Sustainability and Scalability of University Spinouts: A Business Model Perspective

Abstract

Most previous studies of University Spinouts (USOs) have focused on what determines their formation from the perspectives of the entrepreneurs or their parent universities, with few studies investigating how these entrepreneurial businesses actually grow and the role of the evolving business models in the process. This paper examines the evolution of business models in university spinouts during different phases of their development. Based on empirical evidence gathered from three comprehensive case studies, this paper aims to answer how USOs business model evolves, and the ways in which interactions between and within the core components of their business model would result in financial sustainability and operational scalability. This work extends existing research on the development of USOs, and highlights three themes for future research.

Keywords: University Spinout, Business Model, Sustainability, Scalability.

1. Introduction

There has been growing interest among policymakers and academics to generate greater economic (and social) values from publicly funded research projects. University Spinouts (USOs) are regarded as a crucial vehicle to commercialise intellectual properties, particularly those that cannot be easily patented or transacted through a license agreement (Sørheim et al. 2011). USOs are a subset of new business start-ups, and their formation is dependent on (a) formal transfer of Intellectual Property (IP) rights from the university, and (b) an equity investment made by the university (Wright et al. 2006). There has been a sharp rise in USO formation throughout the world in recent years (Djokovic, Souitaris 2008). Though most university spinouts do not generate significant wealth (Lockett, Wright 2005), which can be attributed to the complex process of venture formation and uncertainty regarding how best to develop a business concept (Rasmussen 2011).

The context of university spinout is distinct and significant since they characteristically involve in the development of business opportunities based on novel and disruptive innovation or tacit knowledge emerged from academic environment (Markman et al. 2008). Although many USOs are characterised as new high-tech start-ups, they face two fundamentally different obstacles compared to other typical start-ups. They face specific challenges to become established in a competitive environment, because most universities lack commercial resources and academic entrepreneurs often lacked commercial experiences (Vohora et al. 2004). Furthermore, growth of an USO is often held back by conflicts in the objectives of key stakeholders, such as the senior management of the university, the academic entrepreneurs and the venture's management team (Miller et al. 2014).

Most previous studies of university spinouts have focused on what determines their formation and emergence, with few studies investigating whether and how they actually grow and reach a suitable level of sustainability. These studies can be classified into three broad categories. The first category focused on the resource configuration of USOs to examine the links between the firm performance and its tangible and intangible assets (Barney, et al. 2001, Heirman, Clarysse 2004). The second category is based on the institutional arrangement of USOs to address how institutional context shape the development of such firms (Clarysse et al. 2005, Lockett et al. 2005). The third, and a rapidly emerging category focused on the Business Models (BMs) of USOs, which examined the activities carried out by USOs, their product or

service market choice and the way they transform knowledge into value streams (Chiesa, Piccaluga 2002, Druilhe, Garnsey 2004, Mustar et al. 2006).

Studies that looked into USOs based on their business models have focused either on the activities performed by the spinout or on the characteristics of the market, with some important aspects under-researched. First, in many cases, the development process was described as a single snapshot, and the transformation of the business models through different phases of the USOs growth and development was largely ignored (Rasmussen 2011). Vohora et al. (2004) indicated that as the USOs evolve, their internal and external resources, their relationship with the parent firm and connections with the outside world will change in intensity and nature. Therefore, as one of the key aims of this research, we argue that a more dynamic approach towards the business model concept in the context of USO is required to understand how the core components of their BM evolve over the development phases.

Secondly, although previous studies have examined the notion of formation and growth in the university spinout context (e.g. Vohora et al. 2004 and Mustar et al. 2006), there is a gap in the literature relating to how USOs would actually reach a financially sustainable and operationally scalable phase. Despite being likely environment for high-tech firm creation, ironically universities and academic entrepreneurs are ill-suited to sustain the growth pace of new ventures due to potential conflicts of interest with their tradition role of teaching and research. As a result, it is taking much longer, if ever, for spinouts to return the initial investment and to expand their operations in global scales (PraxisUnico 2012). We attempt to address this issue by investigating the ongoing dynamics results from the interaction between and within the core component of USOs' business model in their development path.

Therefore, this paper aims to address the questions of "how USOs business model evolves, and the way in which interactions between and within the core components of their business model would ultimately result in sustainability and scalability". To address these questions, we draw upon two theoretical frameworks; first we adopt the Development Process Framework initially proposed by Vohora et al. (2004) to explore and explain the formation and growth of USOs throughout five non-linear phases. Secondly, we build on Lecocq et al.'s (2010) RCOV framework in order to ground the concept of business model in a parsimonious and dynamic perspective. Based on empirical evidence gathered from three comprehensive case studies, we discuss how the core components of the USO's business model (proposed by RCOV

framework) have evolved and the extent to which the interaction among the components have resulted in sustainability and scalability throughout the development stages (proposed by the Development Process Framework).

We make several contributions to understanding the business model evolution, sustainability and scalability in the context of university spinouts. In particular, this research is a finer grained analysis of Vohora et al.'s model in which the business model is broken down into three core components as per the RCOV model. This original approach provide a novel context in which to begin to fill the research gap regarding the ways that core components of university spinouts' BM evolve throughout the development stages. The business model perspective offers the possibility to have a holistic view of the USO's value creation logic. Moreover, using business model perspective to address the topic of organisation change and evolution is consistent with the concerns of both practitioners and academics (Moyon, Lecocq 2013)

This paper is structured as follows. Section 2 explains the development of university spinouts and the critical issues to be addressed in order to pass through different phases. Section 3 outlines the scope of business models for USOs and their evolution. Subsequently the study context and the research design will be presented in Section 4, followed by a description of the case studies. Section 6 presents the discussion on the empirical findings and highlights the key lessons learnt. The final section considers the contributions to the theory and practice, and discusses the directions for the future studies.

2. The Development Process of University Spinouts

Smith et al. (1985) argued organisation development follows some unique stages, in which as those stages progress, so do the organisational characteristics such as structure and strategies. One advantage of using the stage-based perspective is that it helps academics and practitioners understand the process of growth, explain how it happens and highlight the effects it has on the organisation (Kazanjian 1988). Drawing on the USO Development Process Framework initially developed by Vohora et al. (2004), we divide the evolution of USOs into six non-linear phases (Figure 1). Each spinout should pass through the previous step to progress to the next one but each phase includes an iterative, non-linear process of development in which there may be a need to revisit some of the earlier decisions and activities. Moreover, a USO would typically experience several "critical junctures" to pass from one phase to another.

<< Figure 1 >>

Many university spinouts emerge from scientific research that has carried out in research centres and academic school over several years (Vohora et al. 2004, Shane 2004). This phase is referred to as the research phase, also known as the "idea phase" (Clarysse, Moray 2004), where the academic entrepreneur started to realise that the knowledge created in the university has potential opportunity for commercialisation. Subsequently, the transition between the recognised opportunity and forming the USO takes place, when the entrepreneur scientists focus on identifying appropriate internal and external resources. Some previous research explored the process leading from opportunity recognition to firm creation (Delmar, Davidsson 2000), and empirical evidence suggested that that during this phase the entrepreneurs begin to examine the potential markets, the applications to be developed to satisfy those markets and the best way to approach the customers (Vohora et al. 2004).

