

MAKING ENGINEERING DEPARTMENTS ENTREPRENEURIAL: A DISCUSSION!

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The concept of an “entrepreneurial orientation” is well established in the literature on the strategic posture of firms. Increasingly, large organizations are also turning to entrepreneurship in their efforts to become flexible and respond to pressures to “do more with less”. To understand what it means for engineering departments to be “entrepreneurial”, interviews with forty faculty members explored this issue. Transcripts of the interviews were analysed using content analysis software. Next, focus groups were employed to identify and establish face validity for the items developed. The results suggest risk-taking is the most important dimension in developing an entrepreneurial engineering department, and a strong requirement for its continued competitiveness. Further, study also supports the notion that entrepreneurial engineering faculty will develop higher levels of industry collaboration, funding and reputation – leading to higher success for internal university stakeholders.

Key words: University entrepreneurship, Entrepreneurial orientation, University department.

INTRODUCTION

It is widely recognized that today’s contemporary environment is dynamic – exhibiting a high rate of change in response to global competition and the application of new technologies (Association of Universities and Colleges of Canada, 2001b; Etemad & Wright, 1999; Hernandez-Gantes, Sorensen, & Nieri, 1996; Liu, 2017; Mudalige, Noor Azizi, & Marlin Abdul, 2018; Paweta, 2015). Consequently, public attention has increasingly focused towards the effective and fiscally responsible management of public institutions. The recent explosion of entrepreneurial activity (National Governors Association, 2000), and the prominent role of knowledge in the “new economy” (Krabel, 2018) has prompted a shift in expectations about the role of universities toward an emphasis on research commercialization and contribution to economic development. Today’s universities are expected to contribute to their communities above and beyond research alone, providing guidance, training and expertise. Going forward, an examination of literature is followed by study’s method section. Thereafter the findings

section is followed by discussion and conclusion sections.

LITERATURE REVIEW

A focused stream of research on the concept of “entrepreneurial orientation” clearly establishes that large organizations can benefit from doing things in an entrepreneurial manner. The study of Entrepreneurial Orientation (EO) has its roots in the field of strategy research, especially the writings of Mintzberg (Mintzberg, 1973) and Miles and Snow (Miles & Snow, 1978). Mintzberg identified three strategy types; entrepreneurial, planning, and adaptive, while Miles and Snow (Miles & Snow, 1978) wrote about “prospector firms” and the role that an entrepreneurial approach to strategy plays when firms are faced with decision such as what products to offer or markets to enter. Building on these early references towards an entrepreneurial approach to strategy, Miller (Miller, 1983) was one of the first to describe the components of the approach. He defined an entrepreneurial firm as one that “engages in product marketing innovation,

undertakes somewhat risky ventures, and is first to come up with proactive innovations (p. 771).” Later, Morris and Paul (Morris & Paul, 1987) refined this definition: EO is the “inclination of top management to take calculated risks, to be innovative, and to demonstrate proactiveness.”

The dimensions of EO (innovation, risk-taking, proactiveness) can provide an organization with entrepreneurial or Schumpeterian rent by allowing it to profit from more risk-intensive activities (Lee & Slater, 2007; Mishra, 2017). Thus, entrepreneurial orientation serves to integrate and focus resources, potentially resulting in (or enhancing) a competitive advantage. EO is associated with improved performance in private sector corporations (Lekmat et al., 2018; Liet al., 2008; Mishra, 2017; Wiklund, 1999). Further, public sector managers have also found entrepreneurship to be a “salient concept for their organizations, and that the key obstacles to its implementation are very similar to those reported by corporate managers” (Morris & Jones, 1999).

The literature contains evidence that even within the private sector the dimensions of EO can vary in their importance and relationship to each other in complex ways (Richard et al., 2004). For example, Kropp et al. (2008) found that the decision to start an international new venture is positively related to the proactiveness and risk-taking components of EO, while the innovativeness component is not an important factor. Naldi et al. (2007) found that the three dimensions differentially impact the performance of family owned firms. In particular, family firms take fewer risks than do non-family firms. Indeed, Naldi’s findings show that risk-taking in family firms is negatively related to their performance. Coulthard (2007) reviewed four Australian industry studies and found positive correlations between performance and the dimensions of innovativeness and proactiveness, while dimensions of competitive aggression, risk-taking, and autonomy varied in their importance between sectors and over time. These studies and others suggest that the influence of EO is contextual. In addition, the original ENTRESCALE was developed using a relatively small sample of large U.S. and Canadian corporations. Thus, it is prudent to question use of this scale in different organizational contexts, especially ones as distinctive as public universities.

