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EXPLORING KEY FACTORS AFFECTING TECHNOPRENEURIAL INTENTIONS: A STUDY OF ENGINEERING STUDENTS' ATTITUDES TOWARDS TECHNOPRENEURSHIP

Abstract: *In the era of digitalization, existing businesses need to embed technological aspects in their operations and new ventures need to come up with ideas based on technology to tackle the challenges of the technological era. At the same time, the economic development of societies is also needed to focus. Entrepreneurship and technological usage are considered as the key driving force of economies. As entrepreneurship with technological changes and advancement is in the limelight and because of its endorsement in economic growth, most universities around the globe offer related programs or courses to their students to enhance their knowledge in this regard. This study aims to identify the impact of education, personal innovativeness, and self-confidence on students' intention towards technopreneurial intentions. Therefore, a conceptual framework is developed with the focus on self-confidence, entrepreneurial education, personal innovativeness of engineering students who are on the way to their career path and studied entrepreneurial courses.*

Keywords: *Technopreneurship; Technopreneurial activities; Technopreneurial education; Technopreneurial self-confidence; Technopreneurial personal innovativeness; Technopreneurial intentions; Theory of Planned Behavior.*

1. Introduction

Current economic situation before, during, and after lifting of COVID'19 restrictions result in a rise in unemployment around the globe. Entrepreneurship is gaining importance and is deemed to be a solution to unemployment (McIntyre et al., 2023; Ahamat, 2023). In developing countries, entrepreneurship is in limelight as a lead of a successful and strong economy. It is a process that occurs over time (Urbano et al., 2024; Kyrö & Carrier, 2005; Gartner et al., 1994).

Different strategies and approaches adopted, to study entrepreneurship, have been transforming over the years (Santos-Cumplido & Liñán, 2007). In this entrepreneurial intention is the determinant for venture creation and startups. During the last decades, witness exponential technology change, technopreneurship is playing a vital part in reshaping the world, by improving current technology, as the tangible world moves in the direction of a virtual one with more usage of artificial intelligence (Abbas, 2018). As a result of the COVID-19 pandemic, many businesses are being pushed

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to incorporate technology and innovation into their operations to handle afterward situations in the post-COVID-19 period (Sallomi, 2020). Economic success, social equality issues, and environmental protection can all be addressed through technology entrepreneurship (Ozen et al., 2023; Sherif, 2023). The educational institutions like STEM (Science, Technology, Engineering, and Mathematics) for the last some years focus to create technical entrepreneurial minds personnel through entrepreneurship education (Shekhar & Huang-Saad, 2021). Academic research related to the technology entrepreneurship has gained rapid prosperity in terms of volume, breadth, and diversity. To become a technopreneur, a person must embrace a certain level of intention toward technopreneurship (Kovaleva et al., 2023; Si et al., 2023). It is thought that the more a person's intention, the greater the likelihood that the individual will become an entrepreneur (Hisrich et al., 2017). Most entrepreneurial intentional studies are focused on conventional entrepreneurship, hence studies relevant to intention towards technopreneurship are few (Koe et al., 2021). Most empirical studies focused on business students to study entrepreneurial intention (EI) among university students (Shah & Soomro, 2017). However, the desire to become a technopreneur among Pakistani non-business students, especially in engineering students as they know more about technology, is still in its infancy. This study aims to examine the level of technopreneurial intention among students of public and private engineering universities of Khyber Pakhtunkhwa Pakistan, specifically targeting universities that adopted entrepreneurial education in the curriculum. Quality plays a key role in shaping engineering students' technopreneurial intentions, as it directly influences their perception of the feasibility and success of their potential ventures. The quality of education, access to top-notch resources, and mentoring from experienced professionals can significantly increase students'

confidence in their own abilities and encourage them to enter technopreneurship. Also, the quality of the business environment, including the availability of support, infrastructure, and financing, can influence their willingness to take risks and start innovative technological projects. Therefore, understanding the relationship between the quality of education, support, and students' technopreneurial intentions is crucial for creating effective strategies that encourage technological entrepreneurship in academic environments.

