International Journal of Industrial Management (IJIM)
ISSN (Print): 2289-9286; e-ISSN: 0127-564x; Volume 3, June 2017

ENTREPRENEURIAL ACUMEN OF ENGINEERING STUDENTS: INPUT IN UNDERSTANDING THE IMPULSE OF BUSINESS START-UPS AMONGST ENGINEER – ENTREPRENEURS IN THE PHILIPPINES

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ABSTRACT

The research aimed to identify the factors that predict the business intelligence of college students enrolled in engineering programs. Participants involved in study were students that belong to the generational cohort called neo-millennials. A theoretical model depicting the factors that affects the entrepreneurial acumen of engineering students was tested using multivariate analysis. Results of the study revealed that characteristics supporting the entrepreneurial acumen of engineer students were: enthusiasm; appreciation of available social resource; having a vision; a sense of entitlement; and having creativity and innovation. It has been identified that the competencies in personal, social, and technical aspect, gained by the students through formal and informal schooling predicted entrepreneurial acumen. The study suggested that the business intelligence of engineering students can also be predicted by entrepreneurial influence such as: early exposure to family business; and taking up entrepreneurial courses. The study also revealed that one's innate entrepreneurial manifestations and characteristics predict entrepreneurial acumen.

***Keywords**:* Business Acumen, Entrepreneurship, Engineering, Generational Cohorts

INTRODUCTION

Although it has long been established that entrepreneurs contribute significantly in economic development, the effect of entrepreneurship in developing economies like the Philippines was studied not quite widely. It has been identified by many empirical studies that entrepreneurship was used by developing countries to introduce new business or reactivate mature ones in response to identified business opportunities in the country. The works of Kantis, Hugo, and Ishida (2002) supported this line of thought. It the earlier works of Porter, (1998); Liedholm and Mead (1999); Loayza, Klaus, and Luis (2000); and Reynolds, Bygrave, and Autio (2004), it has been identified that businesses in developing countries can range from solo projects to major undertakings leading to the creation of many job opportunities and creation of new products and services in the market. This study is coming from a premise that prospective entrepreneurs should have the right personality, characteristics, and

International Journal of Industrial Management (IJIM)
ISSN (Print): 2289-9286; e-ISSN: 0127-564x; Volume 3, June 2017

competencies necessary to own, manage, and to a larger extent own and run a business at the same time. In the past, many studies revealed that business acumen is imperative for an entrepreneur to ensure successful business operation (Baron, 1998; Chell, Haworth, & Brearley, 1991; Egai, 2008; & Wright, Westhead, and Sohl, 1998). The study aimed to identify the entrepreneurial intelligence of students enrolled in engineering programs in two of the premier professional-technological institutions in Philippines. The study focused in identifying the effect of the competencies gained by the students in formal engineering education and the entrepreneurial insights developed by the students through the continuous maturity of their personal, social, and technical skills during their stay in college are predictors of motivation and interest to become an engineer-entrepreneur. Presented in Figure 1 is the research hypothesis.

