction of Toby to WaterScope through the networking events that they organized. Although the circumstances of how Toby was introduced to Solaware were not clarified, it was likely also due to CGE as Solaware was in their Cultivator programme. Part of the Cultivator's agenda was to provide networking to firms in their cohort. Blue Tap on the other hand received mentorship from Dan Storisteanu, a Simprints co-founder, through their college new student orientation event. The founder of Blue Tap stated that the mentorship was useful and helped them win competitions in Cambridge. Simprints' relationship in mentoring the other cases indicates that social enterprises in the Cambridge ecosystem support each other by sharing experience.

4.4.6 Firm characteristics

4.4.6.1 Legal structure

All cases started as not-for-profits. Raspberry Pi decided to create a trading subsidiary after they encountered challenges of conducting business as a charity. Simprints did not change their hybrid not-for-profit structure. WaterScope switched from not-for-profit to for-profit to enable the firm to seek private investments. Solaware was similar to WaterScope.

The legal structure convinced some resource providers to provide support to the cases. For example, ARM cited the not-for-profit legal structure of Raspberry Pi and Simprints as a criterion for ARM to provide philanthropic support. A co-founder at WaterScope similarly said that they received in-kind support because they were not-for-profit. Key volunteers at Simprints and WaterScope have stated that the not-for-profit structure have positively affected their decision to volunteer. A co-founder at Raspberry Pi stated that he believes the support Raspberry Pi received in the beginning could be different if they were a for-profit organization. These facts suggest that starting as a not-for-profit is beneficial to social enterprises to secure resources.

4.4.6.2 Organizational culture

All cases were driven by the motivation to create social impact over personal profits. This is evidenced by the fact that two cases (Raspberry Pi and Simprints) had decided to adopt a relatively open stance with regards to their technology. Raspberry Pi released most of their hardware and software designs online to enabled people to learn more about computing devices. This was in line with their social mission to educate people about computers. Simprints designed their systems to be interoperable to avoid their clients from being locked-in to their systems. Some portions of Simprints technology were also open sourced. It is notable though that Simprints' technology approach (to prevent lock-in and partial open source) could also be a business strategy. Since Simprints was a relatively unknown start-up in the beginning, it could be easier to convince large potential clients to use their services if there were limited risk of being locked-in to Simprints. However, it was still likely the case that a strong commitment to creating social impact was the key motivation of Simprints. This was support by the fact that Simprints rejected opportunities to pursue business in commercial markets (despite having developed an allegedly best-in-class technology) because they wanted to focus on their social impact. Simprints

have also consistently stated "impact over profits" was a key mantra of the company.

4.4.6.3 Organizational legitimacy

A not-for-profit legal structure created a positive perception for some of the cases. This was cited as one of the reasons which convinced resource providers to provide support. For example, Rory Cellan-Jones was convinced to support Raspberry Pi because of the charity status. Simprints strategically utilized their not-for-profit status to acquire resources. Toby Norman stated that the not-for-profit status was important to "plant a flag" on Simprints' commitment to their social mission.

The cases also indicate that the association with the University of Cambridge also positively affected the perception of their firms in the eyes of resource providers. WaterScope and Blue Tap have both stated that they think it was easier to convince people to support their firms because they were associated with the university.

4.4.7 Next cycle

Two cases (Raspberry Pi and Simprints) successfully diversified their products and business. Raspberry Pi diversified to develop devices for different market segments (e.g., Compute Module for industrial customers) and entered the magazine publishing business. Simprints diversified to develop neonatal fingerprint scanner. The diversification only happened after both firms had achieved relative success in their core product line and business and was intended to expand their business. WaterScope also decided to diversify their product line by developing water testing technology for commercial markets. However, WaterScope's diversification attempt was driven by the need to achieve financial sustainability to sustain operations. It was not a necessity in the case of Raspberry Pi and Simprints as their firms were already financially sustainable through their core product line. Solaware did not attempt to diversify but completely changed their main product line (to focus on developing head torches for cyclists). Solaware did not pursue parallel development of products because they were unable to find a non-commercial market that could financially sustain their operations. Solaware also had considerably less resources compared to the three other firms that attempted diversification (Raspberry Pi, Simprints, WaterScope).

4.4.8 Exit

Only two cases (WaterScope and Solaware) explored opportunities to exit through acquisitions. It is notable though that the reason the two firms considered acquisition was to enable them to scale their social impact by tapping into the resources and networks of larger organizations. Raspberry Pi has no intention of exiting through acquisition because it was not necessary for them to scale (since there was still a large demand for their products to be met). Simprints similarly had no intention of being acquired as they had ambitions to be leaders in the technology for international development sector (or in other words, "the Google of international development").

Raspberry Pi and Simprints likely did not need to consider acquisition to scale because there were demand for their products and services that could financially sustain their operations. In contrast, WaterScope and Solaware had not secured a sustainable stream of revenue from sales of their products and services. This was likely the reason they considered acquisition of their firm to achieve social impact.

4.5 Stage 2: Legitimacy-based analysis

The analysis that was based on the resource-based conceptual framework revealed that legitimacy played an important role in facilitating the acquisition of critical resources to support early-stage growth of TSEs. This led to further analysis using a legitimacy-based conceptual framework that was based on legitimation mechanisms by Fisher et al. (2017).

4.5.1 Identity

Raspberry Pi gained identity legitimacy through its actions of prioritizing its social mission. For example, Raspberry Pi open sourced most of the designs of their devices to enable its customers to learn better. Raspberry Pi even went the extra mile to put up a bounty for developers to open the remaining close sourced portions of the Raspberry Pi. These actions indicate Raspberry Pi's attempts to gain identity legitimacy with its customers. Raspberry Pi was also able to gain identity legitimacy through the BBC Micro by virtue of being in Cambridge – the birthplace of the BBC

Micro. The co-founders had pitched the Raspberry Pi device to be a modern-day successor of the BBC Micro. This "story" pitch enabled Raspberry Pi to access resource providers that were tied to the original BBC Micro such as ARM, Hermann Hauser, BBC. With regards to the technology, the framing of Raspberry Pi as a modern-day successor of BBC Micro also made it easier to understand their offering and technology.

Simprints gained identity legitimacy through its actions of forgoing commercial markets to avoid the risk of their fingerprinting technology being misused. In addition, Simprints pre-emptively addressed potential security concerns by ensuring their technology were ISO compliant. Simprints also indicated a commitment to their social mission by not trying to monopolize the market. The technology was designed in a way which does not restrict customers to only use Simprints' technology. A co-founder stated that "Simprints can be replaced by other vendors" so they can get "an ecosystem making better quality, more effective, cheaper technology allowing this access, rather than trying to dominate the market." Simprints also voluntarily incorporated an asset lock into the Articles of Association. A co-founder stated that this action was important to "plant-a-flag" and signal Simprints' commitment to the social mission to potential stakeholders. This action was a symbolic action because there were no resource providers that demanded its (the asset lock) inclusion at the time. Additionally, Simprints also took actions to position itself as a TSE leader in Cambridge. For example, Simprints worked with a reputable law firm in Cambridge (Taylor Vinters) to publish a white paper on possible legal structures for social enterprises. The white paper was referenced by numerous other social enterprises and university websites. Another example was Simprints' engagement with Centre for Global Equality (CGE) and the Tech4Dev Hub. These actions contributed to the impression of Simprints as a leading TSE in Cambridge and contributed to Simprints' identity legitimacy. A resource provider had stated that iPhone's introduction of fingerprinting technology reduced uncertainties for mobile devices to capture fingerprints. Although the iPhone was not explicitly used by founders as a strategy, the emphasis on a portable fingerprinting device was emphasized through simple diagrams.

WaterScope gained identity legitimacy through its emphasis on trending technologies such as 3D-printing. At the time WaterScope started, there was 3-4 years' worth of technology development in Richard Bowman's 3D-printed microscope. WaterScope leveraged on the maturity of the microscope technology by emphasizing its maturity in competition pitches. As 3D-printing became more common, the WaterScope team gradually reduced emphasis on the technology as it

had served its purpose. WaterScope had an open policy with regards to their IP. The policy provided additional identity legitimacy as it increased credibility with resource providers (CUE competition judge and CGE's CEO).

The founder of Blue Tap stated that the term "social enterprise" was emphasized and used to describe Blue Tap because it is "fashionable" to identify as a social enterprise. This indicates an attempt to gain identify legitimacy through impression management.

The data revealed that an open IP policy contributed to identity legitimacy for three relatively mature TSEs (Raspberry Pi, Simprints, WaterScope). The data also revealed that engagement in actions which indicates a commitment to the social mission also contributes to identity legitimacy.

The actions of TSEs to prioritize social mission can also be attributed to the organizational culture. **Figure 4.7** illustrates sources of identity legitimacy.

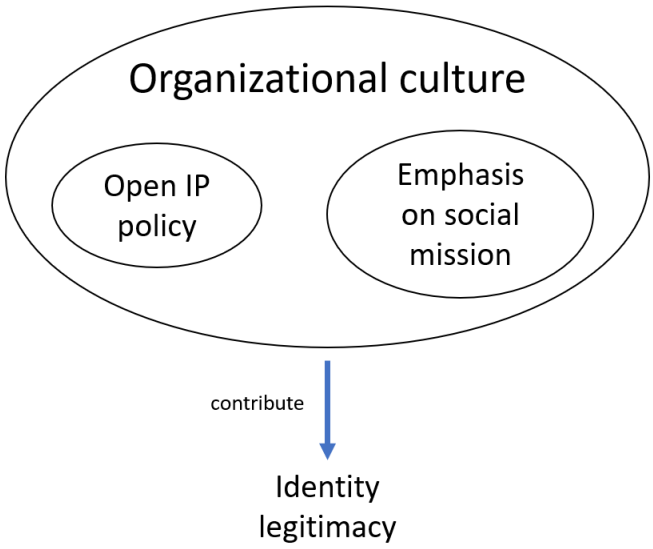


Figure 4.7. Sources of identity legitimacy gained by TSEs.

4.5.2 Associative

Raspberry Pi gained legitimacy through association with the connection to the Computer Laboratory at University of Cambridge. An ARM representative stated that ARM supported Raspberry Pi in the beginning because of the long and positive history with the Computer Laboratory. The fact that many of Raspberry Pi's founders were based at the Computer Laboratory contributed to legitimacy by association since none of the founders had personal history or track record of working with ARM directly. David Braben's presence as a founding trustee also contributed to Raspberry Pi's legitimacy by association. Rory Cellan-Jones from the BBC stated that David Braben's history as a successful entrepreneur and fellow college alumnus made him interested to have the initial meeting to discuss Raspberry Pi. Eben Upton's presence as a founding trustee also contributed to legitimacy by association when acquiring resources from Broadcom. It was likely that Broadcom agreed to support Raspberry Pi because of Eben's position as an engineer at Broadcom. A critical source of legitimacy by association was Rory Cellan-Jones' association with Raspberry Pi. It is arguable that the story of Raspberry Pi's $25 low-cost computer may have merits on its own regardless of who published the story. However, Rory's established position as a technology journalist at BBC (a reputable mainstream media) likely contributed to increased legitimacy of the story.

Simprints gained legitimacy through association with the connection to the University of Cambridge. For example, Prof. Alain Labrique from JHU cited the University of Cambridge's status as a long-standing academic partner of JHU as a reason for his support. This is legitimacy by association since there were no official university research projects by Simprints. Simprints' association with ARM was likely to be another strong contributor to Simprints' legitimacy by association. This fact was recognized by ARM's representative as he stated that it "is a really powerful tool" if Simprints had a letter of support from a "big reputable company like ARM". Prof. Labrique's individual association with Simprints as an advisor likely contributed to increased legitimacy when applying for the Saving Lives at Birth (SLAB) grant competition. There were many contributing factors which led to Simprints award of the SLAB grant. However, it was likely that Prof. Alain Labrique's association played an important role in Simprints' legitimacy by association. A Simprints co-founder stated that having Prof. Labrique onboard "probably helped" their SLAB application. In addition to Prof. Labrique's association, Simprints' association with BRAC was also likely to have played an important role in convincing resource providers to provide support. BRAC was associated with Simprints through two

different paths. The first, Prof. Labrique had made recommendations and introductions to BRAC. The second, a Simprints co-founder had worked with BRAC for his PhD research. Simprints also strategically utilized their association with Prof. Christopher Lowe, who was a lecturer to one of the co-founders and a fellow at Trinity College. Prof. Lowe reached out to Trinity College on the prospects of renting the Chesterton Towers building to Simprints.

WaterScope also gained legitimacy through association with the University of Cambridge. A co-founder stated that some of the partner organizations were interested to support WaterScope because of the association with the university. WaterScope's association with the Centre for Global Equality (CGE) likely contributed to legitimacy by association with Simprints. Simprints was initially introduced to WaterScope through CGE. Considering that Simprints was relatively high-profile in the tech social enterprise space after securing the SLAB grant funding, it would be unlikely for Simprints to actively seek out and support fledging social enterprises on their own. WaterScope's association with Oxfam also contributed to legitimacy by association with grant funding providers such as HIF. A representative at HIF stated that WaterScope's association with Oxfam was an important reason for the grant award. WaterScope's association with the university was a likely reason for Oxfam to provide support. Additionally, WaterScope also gained legitimacy by association through Prof. Jeremy Baumberg as an advisor. Prof. Baumberg's association was cited as a reason for Cambridge Enterprise to provide support to WaterScope.

Solaware's association with Prof. Sir Colin Humphreys contributed to legitimacy by association. Prof. Humpreys' association was cited by Philip Hilton as one of the reasons for increased credibility and for his support. This is legitimacy by association since Prof. Humpreys was not involved directly in Solaware and only played a role in an advisory capacity. In turn, Philip Hilton's individual association also contributed to WaterScope gaining access to other resources such as pro bono legal advice.

The founder of Blue Tap stated that association with the University of Cambridge helped Blue Tap to receive support. She stated that "there is support for a Cambridge-based organization".