For example, a university that is innovative, proactive and able to take risks will develop

internal routines supporting these characteristics. Strategy and strategic orientation were associated with firm based routines in past research (Morgan & Strong, 2003; Schneider, Wheeler, & Cox, 1992). A university that is entrepreneurially oriented may be more open to co-operation with private sector firms (Bonaccorsi & Piccaluga, 1994), possibly leading to more university-industry technology transfer (Behn, 1998).

Entrepreneurship at Universities

Declines in per-student government funding, calls for increased accountability, and a focus by governments on the commercialization of research, are forces influencing many public universities to seek more innovative and “entrepreneurial” approaches to diversify revenue and contain costs (Box, 1999). Calls for increased commercialization of university research have become louder, even from within the university sector (Agrawal, 2001; Association of Universities and Colleges of Canada, 1998, 2001a, 2001b; Conceicao, Heitor, & Oliveira, 1998; Expert Panel on the Commercialization of University Research, 1999). Likewise, collaborative efforts between academia, government, and industry are seen as vital for the regional technology development (Johnson, 2008). Commercialization and technology transfer are seen as a way to increase the benefits of universities to the public (Expert Panel on the Commercialization of University Research, 1999), and to help fill the funding gap left by reduced government funding (Association of Universities and Colleges of Canada, 2001a). This gap is often supplemented through revenue sharing with inventors, or patent-based royalties (Baldini, 2010).

Historically, technology transfer by a given university was almost exclusively through the patenting and licensing the results of university research (Association of Universities and Colleges of Canada, 2001a, 2001b; Association of University Technology Managers, 2000; Berggren & Dahlstrand, 2009; Bonaccorsi & Piccaluga, 1994; Johnson & Tilley, 1999; Macho-Stadler, Pérez-Castrillo, & Veugelers, 2008; Migliori et al., 2017; Nosella & Grimaldi, 2009; van Burg et al., 2008). However, more recently universities have played a direct role in venture start-ups (Bray & Lee, 2000; Miranda et al., 2017; Mustar & Wright, 2010; Steffensen et al., 2000), establishing business incubators (Kolypiris & Klein, 2017; Lasrado et al., 2016; Mian, 1994, 1996, 1997;

Stevenson & Thomas, 2001), and encouraging university-based consulting (Perkmann & Walsh, 2008; Rainsford, 1992; Wolf, 2017). The Canadian government continues to emphasize and support commercialization efforts of Canadian universities (Rasmussen, 2008). Researchers who collaborate with practitioners are found to have significantly superior research performance compared to researchers who do not engage in such collaboration (Abramo et al., 2009). Some universities combine these activities with their education efforts, resulting in more applied education programs (Coman, 2008; Harris & Gibson, 2008; Mallick & Chaudhury, 2000; Solomon & Fernald, 1991). Today there is wide acceptance of the growing importance of university spin-off activity and technology transfer (Bathelt et al., 2010; Hoye & Pries, 2009; Hussler et al., 2010; Linton, 2009; Prodan & Drnovsek, 2010). Although the role of universities is increasingly recognized by governments (Rasmussen, 2008) and perhaps less so by business media (Linton, 2010), changes at public universities still occur relatively slowly. Much of the existing research in this area examines the interaction between the university and industry, or research commercialization at the university level. Researchers have observed an existence of differentiated tools identified for technology transfer at the regional level (Hussler et al., 2010), as well as a variety of business models available to transfer an innovation from the academic world to the practitioner realm (Pries & Guild, 2010). Some researchers focus on the academic inventor, their intentions (Prodan & Drnovsek, 2010), or their propensity to reengage in commercialization (Pries & Guild, 2010). Others focus on the implementation process (Linton, 2002), management team processes, and access to capital (Braunschweig, 2001; Gurdon & Samsom, 2010; Macho-Stadler et al., 2008).