Once the opportunity is identified and framed, academic engagement and commitment need to be considered before progressing to the pre-organisation phase. Bjørnåli and Gulbrandsen (2010) pointed out that during this transition academic entrepreneurs evolve into the management team and the board. The commitment of the board is vital for a potential USO to be taken forward from a recognised idea that has been created academically, to creating of a firm that is operational in the business environment.

In the pre-organisation phase, the USO's board and management team start to develop and implement strategic business plans with the key objective of acquiring required resources (Vohora et al. 2004). During this phase, the management team make decisions regarding who and where to can obtain external resources and knowledge as well as internal resources from the parent organisation i.e. the university. Few studies systematically examined the link between the capability of individual academic entrepreneurs and the level of internal and external funding they can acquire. However, recent empirical evidence illustrate that there is significant positive relationship between the university's business development capabilities and the ability to attract external equity finance (Lockett et al. 2005, Hewitt-Dundas 2012).

The transition from the pre-organisational phase to a fully operational phase depends critically on the entrepreneur's ability to gain financial credibility (Vohora et al. 2004). Credibility has been regarded as one of the key challenges for new start-ups in general (Birley, Norburn 1985)

and university spinouts in specific (Wright et al. 2006). This issue is more significant for USOs for two reasons; first, the key assets of USOs are typically intangible in the form of knowledge and a set of patents, and second, the founding team often have limited knowledge and experience in product development, sustainable supply chain, distribution channel and target market. As a result, the resource providers (such as venture capital companies) often regard USOs as high-risk firms for the investment. Many venture capital firms also find that the decision making processes within a university environment are often not aligned with the time-scale they operate (Wright, et al. 2012).

After the USOs had gained sufficient financial resources (Vohora et al. 2004), the focus shifts to offering something of value to potential customers and generate returns. During this phase, the academic entrepreneurs and their partners often need to reorganise their resources, which further increase the level of their financial credibility (Wright et al. 2012). Ambos and Birkinshaw (2010) discussed the necessity of re-configuration of the resources within the development life-cycle as it brings significant competitive advantage to the firms. The phase by phase transitions need to be effectively executed to position the USO in a sustainable structure. This will enable the USO to become a standalone entity, or one that can be acquired by an incumbent. Vohora et al. (2004) discussed that the sustainability phase requires USO to develop entrepreneurial competencies, which enable the firm to reconfigure deficiency from early phases into resource strengths and social outcome. In the previous phase, the academic entrepreneurs had to find the route and obtain resources to commence business operations. In this phase, in order to overcome the juncture of sustainability, the founding team should gain the ability to reconfigure existing resources and capabilities through information and knowledge they obtained through previous phases.

Nevertheless, reaching this point (i.e. Sustainability phase) does not mean the USO has the capability of scaling up its operations. Scalability can be defined as the extent to which the firm has the potential to serve larger numbers of customers and decrease costs through the use of technologies, equipment, and centralised facilities (Zhao et al. 2013). Scalability enables the USO to deliver the service offering at a lower cost and to exploit the potential to serve a larger number of customers than its competitors. This phase is conceived as a recurrence loop. This means that after the USO becomes financially sustainable, it may start to scale-up its operations in order to produce more products/services and serve more customers. After each point of scalability, the firm requires to be sustainable at that point before any further growth. In order to reach to this point, the business model should be in a re-orientation mode to ensure first, the

integration among the resources is in place so the USO has the capability to develop products to meet the commercial needs (Sirmon et al. 2011) and second, it is flexible in terms of three main factors: the market, the customers and the competition.

3. Business Model Evolution in University Spinouts

The aim of this paper is to understand the evolution of university spinout's business model over their development stages en route for sustainability and scalability. The concept of business model has been largely developing since the introduction of the Internet, when the firms in e-Commerce industry had to explain to their potential investors how they could capture value and generate profit from technology (Chesbrough, Rosenbloom 2002). While the fundamentals of the so-called "digital economy" remained hazy in the late 90's, entrepreneurs used business model to express the essence of emerging start-ups and to prove their viability (Magretta 2002). Following Demil and Lecocq (2010), we perceive of the business model as the way an organisation operates to ensure its sustainability and scalability.

Considering several different approaches towards the business model concept, from those who look at the concept from an entrepreneurial perspective (e.g. Kim, Mauborgne 2000, and Johnson et al. 2008) to those who view it as a tool to represent the way companies capture and create value (e.g. Mahadevan 2000, and Casadesus-Masanell, Ricart 2010a), the academic literature on the concept appears to be a rich and heterogeneous corpus. Though, business model is generally employed to represent the state of a firm or an industry at a specific moment. Hence, research tends to neglect a dynamic outlook in understanding the way in which the business model(s) of a firm evolve through time, in which "*the relationship between business model and time is little discussed (…) it is a snapshot and description at a specific moment in time*" (Osterwalder et al 2005: p.15). Previous studies with more *"static perspective"* focuses on identifying and describing the main components of a business model, including resources and capabilities, value network, collaboration, and customers. (e.g. Osterwalder 2004, Johnson et al. 2008). In contrast, those with *"transformational perspective"* uses business model as a tool to address the transformation and evolution of organisation or the business model itself over time, focusing on the interactions among the core components for the specific organisation under study (e.g. Casadesus-Masanell, Ricart 2010b, Moyon, Lecocq 2013).

The main weakness of the static perspective is that it assumes that the same elements are equally central or core in all types of firms and organisations (Siggelkow 2002). The formation

and growth of university spinouts is rarely just based on the formal configuration of key components. During the early phases of a USO's development, the entrepreneurs are often not clear about their final product/service, which limits their ability to articulate coherent value propositions or identifying customer segments. Therefore, in order to reconcile these two approaches, we use the RCOV framework to facilitate the analysis of the business model evolution at various stages of USO's development. The RCOV framework was initially inspired by the Penrosian view (Penrose 1960) of the firm, which constitute a parsimonious and dynamic approach of the business model (Demil, Lecocq 2010). Based on this view, the business model of a given firm is an outline of the ongoing interactions between the core components of a business.

The basic assumption of the framework is that the growth of a firm results from the interaction between its Resources and Competencies (RC) to propose novel value propositions in market, the Organisation (O) of the firm within the its value network, and the Value proposition (V) through the supply of products and/or services. Note that the three core components each encompass several different aspects – such as various kinds of resources and different types of partners within the value network. Consequently, the structure and volume of the firm's revenues and costs is an outcome of the choices made relatively to the three components.