The data revealed that the association with the University of Cambridge was an important source of associative legitimacy for the TSEs. In turn, the association with the university contributed to securing further sources of associative legitimacy via reputable individuals (e.g., Rory Cellan-Jones for Raspberry Pi; Prof. Labrique and Prof. Lowe for Simprints; Prof. Baumberg for WaterScope;

Prof. Humpreys and Philip Hilton for Solaware). A unifying pattern which emerges through the data is the importance of the environment in contributing to associative legitimacy. The TSEs were able to leverage on their association with organizations (university and companies) and individuals located in the same geographical location (i.e., Cambridge) to secure resources. Although some individuals may not be physically located in the same area (e.g., Rory Cellan-Jones in London; Prof. Alain Labrique in United States), their association came about because of the TSEs' association with organizations in Cambridge.

Additionally, an easy-to-understand technology is also a contributor to associative legitimacy. Three relatively successful cases (Raspberry Pi, Simprints, WaterScope) had their technologies easily understood by stakeholders by leveraging on their association with established technologies (i.e., BBC Micro for Raspberry Pi; iPhone for Simprints; 3D-printing for WaterScope). **Figure 4.8** illustrates sources of associative legitimacy.

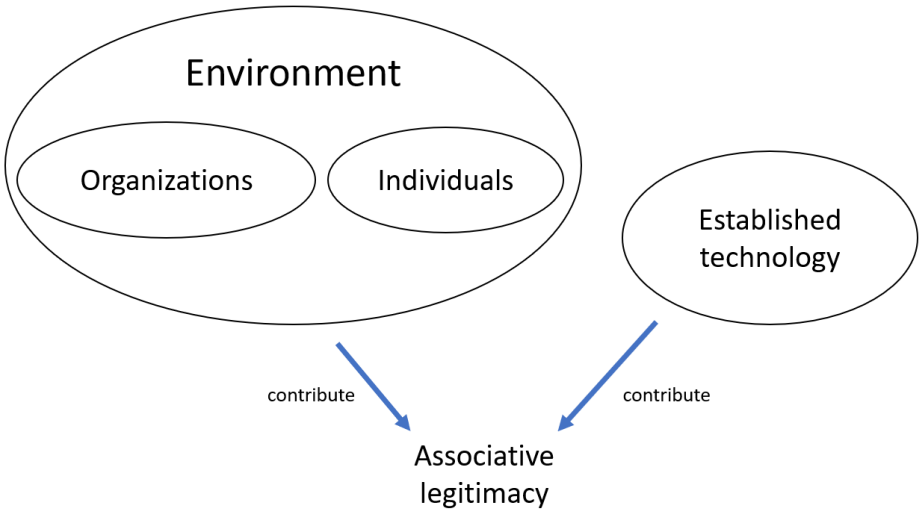


Figure 4.8. Sources of associative legitimacy gained by TSEs.

4.5.3 Organizational

Raspberry Pi gained organizational legitimacy mainly through its charity legal structure. An ARM representative stated that Raspberry Pi's charity structure was a reason for their support. A co-founder of Raspberry Pi stated that the charity status of Raspberry Pi made the organization be

"seen to be honest [by the users], not ripping people off." Most importantly, the charity structure provided organizational legitimacy to garner the support from Rory Cellan-Jones. The prototype which was showcased by Rory Cellan-Jones likely contributed to organizational legitimacy. It would be less likely for Rory to publish a story featuring the co-founders of Raspberry Pi talking about developing a low-cost computer without showing the actual device.

Simprints gained organizational legitimacy through its hybrid not-for-profit legal structure. The not-for-profit structure was cited as a reason for ARM's support. Representatives at Redgate also stated that they may give more consideration to giving their support if Simprints were a for-profit organization. Volunteers have stated that the not-for-profit structure contributed to their support and that it "feels wrong" if Simprints were a for-profit organization. A co-founder stated that the not-for-profit structure is "definitely helpful" as it enabled Simprints to "convince governments or other partners to work with [them]". He elaborated that the not-for-profit structure showed that Simprints "are impact first and […] on their side." This was important because there are a lot of for-profit biometric vendors out there and so the not-for-profit structure "made it easier […] to say '*Look we are on your side. We are ethically there.*'"

WaterScope gained organizational legitimacy through its not-for-profit structure. The not-for-profit positively affected the decision of key volunteers to support WaterScope. The not-for-profit structure was also cited as a reason for Cambridge Enterprise to hand back IP to WaterScope at negligible costs. A co-founder also stated that the not-for-profit structure enabled them to receive pro bono support from various individuals. A resource provider stated that WaterScope having a prototype also helped it gain credibility and secure grant funding. The prototype indicated that WaterScope was at a "stage of development that is more advanced" and made it "easier for the judges to understand what they have". Even after WaterScope decided to switch to a for-profit legal structure, WaterScope managed to maintain organizational legitimacy with some stakeholders such as key volunteers. The volunteers that were initially convinced by WaterScope's not-for-profit structure stated that they understood the need for WaterScope's transition to a for-profit structure.

Solaware gained organizational legitimacy through its not-for-profit structure. Philip Hilton, a key advisor to Solaware, stated that he would have stopped his support sooner if Solaware were a for-profit organization because he saw that the commercialization potential was low.

Blue Tap attempted to gain organizational legitimacy by converting to a Community Interest Company (CIC) structure. The founder stated that the CIC structure enables them to seek for large grants from both charity and business sector. At the writing of this thesis, Blue Tap was still in the process of grant seeking and have not secured additional large grants.

Many of the TSEs also sought external validation through awards and competitions. For example, Simprints, WaterScope, Solaware, and Blue Tap, have actively participated in many competitions and have won numerous awards. In addition to competitions, Simprints have also shown to seek external validation through global certifications. Simprints had sought to gain ISO certifications for their products even though it was not a hard requirement by their clients. According to one of their employees, this was to show that they were serious in ensuring the quality of their products.

The legitimacy gained by the TSEs from having a prototype can be attributed to organizational legitimacy. Resource providers have stated that having a prototype positively affected their perceptions. For example, Raspberry Pi had a credit card-sized prototype of the device when they approached Rory Cellan-Jones at the BBC. ARM similarly mentioned that the Simprints team brought along a prototype to their initial presentation at their offices. WaterScope's prototype also had a positive impact on the perception of resource providers as one of the competition organizers cited the presence of the prototype as a factor which improved WaterScope's credibility. **Figure 4.9** illustrates sources of organizational legitimacy.

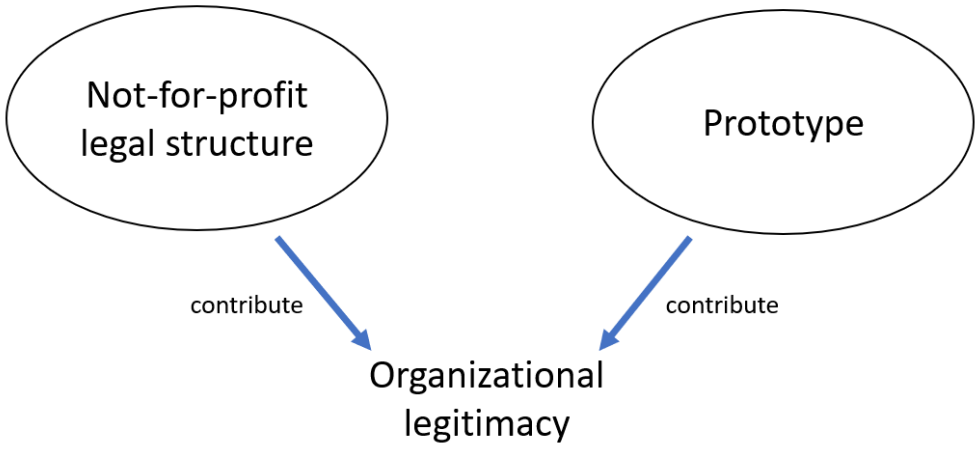


Figure 4.9. Sources of organizational legitimacy gained by TSEs.

4.5.4 Other

The data revealed that the environment can also be a source of legitimacy to TSEs. The case studies revealed that TSEs gained legitimacy by virtue of being geographically located in Cambridge. A resource provider to the TSEs even stated that from her experience, TSEs have more credibility just being based in Cambridge. This sentiment was also independently corroborated by some founders of the TSEs.

Cambridge is an established innovation cluster which hosts many individuals and organizations in the technology sector. The case studies demonstrate that being in Cambridge helped the TSEs gain legitimacy which ultimately led to further resource acquisition. For example, the shared history with the BBC Micro of being in Cambridge helped Raspberry Pi gain credibility with BBC and high-profile individuals such as Hermann Hauser. This was even though Raspberry Pi was only a spiritual successor to the BBC Micro. Being in Cambridge also helped Simprints access pro bono support from other technology organizations. Technology organizations (such as Google, Microsoft, Slack) have an established history of supporting technology-based start-ups. Although Simprints have merits beyond the geographical location of the firm, it was highly likely that being in Cambridge made the process to access those resources much easier for Simprints. This was because those organizations already provide support to many other technology-based start-ups in Cambridge and would likely extend their support to another technology-based start-up like Simprints. WaterScope also stated that being in Cambridge has gained them credibility with partners in developing countries. This was despite WaterScope's clarification and insistence that WaterScope was not officially related to the University of Cambridge beyond its founders' status as staff and students. This suggests that the characteristics of the environment (in this case, the "cluster characteristic") play an important role as an additional source of legitimacy.

Chapter 5 Discussion of Stage 1 and Stage 2 analysis

This chapter discusses the analysis of the case studies in two stages: Stage 1 is in the context of the resource-based literature reviewed in Chapter 2. The analysis is subsequently followed by further analysis, Stage 2 which is based on legitimacy. Based upon both Stage 1 and Stage 2 analysis, modifications are made to the conceptual framework.

5.1 Stage 1 findings: Discussion of initial RBV-structured analysis

5.1.1 Developing business idea

The data revealed that technology social enterprises can be driven by a social problem or by technology that has been developed. This is like for-profit technology-based enterprises where the orientation of the company may be driven by market-pull or technology-push (Lubik, Lim, Platts, & Minshall, 2012).

The cases reaffirm previous findings that companies may transition their orientation between market-pull and technology-push under certain conditions. For example, Raspberry Pi transitioned from market-pull to technology-push to meet a demand for complementary products (such as industrial versions of the Raspberry Pi devices). WaterScope similarly transitioned from market-pull to technology-push as they formed new partnerships with commercial companies (e.g., agar manufacturing company) to explore applications of their technology. Conversely, Solaware transitioned from technology-push to market-pull after being presented with new market information on their product (their initial product based on novel technology would be too costly and difficult to market).

These conditions to transition are similar to those identified by Lubik et al. (2012) for start-ups in emerging industries. However, the cases indicate that the transition of TSEs are usually accompanied by a change in profit-orientation (i.e., for-profit to non-profit and vice versa). Raspberry Pi had a transition to technology-push after it had incorporated a for-profit trading subsidiary. WaterScope similarly transitioned to technology-push after it decided to go for-profit. Solaware also transitioned to market-pull after it shifted to for-profit. In contrast, Simprints

which had a market-pull orientation did not undergo significant transitions as it maintained its hybrid non-profit orientation.

The cases indicate that when TSEs shift to emphasize the "enterprise" component, they may undergo transitions similar to commercial enterprises. Profit-orientation as an enabling factor was not explored in previous studies because the commercial companies of interests are not hybrid organizations. This enabling factor is important to note because despite the transition in orientation, social enterprises must still maintain their social component. A transition in orientation may negatively affect the "social" component of the social enterprise. For example, after Raspberry Pi transitioned to technology-push and focused on developing new products for commercial markets, there were negative criticisms from the press that Raspberry Pi had lost sight of their social cause. In the social enterprise literature, the emphasis on "commercial" at the expense of "social" is referred to, quite negatively, as "mission drift" (Ramus & Vaccaro, 2017). However, it is important to clarify that the data does not indicate that mission drift is a preordained outcome of a shift in profit-orientation. The data simply indicates that profit-orientation is an enabling factor that may affect the transition in orientation (technology-push and market-pull) of a social enterprise. Mission drift is a possible negative outcome because of that transition. It is also possible for social enterprises not to experience negative effects due to transition in orientation. For example, WaterScope did not experience any negative effects (such as mission drift) in their transition.

The environment as a catalyst for the inception of technology-based enterprises has been researched in innovation cluster studies (Engel, 2015; Saxenian, 1990). The data revealed that the environment similarly facilitated the development of business ideas for TSEs. The founders of the TSEs of the cases have strong affiliations to the University of Cambridge. Many of the founders and co-founders met and interacted through their affiliations with the university. Various activities organized in Cambridge – internal and external to the university (such as i-teams, hackathons) – contributed to the impetus for starting the social enterprises. Raspberry Pi, Simprints, WaterScope, Solaware, and Blue Tap, are social enterprises that started because of the Cambridge environment. Although at first sight, Blue Tap might be thought of as an exception because the idea for the business was started outside of Cambridge (in Mexico). However, the impetus for starting Blue Tap as a company can be directly attributed to founder's presence in Cambridge.

5.1.2 Building resource base

5.1.2.1 Financial capital

Financial capital is arguably one of the most important resources as it facilitates the subsequent acquisition of other forms of resources. The data revealed that TSEs from the case studies were able to access finance due to a combination of the strategic use of their legal structure and being in a cluster of innovation (i.e., Cambridge).

The extant literature states that there is a tendency for social enterprises to obtain early-stage funding from grants and donations (Arena et al., 2018; Jacokes & Pryce, 2010; Martin, 2011). Except for Raspberry Pi (which relied on personal funding from founders and a loan from Cambridge Angels), the data from the other TSE cases were found to be consistent with the literature in obtaining early-stage funding from grants and donations. The most significant early-stage funding that Simprints, WaterScope, Solaware, and Blue Tap received, were all from grants and donations. The funding circumstances of Raspberry Pi was likely different from the other TSEs due to the status of the Raspberry Pi founders as mature co-founders and established entrepreneurs, as opposed to postgraduate students and staff with relatively limited personal resources. The personal funding provided by the Raspberry Pi founders was within their financial means and the loan from Cambridge Angels was obtained through the entrepreneurial network of the founders.

