

ENVIRONMENT, EDUCATION, AND PERSONALITY INNOVATION
BASED INDEX

by

Mahmoud Ghandi Mahmoud Al Qawasmi

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Declaration of Authorship

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Approval Signatures

We, the undersigned, approve the Master's Thesis of Mahmoud Gh. Al Qawasmi

Thesis Title: Environment, Education, and Personality Innovation Based Index

Date of Defense:13 April, 2022.....

Name, Title, and Affiliation

Signature

Dr. Hussam Alshraideh
Associate Professor, Department of Industrial Engineering
Thesis Advisor

Dr. Abdulrahim Shamayleh
Associate Professor, Department of Industrial Engineering
Thesis Committee Member

Dr. Ra'afat Abu-Rukba
Associate Professor, Department of Computer Science and
Engineering
Thesis Committee Member

Dr. Moncer Hariga
Program Coordinator
Engineering Systems Management Program

Dr. Lotfi Romdhane
Associate Dean for Graduate Affairs and Research
College of Engineering

Dr. Fadi Aloul
Dean
College of Engineering

Dr. Mohamed El-Tarhuni
Vice Provost for Research and Graduate Studies
Office of Research and Graduate Studies

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Dedication

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Abstract

Innovation and Entrepreneurship (I&E) are evolving as highly important concepts around the world, as they heavily contribute to the economic development of many countries. Identifying, educating, and supporting innovators and entrepreneurs are urgent and crucial as there are no innovators and entrepreneurs' identification frameworks exist yet considering all aspects of I&E. As researchers highlight the importance of I&E in societies, they tried to identify the related factors affecting the development of innovators and entrepreneurs by developing and using different models, such as the General Enterprise Tendency Index, the Complex Process Model of Entrepreneurship, and the Global Entrepreneurship Index. Factors related to I&E as found in the literature are classified as environmental factors, personal factors, and academic performance-related factors. However, the topic of how to identify innovators and entrepreneurs using all three factors combined, and how these factors interact is still ambiguous and needs to be studied. In this thesis, a framework is developed to model and assess the effect of I&E-related factors and their interaction on a newly developed I&E index. We developed a literature review-based questionnaire that addresses all three factors and their effects. Collected responses were analyzed through a Structural Equation Modelling (SEM) approach. The model consisted of three constructs representing the three factors found in the literature and an output variable representing the proposed I&E index. To evaluate the developed model, the Tucker-Lewis Index (TLI), the Comparative Fit Index (CFI), the Root Mean Square Error (RSME) of Approximation, and the P-value were utilized. Model metrics showed an excellent model fit with CFI of 0.911, TLI of 0.905, RMSEA of 0.036, and a p-value of 0.000. Although model results indicate significant effects of the three factors on the developed I&E index, the personal traits factor had the highest effect encouraging more research on personality development for better innovation and entrepreneurship achievements among individuals.

Keywords: Education, Innovation, Entrepreneurship, SEM, Performance Factor, Traits, Environment, Personal Traits, Pragmatic, Interpretivism.

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Chapter 1. Introduction

1.1. Introduction

This chapter intends to develop an understanding of the educational system in the United Arab Emirates and the role of innovation and entrepreneurship in this system. Also, the chapter intends to develop an understanding of Structural Equation Modelling and its relationship with education. Likewise, the chapter will explain the problem statement and the objective of the study.

1.2. Educational System in the United Arab Emirates Overview

John Dewey said, “Education is not preparation for life; Education is life itself”, that is why we see an increasing interest in the educational field. The educational development started along with the establishment of the United Arab Emirates. Sheikh Zayed Bin Sultan Al Nahyan, the founder of the United Arab Emirates said, “the greatest use that can be made of wealth is to invest it in creating generations of educated and trained people”. The United Arab Emirates’ current leaders are following pursue the same vision of the founder Sheikh Zayed Bin Sultan Al Nahyan; hence, they allocate almost a third of the national budget for education. In 2014, the Vice President and the Prime Minister of UAE and the Ruler of Dubai, Sheikh Mohammad Bin Rashid Al Maktoum announced the UAE vision 2021. It includes the educational system improvement to be one of the best systems in the region and the world, which is one of the main goals of the United Arab Emirates National Agenda Goals [1].