The most relevant body of research for understanding entrepreneurship within universities are studies of the university characteristics, and the external (often regulatory) environment within which universities operate. A number of studies focus on the impact of the Bayh-Dole Act on the amount of patenting and licensing by universities in the US (Cockburn & Henderson, 1998; Lipinski et al., 2008; Mowery et al., 2001; Rafferty, 2008; Wadhwa, 2007). Other researchers have examined changes in patent characteristics (Cockburn & Henderson, 1998) as well as the cause of rapid growth in university patenting and licensing

(Thursby & Kemp, 2000). University characteristics that act as obstacles to knowledge transfer have also been identified, especially bureaucracy, and paucity of interdisciplinary research (Bonaccorsi & Piccaluga, 1994; Krabel, 2018; Martins et al., 2018; Migliori et al., 2017). Entrepreneurship is seen as a solution to these obstacles (Behn, 1998; Coman, 2008; Mwasalwiba, 2010; Picco, 2002), as are different methods of facilitating university technology transfer (Barr & Kellaris, 2000; Fini et al., 2017; Miranda et al., 2017), and more relationships between universities and industry (Henderson et al., 1998; Todorovic et al., 2011).

Understanding of the nature of entrepreneurship within universities, and how an EO might translate into an advantage for a university is still in its infancy. Studies of university involvement in entrepreneurship related activities have largely focused on commercialization per se, the partners involved, and the methods of knowledge transfer. The dimensions of an EO in public institutions, such as a university, are not necessarily the same as those in private firms. Differences may arise from mission and mandate, and governance structure. Consequently, this study attempts to build a theoretical base, which will contribute to a better understanding of the effect EO and its dimensions are likely to have on engineering departments.

METHOD

The studies cited in the previous section considered the interaction between universities and industry or the activities within universities – all of which are at the university level of analysis (i.e., the whole organisation). The performance/reward structure, however, as well as faculty interactions are generally focused more at the department level (Todorovic, 2011). Consequently, university departments have significant influence on the organizational culture and activities of the faculty in their departments, and as such are the focus of this study.

This study was undertaken in two stages. In the first stage, we initially interviewed fifteen faculty members of the University of Waterloo Faculty of Engineering. The University of Waterloo and the Engineering and Computer Science faculties in particular, have a reputation for being very entrepreneurial (Media, 2002). Next, we interviewed twenty-five faculty members from the

University of Western Ontario, University of Guelph, and McMaster University. These universities were perceived as representative of Canadian research universities (Media, 2002).

Stage 2 involved the use of focus groups. Three focus groups of 10 to 12 participants each were utilized. Most of the participant are either department / institute chairs or tenured senior professors. At the beginning all the participants were given a chance to write down their opinion on the following question: "If someone stated that a particular university department was very 'entrepreneurial' what would that observation mean to you?" Faculty members were afterward given chance to change their opinions/positions based on the overall discussion.

Items collected from faculty members were summarized, and a representative list of items agreed upon in focus groups. This list was then assigned codes developed from the interviews ("Interview Category"). Following, subject statement ("Subject") was identified for each item, and presented immediately following the Interview category. In order to increase inter-rater reliability, another faculty member was asked to do the same analysis using the same items. The findings of the two faculty members were then synthesized into a single table. That table presents all the items that were agreed upon by all three focus groups, in addition to the two columns discussed earlier. Another table was deduced from the original table, where items were sorted using "Interview Category" column. These columns were organized by frequency of occurrence, where each column contains rows developed from the corresponding "Subject/Source" items.

Study participants were chosen randomly from faculty lists posted in the university web sites. An attempt was made to involve as many department chairs as possible. Department chairs or Centre/Institute directors are analogous to middle managers (or CEOs) in the private sector. The use of CEOs or middle managers as single informants is generally the practice in EO related research (Allen & McCluskey, 1990; Kwaku, 1996; Nahavand & Chestech, 1988; Pearce et al., 1997; Ruppel & Harrington, 2000). Hambrick(1981) showed that CEOs' and managers' perceptions were a closer set of objective measures of the same phenomenon than were those of an organization's other members. Approximately 40% of

respondents were department chairs or centre/institute directors.

FINDINGS

In order to provide as comprehensive discussion of our study as possible, the findings section herein is presented in two stages: Stage 1 and Stage 2

Stage 1

The respondents placed the greatest emphasis on the outcomes of entrepreneurship, followed by the current strategic emphasis of the university. Of the individual codes, spin-off companies and technology transfer were most frequently mentioned as significant indicators of an entrepreneurial department. The participants appeared to focus on the present situation, and describe the desired outcome, incorporating people and organizational culture as the variables moderating the process. The main themes aggregated from the data are the outcomes of entrepreneurship, organizational culture, people, and current strategic emphasis, which are discussed in the following sections.