The challenge of TSEs to obtain early-stage funding from other sources stems from barriers such as high risk profiles, fear of losing control over social mission, and the non-profit legal structure (Arena et al., 2018). The risk profiles of TSEs are claimed to be unattractive to potential investors as they are seen to be "riskier than traditional high-tech start-ups" due to the imbalance between perceived risks and potential financial returns (Arena et al., 2018, p. 156; Bank of England, 2003; Fraser, 2007). The Raspberry Pi and Simprints cases confirm this statement as potential seed investors (loan from East of England Development Agency in the case of Raspberry Pi) which the founders approached, were not interested to invest due to the relatively low financial returns. The fear of losing control by entrepreneurs running TSEs is claimed to be intensified due to the presence of the social mission (Achleitner et al., 2014; Arena et al., 2018; Emerson et al., 2007; Nicholls & Pharoah, 2008). The WaterScope and Solaware cases confirm this statement as the founders of both firms did not initially seek for-profit investments as they were concerned of losing control over the social mission. The non-profit legal structure is also known as a potential

barrier to access certain early-stage funding as it disincentivizes the founders (or from friends and family) from providing personal funding due to a lack of ownership stake (Arena et al., 2018; Dees & Dolby, 1991; Jacokes & Pryce, 2010). Contrary to expectations, the Raspberry Pi case revealed that the non-profit legal structure is not necessarily a barrier to personal funding. The founders of Raspberry Pi contributed personal seed funding (to support the initial manufacturing run) even though the organization was incorporated as a charity and without any ownership stake.

The choice of legal structure is known to have an effect on acquisition of financial capital as certain sources of funding are only available to organizations with certain legal structures (e.g., for-profit venture capital funding are almost exclusively available to organizations with for-profit legal structures) (Lyons & Kickul, 2013). Additionally, social enterprises have been found to transition their legal structures for strategic gains (Haigh, Kennedy, et al., 2015). Beyond early-stage funding, except for Simprints and Blue Tap, the other TSEs from the case studies eventually transitioned their legal structure to further their plans to acquire financial capital. Although the non-profit legal structure of Raspberry Pi was not a barrier to acquire early-stage funding as expected from literature, however, it was a barrier for Raspberry Pi to acquire financial capital through sales as the organization was experiencing massive demands for their product. The charity legal structure of Raspberry Pi made it prohibitive for the organization to sell their products to customers not in the education sector (since education was the charitable mission of the organization), and this subsequently prompted the incorporation of a wholly owned trading subsidiary to resolve the problem. The model of Raspberry Pi (having a charity and a wholly owned trading subsidiary) has been reported as a known configuration of social enterprises (Haigh, Kennedy, et al., 2015). However, the specific circumstances (related to problems of trading technology products as a charity) which led Raspberry Pi to transition to this model were not known. The Raspberry Pi case indicates that a non-profit legal structure may be potentially prohibitive for TSEs to scale their venture through organic sales like their technology-based start-up counterparts. WaterScope and Solaware eventually transitioned to a for-profit legal structure to raise private investments. The driver for WaterScope and Solaware to transition their legal structure to raise financial capital has been observed in social enterprises studied by Haigh, Kennedy, et al. (2015). Blue Tap did not undergo any meaningful transition in legal structures

because it was at a much earlier stage compared to the other TSE cases[53]. Simprints similarly did not undergo any meaningful transition in their legal structure to access financial capital because it was not necessary. The decision by Simprints to amend the Articles of Association to incorporate an asset lock and the social mission was strategic to gain access to financial capital. The match funding from ARM was essential to Simprints and was provided because Simprints was a non-profit. The strategic choice of legal structure to acquire resources by Simprints is consistent with the actions by some non-profits (Townsend & Hart, 2008). However, it is notable that Simprints strategically leveraged on their unique legal structure to obtain resources that were not necessarily meant for non-profit organizations. For example, Simprints managed to secure R&D grants from Innovate UK which are not accessible by non-profits registered as charities. It is known from the literature that there are many types of grants and donations that social enterprises could potentially access (Arena et al., 2018; Jacokes & Pryce, 2010; Martin, 2011), but these types of grants are usually charitable grants that are only available to non-profits (Jacokes & Pryce, 2010, p. 73). The Simprints and WaterScope cases indicate that TSEs can access different types of grants due to the hybrid nature of being a technology organization and a social enterprise. The positioning of their legal structure was essential to enable Simprints to access both R&D grant funding (Innovate UK) and philanthropic grant funding (Gates Foundation). WaterScope was similarly able to access different types of grant funding such as philanthropic grants (HIF) and university research grants (Global Challenges Research Fund (GCRF) and Engineering and Physical Sciences Research Council (EPSRC)).

The TSE cases exhibit various behaviours in accessing financial capital which are consistent with early-stage social enterprises known from extant literature (e.g., tendency to access grants and donations, transitioning of legal structure). However, a common pattern that can be observed from the TSE cases is that the organizations all started out as non-profits. To be more precise, they were perceived as non-profits via their external communication in business plan pitches. The extant literature states that different legal structures provide access to different sources of funding (Arena et al., 2018; Lyons & Kickul, 2013), and under certain circumstances, the legal structure may change for strategic reasons (Haigh, Kennedy, et al., 2015). However, these studies do not mention the importance for TSEs to start their organization as non-profits (or at least

53 Technically, Blue Tap transitioned from a for-profit legal structure to a CIC structure. However, this transition does not count because Blue Tap had always intended to register as a CIC. The registration process for a CIC simply took longer than Blue Tap could afford (as they needed to incorporate to sell their products), so they had to temporarily incorporate as a for-profit entity.

give the perception of a commitment to be a non-profit) to secure early-stage financial capital. There are studies which indicate that non-profit may potentially receive preferential treatment from traditional grant makers (Teasdale, 2010). The data indicates the context surrounding TSEs highlights the importance of starting as a non-profit, especially to obtain early-stage funding.

Apart from the legal structure, the data also revealed the importance of being in the Cambridge cluster of innovation for TSEs to acquire financial capital. One of the benefits to technology-based start-ups in a cluster of innovation to acquire financial capital stems from the presence of individuals and organizations with specific know-how in the cluster (Engel, 2015). More specifically, the presence of financial dealmakers such as venture capitals, angel investors, or mature corporations that are familiar with the process of funding early-stage technology-based start-ups makes it relatively easier for new firms to obtain funding (ibid.). However, the TSE cases did not explicitly benefit from existing financial know-how because TSEs are relatively new to the cluster. For example, this can be observed from the WaterScope case, where Cambridge Enterprise, a regular provider of seed funding to traditional technology-based start-ups in the Cambridge cluster, was unable to provide seed funding to WaterScope despite interest to provide support. According to Cambridge Enterprise, they were unable to provide seed funding to WaterScope because the existing funding mechanisms were not designed to cater to social enterprises which does not prioritize high financial returns[54].

The TSEs, however, did benefit from the presence of people in the Cambridge cluster with expertise to evaluate technology-based start-ups. The evaluators who provided seed funding to all the TSE cases were experienced individuals working in the technology sector. In the case of Raspberry Pi, the personal funding and loan from Cambridge Angels were all made by individuals with extensive history of working in the technology sector. For Simprints, the most significant funding was from the Saving Lives at Birth grant which was likely made possible due to ARM's commitment of matched funding. According to the Simprints founders, ARM had technical evaluators vet the feasibility of their technology and idea before a commitment was made. WaterScope's first significant funding was from the EPOC Business Plan competition. The competition was evaluated by judges with experience of judging technology-based start-up pitches. The CUE Business Plan competition which provided prize money and credibility to

54 At the writing of this thesis, Cambridge Enterprise have evolved to provide seed funding to social enterprises via collaboration with Cambridge Social Ventures, an organization linked to the Judge Business School, University of Cambridge.

many of the TSEs (all except for Raspberry Pi), had David Gill as a judge for the Social Enterprise category. David Gill had been the judge for the technology category of the CUE Business Plan competition for many years prior to his switch to the Social Enterprise category. These examples highlight the importance and presence of evaluators who understood how to judge technology-based start-up ideas for TSEs.

The presence of a world-class University is also a crucial component to many clusters of innovation (Engel, 2015). The data revealed that business competitions and small grants that were provided through the University were essential for many of the TSE cases to get started. However, as the amount of these business competitions and grants were relatively small (and not sufficient to significantly support the venture's operations), the importance of these funding stems from the perceived credibility of the TSEs by other potential funders. The data also reveal the importance of having a humanitarian partner to secure grant funding. Grant providers (e.g., HIF and National Geographic for WaterScope and Blue Tap respectively) have stated that they require social enterprises to have a humanitarian partner to ensure local buy-in.

5.1.2.2 Human capital

The data revealed that TSEs from the case studies were able to access human capital through a combination of leveraging their social mission, being in a cluster of innovation (i.e., Cambridge), and utilizing volunteers.

One of the barriers for social enterprise growth is the difficulty for social enterprises to access human capital (Davies et al., 2019). This is because the relatively low financial reward for achievements is a constraint for social enterprises to recruit and retain employees (ibid.). Consequently, scholars have proposed that social enterprises could potentially overcome human resource barriers by leveraging the social mission to "recruit and motivate employees, volunteers, and trustees" (Davies et al., 2019, pp. 1628-1629). The data from the case studies confirms that leveraging the social mission is indeed a strategy that can be used by TSEs to access human capital. For example, Raspberry Pi and Simprints both managed to recruit employees who were willing to take a salary cut. The founders of Raspberry Pi and Simprints have both stated that potential employees are willing to forgo higher salaries at competing technology enterprises because they are attracted to "make a difference" and to "do the right thing". By leveraging the

social mission, it also enabled TSEs to outcompete other established technology firms present in Cambridge such as Amazon and Apple to hire engineers. Similarly, the WaterScope case shows that TSEs can attract and recruit core members (such as Sammy Mehdi) without a promise of equity upfront. Essentially, TSEs can leverage on their social mission to recruit and retain employees at a lower cost compared to market rates. Apart from employees, TSEs can also leverage their social mission to access experienced advisors and mentors. Raspberry Pi, Simprints, WaterScope, and Solaware, managed to recruit experienced business advisors to mentor and guide their firms without compensation. For example, Raspberry Pi managed to recruit Hermann Hauser and David Cleevely, both who are high-profile entrepreneurs, to advise their organization. Similarly, Simprints managed to recruit Prof. Alain Labrique from John Hopkins University (JHU) and Dominic Vergine from ARM to advise them. The involvement of these high-profile individuals has been cited by the founders as critical for the growth their respective TSEs. These high-profile individuals are not exclusively available to TSEs since they are also regularly involved in commercial technology-based start-ups. However, the social mission of TSEs cannot easily be acquired or replicated by commercial technology-based start-ups.

In addition to the social mission, TSEs were able to facilitate their access to human capital by being in the Cambridge cluster of innovation. The University's role in the supply of human capital to the TSEs was critical to their early success. This is expected as scholars have theorized that proximity of firms to a university would lower the search costs of acquiring human capital (Audretsch et al., 2005). All the TSEs have at some point, recruited students and staffs of the University to work for their organizations. However, it is notable that in addition to geographical proximity, the TSEs were able to access human capital because of their past and present association with the University.

Apart from the University, the presence of established technology firms in Cambridge was also found to facilitate access to human capital by TSEs. Most of the TSEs (Raspberry Pi, Simprints, WaterScope) have received knowledge-based support from other technology-based firms in Cambridge. Scholars have postulated that mature technology-based corporations may support other young firms in a cluster of innovation through collaborations and "open innovation" activities (Engel, 2015; Engel & del-Palacio, 2009). However, in those existing collaborations, there is typically an element of direct benefit to the mature corporations from the process or output of the innovation collaboration. The TSE cases present a slightly different situation as the mature corporations do not directly benefit from the innovation collaborations in the same way

as collaborations with technology-based start-ups. Raspberry Pi, Simprints, WaterScope have received essential human capital support from mature corporations in Cambridge (i.e., Broadcom, ARM, Redgate, Taylor Vinters) even though the mature corporations are not directly involved in the same market. The history and association with Cambridge have been cited as a reason for some of the mature corporations to provide support (e.g., Raspberry Pi's relationship with ARM).

One of the unexpected ways the presence of mature corporations in the Cambridge cluster have impacted TSEs is through the supply of skilled volunteers to the TSEs. The TSE cases were found to access skilled volunteers who were employees in other technology-based firms in Cambridge. The role of mature corporations in the supply of skilled volunteers for the growth of new firms has not been addressed in existing literature (Engel, 2015; Engel & del-Palacio, 2009; Saxenian, 1990). The mobility of human capital that are referenced in those studies suggests that skilled individuals in a cluster may change firms and bring their knowledge to the new firms (Engel, 2015). The case studies, however, shows that in the context of TSEs, there is a possible intermediate step in the transition of human capital between firms – i.e., the transition as volunteers. Many of Raspberry Pi's early hires were existing volunteers from Broadcom. Similarly, Simprints have hired existing volunteers who worked at other engineering firms in Cambridge such as Qualcomm. One of WaterScope's core member (Sammy Mehdi) started out as a volunteer.

5.1.2.3 Technology development/intellectual property

The TSE cases primarily relied on in-house development to acquire their technologies. This is consistent with the behaviour of technology-based start-ups as they typically have limited initial resources to pursue external technology acquisition strategies that are used by mature corporations (Graebner et al., 2010; Mortara & Ford, 2012). In-house development is typically a resource intensive process, which is a constraint for start-ups with limited resources. Some of the TSE cases (Raspberry Pi and Simprints) were found to form alliances with external organizations to overcome their resource constraints. This is characteristic of start-ups that have been known to overcome resource constraints by forming alliances with more established corporations (Martínez-Noya & Narula, 2018; Mortara & Ford, 2012).

The alliances of TSEs with external organizations share similarities with those found in existing studies on technology-based firm alliances. For example, Raspberry Pi's alliance with suppliers during the technology design phase was crucial as it impacted the feasibility of their low costs designs at low initial volumes. Technology-based firms have been known to form alliances with suppliers to lower the cost of production (Chung & Kim, 2003; Martínez-Noya & Narula, 2018). Simprints' alliances with various technology firms to obtain access to key technology components (e.g., Bluetooth software stack from SEARAN) and design services (e.g., design improvement services from Smart Design and ARM), mirrors the objective of technology-based firms to obtain complementary resources through alliances (Martínez-Noya & Narula, 2018; Sakakibara, 2002). WaterScope similarly formed alliances with partners in Africa (e.g., STICLab and Juakal Box) to access complimentary design and manufacturing resources. Simprints' alliance with their customers (e.g., the non-profit BRAC) during the development of their core fingerprint scanner technology, was an effort to reduce the risk of new product introduction as it reduced demand uncertainty (Martínez-Noya & Narula, 2018; von Hippel, 2006).