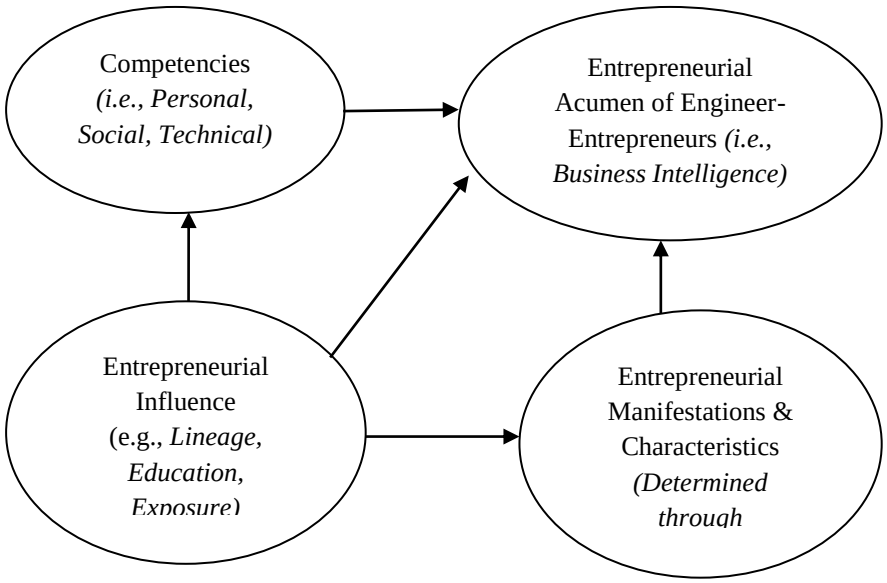

Fig. 1: Research hypothesis

Background of the study

The study suggested an explanation how a student taking up an engineering degree may gain or achieve personal traits, characteristics, or manifestations that will be relevant and contributory to becoming an engineer-entrepreneur in the future (see Figure 1). The study is anchored from the idea that competency in business, and knowledge and skills gained from engineering education influence ones potential of becoming an engineer-entrepreneur. Literature suggests that most successful entrepreneurs do tend to share certain characteristics such as motivation, accessibility, being involved, and ability to build a solid reputation. The works of Gartner (1989); and Gatewood, Shaver, Powers, and Gartner (2002) supported this claim. This research aimed to provide influence in the continuous study of entrepreneurship

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in the Philippines and in Southeast Asia. In the Philippines at present, the integration of the entrepreneurial courses in engineering education was observed not to be a common a practice for the last five years. However, due to recent developments in the education, the economy, and the fast changing world, it was just very recent that higher education institution appreciated the importance of integrating entrepreneurship in the engineering curriculum.

METHODS

Using a developed entrepreneurial readiness questionnaire, constructs were validated through factor analysis using Statistical Package for the Social Science (SPSS). Reliability of the identified constructs was reported using cronbach's alpha. Descriptive statistics and multivariate analysis were used to examine the basic variables and concepts facing a student to become an engineer-entrepreneur. Path analysis was used to test the relationship of the variables. Using factor analysis the research aimed to identify and validate constructs from the following: perceived student competencies; perceived entrepreneurial influence; and perceived entrepreneurial manifestations and characteristics of students enrolled in an engineering program with allied courses in entrepreneurship or any business-related courses. The validated constructs was used as measures in evaluating the entrepreneurial acumen of a students to become a future engineer-entrepreneur.

Participants

The demographics of the participants included age, gender, civil status, year level, and program of study. There were 378 total respondents. The participants are from various engineering programs (i.e., civil, computer, electrical, electronics, environmental and sanitary, industrial, marine, and mechanical) offered in two private-non-sectarian, professional technological institutions in the National Capital Region (NCR) of the Republic of Philippines. The participants were composed of 59.20% male and 40.80% female recruited via convenience sampling. Of the 378 participants, about 90% are on the terminal year in college and 10% were middlers. The average age of the participants is 23 years old (range: 20 to 29 years of age). In terms of civil status, 98.1% of the participants were single, 1.60% of them were married.

The study focused in one of the generational cohorts that has been identified as the second largest generational cohort in the general population in year 2002 (Raines, 2002), the millennials. Prensky (2001) mentioned that millennials are also individuals in the Generation Y. In this research the overlapping years of Generations Y and Z formed the YZ Cusp. Dede (2005); Marx (2006); and Coates (2007) called this generation the neo-millennials. These are individuals born from 1995 to 2000. Presented in Figure 2 is the diagram showing the overlap

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of Generation Y, Generation Z and the Millennials, forming the Generation YZ Cusp also known as the neo-millennials.

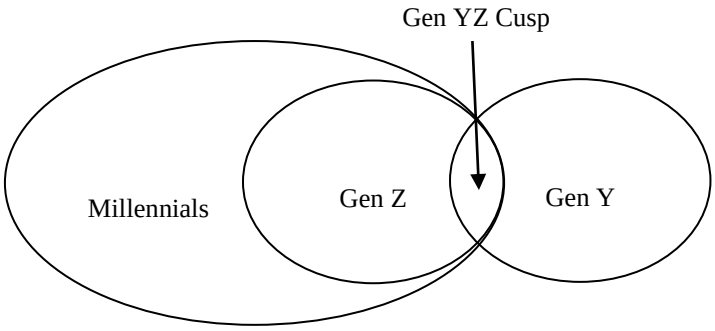

Fig. 2: Diagram showing the overlap of Gen Y, Gen Z and the Millennials, forming the Gen YZ Cusp also known as the Neo-Millennials