Therefore, the paper is organized as follows: Section 2 provides a review of the relevant literature. Section 3 outlines the research methodology and data collection. Section 4 presents the research results. Finally, at Section 5 discussion and conclusions are given.

2. Literature Review

Entrepreneurship makes the achievement of long-term sustainable growth easier and considers as most dynamic vehicle and economic engine in a country like Pakistan where development is in the progressing phase and globalization of the business world pressurized entrepreneurs to think on a new paradigm. Entrepreneurs are the creator, organizers, owners, managers, or caretakers of business ventures who identify the opportunities, eliminate threats, and ensure that all resources are used to their maximum potential to generate certain profits. Cantillon entrepreneurs are people who innovatively start a business and take risks. An innovator who presents new products and technologies is an entrepreneur, termed this process as a disruptive creative process (Aizzat et al., 2009; Schumpeter, 1934).

EI guides and provides pathways to individuals regarding the innovation, remodelling, and operation of a new venture. EI is considered an evaluation indicator of entrepreneurial behavior and leading action which is based on planned behavior and

reality (Bird, 1988).

There is no doubt that entrepreneurial skills and high technological resources are driving economies and societies towards prosperity. The merger of technological resources and entrepreneurial skills comes up with technology entrepreneurship or technopreneurship. Technology entrepreneurship is highlighted as a complete and social-driven endeavor (Garud & Karnøe, 2003; Uhløi, 2005).

For a long-term sustainable competitive edge, one of the reliable tools is technopreneurship. In industries, technology and entrepreneurship collectively pinpoint technology, which is frequently used for practical application of science i.e. development of desired competencies, resolving problems, and making of products. Technology itself serves as a yardstick of the practical application of science and frequent advancement in the technological field is the symbol of global business competition. Technopreneurship is the subdivision of entrepreneurship that deals with the latest technology. Technopreneur could be the one who intends to create something new or add value in existing by utilizing the latest technology. The behavior, attitude, vision, values, and beliefs of technopreneurs have a resemblance to the entrepreneurs. Technopreneurs and entrepreneurs, both handle new ventures and businesses which link with self-employment. For the government, technological innovation is the driver of the economy and entrepreneurship is key to economic growth. In response, universities across the world are now aligning their course content, adding entrepreneurial and technological education which provide technopreneurial learning, (Shah & Soomro, 2017), assist in designing innovative strategies, involve, and support students in entrepreneurial initiatives, and creation of an internal environment favorable. Markkula and Kune (2015) said that zeal and enthusiasm for entrepreneurial discoveries may strengthen its roots in universities which further give a push to creativity and

innovation in the regional innovation ecosystem. Becoming a technopreneur gains attraction among students as they consider it a unique model because of its contribution to the labor market with excellent elasticity in hand. Domestic entrepreneurial activities of universities are supported by a direct and indirect mechanism. Direct support refers to technology transfer from institution to industry, whereas indirect refers to entrepreneurial education supporting entrepreneurial intentions. Here the entrepreneurial intention is the result of the action of planned behavior and prompt opportunity exploitation. For studying entrepreneurial behavior, entrepreneurship could be treated as planned behavior, models of intentions, and their antecedents are considered as a useful framework (Krueger et al., 2000). US-based study of the behavior of technopreneurs with and without a professional business administration degree, i.e. MBA, found that technopreneur with MBA degrees develop their business rapidly (approx. within less than two decades after graduation) as compared to those who don't have a degree (Wadhwa et al., 2008).

Entrepreneurial education and technological advancement help in technopreneurial processes which shapes the latest technology in innovative ways to generate values. Entrepreneurship education among students as a stimulating agent of entrepreneurial intention is well studied by research scholars who demonstrate positive association in between (Martin et al., 2013; Dickson et al., 2008; Pittaway et al., 2007). Yordanova et al. (2020) studied progressing role of technopreneurs' intention among Bulgarian STEM and find out that technopreneurs' intentions are demonstrated by university students. Technopreneurship programs of Multimedia University help the organization to advance and evolve its structure and policies (Pei-Lee & Chen-Chen, 2008). The gender difference was found as a hurdle in the progress of entrepreneurial intention of youth (Sharma, 2018). Furthermore, at the regional level, entrepreneurial intentions, behavior,

