Abstract: *University spin-offs (USOs) are a vital firm class since they are an economically important sub-group of high-tech start-up firms. They have engendered a high volume of academic studies. However, what the firms deliver by way of innovation in the form of new products and services has largely been missing from the academic entrepreneurship literature. By adopting mixed research methodology of in-depth interviews and survey, this study demonstrates the important factors associated with the success of products and services development by university spin-off firms in the UK, such as understanding needs of customers, networks, clear market analysis, application of technology, and vision, mission and value of the company. The findings resonate with various studies in innovation management on the key elements of the products and services performance predictors. It also contributes to filling a gap in the academic entrepreneurship literature by providing an understanding beyond the success factors in setting up USOs. This can raise awareness and benefit actors at different levels, e.g., academic entrepreneurs and Technology Transfer Offices (TTOs) on the provision of actions and skills required to successfully develop products/services.*

Keywords: *Academic spin-offs; university spin-offs performance; product innovation; service innovation*

1. Introduction

University spin-offs (USOs) sometimes known as academic spin-offs, are a vital firm class since they are an economically important sub-group of high-tech start-up firms. Many studies have sought to clarify the diversity of spin-off activities; for example by sector, by their employment and wealth generation possibilities, and by institutional and public policies designed to escalate this activity (see Druilhe and Garnsey, 2004; O'Shea et al., 2004; Shane, 2005; Siegel et al., 2003 in the UK for example). However, the focus on the economic returns from university spin-offs has been criticised with questions having been raised about their longer-term impact (Harrison and Leitch, 2010; Colombo et al., 2010; Siegel and Wright, 2015). Moreover, what the firms deliver by way of innovation in the form of new products and services, as well as factors driving their development, has largely been unrepresented in the *academic entrepreneurship* literature (but see Druilhe and Garnsey, 2004, Shane 2005, Wright et al. 2007 Stephan, 2014, Sternberg 2014).

In general, firms that have maintained their leading position in the market have established an ability to develop products and services effectively and successfully. In other words, there is an evident connection between innovation and economic advancement and effective management of product and service development processes that can bring success to businesses (Cooper and Kleinschmidt, 1995, Shepherd and Ahmed, 2000). Therefore, the development and launch of new products/services is not only critical to the growth and success of firms, but also creates new markets, which in turn provides economic growth and employment (Ahlstrom, 2010).

In this paper, contributions to markets made by UK university spin-offs through transferring and transforming newly invented knowledge and technology into products and services are examined (Shane, 2005). The importance of having an understanding of the factors that contribute to the success of the development of products and services is considered. Therefore, this study aims to address two questions:

1) *What are the important factors driving the development of products and services in the UK university spin-off context?*
2) *What is the relationship between these important factors and the success of product and service innovations?*

The answers are derived from a mixed methods study comprising in-depth interviews with 20 university spin-off founders and a survey of 204 UK university spin-off companies. The structure of the paper is as follows.

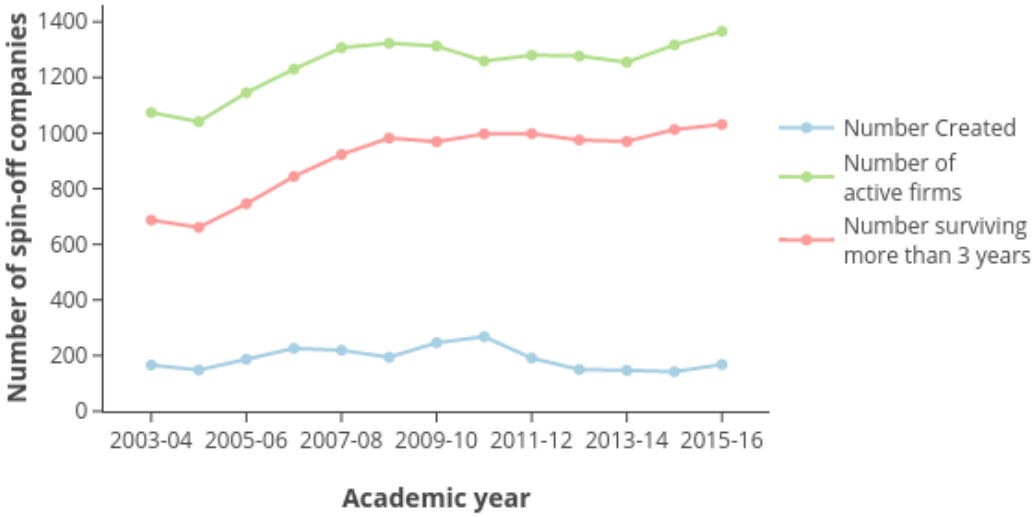
It begins with a discussion of the literature related to the economic contribution of UK universities through spin-off activity. This is followed by two strands of literature relating to the two research questions which inform the framework for analysis of the evidence from the study. Following this, findings from the mixed methods, i.e. in-depth interviews and a survey, are reported and discussed. The paper concludes with the insights and implications for universities and academic entrepreneurs.