Outcomes

Ten codes were aggregated together into the theme of outcomes of entrepreneurship. The codes in this theme look at attracting entrepreneurial students and faculty to the university, as well as increasing involvement with the private sector - including both consulting and technology transfer. There is a sense of the university starting something new, and this is often associated with spin-off companies. This code had the most text unit references. Finally, the theme also suggests an applied approach to research problem selection as well as an increase in grants and funding available to the university. For example, many participants listed a high number of patents, or business start-ups as evidence of an entrepreneurial department.

Organizational Culture

Common code pointed towards a need to create a "proper" organizational culture inside the university as well as being "forward thinking". These two characteristics were mentioned as 'requirements' of an entrepreneurial department. Another code in the organizational culture theme deals with the attitude found within the university, including that of the employees and of the administration. Finally, taking risks and having a supportive university vision and mission were

perceived as crucial to entrepreneurship. For example, one participant stated, “it is hard to be entrepreneurial if this [entrepreneurial behaviour] is looked down upon.”

People

The third theme deals with the people at the university. An entrepreneurial department is one with many entrepreneurial and proactive members who are often quick to act on opportunities in their environment. A different code suggests that people in such a department may be selfish. One participant summarized this theme well in saying that “departments are made of people, and to have an entrepreneurial department, you need entrepreneurial faculty”. It is necessary to point out that a number of participants indicated that a presence of a significant proportion of “conservative” personnel was perceived as a negative factor.

Current Strategic Emphasis

Finally, this theme looks at the present state of the university environment, policies and activities of the university. Items point to the need of universities to seek out commercialisation opportunities and company partnerships to take their innovations to the market. A number of intermediary activities were cited, in which the university acts to bring together researchers and industry. Further, there was reference to the university providing institutional support as well as liberal intellectual property policy (i.e., faculty ownership). Institutional support includes support (social and otherwise) within university

departments for entrepreneurial activities, and recognising this in the faculty performance review system.

There was a significant amount of disagreement between respondents about how entrepreneurial a university should be. While some felt that university should not be entrepreneurial at all, others argued that entrepreneurial universities are the way of the future. Likewise, while some felt that university should be involved in commercialization and creating new ventures, others argued that it should be entrepreneurial when teaching and educating its student population.

In order to evaluate how the EO dimensions identified in the literature (innovation, proactiveness and risk-taking) relate to the themes identified in the interviews, the four themes were compared to the three EO dimensions. Specific terms reflecting the EO constructs were identified, and codes assigned to the text units containing the relevant terms. Intersections of the four themes and EO dimensions were then extracted. The result of this process is the 131 intersects shown in Table 1. The EO dimensions received different emphases across the four themes. Sixty-eight percent of all references made to innovation were made in the context of the outcome theme. Proactiveness was referred to only on a few occasions, accounting for 8.4% of the references made to outcomes. Risk-taking was mentioned evenly across the four themes.

Table 1: Themes and EO Dimensions Intersects

Dimension	Culture	Outcomes	People	Existing Situation	Total
Innovation	4	60	6	18	88
% of dimension	4.55%	68.18%	6.82%	20.45%	100.00%
% of theme	33.33%	83.33%	31.58%	64.29%	
Proactiveness	1	5	4	1	11
% of dimension	9.09%	45.45%	36.36%	9.09%	100.00%
% of theme	8.33%	6.94%	21.05%	3.57%	
Risk-taking	7	7	9	9	32
% of dimension	21.88%	21.88%	28.13%	28.13%	100.00%
% of theme	58.33%	9.72%	47.37%	32.14%	
Vertical totals	12	72	19	28	131 (Grand Total)
% of Grand Total	9.16%	54.96%	14.50%	21.37%	
% of theme	100.00%	100.00%	100.00%	100.00%	

These findings were consequently presented in a graphical model presented in Figure 1. As the reader can conclude, above research strongly

suggests that Risk-Taking Culture is very important in the beginning of the process, while innovation outcomes are presented more as

outcomes (rather than ingredients) of the entrepreneurial department. Organizational Culture and People appear to be critical factors promoting the process forward. One needs to remember that

risk-taking is likely to be impacted by both the organizational culture and the human factor (people).