Measures

Over the years literature suggests that entrepreneurs have common characteristics, traits, and skills that contribute to the creation of a wide range of individuality of businessmen and business owners all over the world. The researches in entrepreneurship and entrepreneurial behaviour also made use of various measures and constructs that described entrepreneurs as someone who has passion, risks-taking attitude, organizational skills, vision, personal effectiveness, and leadership. The works of Ahlin, Drnovšek, and Hisrich (2013); Fairlie and Holleran (2012); Frese and Gielnik (2014); Kvietok (2013); and Lee and Tsang (2002) all mentioned varying traits and characteristics of an entrepreneur. In this study, the competencies as well as entrepreneurial manifestations were defined by the factor loadings as a result of factor analysis. Questions that loaded all together form a construct that described a specific character or trait of a potential engineer-entrepreneur from the neo-millennial generational cohort. Each construct was labelled based on the perceived character or trait produced by questions loading together in one entry. Presented in Table 1 are the questions used to determine the entrepreneurial manifestations and characteristics of the participants.

Table 1: Research questions used to measure the entrepreneurial manifestations and characteristics

Constructs	Research questions loading in each construct
Enthusiasm	I like to know what is going on and take action to find out.
	I am generally casual and easy going with others.
	I work best when someone else is guiding me along the way.
	I like setting my own goals and working hard to achieve them.
	Problem solving is usually more effective when a number of alternatives are considered.

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	Once I have earned something I feel that keeping it secure is important. I am generally optimistic.
	Do you have the moral support of your family or significant other?
Social Resource	Do you have a base of contacts and potential future clients who might require your services or product?
	Do you have trustworthy contacts in the legal and accounting professions to assist you?
	Do you have expertise, a skill, a product or service that is worth buying on the competitive market?
	Do you enjoy contract-chasing, sales and negotiating? Wheeling and dealing?
Vision	I enjoy planning things more than actually carrying out the plans. If faced with failure, I would shift quickly to something else rather than sticking to my guns.
	Making a lot of money is large a matter of getting the right breaks.
Entitled	Do you like to work alone most of the time? Are you self-reliant? I want independence, to be my own boss and have no one to answer to but myself (and to my customers).
	Sometimes moral ethics must be bent a little in business dealings.
Creativity & Innovation	Are you the type of person who is always finding or creating opportunities?
	When you have a good idea or notice an opportunity, do you do something about it - that is, do you seize opportunities?
	Do you like to constantly improve things?
	Do you often predict trends before they happen?

Note: Participants were requested rate the questions using a seven point likert scale.

The entrepreneurial readiness questionnaire used in the study was composed of three parts. The first part was designed to get the profile of the respondents, the second part was designed to determine the entrepreneurial influence of the respondents, and the third part aimed to identify the entrepreneurial characteristics and manifestations of the respondents. Similar to the work of Cohen (1980), the study is grounded from a theory that entrepreneurs share certain personal traits and characteristics and akin to the study conducted by Kao (1989) it has been put forward that entrepreneurship can be environmentally determined which means that intelligence in putting up, managing, and developing business can be learned. In this study the entrepreneurial influence were considered. The measures used were: desire to be an entrepreneur; lineage; entrepreneurship or business courses taken; gap (i.e., in years) by which the courses were taken; and perceived influence of the teacher based on teaching or facilitating performance in entrepreneurship course.

Procedure of data gathering and data analysis

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Convenience sampling was used in the study. The first part was designed to get the profile of the respondents. The respondents were given a survey question during their idle time. All the respondents were given the same instruction to rate their perception on entrepreneurial influence and perceived entrepreneurial characteristics and manifestations. The respondents were also assured that the responses would be held highly confidential. The research methodology involved use of descriptive statistics in describing the demographics of the participants. Pearson's correlation was used to identify the correlation of constructs created based on the questions that loaded all together after performing factor analysis (see Table 1). Exploratory factor analysis was used to determine the constructs in the entrepreneurial readiness questionnaire that resulted to: enthusiasm; social resource; vision; entitled; creativity and innovation. In testing the research hypothesis, Structural Equation Modelling (SEM) using path analysis was used to test if entrepreneurial influence composed family background (i.e., lineage), education, and early exposure to business, affects entrepreneurial manifestations and characteristics which in turn affect one's entrepreneurial acumen. The same methodology was deployed in testing if entrepreneurial influence predict personal, social, and technical competencies which in turn predicts one's entrepreneurial acumen (see Figure 1). Satora-Bentler Scaled Chi-squared, Comparative Fit Index (CFI), and Root Mean-Square Error of Approximation (RMSEA) were used to test the goodness of fit.