These alliances were crucial for early-stage TSEs to acquire their technologies as they enabled the TSEs to overcome their resource constraints. However, there is a noticeable difference that can be observed in the nature of the TSE alliances from those of existing studies, the imbalance of benefits between partners. There is typically an element of mutual benefits to partners in alliances for R&D activities (Chung & Kim, 2003), whether it is from a transaction cost minimising perspective or value enhancing perspective (Martínez-Noya & Narula, 2018). The alliances formed by TSEs appear to be more beneficial to TSEs rather than the partners, when compared against alliances between commercial firms (Chung & Kim, 2003; Martínez-Noya & Narula, 2018). For example, there are limited financial incentives for the external partners (such as suppliers) as the target market of the TSEs are limited. In contrast, the financial benefits referenced in existing studies (Chung & Kim, 2003) arising from cost reduction and new market entry from alliances with suppliers, are typically in the context of large manufacturers operating in markets with significant economies of scale. The TSEs also had limited complimentary technologies to share with their partners as they were in the early stages of their technology development. The external partners do benefit from improving their image and reputation through association with social enterprises and as part of their CSR. However, this benefit as the primary motivation for external partners to form alliances is unlikely since the TSEs were initially relatively unknown organizations. The TSEs and some partners cited the non-profit nature of the TSEs to be key element in forming the alliances with external partners. Raspberry Pi and

Simprints have strategically leveraged their non-profit legal structure to convince external partners to form alliances. As the founder of Raspberry Pi stated, they were able to go to suppliers and say, "Look, don't screw us, right. We are a charity.". The founder of Simprints similarly echoed that their non-profit legal structure enabled them to convince potential customers and partners to work with them by saying, "Look we are on your side. We are ethically there.". The findings reveal that the configuration of motivations and strategies to secure alliances between TSEs and external partners can be different from those of commercial firms in existing studies (Chung & Kim, 2003; Martínez-Noya & Narula, 2018).

Apart from alliances, one of the ways which TSEs overcame their resource constraints for technology development was by accessing volunteers. This was discussed in the previous section on how TSEs accessed human capital resources. However, in the context of technology development, the use of volunteers by the TSEs revealed that there are management issues related to the use of volunteers. The challenges associated with the use of volunteers are similar to those of free and open-source software (FOSS) development (von Krogh, 2003). For example, Simprints experienced challenges in having limited time and control over the volunteers working on the development of their technologies. The lack of a formal contract means firms are unable to legally force volunteers to work on the project (von Krogh, 2003). The lack of control over the recruitment process also means that there is potential for less talented volunteers to compromise the quality of the project (ibid.). For example, Simprints and Blue Tap have both stated that volunteers can choose not to turn up and would disrupt their technology development process. Although these challenges were not explicitly highlighted by Raspberry Pi in their use of volunteers, it is reasonable to think that they were also exposed to the same set of challenges faced by Simprints and Blue Tap.

However, there are also some differences in challenges in the use of volunteers between TSEs and FOSS development. The volunteers of FOSS development typically involve enthusiastic users of the technology that they are developing (von Krogh, 2003; von Krogh & von Hippel, 2003, 2006). These FOSS volunteers typically work online remotely at their own pace (ibid.). The volunteers of TSEs in contrast were not volunteering remotely online (not initially at least), and there were occasional tight schedules to deliver the project. The engagement of volunteers physically arguably requires more effort than online engagement. Unexpectedly, the physical engagement of volunteers was beneficial rather than detrimental to the continued engagement of volunteers by the TSEs. For example, multiple key volunteers at Simprints stated that they were

more engaged working for Simprints physically, when compared to their past online FOSS volunteering endeavours. The engagement of TSE volunteers despite being under tight schedules from an external firm is also uncharacteristic of volunteers in FOSS. The volunteers in TSEs have cited the non-profit legal structure as having a positive impact on their continued engagement and involvement with the TSEs.

Additionally, the data also implies that there is an optimal time to use volunteers for technology development by TSEs. Raspberry Pi and Simprints both benefited from use of volunteers in the early days of their organizations before they could develop their in-house engineering capabilities. Simprints had to stop their public volunteering sessions at one point because the overheads of managing the volunteering process exceeded the benefits as their technology development matured (reached the manufacturing phase). Simprints stated that the volunteers who were critical to their early success in technology development were turning into a distraction. Although Raspberry Pi did not mention they experienced inconvenience due to use of volunteers, the mention of volunteers was mainly within the early days of the organization. These two cases indicate that use of volunteers for technology development is optimal for the early stages of technology development. As the technology development matures, TSEs need to gradually transition to utilize their in-house engineering capabilities. The use of FOSS volunteers in commercial product development in previous studies have largely been under the context of "open innovation" activities by mature corporations (e.g., Henkel, 2009; Höst & Oručević-Alagić, 2011; von Krogh, 2003). These commercial mature organizations are typically endowed with resources and do not engage in open-source development activities in a primary capacity. For the studies which focuses on firms with a primary focus on open-source development (e.g., von Krogh, 2003), these firms are primarily commercial in nature. The suitability on the use of volunteers under a doubly different context of start-ups (as opposed to mature corporations) with a focus on social (as opposed to commercial) has not been explored in previous studies.

The TSEs are also observed to adopt a relatively open approach towards protection of their technologies. Raspberry Pi, Simprints, and WaterScope, have developed parts of their technology in an open-source capacity. Competition from other firms due to having limited proprietary protection on open-source designs is a challenge faced by commercial open-source firms (von Krogh & von Hippel, 2006). The Raspberry Pi case revealed that the IP surrounding the branding of Raspberry Pi was deemed important for the organization to maintain some level of protection over its business. However, before Raspberry Pi gained recognition, their primary

source of technology protection from competitors was from having a relative lack of interest in pursuing high profit margins. The most critical component to Raspberry Pi's early success was the BCM2835 chip. The chip was supplied by Broadcom to Raspberry Pi and was inaccessible to many other competitors due to difficulty in maintaining low profit margins and high volume. The protection from accessing the supply of chips from Broadcom can be attributed to the non-profit legal structure of Raspberry Pi. This preferential treatment enjoyed by non-profits have been reported by studies under the context of obtaining financial grants from grant makers (Arena et al., 2018). Preferential treatment from suppliers because of the non-profit legal structure has not been explored in previous studies, at least not in the context of technology-based start-ups. Simprints, WaterScope, Solaware, and Blue Tap, also protected their technology by keeping it a trade secret. This is consistent with the behaviour of start-ups as reported in previous studies (Levine & Sichelman, 2018).

Raspberry Pi was also found to engage in technology licensing activities to exploit the technologies that they had developed. Licensing was critical as it enabled Raspberry Pi to overcome their lack of resources to pursue manufacturing on their own. This is a known benefit of technology licensing to "overcomes internal resource constraints such as lack of finance, internal product design, manufacturing and marketing skill" (Atuahene-Gima & Patterson, 1993). However, in addition to resource constraints, a key catalyst for Raspberry Pi's pursuit of technology licensing was the inspiration from the business model of ARM. Simprints have also expressed interest to explore licensing approaches due to ARM's presence in Cambridge. This indicates that the presence of mature corporations in a cluster of innovation has had a positive impact on the technology exploitation strategies of TSEs.

5.1.2.4 Pro bono resources

All the TSE cases received offers for pro bono legal services by law firms. The pro bono legal services played an important role for TSEs in the early days because they had limited resources of their own to engage professional legal services. The pro bono services rendered dealt with relatively common legal issues faced by technology-based firms such as legal incorporation (e.g., Raspberry Pi and Simprints) and patent protection (e.g., WaterScope, Simprints). Pro bono services rendered in the legal domain is an established practice that has been explored in the extant literature (Baillie, 2001; Barasch, 2016; Cummings & Sandefur, 2013; Rhode, 1998, 2003).

This revelation from the data is expected since social enterprises have been known to access pro bono services as a human capital resource (Meyskens, Carsrud, et al., 2010).

In addition to pro bono legal services, the data also revealed that TSEs received significant pro bono engineering services from engineering firms. These services rendered played an important role in the technology development process for some of the TSEs. For example, Raspberry Pi, Simprints, and Solaware, all received pro bono engineering services during the product design phase. Unlike its legal counterpart, pro bono services rendered in the engineering domain has received relatively little academic attention (Kulacki, 1999; Moulton, 2010).

The differences between pro bono services in the engineering domain and legal domain have implications towards the manner for firms to seek out these resources. For example, due to pro bono services in the legal domain being an established practice, there is expectation from legal practitioners to engage in those practices (Rhode, 2003). In fact, the practice is so established that there is academic discourse on whether pro bono services in the legal domain should be mandatory (Bretz, 1989; Cramton, 1990). As a result, it is relatively easy for non-profits (and social enterprises by extension) to seek out pro bono legal services. The practice of seeking out pro bono engineering services is less known and remains relatively unexplored as pointed out by Moulton (2010).

The data from the TSEs indicate that the TSEs strategically leveraged their non-profit legal structure and their social mission to obtain engineering pro bono services. As mentioned before, given the expectations towards pro bono services in the legal domain, the role of specific legal structures on accessing pro bono services is less known. Legal firms may have specific policies towards provision of pro bono services to non-profits (Brescia et al., 2020), but this may be largely a tick-box exercise. For TSEs, whose legal structure may be for-profit or non-profit, a commitment to non-profit may be crucial to convincing engineering firms to provide pro bono services. In addition to the social mission and legal structure, another factor which played a role for the TSE cases also managed to secure pro bono engineering services was the personal network of the founders.

5.1.2.5 Volunteers

Volunteers played a significant role across various activities in the early days of most of the TSEs. These activities include but not limited, to technology development, web design, public relations marketing, distribution, and testing. The use of volunteers will be discussed in turn from the perspective of TSEs and the volunteers.

Research on the use of volunteers from the perspective of organizations have largely focused on recruitment, placement, and retention of volunteers (Clary et al., 1992; Handy & Brudney, 2007). The data from the TSE cases reveal that those area of focus are not necessarily the same for early-stage TSEs. The different types of workers used by TSEs can be categorized using Overgaard's (2019) proposed conceptual rethinking of volunteers as paid/unpaid workers under formal/informal capacity. However, Overgaard's (2019) largely treats these categories as distinct as implied from the provided examples. The data from the TSEs revealed a new interaction of transitioning between the categories (**Table 5.1**). For example, Raspberry Pi's informal unpaid volunteers transitioned to formal paid employees. Simprints underwent a similar transition but with an additional step of moving from informal unpaid volunteers to formal unpaid volunteers, and finally to formal paid employees. The transition which occurred are with the same individuals. The TSEs may also engage and maintain workers in different categories without undergoing transition. For example, WaterScope engaged in formalized use of volunteers (i.e., receiving volunteering support from Redgate), but the engagement was one-off and not considered a transition because the informal unpaid volunteers were distinct (i.e., student volunteers). This interaction of transitioning from informal unpaid volunteer to paid formal employee in a technology-based organizational context has not been previously documented.

Table 5.1. Transition of workers in TSEs.

Forms of work	Formal	Informal
Paid	Raspberry Pi, Simprints	Blue Tap
Unpaid	Simprints, WaterScope	Raspberry Pi, Simprints, WaterScope, Solaware, Blue Tap

Simprints was the only TSE which transitioned from informal to formal use of unpaid volunteers through routine scheduled organization of volunteering sessions (i.e., Hack Nights). The informal

sessions of having students volunteer for Simprints over beer and pizza, eventually evolved to regularly scheduled volunteering sessions such as Hack Nights. The formalized use of volunteers by Simprints led to common issues experienced by other non-profit organizations using volunteer labour, such as task assignment problems (Sampson, 2006) and volunteer coordination problems (Lassiter et al., 2015). Simprints also attempted to minimize bureaucracy of their volunteering session to maintain engagement with volunteers. This behaviour is similar to other non-profit organizations in managing volunteers, as recommended by scholars such as Oppenheimer and Edwards (2011) (cited in Overgaard, 2019). Apart from Simprints, the other TSEs also experienced challenges to using volunteers such as limited time (e.g., Raspberry Pi) and lack of control (e.g., Blue Tap) which were similar to other organizations using volunteer labour (von Krogh, 2003).

The additional risks and challenges associated with using volunteer labour for a critical path technology development project has been highlighted by the TSE cases. The Simprints case indicate that as the organization grew with clearer technology development goals, managing the use of volunteers can start to become a distraction. Simprints had to assign volunteers to work on non-critical path technology development to cope with the relatively large number of volunteers which turned up over time. The assignment of volunteers to non-essential projects is not ideal to organizations using volunteer labour as they have been theorized to cause volunteers to reduce their commitment (Sampson, 2006). There is also concern from Simprints on quality accountability of volunteers assigned to critical path technology development projects. Preference to use employees over volunteers due to quality accountability have been highlighted in previous studies (Metz et al., 2017). In addition to quality accountability issues, there was also management overheads of using volunteers. These issues eventually led Simprints to completely stop public formalized volunteering sessions and only rely on their in-house engineering capabilities for technology development. This is in-line with recommendations by scholars which states that volunteer labour is best used when net-benefits of using volunteer labour are positive to the organizations (Handy & Brudney, 2007). However, previous research (e.g., Handy & Brudney, 2007; Handy & Mook, 2011; Handy & Srinivasan, 2005) on use of volunteers by organizations did not explore the suitability and timeframe to use volunteer labour in a technology development context. The TSE cases' transition from using unpaid volunteers to paid employees indicate that use of volunteers in a technology development context might be most effective, if not limited, to early-stage technology development.

The data also revealed that the motivations of TSE volunteers can be classified according to constructs by Clary et al. (1992) and Lakhani and Wolf (2005). One of the main motivations of volunteers at Raspberry Pi, Simprints, WaterScope is wanting to do good. This motivation can be classified under the "values" construct by Clary et al. (1992) which states that volunteers are motivated by "deeply held beliefs about the importance of helping others" (Clary et al., 1992, p. 337). The enjoyment or "fun" of being able to utilize their engineering skills is has been stated as another motivation. This can be classified as "enjoyment-based intrinsic motivation" construct by Lakhani and Wolf (2005) which states that individuals volunteering on open-source projects may be motivated by the creative process of problem-solving. Learning a new skill to advance their careers has also been cited as a motivation to volunteer. This can be classified as Clary's (1992) "career" construct or Lakhani and Wolf's (2005) "economic extrinsic motivation" construct. Lakhani and Wolf (2005) have also stated that a common extrinsic motivation for open-source project volunteers is the user's need for the software (von Hippel, 2001). None of the volunteers at TSEs are users of the technologies which they are helping to develop.