In the context of university spinout, the resources usually come from the parent university or the initial research grant from either public research funding bodies or private funders. The competences refer to the abilities and knowledge of the academic founder(s) developed to leverage or improve the products/services offered. The second component, the organisational structure, encompasses the USO's board formation, and the activities and interactions it establishes with other firms to combine and exploits its IP. This includes the relationship and interaction between the firm and the University Technology Transfer Office (TTO). In most cases, the initial board is formed by three main representatives; the academic entrepreneur, a representative from the University and one from the initial funding body. The third key component of a business model is the value propositions in the form of products or services that a USO delivers to its potential customers. In general, the value proposition of spinouts is defined around the technological innovation or the IP developed prior to or within the formation of the firm. Moreover, the value proposition can be served towards a variety of "customers" – suppliers, other research institutes, the funding bodies and end consumers.

Business model evolution in USOs is the consequences of the ongoing dynamics come from the interactions *between* and *among* the core components that will result in transformation in its cost structure and/or revenue stream. These evolutions can be initiated internally or externally and typically involve new resources (e.g. obtaining new research fund/grant), improve the competence of the USO (e.g. bringing in professional business staff to the firm), reengineer the organisational structure and processes (e.g. changes in the USO's executive board) and/or re-defining the value propositions (e.g. providing new services or collaboration with other research centres). In some cases, changes in business model occur when a firm's performance starts to decrease and there is hope that business model evolution may improve the operations processes and constitute signals about the firm's sustainability (Bower 2003). However, the questions of when, how and why university spinouts business models evolve to reach sustainability and scalability have not been empirically investigated by previous research.

4. Research Design and Empirical Work

Given the nature of the research question, a multiple case study approach is adopted to uncover the evolution of business models through the development phases and the routs to sustainability and scalability. We conducted a comprehensive case study of USO_A for a period of 24 months, supplemented by comprehensive case studies of two USOs (i.e. USO_B and USO_C) for 18 months, all of which have been span out from a leading university in the UK. Specifically for the field of healthcare and medical science, the University and local government are dedicating to establishing a new industrial base through spinouts and attracting inward investment. The selection of the case study was partly dictated by opportunities to gain quality access to senior management of these organisations. All three case studies specialise in health and medical care services that had secured substantial external funding from the National Health Services (NHS) and/or private equity firms. Although all three USOs were formed to commercialise technological innovation and provide a sustainable return to their equity investors, they have been formed under different frameworks used by the university Technology Transfer Office (TTO). The distinction between these frameworks is mainly related to the level of support from the TTO. We deliberately selected the case studies that received different level of support to analyse how different method of formation influence the business model evolution, and the subsequent sustainability and scalability. Finally, all of the cases are relatively at the sustainable return phase of development, allowing greater insights into the path the firms have followed over time. The descriptions of each USO are summarised

in Table 1. For confidentiality reasons coded-names as USO_A, USO_B and USO_C were employed for each of the case studies.

<< Table 1 >>

Staying actively engaged with the spinouts – from early 2011 to June 2013 with USO_A, and from January 2012 to June 2013 with USO_B and USO_C provided us with rich insights into the formation of the spinouts and deep understanding of the development of business strategies and evolution of the firm's business model. Empirical data were gathered through several techniques. Firstly, 12 in-depth semi-structured face-to-face interviews were conducted with (a) the senior members of staff including the academic founder and/or CEOs, operations managers, etc. and (b) senior representatives including the Head of Venturing and Incubator Manager from the University TTO. The interviews carried out in at least three time frames for the purpose of understanding the evolution of business models within the firms and the way in which the key components evolved throughout the stages.

The interview questions consisted of three parts. First, each of the founders was asked to describe and assess the way in which the key components of their business model were developed and evolved through different phases of the spinout development. Second, they were asked to evaluate their relationship with the university's Technology Transfer Office and its impact on their business model evolution. Finally, two of senior managers of the university's TTO were asked to explain the frameworks that the university is currently using to support the academic entrepreneur forming their spinout. Each of the interviews last about 2-3 hours, tape-recorded and transcripts were prepared soon after the interviews.

The initial interviews were followed by observation of the ongoing process of the USOs' development. Several follow up interviews, business meetings and telephone conversations were carried out to obtain updated information regarding the operational processes within the USO. Interviewing a number of key people involved in the development of the USOs enabled the researchers to cross check the interpretation of the events and extract different perspectives from the university, the academic entrepreneur and the firm. After conducting the case studies, cross-case analysis method suggested by (Miles, Huberman 1994) was employed to identify similar and dissimilar issues in the USOs business model evolution. Other documents such as

the USO's business plans, published press articles, and rules and regulations that the firms had to operate within were also collected and analysed.

5. Case Studies and Main Findings

5.1. Case Study 1: USO_A

USO_A was founded in 2010 by an academic entrepreneur who is a Medical Professor, in partnership with the University and The NHS Trust. The firm specialises in the design and development of Assistive Living Technologies and Services (ALTS) such as computer-based applications for assisted living purposes. During the first stages of development (research and opportunity phases), the academic entrepreneurs started to experiment the use of a simple platform, such as XBox EyeToy in rehabilitation. As a result of some excellent outcomes gained through the experiments, the AE realised the need for designing and developing a package consist of a game controller together with an action game to effectively improve the rehabilitation for both children and adults. The AE added:

> " *... In addition to my experience, I started to learn how a business can be formed to commercialise these ideas (...) I realised that knowledge itself doesn't drive the market, money drives. So, I thought the only way that my knowledge translated is to form a company ...*"

The firm secured a major external resource during the pre-organisation phase. The research grant was awarded for the design and development of several ALTS-related products. In regards to the organisation composition, the USO's executive team decided that the firm should act as a video game publisher. Therefore, the key value proposition of the firm was defined as the rehabilitation package (application and controller) designed in-house. On the one hand, USO_A had medical expertise with many years of experience in healthcare and medical studies; and on the other hand it had networks with experts in the video games industry who can actually devise the programme to be applicable in rehabilitation treatment.

Initially, USO_A was not formed based on a clear organisational structure. Firstly, the decision of being just a publisher brought fragmentation in the organisational structure. In a standard structure of companies involved in video games development, there should be a middleware supplier who supplies the facilitating software. Thereafter, there is a game producer who has

the studios and the appropriate skills for designing the games. Finally, the finance should be provided by a publisher who is the key player with networks in the game industry. For USO_A, however, there were no middleware firms in this field, who were capable of providing facilitating software to game programmers.