RESULTS

Data gathered from the developed entrepreneurial readiness questionnaire was subject to correlation to find the relationship among the constructs. The instrument underwent construct validity in SPSS. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy indicates that there is adequate sample. The Bartlett's Test of Sphericity also indicates sufficient correlations, thus factor analysis can be used. No problem variables were seen in the generated pattern matrix. However, it is important to note that coefficients were suppressed to >0.42. Table 2 shows that there are five factors loading labelled as: enthusiasm; social resource; vision; entitled; and creativity and innovation. The reliability of factors for enthusiasm, social resource, vision, entitled, creativity and innovation were .775, .765, .755, .751, and .713 respectively. Table 2 shows that there were eight items loading in enthusiasm, four items were loading in social resource, three items were loading under vision, and three items were loading under entitled, and four items were loading under creativity and innovation. There were 50 items in the developed instrument, but only 22 items loaded. Principal axis factoring with oblique rotation was used to determine the factor loadings. The factors achieved construct validity as there were no two items loading in the same factor. Reliability was moderate for all factors.

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Table 2: Results of the principal axis factoring, oblique rotation, factor loadings > 0.42, N=378

	Enthusiasm	Social Resource	Vision	Entitled	Creativity & Innovation
I like to know what is going on and take action to find out.	.765				
I am generally casual and easy going with others.	.763				
I work best when someone else is guiding me along the way.	.688				
I like setting my own goals and working hard to achieve them.	.688				
Problem solving is usually more effective when a number of alternatives are considered.	.655				
Once I have earned something I feel that keeping it secure is important.	.653				
I am generally optimistic.	.652				
Do you have the moral support of your family or significant other?	.651				
Do you have a base of contacts and potential future clients who might require your services or product?		.840			
Do you have trustworthy contacts in the legal and accounting professions to assist you?		.802			
Do you have expertise, a skill, a product or service that is worth buying on the competitive market?		.675			
Do you enjoy contract-chasing, sales and negotiating? Wheeling and dealing?		.443			
I enjoy planning things more than actually carrying out the plans.			.729		
If faced with failure, I would shift quickly to something else rather than sticking to my guns.			.718		
Making a lot of money is large a matter of getting the right breaks.			.498		
Do you like to work alone most of the time? Are you self-reliant?				.794	
I want independence, to be my own boss and have no one to answer to but myself (and to my customers).				.751	

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Sometimes moral ethics must be bent a little in business dealings.				.696	
Are you the type of person who is always finding or creating opportunities?					.985
When you have a good idea or notice an opportunity, do you do something about it - that is, do you seize opportunities?					.796
Do you like to constantly improve things?					.780
Do you often predict trends before they happen?					.576
Cronbach's alpha	.775	.765	.755	.751	.713

Table 3 shows the descriptive statistics. Enthusiasm has a mean score of 5.0475 (SD=.97016), social resource, vision, entitled, and creativity and innovation obtained a mean score of 4.3800, 4.9325, 4.6250 and 4.6251 with a standard deviation of .95246, .99611, .96955, and .99677 respectively. Table 3 shows that the distribution among the samples is skewed. This justifies the use of robust methods in path analysis in determining the goodness of fit.

Table 3: Descriptive statistics of measures, N=378

Measure	Mean	Standard Deviation	Skewness
Enthusiasm	5.0475	.97016	-7.09466
Social Resource	4.3800	.95246	-5.7234
Vision	4.9325	.99611	-2.18233
Entitled	4.6250	.96955	-4.92473
Creativity And Innovation	4.6251	.99677	-0.19797

Note: Participants were requested rate the questions in each measure using a seven point likert scale.