and barriers perceptions between genders may differ with culture change. Strategic entrepreneurship decisions are complex ones, which require intentional process and entrepreneurial activities are the result of intentionally planned behavior. Theory of Planned Behavior (TPB) underlying the proposed model as behavioral intention is a key component of this theory. Results of previous work guided that theory of planned behavior is useful for the theory of entrepreneurial research. (Liñán & Chen, 2009). Empirical support was also founded, via analytical review, for TPB as a significant predictor for the explanation of entrepreneurial attitude, and intention. (Autio et al., 2001; Iakovleva et al., 2011; Liñán et al., 2011; Maes et al., 2014; Schlaegel & Koenig, 2014). Individual behavior is the molded form of entrepreneurial intentions which is predicted by entrepreneurial attitude. Anderson et al. (2009) and Athayde (2009). As a result, entrepreneurial intentional research is getting a boost among researchers and extending literature. According to TPB, intention and attitude towards behavior may be developed and learned via experience and proper education (Krueger, 2000). Entrepreneurial intention boost by entrepreneurial program supported by evidence (Shah & Soomro, 2017). Proactive personality, entrepreneurial self-efficacy, and support from the university, can help in the progression of entrepreneurial intention among female students at the university. In the same study, the researcher explores that the relationship between proactive personality and entrepreneurial intention is partially mediated by entrepreneurial self-efficacy (Hussain & Imran Malik, 2018). A significant relationship was found between entrepreneurial self-efficacy, growth, and independence-oriented intention along with the positive effect of university support on intentions (Shi et al., 2020). Soomro et al., (2020) study shows perceived feasibility, perceived desirability, and self-efficacy as significant predictors of entrepreneurial intentions in Pakistan. There is a connection

between the beliefs of individuals and corresponding behavior just because of intentions (Boyd & Vozikis, 1994). The intention may increase when an individual has a belief (self-confidence) that he/she can accomplish belief effectively. Self-confidence (sometimes referred to as self-assurance) is about acting with belief in personal powers along with capabilities and surety on the successful transformation of skills into the desired intention. A correlation was found between self-confidence and willingness to take risky action (Kirkwood, 2009). In this context, self-confidence and innovation (personal and technological) considers as required characteristics of an entrepreneur. Related literature shows that entrepreneurs have high self-confidence as it keeps them away from being demotivated by fear and disbelief (Ferreira et al., 2012; Ho & Koh, 1992).

For technopreneurial intention, it's important to consider those determinants which impact behavior and attitude towards new business creation specifically in students. Recently, a new dimension of entrepreneurial intention was studied "technopreneurial intention" among non-business students of Pakistan (Soomro & Shah, 2021). To address the gap found in the study (Soomro & Shah, 2021), Figure 1. suggests that the technopreneurial intentions (endogenous variable) of students get impacted by entrepreneurial education, personal innovativeness, and self-confidence exogenous variable. Following are our proposed hypotheses:

H1: Technopreneurial education has a significant impact on technopreneurial intention.

H2: Technopreneurial innovativeness has a significant impact on technopreneurial intention.

H3: Technopreneurial self-confidence has a significant impact on technopreneurial intention.

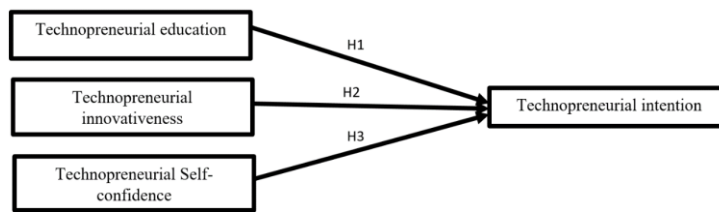


Figure 1. Conceptual framework

3. Methodology and Data Collection

The research was carried out at the public and private sector engineering universities of the KPK province of Pakistan. The purpose behind the sample selection is shortage of engineers and their attitude in era of globalization especially in developing countries. Authors Liñán & Chen (2009), support the idea to take student samples into technopreneurs' intentional research as these individuals are in the process of real career selection. A descriptive research approach was adopted to achieve the objectives of this research study.