2. University spin-offs and product and service innovations

2.1 Context

Universities have played a crucial and creative role in translating knowledge for economic and social development (Etzkowitz, 2016). The creation of technology transfer offices (TTOs) and an increasing number of spin-offs has been found in many European countries including Italy (Algieri et al. 2013, Iacobucci and Micozzi, 2014) and Germany (Egeln et al 2004). In the UK, successive governments have become increasingly interested in whether their research will have a direct 'impact' on the economy, for example through the formation of companies which commercialise university research. In the late 1990s government funding was allocated in order to facilitate this particular form of impact process, for example through the universities challenge fund (UCF) which enabled many universities to establish TTOs and to provide support services to the new companies (Wright et al. 2002). Indeed the 2004 Higher Education Business-Community Interaction (HE-BCI) recorded that between 1999 and 2002 there was a rapid growth in the number of spin-off firms. Since then while the number of spin-offs has slowed down, more are surviving. According to the latest HE-BCI report in 2015/2016, the number of three year-old or older spin-off companies had risen to approximately around a thousand (*See Figure 1*).

Figure 1: University spin-offs formed in the UK, 2003-04 to 2015-16



Source: Higher Education – Business and Community Interaction Survey 2015-16

While the number of USOs is increasing, the direct creation of jobs and wealth by university spin-offs is not enormous (Harrison and Leitch 2010, Ortin-Angel and Vendrell-Herrero 2014). This feature, however, underplays their broader importance as they are potentially an effective means of transferring novel technological knowledge to the market in the form of new products and services (Sternberg, 2014). Indeed while it has been found in many studies, the majority of spin-offs are in biotech and ICT (see for example Salvador and Benghozi 2013) only a handful of studies of academic entrepreneurship have looked at the nature of innovations offered to the market. Shane (2005) seems to be the only one focused on this topic. In his study of the products and services development process of university spin-offs from MIT in the US, he found that prior market knowledge of academic entrepreneurs enables them to see entrepreneurial opportunities anchored in the technologies. This also compels them to undertake further development to create marketable products/services.

2.2 Important factors driving the success of product/service innovations

While it is acknowledged that product and service innovations can bring competitiveness to firms (Shepherd and Ahmed 2000), the development process has associated numerous uncertainties together with a high chance of failure. This has made product/service innovation one of the more perilous activities for the business (Cooper, 2003). Discerning elements supporting the success of new product development continues to be an important managerial interest (McNally, 2011). A review of empirical research by Ernst (2000) underlined the success driving factors of products and services development for firms in general, such as the existence of either formal or informal development processes within the company, the formation of a devoted project team, the awareness and understanding of senior management etc. Later, Bessant and Tidd (2011) found that generally, funding, resources and identified target markets are considered critical success factors in products and services

development. In addition, Knockaert et al. (2011) discovered that in science-based entrepreneurial firms (SBEFs), factors leading to the delivery of first product to market are the combination of staff with commercial experience together with prior technical background.

Moreover, an understanding of customers' needs and experience is necessary in product and service development. A study by Cooper and Kleinschmidt (2011) highlighted that a product and service development process that begins with clear definitions is 3.3 times more likely to be successful, with 85.4% success rate of end product. Clear definitions include clear target market and customers' needs. As also noted by Pullen et. al. (2012), the diversity of networks has positively linked and increased the performance of internal innovation capabilities. It is noted further by Haeussler et al. (2012) that many new high technology firms have formed strategic collaborations to gain an access to knowledge, skills, resources and expertise in order to develop new products and services (see also Faems et al 2005).