Secondly, USO_A as a university spinout has a member from NHS Trust and a member from the University in its executive board, both of them needed to go back to relevant committees at their own host institutions for approval of any decisions. That is a very tenuous and time-consuming process which slows down decision making. In addition, the board members do not have the corresponding knowledge and the determination to keep up with rapid innovations in this constantly-changing market. Improvement of the AE's knowledge and competency and the board's decision on the structure of the firm (to act as a publisher) resulted in the evolution of the value proposition, hence acquisition of additional external resources throughout the re-orientation phase. A key value proposition was added up to the initial one, which was defined in the opportunity framing phase. The new one was identified around the area of gathering medical information through the games played by the patients. The information includes the way the patients play the games, how often they play, whether they do what they have instructed by the therapist, and the weaknesses and strength of the patients in different parts of the game. This approach could also be used to improve the controllers and the games itself; hence the process of physiotherapy and rehabilitation could be improved drastically. In this regard the academic entrepreneur argued:

> "*... We believe that this opportunity adds a great value to our rehab packages and assists us in improving the efficiency and effectiveness of our product ...*"

By presenting the effectiveness of the medical information in rehabilitation process, USO_A managed to secure several rounds of major funding in the re-orientation phase worth more than £2m enabling the company to start commercialising the rehabilitation packages at large scale. In this phase the company decided to go to the market first with a self-purchase approach through health products retailers. However, as the packages developed by USO_A are categorised as medical devices, one of the issues for the company was to gain credibility before going to market. It should be noted that the UK Medicines and Healthcare products Regulatory Agency (MHRA) is in the process of setting out regulatory conformity guidelines. So the company would be able to pass those regulations and register its product as an approved medical device. This issue is holding the company back because professional purchasing (e.g.

from NHS and GPs) cannot be done before they pass the regulations. Regarding this issue the academic entrepreneur noted:

> "*... The rules and regulations are killing the start-ups in healthcare - especially when they have a product or service to be commercialised. Many of such companies die out before they even start selling anything. The last labour government set up a committee to investigate what made a successful SME in Medical Devices Industry, and the very sad conclusion was that you are only successful if you first launched in America, since their regulations are pro-commercialisation of medical devices not against ...*"

In the re-orientation phase when the issue regarding the organisational structure was realised, the academic entrepreneur decided to team up with other academics within the University to form two more new companies; one as the middleware provider and one as the game producer. The founder argued that:

> "*... USO_A as a publisher stands alone, and then we have these two companies. The market is very new in terms of this structure, and also is very new in terms of distribution and how you are going to enter to the market. [USO_A], I think, is quite exposed but I don't think the board think the same ...*"

The academic entrepreneur believes that the new internal and external structure of the firm brings success to the entire chain and would assist USO_A in drawing together new resources in the form of specialised partners from video game industry. This change towards the organisation structure and novel resources is the path through the scalability loop. Table 2 summarises the changes in the key components of USO_A's business model throughout its development phases.

<< Table 2 >>

5.2. Case Study 2: USO_B

The academic founder of USO_B is a leading professor in clinical genetics and a medical consultant with over 20 years of experience. He and his colleagues realised that whilst numerous benefits of using new technologies have been noticed in the field of genomic research, there has been very little application in molecular diagnostics. Therefore, USO_B was established through a partnership between the Hospitals NHS Foundation Trust and the University and staffed by renowned experts from each organisation. The company started by focusing on developing, validating and delivering molecular diagnostics using the latest sequencing and genotyping technologies. By deploying these technology platforms USO_B has gained the capability of handling large volumes of tests ensuring its clients benefit from the economies of scale through competitive pricing and fast turnarounds.

Initially in the first two phases of development, the operations were mainly research-focused and carried out by the academic entrepreneur and his colleagues in the University. Although the founding team was aware of the initial resources (that could be provided by the health organisations), the organisation structure including the relationship with TTO, the supply chain and the distribution channels was not clearly defined. Like many new start-up, USO_B experienced significant changes when developing the initial business model. In the opportunity framing phase, the model was mainly based on two equipment platforms with four staff (two seconded from the University and two from the Trust), and the results of the genetic testing were returned to the NHS Hospitals.

The main evolvement of the business model's key components occurred in the pre-organisation phase, when it was realised that the initial business model was incapable of taking the firm forward. The board decided to bring in professional business executives to develop a new business plan with a new business model. Although the key value proposition of the company was retained, it was re-defined as the genetic testing through advanced medical platforms that is the quickest testing approach and more economical. After demonstrating a strong business model and meeting other organisational and technological requirements, the Trust agreed to fund the company for £700k. However, since the budget was quite low to employ professional and experienced business team, the Venture Office itself got involved in running the day to day business within USO_B. The Head of the Venture Office reported:

"*... I was brought in just to check the business plan, working alongside the clinicians from the Trust to develop the business model. After this, the university asked me to find a potential CEO for the company - but because the limited budget they asked me to do the job for a short period of time – and after nearly 5 years I'm still here. I am employed by the university and am a businessman rather than an academic. So half of my time is involved in [USO_B] operations and the other half I am helping other spinouts to get off the ground ...*"

The empirical evidence illustrate that USO_B is not a typical USO in a sense that it does not have any academic or clinical shareholders and it does not have any private investment company as its shareholder either. It was formed by the two institutional shareholders (i.e. the University and the Trust) to exploit a university IP (the initial genetic testing platforms). Moreover, since the pre-organisation phase, the venture was no longer managed by the academics, but by someone from the University Venture Office with commercial experience and skills. Therefore, through changes in organisation structure in pre-organisation phase, fresh resources were brought into the firm and the value proposition radically modified.

In the re-orientation phase, two key revenue streams were identified. One was Research and Development (R&D) consultancy in which the USO gets paid for carrying out research projects requested by the University and/or The Trust. The second one was focusing on genetic testing for hereditary diseases (mainly different types of cancers). A further income stream was later added to the portfolio by carrying out genetic testing for other medical labs; and also R&D collaboration with others was also considered as a potential income stream. According to the CEO:

"*...Another value stream is going to be personalised medicine - this is where you tailor a drug regimen to person's genetic makeup and this is we think a very lucrative business. This is a whole growing area in medicine and it's very new for us where we are in the ground floor now ...*"

"*...The main and only customer we have is the NHS - on the one hand they give us work to do and on the other hand they help us improving our platforms as well. We don't get the genetic results back to the public – we give them to the NHS and clinicians and they do the rest ...*"

The evolution of the USO_B's business model is summarised in Table 3.

<< Table 3 >>

5.3. Case Study 3: USO_C

The idea of looking at what happens with different bits of brain as well as damaged bits and their consequences led the academic entrepreneur to focus on drug development. After nearly 10 years of experiments, the AE realised that there are some commercial opportunities and around 2001 the company was formed. During the early phases of development (i.e. research and opportunity framing phases), the components of the firm's business model was not rigorously defined since the academic entrepreneur was focusing mainly on experiments on brain activities. Improvement in the AE's knowledge on Therapeutics and his understanding of the commercialisation of potential products/services led to the modification of the firm's organisation structure.

The pre-organisation phase was the point when the University Enterprise Team (within the TTO office) was called in for more rigorous help. Through the support of the business experts within that team, the company secured the first investment from Northstar Equity Investors for the sum of £90k. The management team started to consider three main paths for the company's value proposition (a) selling software to drug companies, (b) engaging with those companies to de-risk their drug development process using the discovered approach (consulting service approach), or (c) more traditional bio-tech models, by duplicating the number of drug candidates in the discovery process. Even though the first approach was quite successful, it did not convince the shareholders as the most suitable business strategy that assist the growth of the company.