Table 4 shows that all the factors are correlated with each other. Table 4 also shows that there is a strong significant positive relationship between social resource and enthusiasm (r=.683). This means that the more social resource is perceived to be available by the students, the higher enthusiasm of becoming an engineer-entrepreneur is expressed. There is a strong significant positive relationship between vision and social resource (r=.672) which means that the vision of a young engineering student to be an engineer entrepreneur is explained by the perception that social resource is available, and vice-versa. There is also a strong significant positive relationship between being entitled and social resource (r=.737) which means that higher the perception of available social resource, the higher the sense of entitlement is expressed by the students. Similarly, there is a strong significant positive relationship between being entitled and having a vision (r=.672), which means that the clearer the vision of a young engineering student to be engineer entrepreneur, higher entitlement is

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expressed. Additionally, social resource, and being entitled also has strong significant positive relationship with enthusiasm (r=.683) and (r=.626), which means that the more social resource is perceived to be available by the students, the higher the possibility of having an entitled attitude is expected. Lastly, it is important to note that there is a strong positive relationship between creativity and innovation and social resource (r=.679) which means that the higher the perception of the students to available social resource, the higher creativity and innovation is perceived.

Table 4: Pearson's Correlation Among Measures, N=378

	Enthusiasm	Social Resource	Vision	Entitled	Creativity & Innovation
Enthusiasm	1				
Social Resource	.683**	1			
Vision	.566**	.672**	1		
Entitled	.626**	.737**	.672**	1	
Creativity And Innovation	.677*	.679**	.670*	.609*	1

*Note. * p< 0.05, ** p < 0.01*

Analysis of the predictors of entrepreneurial acumen of engineering students was tested using path analysis. The model below shows that being entitled, having a vision, and enthusiasm have an influence on social resource, and that social resource, in turn, influences creativity and innovation which influences the perception of engineering students to become an entrepreneur. However, the initial goodness of fit tests yielded a chi-square statistic of 8.46 with df =3 and p=.04. It also resulted to a CFI=.94 and RMSEA=.14. These suggest that the model is not a good representation of reality. To improve the model's goodness of fit, the Lagrange Multiplier (LM) Test suggested creating a new path from enthusiasm to creativity and innovation (see Fig. 3). The goodness of fit tests for the modified model yielded a chi-square statistic of 5.47, with df=2 and p=.06. It also resulted to a CFI=.96 and RMSEA=.13. These suggest that the model can be generalizable. The modified model (Figure 3) shows that all paths are significant. Being entitled is a weak, positive predictor of social resource. Having vision is a weak, positive predictor of social resource, and social resource is moderate significant predictor of creativity and innovation which in turn predicts the entrepreneurial acumen of engineering students.

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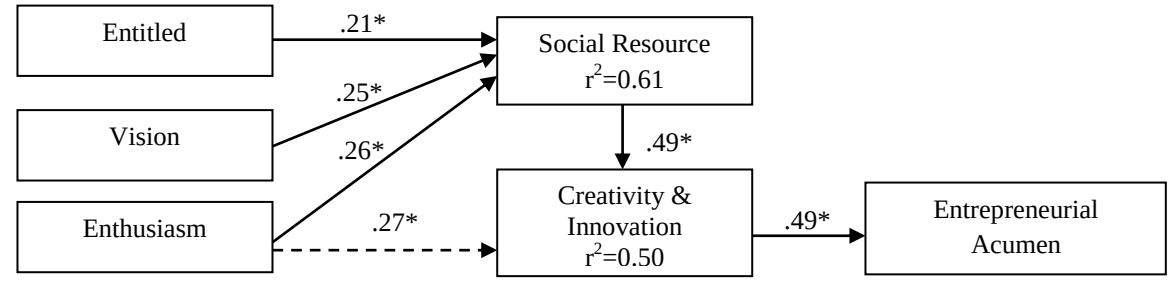
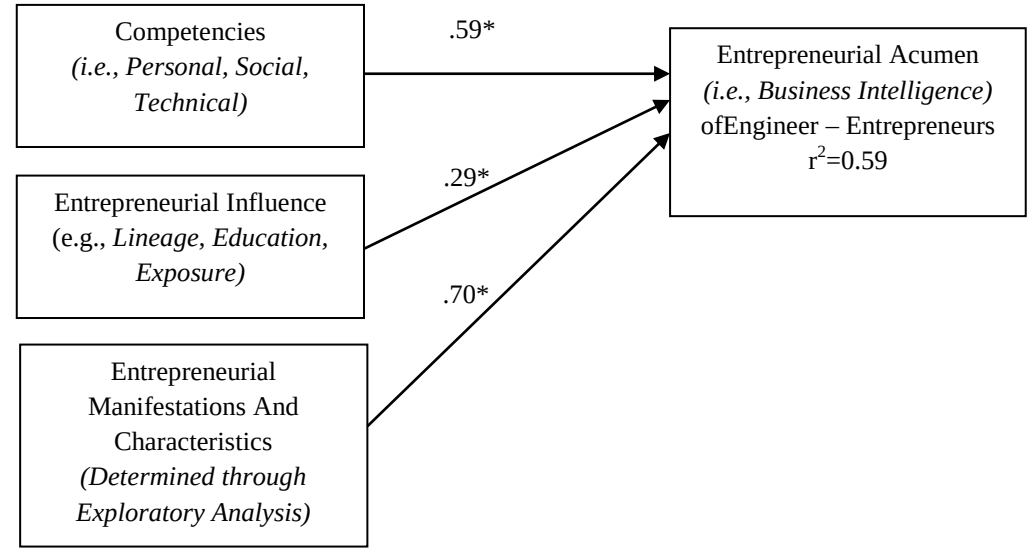