Clarity in vision has also a positive relationship with the success in technical and radical innovations while the stability of vision has a positive association with the success in incremental innovation projects (Reid and De Brentani 2010). This point was made earlier by Lynn and Reilly (2002) who argued for the significance of a well-defined and well-constructed vision playing a role in understanding what leads to the success of product and service development. It is also very important to have clear guidelines for implementation.

In addition, an awareness of the mission is regarded as a strong predictor of R&D projects' achievement and is part of firm success. Joshi and Sharma (2004) have noted that knowledge about customers' demands is an evolutionary learning process of organisations and can occur at all phases or stages of product/service development. Kahn et al. (2012) also placed an emphasis on the importance of the company's strategy and mission as one of best practice in new products /services development. Skarzynski and Gibson (2008) noted the importance of empathy with customers in product and service innovation as being of strategic importance.

For USOs, Shane's (2005) evidence was consistent with that in other studies that acknowledged customers' demands and applying existing technologies to match with those demands are important factors when developing products/services. Additionally, Wright et al. (2007), like Chen and Huang (2009) noted the importance of human capital by showing a significant relationship between both the general and specific human capital of the technological entrepreneurs and innovative products and services offered to the market.

In summary, evidence from a number of studies has shown that there are numerous important factors in driving the success in developing products/services. These include the existence of development process, the formation of project team, support from senior management, funding, identified target markets, commercial experience, networks, clear vision and mission, acknowledging customers' demand, technological applications and human capital.

3. Methodology and data

The data for this research are obtained from the use of a mixed methodology. A combination of in-depth interviews and survey was employed to explore the important factors driving product/service innovations within university spin-offs. A qualitative method was first chosen to explore and ascertain these factors. Then, a questionnaire survey was employed to

empirically test these factors obtained from the qualitative stage to examine the linkage between these factors and the success of product/service innovations.

3.1 The population and sampling

The population in the study is university spin-off companies in the UK. In this study, the definition given by Higher Education Funding Council (HEFCE)[1] is followed. However, the scope is more focused on spin-off firms that have been established by academic or university staff (where the university owns the intellectual property (IP) or when academic entrepreneurs own the IP as it is then easier to identify the population). In addition, firms in the service sector in which firms are set up without any appropriating of IP are included as well as are technology-based spin-off firms.

The sampling frame of this study was drawn from public websites of universities in the UK. A list of 133 universities was obtained from Universities UK[2] which is the central organisation supporting all universities in the UK. It has a comprehensive list of UK universities. The list was cross-checked with information provided by HEFCE and the Scottish Funding Council (SFC). The database of university spin-offs was constructed by searching through the business and innovation centres of universities, such as Oxford University Innovation as well as departmental websites. Since some universities do not provide a list of spin-off firms on their public website, the relevant people in the university were contacted to ensure that there was no omission of any university spin-off firm. Then, these data were merged and reconciled with the company list gathered by a private sector organization, Spinouts UK[3] which provides a list of spin-off companies from universities in the UK. In order to ensure that all those included are university spin-offs from academic or university staff, the names of company directors were checked against the university's website to see if they were affiliated with the university. From 1356 spin-out companies in the database, 844 independent university spin-off companies are active.

[1] the definition set in the HEBCI surveys for Higher Education Funding Council (HEFCE) is broad and expansive by embracing new legal entities and enterprises created by the Higher Education Institute or its staff to allow the commercialisation of knowledge from academic research. The universities may or may not have a stake in these firms. In addition, the term "spin-offs" includes start-up firms established by university staff and students beyond the exploitation of IP. HEBCI also collects other data including patents and licenses and income from knowledge transfer activities

[2] (http://www.universitiesuk.ac.uk),

[3] www.spinoutsuk.co.uk,

Table 1: Summary of population and sampling

No. of population in the database	1,356
No. of sampling (actively operated companies)	844