The company then started to focus on the consultancy approach or as some may call it FEFA service approach. In this approach the bigger company have several specific problems and the consultancy side (e.g. USO_C) is capable of addressing them. Therefore the consultancy firm gets paid for the solution provided to the bigger company. Regarding this approach, the academic entrepreneur discussed:

" *... We did a number of these consultancy projects, e.g. for Cambridge Laboratories. You could grow your business model like that - in fact lots of American companies are following*

such an approach where they get paid to tell their scientific consultation. But still I think it puts a very low cap on your expectation and the growth of your company ..."

Similar to the previous cases, a significant evolution in the firm's business model occurred during the re-orientation phase when the founder realised that very few drug companies were running discovery programmes. As a result, USO_C decided to focus on a novel value proposition that was focused on what the discovery platform can actually do and what can be derived from them. The academic entrepreneur added:

> "… *This approach helped us going beyond the more traditional, American style business model used in bio-tech industry. What we found was the fact that the big box is not in the software or the consulting service approach and we thought if we want to grow, we have to be part of the development process* …"

Due to the recognition of the new value proposition, the organisation of USO_C got restructured and new resources were brought into the firm. Firstly, USO_C entered into several collaboration/partnership agreements with large drug development companies. Thereafter, in 2008, through conducting several successful projects, USO_C proved that their approach can be applied clinically and obtained a new investment of £50m from one of the world biggest hedge fund firms to significantly scale up its operations. The founder reported:

> " *... That was a shining time for us; we had great assets like discovery platforms and drug candidate assets in which without money, we were not able to do anything with them. We became the 11th largest listed bio-tech firm in the UK, among GSK and other big ones ...*"

These significant and successful changes in the firm's business model further pushed USO_C to expand its operations. In order to be more focused on the discovery platform, all the discovery functions and the scientist dealing with them moved to one of biggest centres for network biology in the world located in Oxford. The academic entrepreneur reported:

> "… *We are now working with our partners in phase I of drugs development, examining whether the candidate can be survived in other phases. This will give us not £100k but £10m. If we can get into other phases, we are talking about much larger chunk of money. So, if the candidate can survive in phase 2, you will get much more than you could get through consulting service or selling software package*…"

By opening the new centre, USO_C reshaped its value proposition, building on a new discovery team working on the unique network pharmacology platform. Regarding the near term value, the issue that the company management is faced is the limited number of medical assets they can develop. Based on the interviews, it can be noted that these barriers will gradually fade away once the company starts to focus more on the discovery platform as it can produce much more results that it has ever been developed. In this regard the academic entrepreneur noted:

> "*... We have learnt that the only way really to monetise the value more quickly is to put our discovery platform under other people's cash mountain. One way to do that is to collaborate on discovery processes with larger companies in such way we get some share of downstream value...*"

The firm is selling partially completed development drugs to whoever is the highest bidder. So, the customer in this case is the largest pharmaceuticals and bio-techs who are developing drugs. Therefore, it can be noted that USO_C is making money based on two distinctive approaches; (a) selling the developed bits of drugs and (b) selling the discovery collaboration opportunities. In this context the academic entrepreneur clarified that:

> "*... There is definitely a sweet spot in this type of business model; at one end you have got mainstream discovery which is still populated by molecule and at the other end, there are lots of people who understand what exactly we are doing and we share things with them ...*"

The way in which the key components of the USO_C's business model are evolved within the development phases are reported in Table 4.

<< Table 4>>

6. Discussions

The empirical data revealed that the business model evolution become considerably evident during the transition from the pre-organisation phase to the sustainability and scalability phases. These significant changes in the USO's business model occurred as the result of one or a set of decisions, mainly voluntary, towards one or several core components (i.e. resource and competency, organisation, and value proposition). Although these decisions were voluntarily made, they were influenced by several internal or external factors. For instance, the pressures from the representatives of the university and the NHS (as the main investors of USO_A) forced the AE to make the decision on acting just as a game publisher, hence the value propositions and distribution channels had to be modified. Based on the thematic analyses of the three case studies we have classified the decisions into three common themes: *Organisation structure consolidation* during pre-organisation phase, *innovative value composition* within re-orientation phase, and *value network extension* in sustainability and scalability loop. In this section, therefore, we will explain the ways in which the core components of the USO's business model have been evolved due to the voluntary and/or involuntary decisions throughout the development phases.

Research phase

Although the USOs we studied were set up to address different objectives and each adopted a different organisational support structure, their founders were not clear about the key components of their respective firm's business models in the first two phases of development. In the research phase, the academic entrepreneurs focused on understanding different aspects of their discipline and the way in which they can commercialise the knowledge and ideas, hence the business model is often not formally defined. For instance, the academic team who established USO_B later started to take existing gene-testing technology from the lab and began their research into novel application of it across different industries. Similarly in the case of USO_C, the academic scientists carried out their research and experiments on brain's activities through very small funds in order to test whether the results can be applied in the pharmaceutical industry. Therefore, this phase can be regarded as the set off for defining the core components of the USOs' business model, in which improving the commercialisation competency of the AEs resulted in outlining the organisation structure and potential value proposition(s).

Opportunity Framing Phase

In the opportunity framing phase, the structure of the UOS's business model remained unclear as the tangible or intangible assets were not yet packaged for commercialisation. It should be noted that none of the three academic entrepreneurs established their firms to generate wealth in the first place, but rather to fulfil their goals of commercialising their ideas or technologies developed in their research that could result in bigger impacts in the relevant industry. The path remained unclear in terms of how technological discoveries can be best commercialised to satisfy the market. In this phase, the academic entrepreneurs recognised that their experiments had potential commercial applications in a number of market segments, but without a clear vision on structuring their business model and defining their customers, suppliers, and distributors. For instance, based on extensive experiments on several initial users, the academic team in USO_A became aware of the benefits of computer applications in rehabilitation, but no clear vision on the optimal routes to market.

Pre-organisational Phase

The empirical findings demonstrate that the primary change in the USO's business model emerged in this phase when improvement in the AE's competency in commercialisation and addressing venture credibility triggered the decisions on *consolidation of the organisational structure.* In all three case studies, the AEs realised that in order to address the concern of USO's financial and operational reliability, the structure of the firms should be developed well through supports from the TTO. Therefore, the role of the university TTO became more prominent in this phase.

Note that although the USOs have spun out from the same parent university, three different frameworks were used by the TTO to support their formation. These frameworks can be categorised as low-level (the case of USO_A), medium-level (the case of USO_C) and high-level (the case of USO_B) support framework. We argue that these frameworks have enormously affected the evolution of the USO's business models especially in the pre-organisational phase. In USO_A, for instance, the low-level support from the University TTO resulted in formation of a weak executive board and therefore the firm could not appropriately define its position the market. Strategic decisions regarding the key components of the business

model changed many times during this phase; from designing and developing applications in-house, to acting just as an app publisher and outsourcing the development processes, and from using General Practitioners (GPs) and hospitals as the main channel of distribution, to going to the self-purchase market through large retail distributors. In the case of USO_B and USO_C the impact of the supporting frameworks was less noticeable in the path to sustainability. The reason is that the spinouts either received more support in shaping their firm or tried to reduce the role of the University in their organisation. As an example, a professional business team from the TTO got involved for preparation and development of the business strategies/models of USO_B and in fact, after the opportunity framing phase the development of the USO handed to the technology transfer staff. Regarding USO_C however, the academic founder attempted to reduce the role of the TTO in his firm by first getting help just in the early phases of the development and second by obtaining assistance regarding the key components of the business model from private equity firms.