Clary et al. (1992) and Lakhani and Wolf (2005) have stated that the motivations are not mutually exclusive and volunteers can be motivated by a mix of motivations. The Simprints case revealed that volunteers may have a stronger inclination towards motivations based on "values". For example, a key volunteer at Simprints, Kevin Lemagnen stated that he was motivated by wanting to do good and learning new skills to advance his career. However, after gaining the skills he sought (data science), Kevin continued to contribute to Simprints because of the "social mission" of the company. It is notable that volunteers of TSEs stated that the non-profit legal structure had influence on their decision to volunteer. Although the legal structure is not a motivation on its own, the data indicates that it facilitates the motivations of volunteers in providing confidence that the TSEs prioritized their social mission. The impact of legal structures on motivations to volunteer has not been explored in previous studies since the organizations studied were predominantly non-profit in nature (Eisner et al., 2009).

5.1.3 Creating value

There are two expected types of value which TSEs seek to create – social and economic value (Austin et al., 2006; Weaver, 2018). The data from the TSEs are consistent with this statement as the firms have a dual focus for both types of value. While the language used do not explicitly

reference social and economic value creation (which is as expected since revenue generated is typically used as a proxy for measuring value creation in for-profit firms), the dual focus can be observed from the TSEs' targeting of different markets and sources of revenue.

Existing studies have discussed the differences between the two types of value creation in social enterprises (Agafonow, 2014; Kroeger & Weber, 2014; Moizer & Tracey, 2010; Weaver, 2018). However, these studies have not considered the sequence of prioritizing between the two types of value creation. It is largely a given that social value creation is the ultimate goal of social enterprises (Weaver, 2018), since this is the key differentiator with regular for-profit firms. The data from the TSEs indicate that it is important to prioritize social value creation before economic value creation in the early stages of the firms as it perceived to be more attractive to potential partners and resource providers. Although most partners and resource providers have not explicitly stated that they would not work with the TSEs if they were focused on economic value creation in the beginning, the language used in interviews suggests that they were more inclined to work with the TSEs due to their focus on social value creation.

Raspberry Pi was the exception among the TSEs as they prioritized relatively early on economic value creation after their product found a lucrative market among customers which were not their social focus (education). The focus of Raspberry Pi on economic value creation did lead to concerns of mission drift among its stakeholders, which is consistent with the expectation that commercialization may lead to mission drift (Cornforth, 2014). The strategy which Raspberry Pi eventually adopted to overcome mission drift concerns, which was to create a separate entity to engage in trading activities, was also in line with recommendations by scholars (Cornforth, 2014; Moizer & Tracey, 2010).

A key difference which enabled Raspberry Pi to focus on economic value creation over social value creation when compared to other TSE cases, was the fact that their product required almost no modifications to market to customers that were not their core social focus. The other TSEs required extensive modification to their products to target commercial markets. For example, Simprints' fingerprint scanners are designed to work for the purpose of providing identification to developing country citizens in rural areas. In order to develop a product to be used in developed countries, significant resources need to be allocated to make necessary modifications. While previous studies (Cornforth, 2014; Moizer & Tracey, 2010) have discussed the implications of adopting different strategies to reconcile differences between social and

economic value creation, the importance of the role played by the products in shaping the strategies are seldom discussed.

An additional revelation from the data was the timing of TSEs to shift focus between the two types of value creation. Raspberry Pi eventually shifted to balance focus on social value creation (by focusing on activities by the Foundation). WaterScope and Solaware eventually shifted their focus to economic value creation (by changing to for-profit and their primary target market). Solaware shifted their market focus relatively early compared to the other TSEs and this was identified by stakeholders as a potential reason for the firm's challenges in attracting further resources. In contrast, WaterScope shifted focus to commercial markets (industrial applications for their technology) after having established core partnerships (with Oxfam) and securing funding from various organizations to further their social objectives. The shift by WaterScope was also not a complete shift like Solaware as WaterScope maintained that water testing technology for developing countries would remain as not-for-profit. Put in another way, WaterScope managed to establish their commitment to social value creation prior to their shift towards economic value creation. This transition and sequencing between focus on different types of value creation has not been extensively discussed in existing studies.

The data also indicated that TSEs may adopt business model strategies that are like commercial for-profit firms in the process of economic value creation. For example, Raspberry Pi adopted a licensing model to overcome resource constraints in manufacturing (Atuahene-Gima & Patterson, 1993). This enabled Raspberry Pi to generate significantly higher revenues with relatively little financial capital. Early-stage technology-based start-ups are also known to partner with intermediaries in the process of economic value creation to deliver the product to their final customers (Lubik & Garnsey, 2016). In the case of TSEs, it can be observed that TSEs may similarly form partnerships with intermediaries to deliver their products and services. For example, Raspberry Pi, Simprints, and WaterScope, have all benefited from partnership and support from ARM in the development process of their products. However, the TSE cases also indicate that partnership is important for the process of social value creation. For example, Raspberry Pi formed partnerships (prior to acquisition) with organizations such as Coder Dojo and Code Club to create social value (providing accessible computer science education). Similarly, Simprints and WaterScope both partnered with BRAC and Oxfam respectively as part of their social value creation process.

5.1.4 Capturing value

Value captured in the form of profits is the "raison d'etre" of commercial enterprises. Reinvestment of profits will lead to further growth of the organization. However, the traditional view of value capture may not properly fit social enterprises as profits are not the main priority. Scholars such as Agafonow (2014) has postulated that social enterprises create value and forgoes value capture. Agafonow (2014) proposed that social enterprises engage in "value devolution" which gives away market power to maximize social value for consumers.

The cases reveal different configuration of value capture process for TSEs. The Raspberry Pi case indicates that a separation of the commercial and social entity would enable traditional value capture to still occur. The Raspberry Pi Trading subsidiary operates like any commercial entity and attempts to maximize profits for its parent organization (the Raspberry Pi Foundation). One of the challenges of social enterprises engaging in value capture is the risk of mission drift (Agafonow, 2014; Ramus & Vaccaro, 2017). This was indeed briefly experienced by Raspberry Pi as they began to heavily focus on their commercial activities at the expense of their social objectives. However, the problem of mission drift did not critically impact Raspberry Pi. This can be attributed to a clear demarcation of legal entities. Essentially, splitting the commercial and social component of a social enterprise would enable it to still engage in traditional value capture.

The Simprints case revealed a different configuration in which there is only a single hybrid not-for-profit organization. Traditional value capture (of maximizing profits) is not applicable here since there is only one organization that is setup to maximize social value. However, the Simprints case still does not necessary engage in "value devolution" as proposed by Agafonow (2014). Although Simprints has the goal of maximizing social value, it does not seek to give away market power to achieve that goal. Simprints engage in protection of their technology and business and actively competes with other organizations (social or commercial). Simprints maintains a level of priority for value capture in the form of profits. The main difference from commercial enterprises is that in addition to customers, Simprints also capture value from grants. A certain percentage of Simprints' revenue and profits are obtained from grants. The combination of different sources of profits indicates that social enterprises can still engage in value capture without giving up their market power.

Out of the five cases, only Raspberry Pi and Simprints managed to capture value in the form of profits. This was because the two organizations were more mature.

5.1.5 Environment

The environment plays an important role in the growth of tech enterprises (Saxenian, 1990) as it The environment plays an important role in the growth of technology-based start-ups (Saxenian, 1990) as it affects various stages of the entrepreneurial process. The data revealed that the environment also similarly plays an important role in the growth of TSEs.

Research on innovation clusters revealed that specific components present in an environment may significantly affect the growth of technology-based start-ups in those clusters (Engel, 2015). The data revealed that being geographically located in the Cambridge innovation cluster helped the TSEs to attract various forms of resources (such as financial, human, technological capital) as described in the previous sections. However, a notably different effect (from regular technology-based start-ups) which the environment had on the TSEs was in the acquisition of volunteer resources. Prior studies on innovation clusters (e.g., Engel, 2015; Engel & del-Palacio, 2009; Saxenian, 1990) have not considered availability of volunteers as an important component of the clusters. This is mainly because volunteers are typically associated with non-profit organizations as opposed to technology-based enterprises. In addition, the data also revealed how the presence of mature corporations in an innovation cluster facilitates the acquisition of volunteers by TSEs.

Start-ups in innovations clusters such as Silicon Valley have been known to support each other (Engel, 2015). The data revealed that this behaviour is also observable among TSEs in Cambridge. The presence of Simprints in Cambridge had a positive effect on the growth of younger TSE cases such as WaterScope, Solaware, and Blue Tap. For example, the Simprints founders have provided mentorship to the founders of the other TSEs (WaterScope, Solaware, Blue Tap).

5.1.6 Firm characteristics

5.1.6.1 Legal structure

The choice of legal structure is known to affect the resource acquisition process of TSEs (Jacokes & Pryce, 2010). The literature on the implications of choice of legal structure on resource acquisition has largely revolved around financial resources (Jacokes & Pryce, 2010; Martin, 2011). A specific choice of legal structure may limit the availability of financing options. The data indicate that the TSEs are aware of this and have strategically selected their legal structure to improve their resource acquisition capabilities. For example, Simprints have emphasized the importance of "planting-a-flag" with their choice of legal structure by voluntarily incorporating an asset lock into their for-profit legal structure. Certain providers of finance such as ARM have stated that the non-profit legal structure of the TSEs was a prerequisite for their support.

However, the data also revealed that apart from financial resources, the legal structure also had implications on the TSEs' abilities to acquire other types of resources such as human capital and technology. Key volunteers have stated that the non-profit legal structure played a role in convincing them to participate. The legal structure also played a role in the acquisition of technology. Raspberry Pi was able to convince key suppliers due to its charity structure. Simprints were able to acquire software and hardware from other technology enterprises (such as Google) due to their non-profit structure. This effect of choice of legal structure on acquisition of human capital and technology has not been explored in existing literature.

5.1.6.2 Organizational legitimacy

The perception on TSEs has been found to have positively affected the resource acquisition process. The founders of Raspberry Pi, Simprints, and WaterScope stated that they strategically chose the legal structure to make it easier to gain support from resource providers. This behaviour is similar to how entrepreneurs use symbolic management to acquire resources (Zott & Huy, 2007). Zott and Huy (2007) identified that firms may convey 'professional structures' through its legal status as a form of symbolic management to convince resource providers. However, the data revealed that beyond just being incorporated as a legal entity, the specific form of legal structure also impacts the ability of TSEs to acquire resources.

The relatively successful TSEs (Raspberry Pi, Simprints, WaterScope) have strategically selected their choice of legal structure to garner support from key resource providers. Key volunteers at Simprints have stated that the non-profit legal structure affected their perception of the firm as it would "feel wrong" if it were for-profit. Resource providers have also stated that the open IP position also affected their perception to provide support. A competition judge stated that open IP position of WaterScope provided credibility that they are committed to the social objectives. Similarly, Lara Allen from CGE stated that social enterprises with an open IP approach would appear to have the "right attitude" and would be of interest.

The data indicate that the TSEs sought to affect the perception on their firms as a strategic means of resource acquisition. Raspberry Pi, Simprints, WaterScope, Blue Tap made strategic decisions to create positive perception (which can be conceptualized as organizational legitimacy) (Suchman, 1995), on their firms to acquire resources. Although organizational legitimacy is also important to technology enterprises in general (Audretsch et al., 2012), the data suggest that organizational legitimacy may have greater importance to early-stage TSEs. This is because in addition to organizational legitimacy, other factors may affect the resource acquisition capabilities of technology enterprises such as the potential for significant financial gains (Arora et al., 2016). The potential for significant financial gains is typically absent in the context of TSEs which hinders the firms' ability to attract resources based on this factor. This suggests that other traits and actions of the TSEs which affects perception and ultimately leads to organizational legitimacy (such as symbolic management suggested by Zott and Huy (2007)) would play a larger role in early-stage TSEs' ability to acquire resources.

The data revealed that the choice of legal structure played a role for TSEs to gain organizational legitimacy. Institutional theory dictates that new ventures can gain legitimacy by engaging in "standard" or "normal" organizational behaviour within a given field of activity (Meyer & Rowan, 1977). Prior research stipulates that new ventures which adopt organizational forms and structures of mature corporations provide credibility to resource providers because of familiarity (Khaire, 2010; Zott & Huy, 2007). However, in the case of TSEs, these hybrid organizational forms are so new that "standard" or "normal" behaviour have not been established. As social enterprises can have either a for-profit or not-for-profit legal structure, the data indicates that an initial not-for-profit structure enables TSEs to gain organizational legitimacy. This is because some resource providers are more inclined to provide support to an organizational form that is visibly committed to the social mission. The WaterScope case indicates that even if the

organization transitions to for-profit in a later stage, they are still able to maintain organizational legitimacy with stakeholders. Having a prototype also contributed to organizational legitimacy by indicating the maturity of technology development to resource providers. This is consistent with the findings of Audretsch et al. (2012) which found that new ventures with prototyped innovations are more likely to receive funding.

The data also suggest that there may be more layers to the conceptualization of organizational legitimacy of TSEs. For example, the role played by the presence of the University as well as the geographical location of the TSEs are not properly explored in the current conceptualization, even though they have been remarked by interviewees as having an impact on their firm. The data suggests that legitimacy may be conceptualized as a resource or "thing" to be strategically acquired by TSEs. This will be reviewed in greater depth and explored in the later section of this chapter.

5.1.6.3 Organizational culture

Organizational culture is "how an organization perceives, evaluates, and reacts to the internal and external factors shaping the environment" (Arikan & Enginoğlu, 2016, p. 680). Elements of organizational culture have been known to positively affect firm performance (Arikan & Enginoğlu, 2016). The data revealed that organizational culture may similarly have a positive effect on TSEs. The TSEs' prioritization of "impact over profits" is embedded into the organizational culture of TSEs through actions and statements. This may have positively affected the TSEs' abilities to acquire resources and form partnerships, which ultimately contributed to improved firm performance.