The Ministry of Education in the United Arab Emirates took huge efforts to achieve these goals, by developing the educational policies, providing educational services, improving the performance results in comparison with the international standards, and moving to the smart learning methods. Therefore, the United Arab Emirates spent 10.4 billion AED in 2018 on education from the federal budget. As of today, there are around 1.2 million students under the educational umbrella in the United Arab Emirates [1].

1.2.1. Private Education in the United Arab Emirates

In the last couple of decades, the United Arab Emirates has been known as one of the best countries in the Middle East to attract professionals from all over the world

to participate in the development of the country. The United Arab Emirates is now considered the sixth-largest country with expatriates, or non-local population in the world, the expatriates form almost ninety percent of the whole population of the United Arab Emirates [2].

These skilled people, mostly prefer to settle in the country with their families due to different factors, which increased the need for high-quality education services provided by different institutes and establishments from all over the world to facilitate the education service for both Expats and Locals.

As a fact, the United Arab Emirates has considered education a high priority pillar and a key element for the county’s development and economic modernization from the beginning of its establishment in 1971 [3].

Private Education in the United Arab Emirates is operating under the supervision of the Ministry of Education and the local entities. To be more precise, the Ministry of Education is supervising public schools as well as private schools as shown in Figure 1.

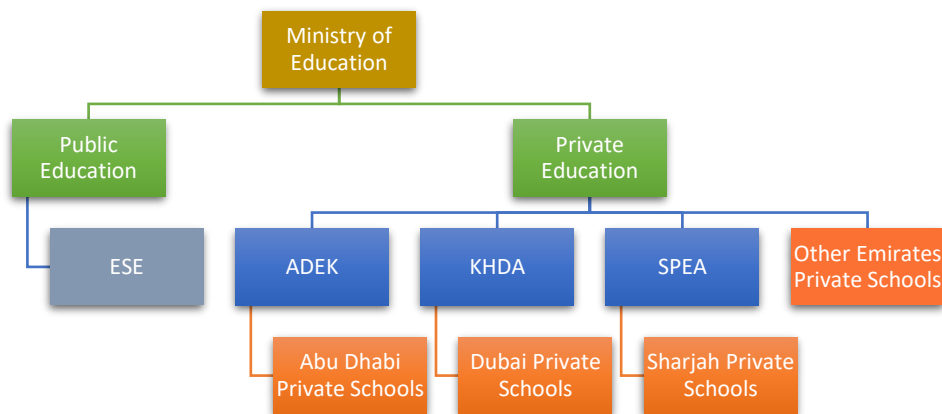


Figure 1: Educational Service Providers in UAE

As shown in Figure 1, the private schools in Abu Dhabi Emirate are supervised by the Abu Dhabi Department of Education and Knowledge, also known as ADEK. Also, the private schools in Dubai are supervised by the Knowledge and Human Development Authority in Dubai, KHDA. The private schools in Sharjah Emirate are supervised by Sharjah Private Education Authority, SPEA. Where the other private schools in the other four Emirates are supervised by the Ministry of

Education directly beside the Public Schools which for the record, are operated by Emirates Schools Establishment, ESE [3].