Although it cannot be generalised, the empirical findings of the case studies show that a medium-level support from the parent university TTO has more positive influence on the path to sustainability and scalability. It gives more autonomy to the academic entrepreneurs to evolve the components of their business model while learning and improving their knowledge about their resources and the markets they want to serve. Whereas, applying the low-level and high-level support framework makes the academic entrepreneurs dependent on the university support even after the early phases of development. Nevertheless, changes in the USO's organisation structure through maintained cooperation with the TTO resulted in securing new sources for the USOs; £250k for USO_A to design serious games for rehabilitation, £700k for USO_B to provide efficient molecular testing methods and £90k for USO_C to offer its discovery platforms to the drug companies. Therefore, by this phase, the business model was reconfigured to fulfil research contract and provide specialist consultation.

Re-orientation Phase

Securing the first major research grants during the previous phase enabled USOs to develop sophisticated and customer-oriented value propositions. For instance, USO_A started to focus on users' information to offer more effective solutions, while USO_B developed three new platforms to accelerate the process of genetic testing and USO_C made two novel data resources available to drug development companies for more advanced drug development

process. These changes in the spinouts' value propositions resulted in modifications in organisation structure in all three cases. For instance, USO_A brought in several academics from another department who had extensive experience in the game industry in order to form two other firms as the middleware provider and game producer. Similarly, more medical experts were brought into USO_B in order to improve the platforms that may enhance the time and quality of the genetic testing processes.

The process of revising earlier strategic decisions (e.g. in the opportunity framing and pre-organisational phases) occurred within all phases, however, appeared to be more notable in the re-orientations phases when the USOs had managed to obtain substantial resources and commitments. It can be argued that particularly in the re-orientation phase, the academic entrepreneurs realised that the business model design must have the potential to eventually deliver sustainable returns at large scale. Therefore, they focused on re-defining their value propositions, re-structuring the organisation structure, which would result in obtaining more resources. For instance, these reconfigurations in USO_A were involved in revising the technology in order to gather users' information to improve the process of rehabilitation. Within USO_B the activities were involved in modifying the platforms for accelerating the process of genetic testing and be more focused on personalised medicine. In USO_C the reconfigurations were focused on the compositions of innovative databanks that assist the firm entering into drug's development processes.

Therefore, innovative value composition impacts two core components of the USO's business models. In the first place, the organisational dimension was transformed when the USOs realised the need for more professional staff and effective delivery channels. Second, illustrating customer-oriented products and services as well as venture credibility caused by transformed firms' structure resulted in acquisition of novel resources and competencies i.e. extensive funds.

Sustainable Return Phase and Scalability Loop

All three firms studied in this research, although at different scale, have reached to a financially sustainable phase and, especially USO_C has started to scale up its operations. Based on the empirical information, a momentous incentive emerged in this phase. The USOs started to expand the scope of their activities or as we call it *value network extension* by collaborating

and partnership with other firms (inside and/or outside the same industry). For instance, USO_A realised that there are two very different customer segments; one should be targeted through collaboration with large health retailers store while the other groups, in addition to stores, have the opportunity to download games via the Internet. In the case of USO_B, after the initial genetic testing platforms brought a sustainable return into the firm, the company started to scale its operations by offering the results to other part of the NHS as their new customers. USO_C, similarly, has successfully progressed through the sustainability phase by collaborating with drug companies and providing them with the results of their discovery platforms. The firm therefore started to scale up its operations by engaging in drug's development itself.

Changes in USO_C' business model enabled the firm to generate value not only from its existing technological platforms and become sustainable, but also respond to new commercial opportunities such as penetrating new market segments and collaborating with multinational drug companies. In the sustainability phase, USO_C initiated several collaborations with large pharmaceutical companies in order to become a key player in the drug development process rather than just act as a consulting firm. That helped the spinout to cut its operational costs while increase the number of projects and experiment, and further de-risk their drug development process.

The decision on extending value network resulted in a drastic transformation in the USO's business model because it influenced all the three core components. Essentially, it impacted the organisation structure of the USOs as they developed several partnerships with companies outside their boundaries. This either outsourced or brought in multiple activities that were initially performed by the USO itself or outsiders. The value proposition of the firms also drastically changed because they no longer focused on a single line of product or service and rather diversify their offers to cover new market segments. Generating value through serving a larger market segment and partnership with larger players in the industry resulted in a great transformation of the USO's resources in which they accessed to a combination of infrastructure and competencies. Figure 2 summarises how different components of the USO's business models changed in the last three stages of development.

<< Figure 2>>

Table 5 presents the evolution of USOs business models through different phases of development, as well as internal and external determinants within each phase.

<< Table 5 >>

7. Conclusion, Contributions and Future Directions

Previous studies of university spinouts mainly focus on their formation, but not the way in which they actually grow to sustainable and scalable operations. Hence, this paper attempted to answer to the questions of "how USOs business model evolves, and the ways in which interactions between and within the core components of their business model would result in financial sustainability and operational scalability". To answer, we outlined a multi-phased development model for USOs and through employing empirical evidence gathered from comprehensive case studies, we demonstrated how the key components of the USO's business model evolve through different phases. The empirical examination of the university spinouts development across several levels of analysis emphasises that, dissimilar to any other kind of start-ups, USOs are not clear about their business models and the complex relationships between its key components in the early phases of development. Hence they are incapable of following the traditional ladder in which the value proposition is first to defined followed by characterising the customer segment, classifying the key resources, activities and other key components of the business model.

More specifically, in the Research and Opportunity Framing phases of development, the USOs do not establish a business model as such we have experienced in commercialised environment. Phase 1 and 2 of the evolution are purely based on the primary knowledge of the academic entrepreneurs in which no organisational structure and value proposition is considered by the entrepreneur. It is in the Pre-organisation phase of development that as a result of organisation structure consolidation the three key components of BM begin to shape. However, the notion of value proposition is still unclear due to uncertainty about the potential and available funding. The first commercial-type of business model (customer-oriented model) is generated in the re-orientation phase when the direction of the three components is moving towards potential customer and during which professional people join the team, formal structure of supply chain and distribution channel is exposed and the USO has fairly clear vision about the cost structure and value stream. When the USOs reach an appropriate level of return, they start to extend their

value network and the business model is shifted towards more collaboration-oriented model, in which the key partners are coming to play. It is in this stage when the USOs realise the fact that keeping on sustainable in the industry is subject to first organisational flexibility to constantly revise the business model and second, collaboration with the key players in the industry. Soon after gaining the two above advantages, the USO would be capable of scaling up its operation into more production lines and serving more customers in national and international markets. Entering into the scalability loop indicates that the firms should come back to the sustainability phase when they scale up their operations, and then re-enter to the loop for more growth.