* Indicates significant at the 0.05 level

Fig. 3: Modified model for entrepreneurial acumen of engineer–entrepreneurs



* Indicates significant at the 0.05 level

Fig. 4: Robust model for entrepreneurial acumen of engineer–entrepreneurs
(competencies and entrepreneurial influence as additional variables)

Using path analysis the relationship of the competencies, entrepreneurial influence, and the entrepreneurial manifestations and characteristics determine through factor analysis was tested (see Figure 1. Research Hypothesis and Table 2. Results of the Factor Analysis). Presented in Figure 4 is the robust model for engineering students to achieve business acumen. The developed model yielded a chi-square statistic of 3.88, with df= 3 and p = .27. It also yielded a CFI=.99 and RMSEA=.06. The fit indices indicated that the model is robust and generalizable. The model presented in Figure 4 shows that the personal, social, and technical competencies gained by students in formal and informal schooling predicts entrepreneurial acumen. Similarly, the entrepreneurial influence of the students which can be gained through early exposure to business, entrepreneurship courses, and one's lineage or ancestry predicts entrepreneurial acumen. The developed model suggested that 59% of business intelligence of engineering students can be explained by these compound variables.

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CONCLUSION

The study revealed some distinguishing psychological characteristics of potential engineer-entrepreneurs in the future that belong to the neo-millennial generational cohort. The theoretical model developed in this study show that the traits and entrepreneurial characteristics of college students enrolled in an engineering program can be directly proportional to business intelligence and a palpable entrepreneurial performance in the future. In the earlier study of Hurley (1999), psychological influences, personal characteristics, and effects of previous experiences acquired from formal education, work and industry practice, civic activities, and community involvement were identified to be predictors of successful entrepreneurs. This study supported the earlier research findings. Identifying that neo-millenial generational cohort does not directly affect entrepreneurial predictors is an added knowledge developed in this study. This reseach is suggesting that acquiring entrepreneurial acumen may cut across generational cohorts, making interest in business to be acquired and developed in a very conventional way. Lastly, the study uncovered that a robust model to enhance one's entrepreneurial acumen requires strong relationship with social capital which in turn engender creativity and innovation that is needed in producing new business ideas with an end in view of making profit and economic growth. Additionally, considering that a strong positive entrepreneurial acumen can exist to neo-millennial as generational cohort, a robust entrepreneurship program can be feasible for more than 2000 higher education institutions in the Philippines. Strengthening the entrepreneurial characteristics of students and young professionals in tertiary education in the Philippines that have flagship programs in information technology and engineering may contribute to the future of business engineering, technology development, and technology entrepreneurship in the country in many ways.