This prioritization of "impact over profits" can be observed from the actions and statements of the relatively mature TSEs (Raspberry Pi, Simprints, WaterScope). For example, Raspberry Pi insisted on a commitment to open their technology and hope for competitors to create copies of their technology. Simprints similarly prioritized ethics to forgo commercial markets to avoid the risk of their fingerprinting technology being misused. WaterScope similarly indicated that they prioritized impacts by deferring to seek private investments to avoid "being pulled in undesirable directions". These actions can be categorized under "corporate citizenship" element proposed by Flamholtz and Kannan-Narasimhan (2005) which states that the way an organization operates as

a member of its community is an important cultural element to affect the firm's financial performance. Additionally, Simprints also ensured their customers would not be locked into their technology as a show of commitment to their openness. This action reflects how customers are viewed and treated by the organization and has been identified as an cultural element by Flamholtz and Kannan-Narasimhan (2005).

The data is limited to conclusively determine whether these specific actions contributed to the TSEs' increased abilities (compared to other TSEs) to acquire resources and increased financial performance. However, the language used by some of the key resource providers suggests that their decision to support were positively affected by the TSEs' commitment to impact which were reflected by some of the cultural elements mentioned earlier. This suggests that a specific organizational culture of TSEs – a commitment to the social mission to internal and external stakeholders – may subsequently lead to competitive advantages in the resource acquisition process. A commitment to social mission can also be interpreted as "purpose" (Muñoz et al., 2018). Muñoz et al. (2018) have recommended not to emphasize "purpose" too early in the venturing process (before business model is fixed) as it may limit the social enterprise's ability to adapt their business model. The data suggests that emphasizing "purpose" early on may support the resource acquisition process by having a positive effect on potential stakeholders through organizational culture.

5.1.7 Next cycle – diversification

Oster (1995, p. 88) stated that non-profits diversify because of three reasons: 1. To meet the mission in a changing world; 2. Take advantage of production and/or distributional complementaries; 3. Increase opportunity for cross-subsidization. The data revealed that TSEs may diversify for reasons that are consistent with non-profits as described by Oster (1995, p. 88). For example, Raspberry Pi diversified their business from manufacturing computers to include magazine publishing to better meet their mission of providing education in computer science. Simprints diversified to develop new technologies for neonatal fingerprinting (a different market segment) to take advantage of their production complementaries (since their existing fingerprinting R&D capabilities can also be applied to the new market). WaterScope diversified to explore industrial water testing to increase opportunities for cross-subsidization.

However, it is notable that Raspberry Pi having a separate for-profit trading subsidiary, exhibited diversification behaviours that were more similar to technology-based for-profit firms. For-profit firms primarily engage in R&D for diversification to increase their revenues (Baysinger & Hoskisson, 1989; Rumelt, 1982). Raspberry Pi developed multiple product lines for different market segment (e.g., Compute Module for industrial use). Although the diversification of Raspberry Pi was financially rewarding, it also raised concerns from stakeholders that Raspberry Pi was too focused on new product introduction as opposed to their core mission of education. This effect of successful commercialization leading to increased risk of mission drift was consistent with the expectations laid out by Cornforth (2014). The strategic management issues resulting from combining for-profit and non-profit activities were similarly highlighted by Oster (1995). Oster (1995) mentioned that the management of for-profit business may require a different strategy and structure compared to the non-profit business. Raspberry Pi addressed this issue by merging and acquiring new organizations (Coder Dojo and Code Club) with their Foundation to develop the capabilities to deliver on their core mission of education.

Simprints avoided the problems of managing a separate for-profit business by deliberately refusing to diversify into commercial markets with their fingerprinting technology, despite having interest from potential customers. This decision comes at the expense of lower financial revenue as Simprints must rely on a combination of grants and sales revenue. In contrast, Raspberry Pi's revenue from its for-profit business is more than sufficient to sustain the entire organization's (both for-profit and non-profit) operations. Simprints decided not to diversify into commercial markets to maintain their focus on delivering social impact. However, Simprints diversified their product line (development of neonatal fingerprinting technology) to increase their social impact delivery. The Simprints case essentially revealed that TSEs may engage in product diversification to further the social mission at the expense of financial gains. This indicates that TSEs may have different reasoning for diversification that is different from for-profit firms (that typically engage in product diversification to increase their financial bottom line) (Baysinger & Hoskisson, 1989; Rumelt, 1982), and non-profits (as TSEs may take advantage of production complementaries for the mission but not engage in opportunities for further cross-subsidization) (Oster, 1995, p. 88)).

5.1.8 Exit

Entrepreneurial exit strategies have been found to influence the future behaviours of new firms, including resource acquisition, funding, growth, and risk-taking propensities (DeTienne, 2010; DeTienne & Cardon, 2012; DeTienne et al., 2015). Although none of the entrepreneurs from the TSE cases have gone through the exit process, either through external acquisition or voluntary change of leadership, some of them have explored exit strategies (e.g., WaterScope and Solaware), or a deliberate choice not to have one (e.g., Raspberry Pi and Simprints). These will be discussed in turn.

WaterScope and Solaware explored exit via acquisition to capitalize on the potential acquirer's distribution channels and resources to deploy their technologies. This exit strategy was viewed by both TSEs as a means and further their social objectives. After a review of the literature, DeTienne et al. (2015) proposed a typology with three types of entrepreneurial exit strategies – financial harvest, stewardship, and voluntary cessation. However, the behaviour exhibited by WaterScope and Solaware to consider exit strategies as a means to further their social objectives suggests a new dimension to the proposed strategies by DeTienne et al. (2015). The financial harvest exit strategy is the closest fit to the exit strategy considered by WaterScope and Solaware as it may involve external acquisition. However, it is not a complete fit as the financial harvest strategy is described by DeTienne et al. (2015, p. 257) to result in "substantial value accrued to the entrepreneur". In contrast, although WaterScope and Solaware had explored acquisition as an exit strategy, it was not to accrue (or to "harvest") substantial financial value to the entrepreneurs but rather for a non-financial reason.

Raspberry Pi and Simprints had decided relatively early not to exit via acquisition, as they had the intention to be leaders in their respective sectors. As such, both firms avoided seeking private investment funding which may affect the control over their firms. Raspberry Pi and Simprints were comfortable with their rate of growth and were adamant on staying independent to maintain control over their social objectives. Based on the strategies proposed by DeTienne et al. (2015), the stewardship exit strategy may be probable as a fit as it suggests the need for some degree of control over the firm's direction even after exit. This strategy, however, is speculative as it remains to be seen on how the founding entrepreneurs in both firms will eventually exit as the firms have yet to reach that stage. It is possible that the early decisive intentions of Raspberry Pi and Simprints to maintain independent control and be leaders in their sectors may have

contributed to their eventual rapid growth. Although the data is not sufficient to conclusively draw that conclusion, it does suggest a nuance to the exit strategies proposed by DeTienne et al. (2015). DeTienne et al. (2015) proposed the strategies with the presumption that all entrepreneurs eventually exit. While this may be true, the data suggests that for early-stage TSEs, a deliberate choice not to have an exit strategy may have implications on the firms' future behaviour and performance.

5.1.9 Summary of Stage 1 key findings

The findings suggest that legitimacy played an important role in the acquisition of various resources by TSEs. The framework proposed by Moizer and Tracey (2010) separates organizational legitimacy from resource accumulation activities. The data revealed that organizational legitimacy may have a larger role in affecting the resource accumulation process which goes beyond just having "support from community bodies". The data indicates that the TSEs deliberately and strategically shaped the perception on their firms to secure resources. This suggests that organizational legitimacy was actively sought as a "resource" to further secure other resources. This implication requires further review of the legitimacy literature to incorporate it into the framework since the original conceptual framework had considered organizational legitimacy as separate from the resource acquisition process. Stage 2 of the analysis will be described in the following section.

5.2 Stage 2 findings: Discussion of legitimacy-based analysis

The data revealed that the TSEs leveraged on various mechanisms (Fisher et al., 2017) to gain legitimacy during the early stages of their organizations to facilitate resource acquisition activities. The ways in which TSEs strategically utilized the four legitimacy mechanisms in Fisher's (2017) framework (i.e., identity, associative, organizational, and other) will be discussed in turn.

The TSEs were found to engage in storytelling (Aldrich & Fiol, 1994), impression management (Benson et al., 2015), and symbolic actions (Zott & Huy, 2007) to gain identity legitimacy in the eyes of resource providers. Raspberry Pi's early attempts to secure funding were pitched with a "story" of its connection to Cambridge and the BBC Micro. This strategy is in line with early-stage start-ups utilizing a narrative "to make a case that their ventures are compatible with more widely established sets of activities" (Aldrich & Fiol, 1994, p. 652). A founder of Blue Tap's statement that it is "fashionable" to identify as a social enterprise, is an indication of impression management. The language used indicates that there is an element of performing for an external audience (Benson et al., 2015). A few of the TSEs (Raspberry Pi, Simprints, WaterScope) have engaged in symbolic actions (Zott & Huy, 2007) such as having an open IP policy and appropriate legal structure to reinforce the perception that their organizations prioritize social impact over profits. The data indicates that TSEs engage in behaviors which are similar to commercial technology-based enterprises (Fisher et al., 2017). However, the strategic choice of legal structure as an act of symbolic action to gain identity legitimacy by TSEs has not been explored sufficiently in the extant literature.

The TSEs leveraged on organizational (Singh et al., 1986; Zimmerman & Zeitz, 2002), top management (Higgins & Gulati, 2006), and individual (Packalen, 2007) ties to gain associative legitimacy. Raspberry Pi's organizational ties to the University of Cambridge's Computer Laboratory played an important role in securing resources from ARM. Raspberry Pi also strategically leveraged on the founders' backgrounds to gain access to resources. This is similar to how commercial start-ups leverage the ties of their top management team to gain resources (Higgins & Gulati, 2006). However, apart from Raspberry Pi, all the other TSEs had a top management team with minimal established ties. The TSEs leveraged on many individual ties (such as academics and alumni of University of Cambridge) to gain associative legitimacy which provided additional positive influence on resource providers. The data revealed that the Cambridge environment in which the TSEs were situated played an important role in facilitating

organizational and individual ties. Existing literature on legitimacy (e.g., Fisher et al., 2017) has not explored the role played by the environment in facilitating associative legitimacy. Additionally, three TSEs intentionally made associations with established technologies to convince resource providers (i.e., BBC Micro for Raspberry Pi; iPhone for Simprints; 3D-printing for WaterScope). This suggests a possible new mechanism by organizations to gain associative legitimacy – through technological ties.

In addition to contributing to identity legitimacy, the legal structure of TSEs has also found to contribute to organizational legitimacy through the establishment of structures, which has been discussed in Section 5.1.6.2. Due to the relative infancy of TSEs as a distinct form of organization, "standard" or "normal" behaviour have not been established for new TSEs to "mimic" (Khaire, 2010). The importance of the role played by the legal structure in facilitating resource acquisition by early-stage TSEs has not been highlighted in existing literature. The data also provides a limited look into how TSEs may strategically transition their legal structure and its effect on legitimacy in the eyes of stakeholders. Prototyping also contributed to organizational legitimacy by indicating the maturity of technology development to resource providers, which is consistent with the findings of Audretsch et al. (2012).

The data also revealed the environment as a source of legitimacy which is beyond the control of the venture (categorized as "other" by Fisher et al. (2017)). The Cambridge environment played a role which cut across various legitimacy mechanisms of the TSEs. The geographical proximity to other technology ventures in Cambridge has enabled TSEs in Cambridge to be considered part of the cluster, subsequently positively affecting acquisition of legitimacy by TSEs.

5.3 Drawing upon Stages 1 and 2 to enhance technology-based social enterprise conceptual framework

Analysis of the data and reflection back to the literature suggests that the initial conceptual framework that was developed in Chapter 3 to describe the growth process of TSEs requires modification. There are three primary modifications to the framework – splitting of commercial and social resource providers, splitting of social and economic value creation, and emphasizing the importance of acquiring legitimacy as a resource prior to other resources. The proposed modified framework to describe the growth process of TSEs is shown in **Figure 5.1.**

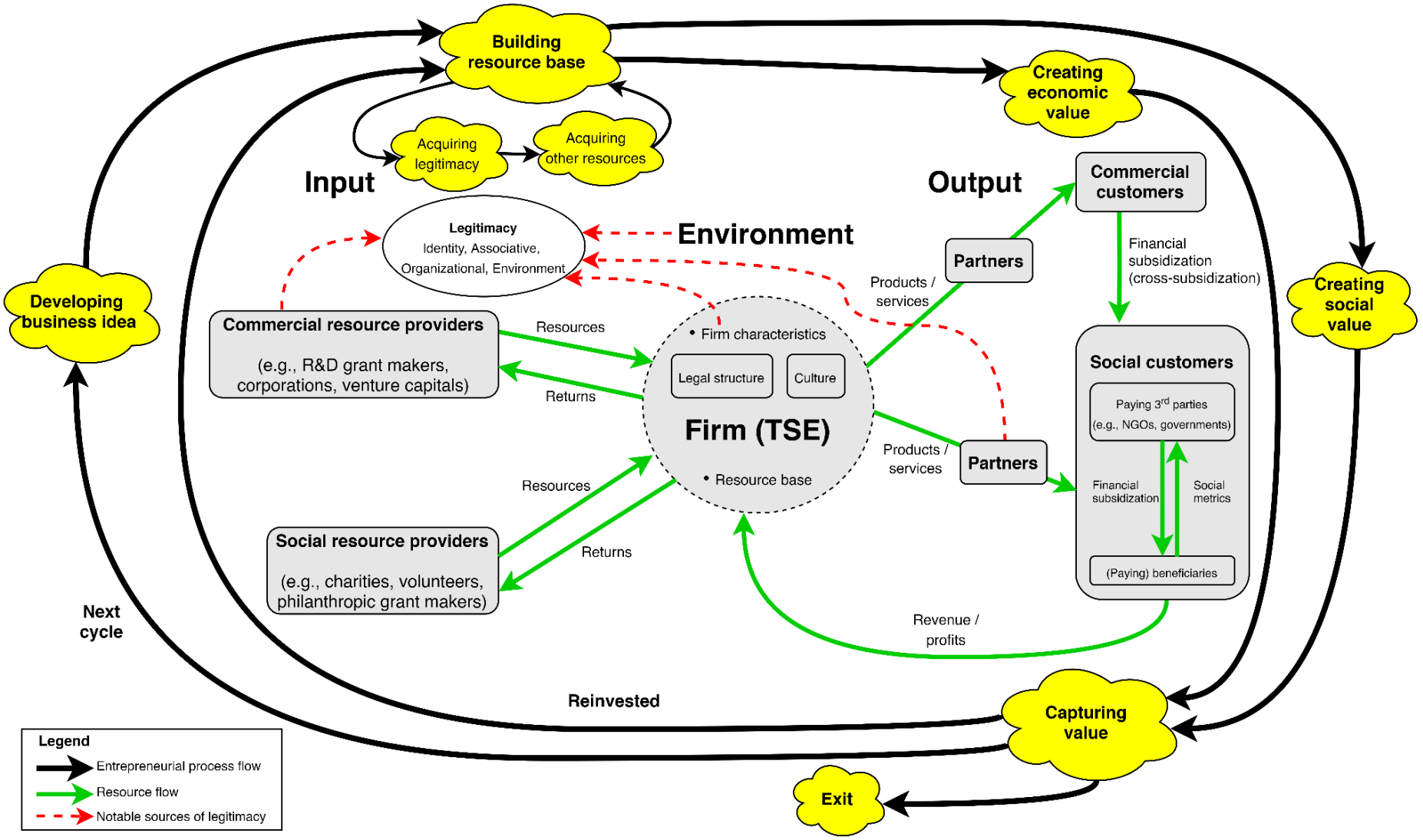


Figure 5.1. Proposed modified conceptual framework to describe growth process of TSEs.