This research contributes to research on the development of USOs in several ways. Firstly, it extends the conceptual framework proposed by Vohora et al. (2004) by demonstrating that the sustainability phase should not be considered as the final stage of development since reaching this point does not mean that the USOs can actually scale up their operations. Hence, we highlighted the scalability loop, which demonstrates that after USOs become financially sustainable, they may start to expand their operations in order to produce more products/services and serve more customers. Secondly, by adding the RCOV framework (Demil , Lecocq 2010) to share a revolutionary perspective towards business model concept, this study provides a more comprehensive framework for university spinout process that takes into account how BM changes towards the development stages. We clarified that in addition to describe the configurations of business model elements (static view), the way in which a business model evolves (dynamic view) over time should be taken into consideration and examined. Hence, we explained how each stages of BM evolution are preceded throughout the development phases to reach operational scalability. We also contribute to the literature on entrepreneurship by focusing on the evolution of business model, extending previous studies on the role of the academic entrepreneurs or the parent university. This study also explicitly addresses the concerns of academic entrepreneurs seeking to commercialise scientific innovation and experiments through establishing a USO backed by the Parent University and venture capital investor. The evolution of the key components of the USO's business model means that academic entrepreneur should constantly pay attention to the arrangement of their resources to pass through the phases and in order to generate new value propositions and to modify their organisation structure.

Three types of studies are required in the future. First, future studies should investigate the external validity of the findings within the USOs operating in other disciplines and have span

out from other types of universities. Second, the effectiveness of different models employed by the University's TTO in helping USOs reaching sustainability and scalability need to be examined. Third, the circumstances in which business model evolution may put the USO in a critical stage where the founder(s) considers implementing an exit strategy require further analysis.

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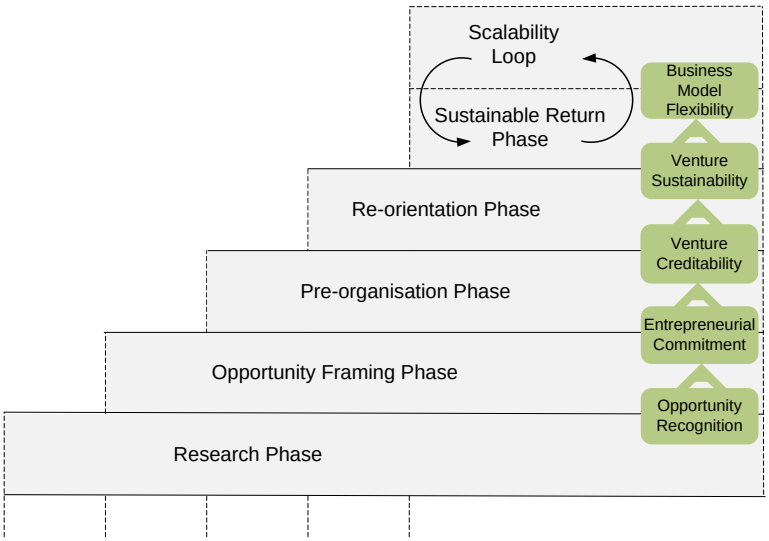

Figure 1. The Development Process of University Spinouts (Adapted from Vohora et al. 2004)

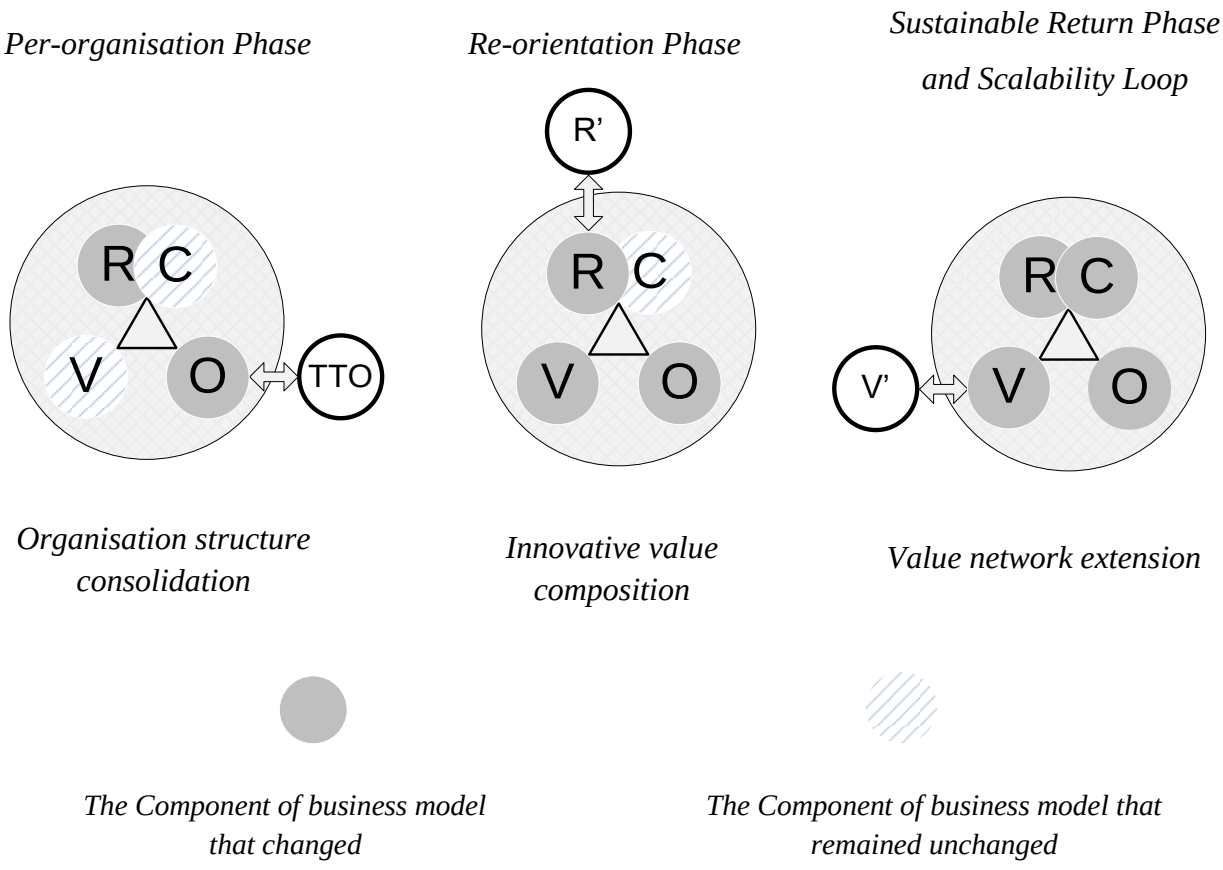

Figure 2. Changes in Key Components of the USOs' Business Model

Spinout / Year	Business Nature	Phase of Development	Initial Founder / Current CEO	Main Shareholders	Formation Framework	Initial Major Fund
USO_A 2010	Design and develop of assisted living technologies and services	Sustainable Return	Academic Entrepreneur / Academic Entrepreneur	University and NHS Foundation Trust	Low- level Support	£250K
USO_B 2008	Genetic testing service and providing competitively priced and rapid DNA and RNA based assays	Sustainable Return	Academic Entrepreneur / Professional Business Person	University and NHS Foundation Trust	High- level Support	£700
USO_C 2001	Systems biology drug discovery company through patented platforms	Sustainable Return Phase – entered into Scalability Loop	Academic Entrepreneur / Academic Entrepreneur	Venture Capital Firm, Academic Entrepreneur and University	Medium-level Support	£90K