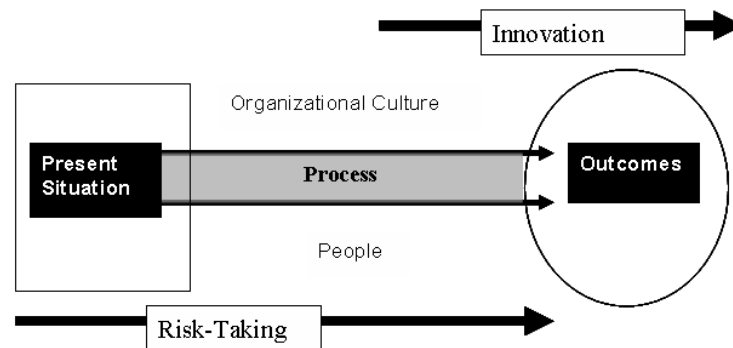


Figure 1: Relationship between Themes and EO Dimensions

Stage 2

Table 2. presents the list of items agreed upon by the three focus groups as being the most representative of the topic in question, as well as

the “Interview Category” and “Subject/Source” items. Table 3 is the reorganization of the said two factors, using frequency as the sorting determinant.

Table 2: Items Signifying Outcomes of EO within University

Items:	Interview category	Subject/Source
University department has close ties to industry	Collaboration	Industry
University department recognized by industry for our entrepreneurial contributions	Recognition	Entrepreneurial contributions
University department significant funding from industry	Funding	Industry funding
Entrepreneurial faculty members bring significant funding to the department	Funding	Funding Sources
University department receives funding from many different sources	Funding	Funding Sources
University department is highly regarded by media	Reputation	Regarded by Media
University department is highly regarded by industry	Reputation	Regarded by Industry
University department collaboration with industry resulted in significant publications in the department	Collaboration	Resulted in research
University department industry contacts have resulted in patents	Collaboration	Resulted in Patents
University department faculty members often receive help for their research from outside the university	Collaboration	Help with research
Increased department funding resulted from our partnership with industry	Funding	Industry partnership
University department graduate students are considered among the best	Grad students	Students considered the best
Industry is highly motivated to hire our graduates	Grad students	Students hired
Our faculty members are often mentioned in the media	Faculty	Media mentions
Significant proportion of our faculty members made a substantial contribution to industry	Faculty	Industry contribution
University department is often approached by industry	department	Approached by industry
University department research has resulted in a high number of patents (compared to other similar departments)	Department	High number of patents
New ideas generated by faculty members often result in financial gains for our department	Department	Department finance gains
University department funding has increased in last few years	Funding	Funding increased

Table 2: Items Signifying Outcomes of EO within University (extension)

Items:	Interview category	Subject/Source
We often have Start-ups result from research	Start-ups	Start-ups from Research
University department has a high number of industry partnership agreements	Collaboration	High number of Industry partnerships
University department has very high faculty retention rates	Faculty	High Retention Rates
University department has a high number of industry licensing agreements	Collaboration	High number of Licensing Agreements
University department has significant influence within the university	Reputation	Department Influence in University
University department Students set up their own companies	Startup	Student Start-up
University department Faculty set up their own companies	Startup	Faculty Start-ups

Table 3: Items Organized by Category

Collaboration	Funding	Reputation	Department	Faculty	Start-ups	Grad students
Help with research	Funding increased	Entrepreneurial contributions	Approached by industry	High Retention Rates	Faculty Start-ups	Students considered the best
High number of Industry partnerships	Funding Sources	Department Influence in University	Department finance gains	Industry contribution	Student Start-up	Students hired
High number of Licensing Agreements	Funding Sources	Regarded by Industry	High number of patents	Media mentions	Start-ups from Research	
Industry	Industry funding	Regarded by Media				
Resulted in Patents	Industry partnership					
Resulted in research						

Table 3 presents a clearer visual of the observations made by the investigators. Participants perceive a more entrepreneurial University Engineering department to be one that first and foremost results in high level of collaboration with off-campus stakeholders – mainly industry. In fact, current literature also seems to support industry collaboration as one of the variables of interest (Abouzar & Moshabaki, 2011; Martín-Roja et al., 2011).

Next, this study supports the notion that an entrepreneurial engineering department is one that will gain in funding and reputation. This notion is further supported by the column titled “Department” which mentions both collaboration with the industry and financial gain for the department. This is in agreement with Dooley and Kirk (Dooley & Kirk 2007) who presents a need for research universities to “to engage successfully in collaborative research with industry partners” (p. 316).