This study used a questionnaire survey to collect desired input from respondents. The target population was university students enrolled in the engineering degree program of public and private universities. As there are many engineering universities in Pakistan, so this study targets the universities in Peshawar, Mardan, Bannu, and Abbottabad districts of KPK. For data collection, the researcher gets permission from the head of the department. Respondents were requested to fill out the survey questionnaire in presence of the teacher and explained to them the purpose of this research. An electronic link (Google form) was shared with the respondents via an online group of Whatsapp and email on demand. For maintenance of transparency, respondents need to log in before giving a response. Confidentiality of respondents' email IDs and the response was also ensured.

3.1. Sample and descriptive analysis

Concretely, participants in this study were 288 engineering students, who are at the end of their degree or already cleared the courses related to basic technology and entrepreneurial education. All enrolled students were invited to participate, and none of them refused to participate in the survey although 9 responses were discarded because of missing information. Among the students who participated, 91% are male while only 9% of the sample consist of females. Among these respondents, 93% are between the ages of 20 to 25, while the rest of the 7% are between the ages of 15 to 20.

3.2. Measures

We adopted questionnaire items from reviewed literature. We adopted technopreneurs' intention 6 items scale from Liñán & Chen, (2009). The self-confidence factor was measured on 8 items adopted from Chen et al., (2001). Similarly, personal innovativeness was evaluated on 10 items picked from the research of Agarwal & Prasad, (1998), Scott & Bruce (1994). Technopreneurial education was measured with 3 items using the scale of Franke & Lüthje (2004), Qi (2017), Wei et al. (2019). All items were closed-ended and the respondent's level of agreeableness or disagreeableness evaluated through 5 points Likert scale ranging from 1 as strongly disagree and 5 as strongly agree.

3.3. Variable indicators

This study covers four variables including technopreneurial education, self-confidence,

personal innovativeness, and intention. Each scale item was chosen after careful consideration and understanding of the research plot. Technopreneurial intention items indicate the intention to become an entrepreneur with suitable usage of technology and intention to start a new venture. Items of education scale cover three aspects, i.e. entrepreneurial atmosphere (in terms of technology usage and advancement), entrepreneurship curriculum, and university support in funding and entrepreneurial activities. Self-confidence items cover self-efficacy, and belief on own skills. Personal Innovativeness in technology covers role-modeling, openness for feedback, usage of advanced and new technology, creativity, and innovative ideas for usage of technology, continuous upgradation with technological developments.

4. Research Results

The questionnaire used for study consists of two sections and 27 questions. To ensure the

reliability and validity of the items, all questions of the survey questionnaire were adopted from the literature. Validity and reliability of research survey questionnaire considered to be significant and conducted to assess the stability and consistency of the result (Taherdoost, 2016).

For the validity of items, Principal Component analysis (PCA) through rotated components with the varimax rotation method was employed (Soo Wee & Quazi, 2005; Koh & "Ted" Nam, 2005). Most of the items were loaded with good loading. Those items were loading above 0.5, considered reliable. However, 7 items were removed due to lower loading and loading with other components. Cronbach alpha, composite reliability, AVE, and hypotheses were calculated after removal of these lowly loaded factors.

After factor loadings via principal component analysis, the value of composite reliability (CR) calculated [manually in excel] ranging in between 0.84 and 0.93 (Table 1).

Table 1. Loadings, CR, Alpha, and AVE

Variables	Code	Factor loadings	CR	AVE	α
Self Confidence	SC3	.766	0.932681	0.698368	0.927
	SC4	.791			
	SC5	.868			
	SC6	.859			
	SC7	.835			
	SC8	.888			
Personal Innovativeness	PIT1	.684	0.905728	0.579831	0.892
	PIT2	.818			
	PIT3	.707			
	PIT4	.781			
	PIT8	.758			
	PIT9	.849			
	PIT10	.719			
Technopreneurial Intentions	TI3	.541	0.848265	0.58946	0.806
	TI4	.829			
	TI5	.829			
	TI6	.832			
Technopreneurial education	TE1	.795	0.908146	0.767939	0.876
	TE2	.917			
	TE3	.912			

This value crosses 0.70 as approved by many renowned scholars including Gefen et al. (2000). We put in the average variance extracted (AVE) to observe the measure of the homogeneous construct. We get the values of AVE ranging in between 0.579 and 0.767 for tested construct that is above the demanded threshold 0.50 (Hair et al., 2010). Collectively, the required values of convergent have been satisfied by all the variables. In last, Cronbach's alpha coefficient used to measure the reliability of the construct.