Table 1. The Description of the Case Studies

	Research Phase	*Opportunity Framing Phase*	*Pre-organisation Phase*	*Re-orientation Phase*	*Sustainable Return Phase & Scalability Loop*
Resources & Competencies	Medical academics experts in identifying innovative ways to improve the process of rehabilitation.	Bringing in few software and hardware developers as well as business experts for business plan preparation.	Securing the first major research grant worth £250K to design applications for rehabilitation.	Securing a £2.1m research grants to design and develop the entire package of rehabilitation in-house.	Employing more IT experts to develop novel algorithm to collect patients' information in a more systematic and efficient way.
Organisation Structure	The academic entrepreneur and few academic colleagues pursue their interest in using technological innovation for assistive living purposes.	Representatives from the Hospital and University joined the executive board.	Business experts from the TTO recommended staying just as a game publisher. No formal conclusion regarding suppliers and distributors.	Forming two other firms as the middleware and game producer. Initiating negotiations with large suppliers in healthcare.	Starting collaboration with large health and medical care retailer in order to reach self-purchased market.
Value Proposition	Knowledge of identifying the areas that computer-based applications can improve the efficiency and effectiveness of rehabilitation.	The applications that could be used in PC, laptop and other platforms to assist the physiotherapy.	Rehabilitation package designed in-house with support of software and hardware developers.	Medical information gathered through the package to improve the process of rehabilitation and the package itself.	Offering more personalised assisted living technologies and services for self-purchased market.

Table 2. The Evolution of Business Models within the Development Phases in USO_A

	Research Phase	***Opportunity Framing Phase***	***Pre-organisation Phase***	***Re-orientation Phase***	***Sustainable Return Phase & Scalability Loop***
Resources & Competencies	Professor of Clinical Genetics focused on applying latest sequencing tech in molecular diagnostics.	Knowledge and skills gained through in-depth experiments on genetic testing through new technological platforms.	Securing the first major research fund worth around £700K through illustration of the efficiency of the new method.	Entering into several collaboration with major labs and drug companies to improve the testing platforms.	Although the business is profitable, plans have been prepared to improve and increase the level of medical experts.
Organisation Structure	The academic entrepreneur as the main founder with support of some academic colleagues.	Four staff, 2 seconded from the University and 2 from the Trust joined the company to prepare the formal business plans.	Bringing in another 12 professionals to maintain the developed platforms as well as design and develop new platform.	Strategic decisions to (a) focus more on the personalised medicine testing services, (b) get support from the NHS to improve the platforms.	*No plan has yet been prepared to reform the organisational structure.*
Value Proposition	Knowledge of binging new technological innovation into genetic testing experiments.	Innovative genetic testing platforms that could decrease the process time and improve the accuracy of the results.	Offering a molecular diagnostic service using the latest next generation sequencing technology and services for human genome capture using.	Three new platforms for accelerating the process of genetic testing and be more focused on personalised medicine.	New testing platforms that can run more genetic tests at the same time with a lower maintenance cost.

Table 3. The Evolution of Business Models within the Development Phases in USO_B

	Research Phase	*Opportunity Framing Phase*	*Pre-organisation Phase*	*Re-orientation Phase*	*Sustainable Return Phase & Scalability Loop*
Resources & Competencies	Small grants that enabled the academic entrepreneur and his colleagues carried out preliminary research on brains activities.	Knowledge gained through the small granted projects.	Securing £90k from Northstar Equity Investors. Suggestion to fill in IPO and become public.	Joining London's Stock Exchange and became public, which raised £1.3m.	Raised £50m to advance lead cancer drug and exploit network pharmacology platform.
Organisation Structure	Research-focused activities and experiments by the academic entrepreneur and his colleagues within the University labs.	No external employee – still the academic entrepreneur focusing on selling bio-tech software to drug companies.	Bringing in professional business staff from TTO, engaging with drug companies to de-risk the drug development processes.	Focusing more on partnership/collaboration agreement to get involved in drug development processes with big drug companies.	Discovery functions and the scientist dealt with them moved to one of biggest centres for network biology in the world located in Oxford.
Value Proposition	The knowledge and experience gained through analysis of network system to identify drugs that are both safe and effective.	Published results of the experiment in top medical journals, preliminary discovery platforms and computers.	Clinical assets including several sophisticated discovery platforms, enabling USO_C to enter into drug development processes.	The two very large data resources; one focuses on protein interacts another one includes 15m unique compounds by 2.6m unique proteins.	Results of the phase I of drug discovery; examining whether the candidate can be survived in other phases.

Table 4. The Evolution of Business Models within the Development Phases in USO_C

	Research Phase	Opportunity Framing Phase	Pre-organisation Phase	Re-orientation Phase	Sustainable Return Phase & Scalability Loop
Resources & Competencies	No specific resources. Primary knowledge of the academic entrepreneur in the field.	Knowledge and skills gained through in-depth experiments / knowledge about potential opportunities. Still no fund.	The first research grant to carry out more in-depth and advanced experiments.	Several large research grants. – Professional and skilful employees.	Combination of infrastructure and competencies through partnership. Become public to raise more cash flow.
Organisation Structure	No Formal structure. The AE as the only person who undertook the initiative of commercialisation.	No Formal structure. Negotiation with the University to bring professionals to form the executive board.	Formal executive board / Business experts and professionals. No formal strategies regarding the suppliers and distributors.	Defining the position in the industry - Characterising the distribution channel and supply chain management.	Enter into collaboration with other USOs or private companies – share the risk and profits.
Value Proposition	No tangible product/service in this stage.	Still no customer-oriented product/service in this stage. Initial results of the experiments.	The intellectual property – the preliminary product and services.	More personalised product/services based on the customers' requirements.	Diversity in products/services that can serve new market segments/international markets.
Internal & external determinants	Academic entrepreneur's lack of incentive to think commercially.	Academic entrepreneur's inability to research and articulate a clear business strategy.	Formation frameworks proposed by the parent university.	Governmental and/or non-governmental regulations and policies.	International regulations and policies – accountability and transparency after IPO.

Table 5. The Evolution of Business Models within the Development Phases in USO