3.2 Data collection method

A qualitative method, i.e. in-depth interviews with founders of university spin-offs was employed to explore important factors in first developing products and services and second in their success. In-depth interviews were conducted with academic founders of 20 university spin-offs. The sampling at this stage was selected from the database of UK university spin-offs developed for the purpose of this study, aiming to represent the various sectors, firms' size and different regions within which university spin-offs operate. The respondents were selected based on the following criteria:

- being a founding member of a university spin-off firm
- owning an equity in the firm
- used to/ currently hold an academic position when establishing the company
- having product/service offerings in the market

The firms' locations are spread throughout the UK. There are 6 firms in software, 5 in consultancy, 4 in biotech, 3 in engineering, 1 in pharmaceutical, and 1 the geography consultancy sector. The majority of the firms are categorised as micro with only 1-10 employees; only one in the sampling is a medium-size firm (with more than 50 staff). Most of the founders interviewed were men, though 5 female founders were also interviewed. Additionally, 14 founders in the sample still maintain their academic position while running the firm's operations. The findings from the in-depth interviews allowed the development of observed variables in the survey questionnaire.

Subsequently, the collection of quantitative data used a structured on-line and postal questionnaire. The survey was conducted between October 2013 to March 2014. The founders were targeted for the survey since they usually have a broad knowledge on the firm's history (Carter et al., 1994). The sampling (n=844) at this stage was from the database of UK university spin-offs developed for the purpose of this study as explained in section 3.1. The survey questionnaires were pre-tested as thoroughly as possible through discussion with founders and product development managers of university spin-offs prior to distribution. The survey questionnaire and its observed variables are derived and developed from the in-depth interviews, which are identified and summarised in *Table 3*.

Table 2: Sampling and response rate for survey

No. of sampling	844
No. of paper-based questionnaires sent	322
No. of on-line questionnaires sent	522
No. of completed questionnaires (both paper-based and on-line)	204
Response rate	24%

3.3 Findings

The findings are divided into two parts in order to address the two research questions. Those on the important factors driving the development of product/services derived from the in-depth interviews with 20 founders of university spin-offs in the UK are presented. This is followed by the empirical evidence from the survey, which shows the relationship between these important factors and the success of product/service innovations.

Research question 1 data from the in-depth interviews: Identifying important factors driving the development of products and services in the UK university spin-off context

The data from the in-depth interviews have highlighted the important factors that drive and contribute to developing products and services and their success within university spin-offs as presented in *Table 3*. Some of these are factors which apply to new innovative firms generally; others relate more directly to the university environment. Those, which relate most to the academic context, are numbers 3 (*Application of technology to the needs of the market)*, 7 (*Networks)* and 8 (*Funding and investment)* as these cover the nature and context of the academic commercialisation process.

Table 3: Summary of important factors contributing to the success of products and services from in-depth interviews