Remaining columns in Table 3b seem to suggest that such an entrepreneurial engineering university department will stand the benefit internal stakeholders such as the faculty and students. This benefit is presented in both the traditional innovation measures such as “start-ups and “patents and licensing” as well as some less traditional matrices. In fact, study results are suggesting that, contrary to some concerns presented to the opposite, the overall education quality, and thus university reputation, will also increase. Indeed, having an entrepreneurial department will go a long way towards enriching entrepreneurship education, and overall education within the university (Edelman et al., 2008; Jones & Iredale, 2010; Mwasalwiba, 2010).

CONCLUSION

While the importance of entrepreneurship is well recognized in the private sector, increasingly large public organizations, such as universities, are turning towards entrepreneurship in their efforts to

regenerate and rejuvenate themselves. This study examined a crucial question: What constitutes an entrepreneurial university department (in this case engineering), through personal interview of 40 faculty members at four different universities, followed by three focus groups. The research reported in this paper addressed the extent to which these dimensions characterize the notion of entrepreneurship within universities.

Analysis of forty open-ended interviews with faculty members found four themes that distinguish entrepreneurial departments: organizational culture, outcomes of entrepreneurship, people and current emphasis. Intersections with the dimensions of an EO show some associations, especially between innovation and outcomes, and risk-taking and all four themes. A graphic model summarises the results, and posits that risk-taking may be the most important dimension in developing an entrepreneurial university. Innovativeness is more closely associated with entrepreneurial outcomes and results.

Results of focus group study support the notion that entrepreneurship is beneficial to engineering departments and faculties. In fact, entrepreneurial departments will enrich their collaboration with industry as well as increase department funding and reputation. Equally important, this study shows strong support for the notion that all department's internal stakeholders (faculty, staff and students) will also benefit from its entrepreneurial posture.

This study also has practical significance. While it is popular to emphasize innovation in universities, our findings suggest that it is crucial to have a risk tolerant environment, and to develop the right organizational culture and people to support this. Likewise, this study also shows that engineering departments cannot do this alone. Instead, by collaborating with industry, engineering departments will grow in reputation and financial wellbeing, while at the same time enriching their own faculty, staff and students.

LIMITATIONS AND FUTURE RESEARCH

Although this study provides interesting results, the generalizability of these results is limited by the sample size. Consequently, this study needs be followed by a more comprehensive analysis that examines the concepts presented herein in more

detail. This should include a more comprehensive empirical evaluation which would employ statistical techniques (e.g., exploratory factor analysis, structural equation modelling) as suggested by Churchill (1979).

This study has a number of limitations, of which the greatest is the sample size. A sample of forty interviews, and three focus groups is adequate for gaining a general understanding of the issues, but there is a need to conduct a larger study to explore further the issues identified. The use of a single question, coupled with a small sample size is another source of limitation. Although other questions were also used to supplement the main question in this study, there is a need to further research entrepreneurship at university, and define more precisely the role entrepreneurship plays in post-secondary educational institutions.

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ORIJENTACIJA KA PREDUZETNIŠTVU NA INŽENJERSKIM DEPARTMANIMA: DISKUSIJA!

Koncept “preduzetničke orijentacije” je dobro utvrđen u literaturi o strateškom položaju preduzeća. Velike organizacije se sve više okreću preduzetništvu u svojim naporima da postanu fleksibilne i da odgovore na pritiske da “učine više sa manje” . Da bi shvatili šta to znači da su inženjerski departmani „preduzetnički“ , sprovedeni su intervjui sa četrdeset članova fakulteta . Transkripti intervjua su analizirani korišćenjem softvera za analizu sadržaja . Zatim, izabrane su interesne grupe radi utvrđivanja validnosti razvijenih elemenata . Rezultati ukazuju na to da je preuzimanje rizika najvažnija dimenzija u razvoju departmana za preduzetnički inženjering i neophodnost za njenom kontinuiranom konkurentnošću . Dalje, studija takođe podržava ideju da će preduzetnički inženjerski fakultet razviti viši nivo saradnje , finansiranja i ugleda u industriji - što će dovesti do većeg uspeha za interne univerzitetske aktere.

Key words: Univerzitetsko preduzetništvo, Preduzetnička orijentacija, Univerzitetski departman.