There are 1386 private schools in the emirates delivering their education to the enrolled students through different curricula. The main delivered curriculums in these private schools are MoE-UAE, British, American, International Baccalaureate, French, German, and Indian as shown in Table 1[4]:

Table 1: Curricula provided in UAE [4]

School Program	ADEK	KHDA	MOE	SPEA	Grand Total
Ministry of Education	50	12	717	33	812
British	59	86		26	171
American	67	39	14	27	147
Indian	29	34	26	27	116
International Baccalaureate	9	17	2		28
ATHS			19		19
G.C.S.E			18		18
French	5	6		1	12
Philippine	3	2		4	9
SABIS (UK/US)	5	2		1	8
Special education program			5	2	7
Pakistani	3	2	4	3	12
Iranian		5			5
Canadian	3				3
German	1	1		1	3
Australian				2	2
Bangladesh	1		1		2
CE Applied Stream			1		1
Chinese		1			1
Japanese		1			1
Nursery	1				1
Russian		1			1
SOD Specialized Provision	1				1
Spanish	1				1
VEDC			1		1
Other		1	3		4
Grand Total	238	210	811	127	1386

As can be seen in Table 1, a total of 1386 schools are in UAE, private and public. Where 238 private schools are under ADEK, 210 private schools under KHDA, 127 private schools under SPEA, and the rest 811 private and public schools under

the MoE. The public schools offer the Ministry of Education curricula, whereas the private schools offer the Ministry of Education curricula as well as other types of curricula. There are 812 schools that offer the Ministry of Education curricula as their main curricula, followed by American curricula provided by 171 schools, then 147 schools provide the British curricula, 116 schools provide the Indian curricula, and the rest of the schools offer other types of curricula [4].

1.2.2. Public education in the United Arab Emirates

Regarding the Public General Education in the United Arab Emirates, the Ministry of Education introduced two main streams, which are General Stream and Advanced Stream, both streams are available for all students in public schools. Also, another two streams have been introduced recently which are the Elite Stream and the Professional Stream to provide more options for the students who are willing to pursue other careers and options. The Ministry of Education in UAE also supports homeschooling and continuous education for the locals as well as the residents of the country. Figure 2 shows the previously mentioned streams [3].

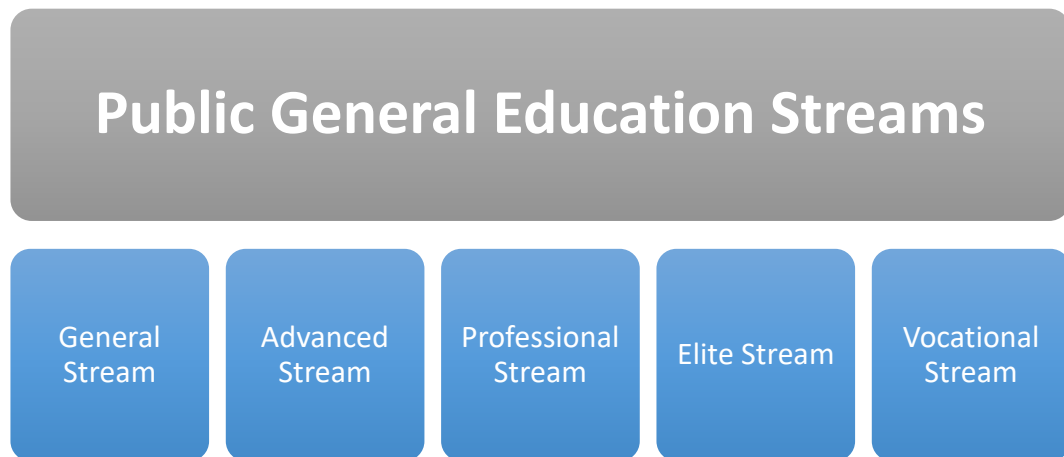


Figure 2: Educational Streams in UAE Public Schools

1.2.3. Innovation and entrepreneurship in the United Arab Emirates

The United Arab Emirates pays huge attention to innovation and entrepreneurship as it is the current cornerstone for both economic and social development. The Prime Minister's Office at the UAE Ministry of Cabinet Affairs published the UAE national Innovation Strategy under the United Arab Emirates 2021 vision, which states that "Innovation, research, science, and technology will form the pillars of a knowledge-based, highly productive and competitive economy, driven by

entrepreneurs in a business-friendly environment where public and private sectors form effective partnerships” [5]. Hence, it focuses on the main sectors in the country to enable the innovation and entrepreneurship culture in it as shown in Figure 3:

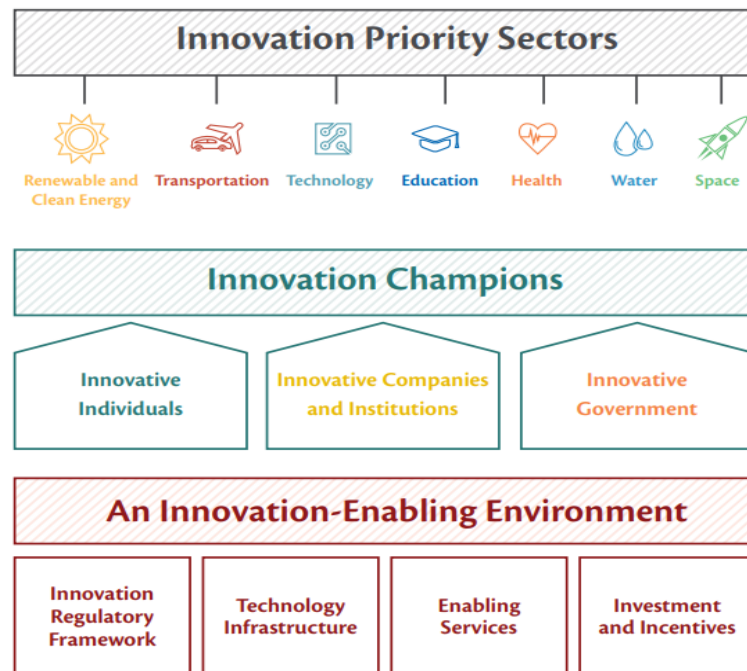


Figure 3: Innovation Priority Sectors in the UAE [5]

Focusing on the Innovation and Entrepreneurship Educational, the UAE launched a range of different innovative projects such as the Mohammed bin Rashid Smart Learning Program, the Think Science competition for the students to show their projects and innovative ideas, and the Emirates Skills Program which was launched by Abu Dhabi Government. This proves that the United Arab Emirates is taking huge steps to empower the innovative and entrepreneurs from the educational sector, hence, the early discovery of these innovators and entrepreneurs will be an added value to the country as well as the region [5].

1.3. Innovation and Entrepreneurship

1.3.1. The definition of innovation and entrepreneurship

Today, the world depends on many tools and technologies that have been introduced recently. Hence, these new tools and technologies are closely related to

innovation and entrepreneurship. Therefore, a good understanding of innovation and entrepreneurship is a must for scientists and researchers to determine what part of innovation and entrepreneurship is needed to be followed. Innovation can be described as “the creation of a new idea, and implementation into a new product, process or service, leading to the dynamic growth of the national economy and the increase of employment as well as to a creation of pure profit for the innovative business enterprise” as described by Urabe in 1988 [6]. On the other hand, Entrepreneurship is defined as “an activity that involves the discovery, evaluation and exploitation of opportunities to introduce new goods and services, ways of organizing, markets, processes, and raw materials through organizing efforts that previously had not existed” as stated by Shane and Venkataraman in 2000 [7].

1.3.2. Innovation and entrepreneurship in education and societies’ development

The educational system development is vital as it lays an impact on both individuals and societies. For individuals, it provides financial security, especially in today’s world of unstable economic status, it also provides the most needed skills to excel in their careers, which also helps them to secure better jobs with higher pay. Education also allows individuals to realize the importance of being self-dependent. Individual self-dependency can be in the financial domain or even influence different choices, which allows individuals to become more conscious about themselves and reject the idea of depending on other people. Another important aspect is individual satisfaction, which can be reached by having real and tangible achievements done by individuals who are well equipped with the knowledge and the skills needed to achieve their own goals, which also helps to a common society satisfaction. Educating individuals is more about teaching them the difference between the right and wrong common understanding, which would help them to be aware of the consequences of their choices and acts, hence, educating individuals should help them to be more mature when it comes to their daily choices and decisions which leads to the safer community due to this common understanding. In addition to that, educating people will make them more confident to express their thoughts, ideas, and feelings as they have confidence in their educational background. This leads to the next point which is becoming a contributor to the community around the individual [8].