Important factors	Discussion	Responses from university spin-off' founders
1)Identifying the right target customers/ understand the needs of customers or clients	Understanding the needs of customers is regarded as the most important factor and a starting point in developing products and services.	*"I think you need to solve a need for people, ultimately. Ultimately, what you're doing is solving a need so that's the starting point, in my opinion.* (Male, design/engineering spin-off firm in London) *"I think the most important thing is to just…is to work with the customer, the people that use it, and just listen to exactly what they want to do with it, any questions, any feedback they may have, and just try and incorporate their requests as much as possible really."* (Male, software spin-off firm in East Midlands) *"number one is…being able to listen to your client to understand what they really need. Number two is being able to observe your clients to see what they need that they don't know they need."* (Male, consulting spin-off firm in London)
2) Clear market analysis	Understanding the market or having a clear market analysis is also a vital success factor in developing products and services.	*"Clear market analysis and need – got to be identified."*(Female, biotech spin-off firm in London) *"You have to have a market and you have to validate that market and, you know, make sure the demand is there, if you like…."* (Male, pharmaceutical spin-off firm in North West England)
3) Application of technology to the needs of the market	It is evident from the findings that innovative and novel ideas have been highlighted as one of critical success factors in developing products and services within the university-spin-off context. In addition, the application and relevancy of technology or knowledge were mentioned and highly valued because technology or knowledge developed within the academic context is usually regarded as theoretical or conceptual.	*"….if you can generate IP, obviously that's extremely useful"* (Male, pharmaceutical spin-off firm in North West England) *"….the critical thing was always to place our services within, and what we talked about or advice we gave, in the context of academic rigour and evidence."* (Female, consulting spin-off firm in Yorkshire) *"So, the first thing is to actually find…a place where application is not only possible but is relevant….."* (Male, software spin-off firm in East Midlands) *"the things that were critical was for it to be easy to understand, first, and easy to use. So, the key things you wanted was something that was simple to use online, and simple to understand, because, you know, the product is an output. The other part of it was to produce a product which, yeah, had features that were not, you know, that were not present in other tools but which made it accessible and relevant to a variety of different contexts."* (Male, consulting spin-off firm in West Midlands)
4) Pricing model	Revenue and pricing model was rated as an important element to the success of products and services development. In order to develop successful products and services, a pricing structure needs to be in place.	*"then, …..I think it's a sense of the revenue model, so what's your end point, you know? Is this something you're going to sell directly to a client? So you definitely need a combination of those two things [ideas and business model]."* (Male, management consulting spin-off firm in London) *"It's always the balance between cost and capability that you can actually create, and that's where the value lies, you know, whether you can monetise."* (Male, software spin-off firm in London) *"You've got – with a reasonable, I think, commercialisable price structure – so you've got to have that."* (Female, biotech spin-off firm in London)

Important factors	Discussion	Responses from university spin-off' founders
5) Vision, mission and value of the company	Vision, mission and value are underlined as one of the success factors to product/service development since they will determine the strategic direction of products and services.	*"you need to have a vision of the final product. I think this is the most important thing. You really need to have…to have…to know in your mind how it's going to look like and what kind of customer is going to…it's going to serve. This, you really have to have it clear…… You need a vision and a drive."* (Male, biotech spin-off firm in London) *"……we were driven by a passion, quite honestly. I mean, all of our company is about values."*(Female, consulting spin-off firm in Yorkshire)
6) Capable staff	Skilled and capable staff is highlighted as an important element in developing a successful product and service.	*"And then of course, resources… You should not compromise in finding the right people."* (Male, biotech spin-off firm in London) *"That is critical, very good people. And you need, I think, once you start to get funding and you have a board and a management team, you need for that board and management team to be inclusive, and they need to be…they need to manage in a very inclusive way, and they need to manage…they need to be very capable, technically as well as, commercially."* (Female, biotech spin-off firm in London)
7) Networks	Business networks are regarded as a significant factor since these networks give university spin-offs a good ground to establish customer base.	*"….so we already had established networks of people across the UK, and indeed internationally. We understood the problem, from different perspectives. So, in developing our…developing our marketing messages and trying to establish a customer base, that probably gave us a very good starting point."* (Male, software spin-off firm in Wales)
8)Funding and investment	Funding and investment are highlighted as one of the important factors because a lot of funding and investment are required to transform concept or technology from university lab into tangible products.	*"……you really can't succeed in business unless you have funding".* (Male, geography spin-off firm in East Midlands) *"…… now, I think this is actually em… It's a very difficult problem for companies because you invest… a lot of money in the product design and development, and you have to do that because your customers are not really interested in talking with you, as a small company, until you have a product they can actually look at, so they actually want to see the product. …….. you invest a lot of money in developing the product, and it may not be a good match to what the customer wants. …… you actually put in quite a lot of investment before you can actually test what the customer actually is going to expect from the product. So, you almost can guarantee that the first product isn't…you don't…don't tend to get it first time, and it's not easy to…to trial it, and it is a problem because it's a big investment – you know, in our case, certainly several million dollars were put in and, you know, generated not much revenue."* (Male, engineering spin-off firm in East of England)

Research question 2 data from the questionnaire survey - Examining the relationship between these important factors and the success of product and service innovations.