The splitting of resource providers comes as the data revealed that TSEs view resource providers as two distinct categories, namely social and commercial resource providers. Although these two categories are not explicitly referenced by the TSEs, it is observable from their actions to strategically acquire resources from one source or the other. For example, the choice (and subsequent transition) of legal structure by TSEs were made to appeal to a specific category of resource providers.

The splitting of value creation into economic value creation and social value creation comes as the data revealed that the initial focus of the TSEs in the form of value creation has implications on the growth process of the firm. For example, Raspberry Pi focused on creating economic value led to relatively great financial success but at the risk of mission drift. However, Raspberry Pi's ability to focus on creating economic value before social value appears to be an exception rather than the norm due to characteristics of its core product offering (i.e., having the same product that can be offered to both social and commercial markets). The other TSEs' focus on creating social value has implications on their ability to acquire resources in the early stages of the firms. These differences suggest that a singular value creation construct which has been used to describe commercial enterprises may not be a suitable fit for TSEs.

Finally, modifications were made to emphasize the importance of acquiring legitimacy as a resource prior to acquiring other resources. In the framework, red dashed lines were used to highlight notable sources of legitimacy which contributes to the various categorization of legitimacy (i.e., identity, associative, organizational, environment). This does not imply that other components not highlighted in the framework do not contribute to legitimacy, but rather it emphasizes sources that have been revealed by the data to influence the specific context of TSEs. Firm characteristics such as legal structure and culture have an impact on legitimacy that are different from those reported in existing studies. For example, in existing studies, just having a legal structure was found to increase legitimacy of firms since it conveys 'professional structure' (Zott & Huy, 2007). However, the data from the TSEs revealed that different types of legal structures may have different implications on how the firm is perceived. The data also revealed that having partnerships in the social value creation process contributed to the firm's legitimacy in the eyes of resource providers. Unexpectedly, partnerships with commercial resource providers (such as ARM) were perceived to have a bigger impact by other resource providers (such as competition judges). This suggests that different sources of legitimacy affect the two main components of TSEs – namely, technology and social aspect – differently. Partnerships with

commercial technology-based enterprises contributed to legitimacy of the firm's technology, whereas partnerships with social organizations contributed to legitimacy of the firm's social mission. The environment was also found to have a notable positive effect on TSEs' legitimacy. This is important as it indicates that being in a cluster of innovation may increase legitimacy of the TSEs, which helps the resource acquisition process.

Chapter 6 Conclusion

This thesis has sought to address the emergence of an important phenomenon – technology-based social enterprises. The importance of TSEs stems from their potential to provide scalable solutions from a technological perspective to address diverse social challenges in the world. However, the set of challenges faced by TSEs due to their hybrid nature, is different from those faced by purely commercially focused technology-based start-ups and traditional non-profits. Thus, it is imperative to investigate the underlying growth process of TSEs for a better understanding to support their development and address their unique challenges.

The research question that this thesis has addressed is:

> *"How do technology-based social enterprises acquire and manage resources to grow the venture, and develop their technologies?"*

The answer to the research question is:

> *"TSEs can acquire various resources (e.g., financial capital, human capital, technological capital, as well as pro bono and volunteers) by leveraging on legitimacy as a resource to facilitate acquisition of other resource. TSEs can obtain legitimacy as a resource through various mechanisms. Additionally, the study also revealed that the environment plays a crucial role in facilitating resource acquisition by TSEs. An environment that has a rich ecosystem of individuals and organizations to support technology-based organizations will help the growth of TSEs. With regards to management of resources, TSEs need to manage resources to focus on the social component before the commercial component of their organizations in the early stages of growth. To overcome lack of resources in the early stages of growth, TSEs may also leverage on skill-based volunteers to support technology development activities. The study suggests that TSEs may access volunteers in the initial start-up phase to support technology development before resources can be acquired to develop its in-house engineering capabilities."*

The question was addressed using the case study method (Yin, 2014) to conduct case studies on five prominent TSEs located in Cambridge, United Kingdom – Raspberry Pi, Simprints, WaterScope, Solaware, and Blue Tap. The case studies were conducted in two stages structured around different conceptual frameworks: Stage 1 – resource-based; Stage 2 – legitimacy-based. In Stage 1, an initial resource-based conceptual framework was derived from the literature as a structure for the case studies (**Figure 3.16**). The findings from Stage 1 revealed that legitimacy as a resource played an important role towards the growth of TSEs, more than could be captured using the resource-based conceptual framework. This led to Stage 2 of the case studies which was structured around a legitimacy-based conceptual framework derived from literature (**Table 2.5**). The findings of both stages subsequently contributed to the modification and enhancement of the initial resource-based conceptual framework to form a new conceptual framework to describe the growth process of TSEs (**Figure 5.1**). The following sections will describe contributions to theory and practice, limitations of study, further research directions, and state a conclusion to the study.

6.1 Key findings

There are four key findings from this thesis:

1. **Conceptual framework for growth process of TSEs;**
   A key finding of this thesis is the conceptual framework to reveal the underlying growth process of TSEs. The final conceptual framework is based on a combination of resource-based and legitimacy-based theories and informed by empirical data analysis. Empirical data enhanced the original framework that was derived from literature by revealing the need to separate the resource providers and value creation into respective social and commercial (or economic) components.

2. **Importance of acquiring legitimacy as a resource to support growth of TSEs;**
   Another key finding of this thesis is the important role played by legitimacy in resource acquisition by TSEs. The data revealed that TSEs may leverage on various mechanisms to gain legitimacy to facilitate access to resources. Notably, the analysis also suggests that there is a sequence to prioritize acquisition of legitimacy as a resource by TSEs prior to acquisition of other resources.

3. **Role of volunteers towards technology development by TSEs;**

The role played by volunteers in technology development process of TSEs is also a key finding of the study. Prior research on the management of volunteers in the context of technology development is scarce. This study revealed the manner which TSEs successfully managed volunteers to contribute to technology development activities.

4. **Role of environment for facilitating resource acquisition by TSEs.**

Lastly, the data also highlighted the important role played the environment to facilitate acquisition of various resources by the TSEs. The Cambridge environment was found to have contributed positively towards critical resources needed by TSEs at the early stages of their organizations. TSEs in the Cambridge environment were able to access resources

6.2 Contributions to theory and practice

6.2.1 Contribution to theory

This study makes four contributions to the literature. Firstly, the study addresses a gap in the literature on an emerging phenomenon – the growth of TSEs. The gap is addressed through the development of a conceptual framework that was inspired by existing frameworks for the entrepreneurial process. The conceptual framework was then used to conduct case studies to provide an empirical account of the growth process of TSEs. This responds to calls by scholars on having more qualitative-based case studies on growth of firms (Davidsson et al., 2010; Zupic & Giudici, 2018). Although resources predominantly available to non-commercial organizations (such as pro bono and volunteers) are anticipated to play a role in the growth of social enterprises, prior research do not account for the use of those resources by organizations engaged in technology development. This subsequently revealed the role played by skill-based volunteers to perform technology development activities.

Secondly, the study also contributes to the legitimacy literature by revealing the importance of acquiring legitimacy as a resource to support growth of TSEs. This discovery led to further revision of the conceptual framework to integrate legitimacy-based constructs. Legitimacy was found to have played a critical role in the resource acquisition process of TSEs. An empirical account gathered through a legitimacy-based lens revealed how various legitimation mechanisms led to acquisition of legitimacy by TSEs. The empirical data shed new light on acquisition of

legitimacy by new forms of hybrid organizations. For example, prior research stipulates that new ventures which adopt organizational forms and structures of mature corporations provide credibility to resource providers because of familiarity (Khaire, 2010; Zott & Huy, 2007). In the case of TSEs, the hybrid organizational forms are so new that there were no mature hybrid corporations to emulate. The findings revealed that an initial adoption of not-for-profit legal structures enables the organization to gain organizational legitimacy. This organizational legitimacy gained through the legal structure revealed itself to play an important role in the further acquisition of resources (such as strategic partnerships and volunteers) by social enterprises.

Thirdly, the study also contributes to the volunteer management literature by providing empirical data to describe how TSEs managed volunteers to contribute to technology development activities. Notably, the transition of volunteers is a new finding which builds upon the conceptualization of volunteers by Overgaard (2019). Additionally, the study also contributes to the conceptualization of skill-based volunteers as a resource for TSEs, which has not been sufficiently explored in existing literature.

Fourthly, the study also contributes to the innovation cluster literature by highlighting the importance of the role played by the environment towards acquisition of resources by TSEs. Notably, the case studies revealed that the Cambridge environment facilitated the acquisition of legitimacy by TSEs. In more than one case, the environment was discovered to be a source of legitimacy to the TSEs. For example, the TSEs managed to gain legitimacy by virtue of being geographically located in Cambridge. This adds a new dimension to the strategies used by firms to acquire legitimacy (Fisher et al., 2017). Legitimacy further enabled the TSEs to acquire other critical resources from the environment such as financial resources and access to volunteers. The role played by the environment to facilitate access to volunteers adds a new component to characteristics of innovation clusters which has not been considered in prior studies (e.g., Engel, 2015; Engel & del-Palacio, 2009; Saxenian, 1990).

6.2.2 Contribution to practice

The findings from this study have implications for entrepreneurs and managers of TSEs. The conceptual framework provides a high-level overview of the entrepreneurial process and resource flows of TSEs to practitioners. Entrepreneurs may utilize the framework to formulate strategies to chart the growth of their TSEs.

In addition, the findings also shed light on the resource acquisition process of TSEs. The findings highlight the importance of specific resources accessible by TSEs, such as the use of volunteers and pro bono resources. These resources are unconventional to both commercial technology-based enterprises and traditional non-profits. The findings may also provide guidance for managers in TSEs to implement strategies to access volunteers and pro bono resources.

The study helps entrepreneurs formulate strategies to chart the growth of their TSEs. The study highlights where and when entrepreneurs should concentrate their focus (commercial vs social components of TSEs). The study suggests that TSEs should focus on developing the social component (e.g., securing partnerships with humanitarian/social partners, building legitimacy) before focusing on the commercial component. Although success on the commercial component is highly desirable to ensure sustainability, it is more challenging for TSEs to put their initial focus on this component. This subsequently brings to light the role of legitimacy towards further resource acquisition. The study also describes the various forms of acquiring legitimacy by TSEs. Certain activities such as selecting a particular legal structure or employing the right communication strategy can be executed with low cost but has an important impact on the firm's legitimacy.

Finally, the study also highlights the importance of the environment on the growth of TSEs to practitioners. The environment played an important role in facilitating the resource acquisition process of TSEs. Practitioners can now factor in the geographical location of their TSEs when planning for resource acquisition.

6.3 Limitations of study

The study is susceptible to limitations of the case study method (Yin, 2014). The external validity (or generalizability) of the findings is limited by the fact that only Cambridge-based TSEs engaged in manufacturing activities were selected as cases. However, the need to focus on TSEs in a confined geographical area and industry was necessary at this exploratory stage to minimize sample variations due to environmental and industry factors.

The data was collected in a snapshot manner which leads to the possibility of recall bias by interviewees when retelling past events. An interviewee even made a disclaimer by saying that "history is told by the victors" as he suggested that his recall of the early history of the firm may not be exactly accurate. Efforts have been made to reduce bias by triangulating data from various sources, but limitations may persist due to the young age of the firms (which limits the available sources for triangulation).

An important finding of the study was the importance of the role played by humanitarian/social partners to convince resources providers to support the case study firms. However, due to limitations in time and resources, a first-hand account from the humanitarian/social partners of the case study firms of why they supported the TSEs was unable to be obtained (e.g., BRAC, Bill and Melinda Gates, Oxfam).

6.4 Further research directions

The study revealed the importance of the Cambridge environment in facilitating the growth and resource acquisition process of TSEs. A potential avenue for further research is to explore development of TSEs in other innovation clusters or geographic locations. In addition to the geographic location, further research may also explore TSEs in different industries. For example, TSEs engaged in purely software development activities may have different resource acquisition needs and strategies when compared to TSEs in this study that are engaged in manufacturing activities. The conceptual framework that has been developed in this study can potentially be used as a tool to structure additional data collection and analysis in future studies.

Another avenue for further research is a growth comparison between TSEs and non-TSEs within a particular cluster. The findings would reveal if there was a distinction in the role played by the environment on different types of social enterprises (technology-based versus non-technology-based).

At the writing of this thesis, TSEs are still a relatively new phenomenon. As TSEs mature, a possible research direction is to re-evaluate their growth process and to compare structures of mature TSEs with mature technology-based enterprises. As the number of TSEs increase, further research may also incorporate a mix of quantitative and qualitative methods to investigate the phenomenon through readily available datasets.