On the other hand, from a governmental perspective, the investment in education is important as it is the main capital that the country depends on. Aside from the natural resources which help in national income, yet can be consumed at a certain point, educated people help countries to be able to manage these resources efficiently and open new national income resources other than the current ones. Additionally, reducing the unemployment rate is crucial in societies and can be achieved in many ways depending on the government policies and legislation, and improving the education rate is one of them. Therefore, having higher education rates in societies will eventually lead to diversity in subjects' specialization, and will reduce unemployment rates. Also, having an educated society will help in securing higher national income, as the country will have more specialized employees, who might be heavily involved in foreign countries' projects internationally, which develops the national income rate and reduces the unemployment rates. This leads us to the next coming point, which is improving the overall economy rating, having a good educational system will help the society to have better-paying jobs in the future which helps in opening new income opportunities to people especially, the poor ones, this contributes heavily to reduce poverty rates and eliminate the gap between the economical levels in the society. In brief, improving the educational output contributes heavily to enhancing the state of society in all aspects [8].

Another major reason for encouraging innovators and entrepreneurs is to come up with innovations, ideas, and startups to accelerate economic growth. More precisely, innovators usually come up with new ideas, processes, or strategies, which are highly developed, to change the way people conduct their work. On the other hand, entrepreneurs are the individuals who start businesses that generate value for the society which can be done by either introducing or expanding new economical fields.

Developed countries consider innovators and entrepreneurs as a national asset due to their significant role in the economic impact on the country. This consideration is supported by a couple of measured factors that can be noticed nationally and internationally, such as economic growth acceleration, promoting innovation,

promoting social changes, improving research and development, and finally improving and supporting existing companies and enterprises.

Starting with the economic growth acceleration, entrepreneurs are always looking for new methods and ways to improve the way people conduct their work as previously mentioned, which as a result, drives them continuously to adopt innovations introduced by innovators such as new products and services. As a result, this attitude stimulates the wave of employment in the country, hence, pushing the national economy growth wheel. Consequently, the newly introduced job opportunities will help the newly graduated students with their entry-level skills to improve and develop themselves to match the needs in their career path. Thus, the big companies which require skilled workers will find their requests from the local labor market instead of the international labor market. This will also help the country to develop and improve its products and services as innovators and entrepreneurs are on a continuous mission to level up what they offer in competition with both local and global markets, which again, will push the country's productivity and so, its economic growth [9].

Another factor is promoting innovation in the community, which helps to introduce new solutions to existing problems that cannot be solved by current practices. Promoting innovation is also coupled with promoting social changes, research, and eventually industrial development by reducing the dependency on fixed methods and approaches to solve problems, hence, raising the consensus related to accepting change in a dynamic environment introduced by innovation and entrepreneurship [9].

1.4. Structural Equation Modelling – SEM

Structural Equation Modelling can be best considered as a dynamic environment that forms a general modeling framework. This general modeling framework cannot be considered as an ordinary single technique to measure the relationship between data, yet, it can be considered as a combination of different analysis techniques, combined to form this general modeling framework. Some of the analysis techniques that are integrated into this framework are Regression Analysis, Factor Analysis, and Path Analysis techniques [10].

As the Structural Equation Modelling is a general model that fits different environments, it can be used to address different research topics. Hence, the Structural Equation Modelling is more powerful and insightful when it comes to research including questions with a complex nature, as the social and psychological research. This type of research usually includes concepts that are difficult to measure and there is a high possibility of including errors in them due to different factors which may or may not be visible to the researchers. these errors can be corrected automatically by SEM as needed to eliminate or reduce their effect.