This section examines the relationship between the important factors identified from the previous section (qualitative data from in-depth interviews) and the success of products/service innovations. The number of products and services is used as a proxy for the success of product/service innovations. The number of products and services were received from the self-reported questionnaire surveys. An assumption has been taken that the reported number of products and services are the number of products/services currently available in the market. With this assumption, the data allow some consideration of what driving factors can attribute to the higher number of products and services. However, this has presented a limitation since the assumption has discounted incremental innovations which can potentially be counted as part of the success of products/service innovations.

A multinomial logistic regression was employed to examine the relationship. In this case, the dependent variables are categorical of number of products and services offered, while the independent variables are important factors in developing products and services, which have been identified from the in-depth interviews. These together with the sectors, wherein the firms operate, and with the size (based on number of employees) of the firms, are chosen as controlled variables. The output shows the R^2; the value on Cox and Snell measure is 0.5 and the value of Nagelkerke's measure (adjusted R^2) is also 0.5. They are similar values and indicate decent-sized effect.

In the likelihood ratio tests, "*understanding needs of customers*", "*application of technology*", "*vision and mission of the company*", "*funding and investment*", "*capable staff*" and "*networks*" are predictors that significantly allow us to predict the outcome category, though the effect is not presented. *See Table 4*.

Table 4: Likelihood ratio tests

Likelihood Ratio Tests

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	378.2	0.0	0	
factor- identify right target customers	381.7	3.4	5	0.6
factor-understand needs of customers	443.0	64.8	5	0.0
factor-clear market analysis	354.3		5	
factor-application of technology	411.1	32.9	5	0.0
factor-pricing model	377.8		5	
factor-vision and mission of the company	420.0	41.8	5	0.0
factor-funding and investment	407.2	29.0	5	0.0
factor-capable staff	409.7	31.5	5	0.0
factor-networks	433.6	55.4	5	0.0
size-1-30 employees	378.2	0.0	0	
size-31-49 employees	378.2	0.0	0	

size-50-99 employees	378.2	0.0	0	
size-150+ employees	378.2	0.0	0	
sector-biotech	378.2	0.0	0	
sector-engineering	378.2	0.0	0	
sector-medical	378.2	0.0	0	
sector-pharmaceutical	378.2	0.0	0	
sector-software	378.2	0.0	0	
sector-telecommunications	378.2	0.0	0	
sector-web/internet	378.2	0.0	0	

a. This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom. b. Unexpected singularities in the Hessian matrix are encountered, which indicates that either some predictor variables should be excluded or some categories should be merged.

In Table 5, the summary of parameter estimates shows the result of the predictors' effect by category. These parameters summarise the results of the compared pairs of outcome categories and there are 6 categories of products and services. The category 0-1 product and service is used as a reference category (baseline category). This means category 2-5 products and services, for example, is comparing against 0-1 product and service.

Table 5: Summary of parameter estimates*

products/service[a]		B	Std. Error	Wald	Df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
2-5	[understand needs of customers=0]	-1.1	0.6	3.2	1	0.1	0.3	0.1	1.1
	[application of technology=0]	-0.9	0.5	3.5	1	0.1	0.4	0.2	1
	[sector-telecommunications =0]	-2.1	6.7	0.1	1	0.8	0.1	2.57E-07	63242.7
6-10	[understand needs of customers=0]	-1.3	0.8	2.4	1	0.1	0.3	0.1	1.4
	[networks=0]	-1.4	0.7	4.2	1	0	0.2	0.1	0.9
	[sector-telecommunications =0]	-2.9	6.8	0.2	1	0.7	0.1	9.08E-08	30340.1
11-15	[networks=0]	-2.9	1.2	6	1	0	0.1	0	0.6
	[understand needs of customers=0]	-2.3	2.3	1	1	0.3	0.1	0	9
	[application of technology=0]	-1.4	1.2	1.3	1	0.2	0.3	0	2.5
	[sector-engineering =0]	-1.8	2.3	0.7	1	0.4	0.2	0	13.3
	[sector-pharmaceutical=0]	-3.2	2.2	2.1	1	0.1	0	0	3.1
16-20	[understand needs of customers=0]	-2.3	2.2	1.1	1	0.3	0.1	0	7.2
	[application of technology=0]	-1.9	1.8	1.1	1	0.3	0.1	0	4.9
	[networks=0]	-1.3	1.7	0.6	1	0.4	0.3	0	7.6
20+	[understand needs of customers=0]	-2.7	1.2	5.1	1	0	0.1	0	0.7
	[vision and mission of the company=0]	-1.2	0.9	1.8	1	0.2	0.3	0.1	1.7

The category 0-1 product/service is used as a reference category (baseline category).
*This table only summarises the predictors that show a strong effect towards each product category.