In this context, the alpha coefficient is considered as general measure of reliability and internal consistency. (Whitley, 2002; Robinson, 2010). For descriptive studies, alpha values above 0.70 shows excellent internal consistency of the construct. (Whitley, 2002; Robinson, 2010; Pallant, 2016; Nunnally & Bernstein, 1994; Kannan & Tan, 2005). Whereas, for exploratory studies, the alpha values must be equal to or above 0.60 (Straub et al., 2004). In this research, we found that all values of reliability were greater than 0.70, which is

excellent. Alpha values of scales used in this study ranged from 0.806 to 0.927. Alpha values showed the internal consistency of construct which was achieved and items were reliable too.

4.1. Data analysis

In the first step, user-friendly software SPSS used for fundamental analysis. This analysis includes descriptive statistics, reliability and validity, and data reduction. In data reduction, 7 items have been removed because of lower factor loadings. In the second step, hypotheses were tested by using regression. Regression is considered good for exploring the relationships among variables. (Hair et al., 2010; Lowry & Gaskin, 2014). This method is quite popular for analysis and is considered a useful statistical tool for testing hypotheses of empirical models and conceptual theories. (Hair et al., 2010).

4.2. Findings and hypothesis testing

This study employed simple linear regression for testing hypotheses (Table 2).

Table 2. Model report and regression analysis

Hypotheses	Model report [Regression Analysis]			
	F- Value	P = Value	Results	Equation of the line
Technopreneurial education has a significant impact on technopreneurial intention.	F(1,286), = 5.986	p = 0.015	Accepted	Y = 0.109 X + 3.827
Technopreneurial innovativeness has a significant impact on technopreneurial intention.	F(1,286), = 36.827	p = 0.000	Accepted	Y = 0.290 X + 3.176
Technopreneurial self-confidence has a significant impact on technopreneurial intention?	F(1,286), = 54.148	p = 0.000	Accepted	Y = 0.383 X + 2.619

This study analyzes the technopreneurial intentions with predictors including technopreneur's self-confidence [SC],

technopreneur's innovativeness in technology [PIT], technopreneur's education [TE] related to technology and

entrepreneurship among students of engineering. The conceptual model studied was constructed after a critical and rigorous analysis of existing literature.

This study targets the engineering students at different universities of Khyber Pakhtoon Khuwa, Pakistan. For testing hypotheses, simple linear regression in SPSS'21 was used. In this study, H1, H2, and H3 are significant as self-confidence, personal innovativeness, and technopreneurial education, all impact significantly on technopreneurial intentions. Among tested variables, self-confidence results as one of the strongest among them. The underlying theory of planned behavior is also supported by our tested model.

5. Discussion and Conclusions

The current business era is the era of digitalization which forces businesses to adopt the strategies that ensure their survival in long run as well as to adopt ongoing changes. This study analyzed the conceptual relationship of self-confidence, personal innovativeness, and entrepreneurial education with technopreneurs' intentions on the theoretical ground of planned behavior theory. The study highlighted the role of effect in the entrepreneurial process by showing that all are significant predictors of intention. In order to support hypotheses, technopreneurial education is considered a significant predictor in the positive outcome of intentions as behavior and attitude can be influenced by entrepreneurship education (Fayolle et al., 2005; Hannon, 2005; Lüthje & Franke, 2003). Our result reflects a significant relationship of technopreneurial education with intentions. This finding is in line with the previous studies. Rideout & Gray (2013) and Dickson et al. (2008) reviewed university-based entrepreneurship education and showed a significant effect on entrepreneurial intentions and behavior. Bae et al. (2014) showed a greater correlation between entrepreneurship education and entrepreneurial intentions than the correlation

between business education and entrepreneurial intentions. Technopreneurial intentions of students get a positive impact from learning (Hoque et al., 2017). Education related to technology and entrepreneurship gives inspiration to a learner that enhances the positive behavior and intention of students. (Souitaris et al., 2007) university not only provides education but also provides an environment, awareness, and support to adopt technopreneurial career (Walter et al., 2013). However, only one study found no direct relationship of entrepreneurial intention with education but a direct relationship with antecedent variables which indirectly contributes to entrepreneurial motivation and attitude (Mahendra et al., 2017).