On the other hand, the SEM is designed in a way to find the relationships between the different factors, which can be difficult to design using other methods such as linear regression for example. Hence, the SEM is suitable for research that focuses on causal analysis or indirect effects of different factors in complicated systems. As an example, if a researcher is studying a complex system with different factors, assuming three different latent variables A, B, and C, with an output D, the researcher could use different models and analysis methods to study the effect of any of the three factors on the output D. However, SEM will study the effect of these three factors as well as the intra-effect of these three factors, on a direct, or an indirect way on each other, and then affecting the result D.

1.4.1. Structural equation modeling and education

It is well known that the education sector is one of the most important sectors as mentioned before, hence Structural Equation Modeling besides machine learning and artificial intelligence is expected to play an important role in this field. The applications can range from predicting the career paths for the students based on their grades and understanding of specific subjects and topics, precise grading for the students away from the traditional way of grading, and more personalized classrooms for students.

Regarding predicting the career paths for the students, students who graduate from high school have no obvious decision regarding the desired and most suitable university to join or even the specialization of the study in that university. Structural Equation Modeling algorithms can help with that by investigating the scores of the students and all the subjects before joining the University and then giving the most suitable recommendations to them without any bias.

For the precise grading, today the grading for the students is mostly biased by the attendance of the students or their overall academic performance. The Structural Equation Modeling can eliminate all these factors resulting in a biased free grading for all the students under a specific educational system if not all [10].

The personalized classroom is a concept that has been requested for a long time ago, it's well known that the students have different ways of receiving the information in a classroom, however, due to several factors such as the number of the students in one classroom and available tools to assist the students, it is difficult for a teacher to monitor all the students and make sure that all of them receive the information as desired. machine learning can assist in studying the performance of the students in a classroom and notify the teacher if there is a student who needs more attention or a different way of delivering the information to him/her.

1.5. Problem Statement

According to recent studies, innovation and entrepreneurship are highly dependent on environmental traits, personal traits, and educational performance traits. These traits are mostly used separately to predict innovators and entrepreneurs in different environments and sectors. Environmental traits are mostly related to the government's policies and regulations towards supporting innovation and entrepreneurship which can be measured in many ways, such as but not limited to, the quality of the provided social services, the goals of the educational system in alignment with the global market, the local market efficiency and competitiveness, and innovation and entrepreneurship development and adoption level [19]. Then again, personal traits are usually measured by different tools, such as the GET Examination, which measures the personal need for achievement and autonomy, the tendency for creativity and calculated risk-taking, and the internal locus of control. On the other hand, performance traits can be measured depending on the person's academic achievement whether in general or higher education.

While there are a lot of studies related to I&E tendency measurement and discovery currently in practice, few of them are addressing the relationship between the three different traits, and the actual contribution to the innovation and entrepreneurship process. However, it is more practical to integrate the three different traits with the

actual personal contribution to I&E to build a holistic view, which may lead to more accurate I&E tendency measurement and discovery for potential innovators and entrepreneurs in an earlier stage. Therefore, the integration between the different traits in the process must be addressed explicitly and a way for measurement must be introduced in this study.[16]

Therefore, this study intends to introduce an index to measure innovation and entrepreneurship tendency by measuring the actual personal Innovation and Entrepreneurship output and its relationship with the environmental traits, personal traits as well as educational performance traits through related questions phrased carefully as per Innovation and Entrepreneurship experts' recommendations.