Explaining the predictor's effect

- *Category 2-5 products and services* –The odds ratio (Exp.*b*) shows that having 2-5 products and services is increased to 3.33 times more when an importance is given to the factor "*understand customers' needs*". In the same way, the chance, of having 2-5 products and services is increased to 2.5 times more when giving an importance to *application of technology*.

- *Category 6-10 products and services* –the odds ratio shows that, when the predictor "*understanding customers' needs*" changes to importance, the odds of having 6-10 products and services is increased to 3.33 times more. Likewise, when the predictor "*network*" changes from no importance to importance, the odd of having 6-10 products and services is increased to 5 times more.
- *Category 11-15 products and services* –When the predictor "*network*" changes to importance, the odds of having 11-15 products and services is increased to 10 times more. Similarly, the odds of having 11-15 products and services are increased to 10 times more, when the predictor: "*understanding customers' needs*" is given an importance. In the same way, the odds of having 11-15 products and services are increased to 3.33 times more when giving an importance to the factor "*application of technology*".
- *Category 16*-20 *products and services* – With the predictors "*understanding customers' needs*" and "*application of technology*", the odds of having 16-20 products and services are increased to 10 (1/0.1=10) times more when importance is given to these factors. In addition, the odds of having 16-20 products and services are increased to 3.3 (1/0.3=3.3) times more, when the predictor "*network*" changes to importance.
- *Category more than 20 products and services* - As when the predictor "*understanding customers' needs*" changes to importance, the chance of having 20+ products and services is increased to 10 (1/0.1=10) times more. Likewise, the chance of having 20+ products and services is increased to 3.33 times more, when the predictor "*vision and mission of the company*" is given an importance to.

To summarise, the factor "*understanding customers' needs*" seems to be the common predictor for higher number of products and services, which is used as a proxy for the success of product/service innovations. Additionally, the factor "*network*" appears as a predictor of the category of 11-15 and 16-20 products and services. The factor "*vision, mission and value of the company*" acts only as a predictor of a category of more than 20 products and services.

4. Discussion

4.1 The important factors driving the development of products and services in the UK university spin-off context

To address the first research question data from in-depth interviews have shown that driving factors that contribute to the success in developing products and services within university spin-offs, which relate most to the academic context, are *application of technology to the needs of the market*, *networks* and *funding and investment.* These cover the nature and context of the academic commercialisation process of in particular the importance of building links external to the university in order to develop a viable business model. These data show the patterns within a sample of university spin-offs and point to areas where technology transfer support systems need to be effective - which are further complicated by the diversity of product and service categories offered by USOs.

4.2 The relationship between the driving factors and the success of product and service innovations

To address the second research question, the discussion is based on the findings shown in Table 5 in section 3.3. The findings show that the factor "*understanding needs of customers*"

is a predictor of the higher number of products and services with generally a strong effect. They are consistent with other studies of new technology-based firms. As noted by Skarzynski and Gibson (2008) product/service innovation should be generated by empathy with customers as well as an intention to mitigate customers' problems. Additionally, with the factor "*networks*", this finding agrees with previous studies that the degree of product/service innovations and a firm's competitiveness depends on the success with which firms can form collaborations with external partners and get access to external technological knowledge and skills (Faems *et al.*, 2005).

In addition, the factor "*application of technology*" appears as one of the predictors with a reasonably strong effect. Having to find the application or market relevancy is important to successful product/service development. According to Bessant and Tidd (2011) the main factors distinguishing winners from losers are product superiority in the eyes of the customers, real differential advantage, high performance-to-cost ratio, and delivery of unique benefits to customers. This element on unique benefits to customers also links with the points above on understanding both customers' demands and the market. It is interesting that "*vision, mission and value of the company*" only appears as a predictor of a category of more than 20 products and services. The findings resonate with the study of Reid and De Brentani (2010) which shows that having the right vision of the market for new product enables companies to attain competitive advantage.