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Appendix 1. List of sustainable developments goals

Source: United Nations Department of Global Communications

Appendix 2. List of key individuals from relevant organizations

	Title	Name	Affiliation	Position
1		Dan Sutch	Centre for Acceleration of Social Technology	Director
2		Jessica Stacey	Bethnal Green Ventures	Communications Manager
3	Dr.	Lara Allen	Centre for Global Equality	Director
4	Dr.	Laura James	Makespace Cambridge Limited	Co-founder/Director
5		Paul Hughes	Future Business Centre	Head of Venture Development
6		Stewart McTavish	ideaSpace	Director
7		Tania Villares Balsa	Cambridge Enterprise	Investment Director
8	Prof.	Tim Minshall	i-Teams	Advisory Committee Member

Appendix 3. Data collection chart

Name: Company:

Constructs	Time 1	...	13
1. Technology a. What is the core technology?		...	
2. Technology development a. What is the origin of the technology? b. How was the technology developed?		...	
3. Business model / Idea a. What is the origin of the business idea? b. What is the business model? Why?		...	
4. Operations a. What is the scope of operations? E.g., Systems design to manufacturing		...	
5. Markets a. What are the markets targeted? Why?		...	
6. Legal structure a. What is the organizational legal structure? Why? b. Did the legal structure provide access to new resources?		...	
7. Revenue / profitability a. What are the revenues generated? b. Is the organization profitable?		...	
8. Partnerships a. Who are the partners and what resource did they provide? b. How was the partnership formed?		...	
9. Financial resources a. Who provided financial resources and how much? b. How was value assessed by the financial providers?		...	
10. Key people a. Who are the key people associated with the company?		...	
11. Employees a. How many employees are there in the organization? b. What were their roles?		...	
12. Volunteers / Pro bono a. Who were the volunteers involved with the organization (If any)? How many and what did they do? b. Who provided what pro bono and why?		...	
13. Intellectual property a. Were there any registered patents associated with the technology? b. What is the intellectual property strategy of the company?		...	
14. Awards and recognition a. What are the awards and recognition given to the people or organization?		...	
Other resources accessed		...	

Simplified data collection chart

Appendix 4. List of interviewees

Raspberry Pi

	Title	Name	Affiliation	Position
1	Prof.	Alan Mycroft	Department of Computer Science and Technology, University of Cambridge	Trustee/Co-founder
2	Dr.	Daniel Bates	Raspberry Pi Foundation; University of Cambridge	Volunteer; Research Associate
3		David Braben	Frontier Developments	Trustee/Co-founder
4	Dr.	David Cleevely	Raspberry Pi Foundation; Cambridge Angels	Chairman; Co-founder
5		Dominic Vergine	ARM	Head of sustainability
6	Dr.	Eben Upton	Raspberry Pi Trading	CEO/Co-founder
7		Jack Lang	Raspberry Pi; University of Cambridge	Chairman/Co-founder; Lecturer
8		Phillip Cooligan	Raspberry Pi Foundation	CEO
9	Dr.	Rob Mullins	Department of Computer Science and Technology, University of Cambridge	Trustee/Co-founder
10		Rory Cellan-Jones	BBC	Technology Correspondent

Simprints

	Title	Name	Affiliation	Position
1	Dr.	Alain Labrique	John Hopkins University	Associate Professor
2	Dr.	Alexandra Grigore	Simprints	Co-founder
3		Anne Radl	Social Tech Trust	Social Investment Manager
4	Dr.	Cassi Henderson	University of Cambridge; Simprints	PhD Student; Volunteer
5	Dr.	Dan Storisteanu	Simprints	Co-founder
6	Dr.	Darrin Disley	Carpe Diem Investment Fund	Principal/Founder
7		David Gill	St. John Innovation Centre	Managing Director
8		Doerte Letzmann	Redgate Software	Product Manager
9		Dominic Vergine	ARM	Head of Sustainability
10		Emma Millar	Taylor Vinters	Senior Associate
11		Giles Hutchison	Simprints	Product Design & Manufacturing
12		Helen Lundebye	Simprints	Project Manager
13		Jeff Foster	Redgate Software	Head of Product Engineering
14		Jordan Hrycaj	Mjh-IT	Consultant
15		Kevin Lemagnen	Qualcomm; SMAP Energy; Simprints	Engineer; Engineer; Volunteer
16	Dr.	Lara Allen	Centre for Global Equality	Director
17		Martin Riddiford	Therefore Design Consultants	Director/Founder
18		Patrick Farrant	Taylor Vinters	Partner/Head of Technology Group
19		Pawel Moll	ARM; Simprints	Principal Engineer; Volunteer
20		Rory Landsman	Trinity College, University of Cambridge	Bursar
21	Dr.	Toby Norman	Simprints	CEO/Co-founder
22		Tom Daley	Aptivate; Simprints	Engineer; Volunteer

WaterScope

	Title	Name	Affiliation	Position
1	Dr.	Alexander Patto	WaterScope	CEO/Co-founder
2	Dr.	Cassi Henderson	University of Cambridge; WaterScope	PhD Student; Volunteer
3		Cecilie Hestbæk	Humanitarian Innovation Fund (Elrha)	Senior Innovation Manager
4		David Gill	St. John Innovation Centre	Managing Director
5		Doerte Letzmann	Redgate Software	Product Manager
6	Dr.	Gillian Davis	Cambridge Enterprise	Commercialisation Director
7		Jeff Foster	Redgate Software	Head of Product Engineering
8	Dr.	Lara Allen	Centre for Global Equality	Director
9	Dr.	Michael Coto	Majico	CEO
10	Dr.	Nalin Patel	WaterScope	Co-founder/Treasurer
11	Dr.	Richard Bowman	WaterScope; University of Bath	Co-founder; Lecturer
12	Dr.	Sammy Mahdi	WaterScope	Electrical Engineer/Volunteer
13		Tania Balsa	Cambridge Enterprise	Investment Director
14	Dr.	Tianheng Zhao	WaterScope	Co-founder/Engineer

Solaware

	Title	Name	Affiliation	Position
1	Dr.	Belinda Bell	Cambridge Social Ventures	Programme Director
2	Dr.	James Griffith	Solaware	CEO/Co-founder
3	Dr.	Lara Allen	Centre for Global Equality	Director
4	Dr.	Philip Hilton	Solaware	Business Advisor
5	Dr.	Thomas Choi	Solaware	Co-founder

Blue Tap

	Title	Name	Affiliation	Position
1	Dr.	Francesca O'Hanlon	Blue Tap	CEO/Co-founder
2		Ian Sanderson	Afrinspire	CEO/Founder
3	Dr.	Lara Allen	Centre for Global Equality	Director
4	Dr.	Miguel Vilar	National Geographic	Senior Program Officer, Scientific Director
5		Suhaa Mahmood	Blue Tap	Intern, Technology Team

Appendix 5. Interview protocols

The following line of questioning was used during interviews with founders/employees of TSEs and their resource providers.

Interview with founders/employees of TSE

- Brief introduction to objectives of the study.
- Interviewee's role, position, background, and involvement within the [TSE].
- Recap the history of [TSE] – how it started, highlight any significant events, why were they significant?
- What is the current stage of [TSE]?
- Based on interviewees' recap and the resource-based constructs in the frameworks, ask specific questions to fill in the gaps of acquiring resources (e.g., financial capital, human capital, technology). Example questions:
    - How did you obtain funding?
    - How was the prototype of the technology developed?
- Who were the key people involved with [TSE]?
- What are the most important resources that [TSE] has? Why?
- How did [TSE] access those resources? Was there a strategy to acquire those resources?

Interview with resource providers

- Brief introduction to objectives of the study.
- Interviewee's role, position, background, and involvement within the [TSE].
- Follow-up questions are based on the interviewee's specific involvement with the TSE. For example, if the interviewee is a decision maker of a grant maker or judge at a competition, the following questions would be asked:
- What was the evaluation criteria for providing the grant/prize to [TSE]?
- Can you talk about the [TSE]'s application?
- What stage was the [TSE] at when they applied?
- Did they have [key resources highlighted by TSE] when they applied?

Appendix 6. List of keywords

The following are keywords were used in combination to obtain information from Google searches, Bing searches, Youtube, Vimeo.

General keywords

social enterprise
social venture
social business
technology start-up
Cambridge

Specific keywords relevant to TSEs

Raspberry Pi	**Simprints**	**WaterScope**	**Solaware**	**Blue Tap**
Raspberry Pi Trading;	biometrics	3D-printed microscope	wearable devices	3D-printed chlorine injector
Raspberry Pi Foundation	fingerprint scanner	water testing	solar-powered LED	water purification
low-cost computer	[countries which TSE operated]. E.g., Bangladesh	[countries which TSE operated]. E.g., Tanzania	[countries which TSE operated]. E.g., Vietnam	[countries which TSE operated]. E.g., Uganda
[list of founders]	[list of founders]	[list of founders]	[list of founders]	[list of founders]
[list of resource providers]. E.g., ARM; Rory Cellan-Jones	[list of resource providers]. E.g., ARM; SLAB	[list of resource providers]. E.g., Oxfam; EPOC	[list of resource providers]. E.g., Philip Hilton	[list of key resource providers]. E.g., National Geographic, Afrinspire

Appendix 7. Legitimacy-based interview protocols

The following line of questioning based on the legitimacy framework was used during interviews with founders/employees of TSEs and their resource providers.

Identity mechanisms

- How did you tell the story of [TSE]? Does this change when dealing with different audience?
- What information did you convey to resource providers to give you resources?
    - Did it change when dealing with different resource providers?
    - Did it change when at different stages of the company's growth?
- In your opinion, what convinced or gave confidence to resource providers to provide resources to [TSE]?
- Based on the interviewee's response, ask if they thought other resources played a role to influence resource providers. For example:
    - Do you think the legal structure of the company played a role to influence resource providers?
    - Do you think the location of the organization had any influence on securing resources?

Associative mechanisms

- Who are the most important partners of [TSE]? Why?
- How did [TSE] convince those partners to support?
- Did [TSE] emphasize the partnerships formed with [organization/resource providers]? Why? When or where does this occur?

Organizational mechanisms

- What were the important milestones achieved? Why?

Appendix 8. Examples of coding procedure

The following examples are excerpts from coded interviews in Atlas.ti.

Interview with Toby Norman

T: To give some concrete examples, so Taylor Vinters, [15:20] we... not only helped us with the registration as... just as a paid lawyer, but they also worked on us on a pro bono project to map out the legal landscape of options for social enterprises in the UK and then actually create an open white paper on those findings. And so Simprints did a lot of work interviewing different social entrepreneurs, asking them which legal model they had chosen and why. And then Taylor Vinters provided a really strong legal analysis, looking at the implications of these different models and together we co-authored a white paper on that. therefore [15:52] Design is a London design consultancy who helped us design the casing for the Vero. And so although they were paid consultants, they also gave us significant reductions compared to say their corporate clients,

B: I see.

T: and that meant that we... I think could go a lot farther with the casing design process. In fact, one of their lead designers, Martin, actually came with us to Bangladesh to see the interactions of health workers with the technology in the field. And that was great because we were students coming out of a PhD program. None of us had ever done industrial [16:22] design before and actually design something like plastics casing. So that was support from a lot of the key partners that we have on the website was huge.

B: I see.

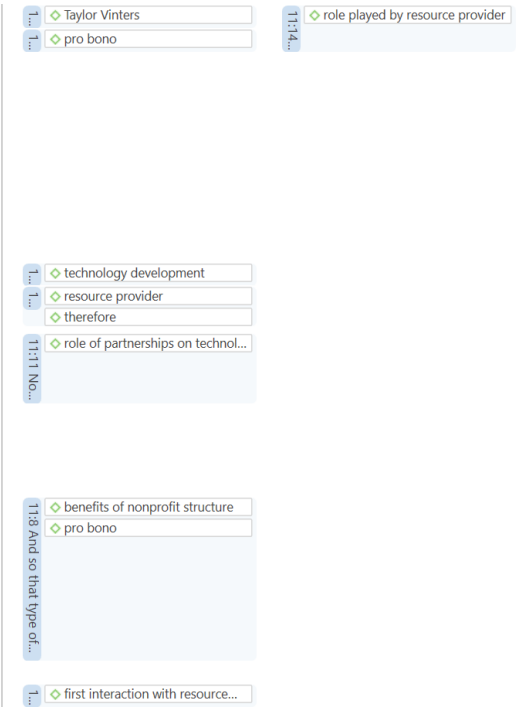
T: I particularly wanted to shout out like SMART Design, another London design firm. They've done now, two massive pro bono design projects.

B: Now? Or back…

T: Back then and also today. One… one's actually going on today. And so that type of in-kind support for social entrepreneurs who are trying to frankly, [16:52] bootstrap their way to the market can be a huge advantage and it's something that not all entrepreneurs gets access because we're doing something that added social impact. A lot of teams were willing to spend time to give us advice that you wouldn't necessarily have had if you were say a for-profit company doing something boring like restructuring SQL databases. You just... you wouldn't get the type of in-kind support.

B: I see. [17:16] How did this SMART Design come about? Was it…

T: Meeting people at events.



Interview with Dan Storisteanu

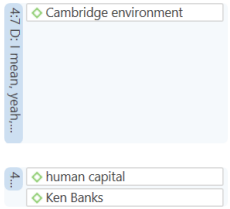
D: I mean, yeah, maybe WHO is probably afterwards but a lot of it was before. And I think also when you have people who are just like [14:19] at the top of their field, but it's not in a field that's like widely recognized, when you are approached by a bunch of super enthusiastic students who'd love to hear more about what you do, doesn't matter that you're at the top of the field, you give them time and advice and mentorship and I think the Cambridge environment is also something that fosters that.

B: Ah, I see.

D: We talked a lot with Ken Banks at the time, he is a social entrepreneur, did Frontline SMS and others who is also quite a you know, he's a big name in that kind of space but we were enthusiastic and he liked the idea and so we would... we would get good great mentorship.

B: Was he also just involved just in the early days or is he still…?

D: We still reach out to him sometimes, yeah.



Appendix 9. Illustration of data analysis procedure

The following example illustrates how interview data were coded to form a code tree, in which the second-order code is subsequently compared against the conceptual framework.