1.6. Thesis Proposal Objective

The objective of this study is to develop and introduce a new index named as Innovation and Entrepreneurship Index. This new proposed index is based on the actual personal contribution to the I&E process, which depends on the number of related projects and ideas introduced by the person. On the other hand, the three main traits introduced, which are the environmental traits, personal traits, and educational performance traits, will be used to predict the I&E Index and to inspect the effect of each of them on the I&E Index. These traits will be combined to measure and predict the tendency of different individuals from different backgrounds to become entrepreneurs and innovators in a community. The innovation and entrepreneurship index will highlight which of these traits play a major role in influencing the process of improving the innovation and entrepreneurship culture in the community. The newly introduced index will focus also on measuring the relation between all three main factors together at once, separately, and correlatively, and how they affect the innovation and entrepreneurship tendency at the end.

1.7. Research Contribution

The contribution of this study is the introduction of the I&E Index based on the actual relevant projects and ideas introduced by a person. Alongside the integration of the different innovation and entrepreneurship factors, which are the environmental, personal, and academic performance factors and traits combined

with the I&E Index. Therefore, this thesis work can be used by the educational community to have an informed decision regarding the relationship between the previously mentioned traits and factors, and the possibility of innovation and entrepreneurship by all involved educational stakeholders (schools, universities, and institutes). the decision-makers in countries can also refer to this study to focus more on the traits that most affect innovation and entrepreneurship in their countries as it highlights innovators and entrepreneurs' contribution to the country's development.

Data samples will be collected from individuals residing in the United Arab Emirates using a questionnaire built on top of the three main traits mentioned previously. Then the data will be analyzed and validated by the innovation and entrepreneurship specialists in a way to understand the credibility, effectiveness, and efficiency of the study. then a model will be built to predict the possibility of being an innovative or an entrepreneur depending on the environmental, personal, and educational performance traits.

1.8. Thesis Organization

Chapter 1 provides a brief overview of the educational system in the United Arab Emirates, the Private education as well as the public education in the country, and how they are contributing to innovation and entrepreneurship. Also, the chapter discusses Structural Equation Modelling and how to use it in education. The problem statement followed by the thesis proposal objective and research contribution, are discussed in this chapter. Chapter 2 sheds light on the traits used to identify innovation and entrepreneurship in a form of a literature review, it discusses the recent research traits, shortcomings of current practices and initiatives, research gap, and thesis objective. In chapter 3, Research methodology is introduced including questionnaire design, structural equation modeling, model fit statistics, and questionnaire data collection. Then after that, chapter 4 which is about findings, results, and discussion includes data pre-processing and preparation. And finally, chapter 5 talks about the conclusion and the future work.

Chapter 2. Traits Used to Identify Innovation and Entrepreneurship, a Literature Review

2.1. Recent Research and Trends

Regarding innovation and entrepreneurship, we found that there is a close relationship between innovation and entrepreneurship, intelligence, and gifted people. Therefore, we will summarize these publications and try to relate them to each other under the innovation and entrepreneurship umbrella.

As following the traits that may identify the innovation and entrepreneurship of the students from their early educational journey, the gifted students may be possible subjects for this study, based on Gang's (2009) differentiated model of Gifted and Talent, the components which are related to the gifted and talent can be divided into four different components [11]. These components are the Natural Abilities, Intrapersonal Catalyst, Environment Catalyst, and Development process. Starting with the natural abilities, these abilities can be divided into the Intellectual Abilities domain such as fluid reasoning and general intelligence, the Creative Abilities domain such as problem-solving and logical thinking, the Social Abilities domain, and the Perceptual Domain. On the other hand, an Intrapersonal Catalyst may include the awareness of the person, his self-management and self-regulation, motivation, autonomy, etc. however, the Environment Catalyst can be used as well, as it can be divided into the cultural factors, human factors, and sources factors. The importance of these domains is that they lay the foundations needed for the innovators and intrapreneurs to grow any society.

In Identification of Gifted Students in the United States Today publication, Mary-Catherine McClain and Steven Pfeiffer included the Creativity Domain, Intelligence Domain, and Achievement Domain under the Gifted Domains beside other domains, which as discussed previously, lay the foundations needed for innovation and entrepreneurship growth. They even went a little bit deeper in discussing the methods for assessment for identifying gifted students, these assessments vary from the behavior assessment, performance assessment, teacher rating scale, Nominations, Achievement assessment, and IQ assessment [12]. These methods of assessment can be used combined or separated to identify gifted

students. The assessment methods and the gifted domains can be used as well to examine the supportiveness of the environment surrounding these students and how this would help them to cultivate these abilities in the future to be entrepreneurs.