Some factors do not predict a higher number of products and services. These include "*capable staff*", "*identifying the right target customers*", "*funding and investment*" and "*pricing/revenue model*". It can also be noted that these factors seem to be important for the first launch of products and services to the market, especially "*funding and investment*" and "*capable staff*". As explained by Chen and Huang (2009) with respect to the crucial roles of human resource in the innovation process, to design and develop products and services, human skills (both management and technological) have to be readily available (Bessant and Tidd, 2011). This can possibly explain why they do not predict a higher number of products and services. Unlike the factors "*understanding the needs of customers*" and "*networks*", they continually play an important role not only throughout the development process, but also beyond the first launch of the products and services. For example, "*networks*" would enable firms to expand or increase their products and services because firms can gain access to knowledge, expertise or market, which they may not necessarily have at the initial launch of their first product/service.

As well as "*networks*", "*understanding the needs of customers*" may well be a consequence of the success in product/service innovations and the growth of the company. Zheng *et al*. (2010) offered the view that when spin-off or start-up firms become more mature and have successful product/service innovations they tend to develop routines that allow them to extract higher value from networks as well as to manage more effectively through either internal innovation or external collaboration. Consistent with Joshi and Sharma (2004), learning as well as resources has played an important role capturing this process. When firms have grown or have become successful, more resources and routines can be set up to better attain, analyse and utilise the knowledge about customers' needs.

5. Conclusions

In sum, the study highlights the important factors driving the successful products and services development within the university spin-off context including skills and actions required in

transforming academic research to a commercially viable product or service, such as, *understanding needs of customers, application of technology*, *networks* and *funding and investment.* Additionally, the relationship of the driving factors towards the number of product and service innovations achieved have been further explored. The results are consistent with the previous studies in the discipline of product and service innovations, on the strong effects of various factors, such as *understanding needs of customers*, *networks*, and *vision mission of the company*, towards the increased number of developed products/services (Faems *et al.*, 2005; Skarzynski and Gibson, 2008; Reid and De Brentani, 2010). Even though most of these factors have shown attributes akin to other types of firms, especially small firms, the factor *application of technology* is deemed uniquely more important for USOs than other firm classes, since basic research developed within academic context will need to be transformed into applied technology that can respond to customers' problems and needs.

The findings of this research have contributed to filling a gap in the academic entrepreneurship literatures by illuminating on another key aspect of USOs'operations in transforming, introducing and adding the innovative elements of their technology, i.e. products and services, to the market. This study has offered novel insights to the discipline of academic entrepreneurship by demonstrating on collective factors and skills essential for USOs to successfully develop products/services. They are arguably given a different perspective on the contribution of USOs to the market through the development of products/services over and above data collected in the governmental survey (e.g. HE-BCI survey) or in previous studies, such as, firm formation, job creation and other indicators of technological advancement, i.e. patents and licenses.

The study has provided implications for actors at various levels. For academic entrepreneurs at firm-level, this study has given them awareness on various factors involved in developing products and services. These factors have highlighted on what actions are required in transforming academic research to a commercially viable product, especially on the importance of understanding the needs of customers as well as an application and adaptation of technology to these needs. Further, for TTOs, certain activities or driving factors, such as clear market analysis or setting goals for the company, can be foreign to typical academic cultures and environments. At university level, TTOs can play a vital role to introduce or foster these required management skills to academic entrepreneurs in order to allow them to further develop and transfer the innovations to commercial and later profitable products/services.

This study is not free from limitations. The scope of this study is limited to the firm-level investigation; hence, it reflects only on what elements are required by USOs to equip and allow them to undertake successful product/service innovations. Further research needs to be carried out to investigate on supporting factors, such as, financial and fiscal conditions as well as market regimes and the regulatory environment. These factors are equally important to making the innovative businesses successful and sustainable in both short and long terms. In addition, support programmes provided by host universities for entrepreneurial activities need to be further explored so as to understand the effectiveness of the existing support schemes offered and their impact on product/service development activities.

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