The study straightforwardly contribute to both theoretical and practical implications in many untapped researches in the fields of entrepreneurship, business intelligence, business engineering, and even engineering education not limited to the subcategories of curriculum design and development, curriculum management, teaching methodology, pedagogy, teaching and learning techniques and among others. Also, policy makers may utilize the model for further studies, educational planning, and even designing robust education training for teachers in the areas of business and entrepreneurship. Theoretically, the study is suggesting that the engineering competencies developed by the students enrolled in an engineering program can be used as basis in studying entrepreneurship, and to a large extent understanding how interest in engineering-entrepreneurship can be developed. In line with this, the study is also suggesting that for an engineering student to be a future engineer-entrepreneur an entrepreneurial mindset is imperative. Hence, business intelligence should be introduced to students to trigger entrepreneurial outlook. Both formal and informal education may predict the business acumen of students. Although it is unclear, and no available studies yet in southeast asia proved that an entrepreneurial mindset can be predicted if introduced on a certain year level in college, this study is suggesting that entrepreneurship in general is all about drive and emotional connection. An engineering student's interest to become an entrepreneur is not just solely influence by the technical competencies gained from formal education, but again to a large extent driven by feelings, excitement, and enthusiasm. This also means the both personal and social competencies are contributory to one's mindset of becoming an entrepreneur. On the practical side, the study is suggesting that higher

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education institutions that aim to include engineering entrepreneurship as an intended learning outcome need to align the needed competencies that will be necessary for business startups and entrepreneurial practice. Additionally, the idea of entrepreneurship being highly attached to feelings, excitement, enthusiasm and mostly emotional association, is suggesting that teachers need to be capacitated on how to elicit entrepreneurial mindset to students in engineering courses.

DIRECTIONS FOR FUTURE RESEARCH

Although neo-millennials may have a different set of entrepreneurial characteristics and manifestations – enthusiasm; appreciation of available social resource; having a vision; a sense of entitlement; and having creativity and innovation, the study confirmed that Cohen's (1980) theory of entrepreneurs sharing certain personal traits and characteristics still remains to be applicable nowadays. Similarly, Kao (1989) who believed that entrepreneurship can be environmentally determined is true and acceptable in the case of neo-millennials. This study explained that it is possible for an individual with an engineering background, with limited exposure to business to become an engineer-entrepreneur, because startingup a business, managing and remodelling existing business can be learned. However, one of the notable characteristics of neo-millennials identified in this study was "sense of entitlement". It is rather alarming to know that affirmative answers were given by most of the respondents to statements like: "sometimes moral ethics must be bent a little in business dealings" and "I want independence, to be my own boss and have no one to answer to but myself." Although the items loading together in the construct may also be attributed to sense of power and control, it may also be give an egoistic impression which may not necessarily be good character of a business person. Morrison (2001) mentioned that aside from personal characteristics and manifestations, other factors that can be considered in interpreting entrepreneurial intelligence can be cultural assimilation, moral values, religious, marginality, and work ethic. These aspects were not covered by this study.

In line with the practical implications that the study is suggesting, the teaching and learning approaches used in engineering education, specifically in teaching entrepreneurship can be studied. The impact of using case studies, lectures, small group discussions and other traditional teaching and learning approaches can be compared with non-traditional way of processing learning. For example, real-life entrepreneurs can invited to share stories in seminars, workshops, and symposia. Students studying entreprenurship can be assessed by the faculty member based on the level of appreciation and the degree of comprehension fostered after addenting a more realistic way of introducing entrepreneurial knowledge, skills, and motivation. Researches coming from a premise that entrepreneurial mindset is attached to one's emotional astuteness may be considered. In line with this, qualitative researches instead of quantitative approaches may be appropriate. The use of narrative analysis, thematic analysis, grounded theory approach and other qualitative research designs in understanding the affect and emotional inclination of an individual to entrepreneurship is something that can be explored. On top of better understanding the various teaching and learning approaches used in engineering education, the development of one's creative and innovative sense is also something that can be studied in the future. The model in this study is suggesting that an engineering student need to gain technical knowledge in engineering prior to becoming creative and innovative. However, future researches may consider if there

is a way to determine if creativity and innovation can be developed in the individual's psyche while learning the technical competencies. One may also take a look if individuals that have developed creativity and innovation directly affects entrepreneurial intentions. Lastly, in this study the primary focus was to determine the characteristics that trigger entrepreneurial acumen of engineering students. One may also look into the possibility of studying how individuals in other non-business education can be responsive to entrepreneurship. A comparative study may be considered in understanding the process of developing entrepreneurial mindset from those in information technology, applied mathematics and sciences, and hard-core sciences like biology, physics, and chemistry. Also it will be interesting to know how people in medicine, politics, arts and music may develop an entrepreneurial mindset.

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