Similarly, self-confidence and personal innovativeness make the person develop innovative strategies for creative conduct and strive to the achievement of values and goals. Ho & Koh (1992) argued that self-confidence is linked with other psychological characteristics and needed attributes that support and encourage a spirit of continuous creativity as well as the development of new ventures in an entrepreneur (Cuervo et al., 2007; Bayon et al., 2015). Self-confidence also affects how individuals negotiate difficult situations and how individuals see effects in planning and forecasting and on managerial behavior in operations (Willard et al., 1992). Findings from prior studies also support our findings. Self-efficacy was studied by Zhao et al. (2005), and Wilson et al. (2007) and stated that individual self-confidence in the accomplishment of tasks has high self-efficacy which influences the intention of entrepreneurship. Other studies also showed that self-confidence influences entrepreneurial intentions (Anderson et al., 2009; Athayde, 2009; Ferreira et al., 2012; Sugandini et al., 2018). Young entrepreneurs with high self-confidence can decide on their venture confidently as they have firm belief in their ability to adjust and adapt to other environments, accept technology change, catch opportunities, and forecast the risk. Personal innovativeness is linked with

creativity and innovativeness to exploit limited resources. It generally comes in discussion with intent and behavior which involves entrepreneurs in ideas creation and decision making that further leads to new venture formation. (Ko & Butler, 2007). The findings of this research are consistent with previous studies of other scholars as they claim the same i.e. personal innovativeness in ideas contribute to intentions and found it as one of the indicators of entrepreneurial intention (Gielnik et al., 2012; McMullan & Kenworthy, 2016; Biraglia & Kadile, 2017; Hu et al., 2018; Ip et al., 2018; Khedhaouria et al., 2015; Ko & Butler, 2007; Kumar & Shukla, 2022; Zampetakis & Moustakis, 2006). Creativity, on the other hand, is not directly related to entrepreneurial intention but shows an indirect relationship with entrepreneurial intent through self-efficacy. Globalization and digitalization give to raise the need to shift to a new business paradigm that has emerged before but increase rapidly in post COVID-21 times. Digitalization in businesses is not only responsible for bringing changes in business plans, strategies, or ways of living but also in social, economic, and educational activities. This digital transformation and advancement change the business plot and opens new space for technopreneurs, especially for those who are in process of career selection. The results of this study provide a valuable guideline for curriculum planners and policymakers of universities. This study enhances our knowledge about how universities make the effort to enhance self-confidence and support technopreneurial activities. Here empirical

evidence also provides understanding about personal creativity and innovativeness related to technology. For the promotion of technopreneurial culture in Pakistan, government agencies need to organize a professional development program that enables the attendees to embed high-end technology (including artificial intelligence-based and robotics) in business plans. The government also needs to mention ongoing issues (priority wise) which need to handle better development in the field of technology and call for fresh ideas (from students) which are further supported and funded by the government to ensure its successful implementation. In this context, educational institutions need to develop technological infrastructure whereas government needs to establish directive policies and strategies.

Future researchers need to analyze the effect of technopreneurial education or the role of an institution on other personality domains such as self-esteem, self-motivation, student morale, student creativity, which are further associated with technopreneurial intentions. As previous research showed that education, increases self-confidence which controls the behavior and brings changes in it. Training, family background (entrepreneurial or non-entrepreneurial), and awareness of high-end technology are also responsible for behavior control and self-confidence. Future researchers need to study these areas by considering discussed variables as mediators or by comparing family backgrounds. In last, this study extends the literature on technopreneurial intention and its determinants with empirical evidence.

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