The Big Five Personality Traits are summarized with main five factors including 45 items that would help in identifying the innovative people as well as the entrepreneurs [14]. The first factor is the Conscientiousness factor which includes autonomy, order, accuracy, perseverance, and compliance. The second factor is Openness, which consists of intellectual openness, creative openness, and cultural openness. The third factor is Extraversion, which includes sociability, activity, enthusiasm, assertiveness, and self-confidence. The fourth factor is Agreeableness, whether it is prosocial agreeableness, degree of cooperation, and sensibility to others and their needs. Finally, the fifth factor is Emotional Instability, which describes the person in terms of anxiousness, depression, discontentedness, concentration, irritableness, manifest, and upset [18].

Dr. Sally Caird developed a test to measure the General Enterprising Tendency (GET) for persons [49]. It measures the different trait levels for entrepreneurs such as the need for achievement, the need for autonomy, the creativity tendency, the calculated risk-taking, and the internal locus of control. A publication named “Entrepreneurship Traits for Science, Engineering and Technology (SET) Students” was published in 2015 by Elma van der Lingen and Gerhard van Niekerk to measure the GET scores for the SET students to structure “technopreneurship” courses to deliver effective training objectives for the students who are doing their studies in Science, Engineering, and Technology [49]. The study showed that the SET students achieved GET scores higher than the average in each trait as shown in Table 2:

Table 2: Enterprising Tendency GET Scores for Engineering, Science, and Technology Bachelor students

Enterprising tendency	First degree	No	Maximum GET score	Average GET score	Actual mean score	Standard deviation
Total GET score	BEng	47	54	37	40.81	5.58
	BSc	28			38.36	5.42

	BTech	114			40.07	4.91
	Total	189			40.00	5.19
Need for achievement	BEng	47	12	9	9.83	1.75
	BSc	28			9.71	1.49
	BTech	114			10.07	1.36
	Total	189			9.96	1.48
Need for autonomy	BEng	47	6	4	3.74	1.36
	BSc	28			2.93	1.33
	BTech	114			3.14	1.32
	Total	189			3.26	1.35
Creative tendency	BEng	47	12	8	9.62	1.55
	BSc	28			8.71	2.07
	BTech	114			8.82	1.84
	Total	189			9.00	1.83
Calculated risk-taking	BEng	47	12	8	9.04	1.78
	BSc	28			8.50	1.50
	BTech	114			9.09	1.70
	Total	189			8.99	1.70
Internal locus of control	BEng	47	12	8	8.57	1.66
	BSc	28			8.50	1.97
	BTech	114			8.96	1.58
	Total	189			8.79	1.67

From Table 2, we can notice that in general, the SET students' scores are above the average. Regarding the Need for Achievement, the average score is 9, while the score for the SET students is 9.96 out of 12. Also, for the Creative Tendency, the SET students' score is 9 out of 12 which is above the average score which equals 8. For the calculated risk-taking, the SET students' average score is 8.99 out of 12 which is also above the general average of 8. The Internal Locus of Control is above the general average as well which is 8, the SET students scored 8.96 out of 12. On the other hand, the SET student scored less only in the trait of Need for Autonomy with an average score of 3.26 out of 6 with a general average of 4. Hence, we can notice that the SET students have the foundations to be entrepreneurs.

In 2020, a study of the effect of entrepreneurial education on entrepreneurial intentions. To be more precise, the study focused on the relationship between entrepreneurial psychological traits and entrepreneurial development [38]. The

traits included in the study were the need for achievement, the risk-taking propensity, and the internal locus of control as follows in Figure 4:

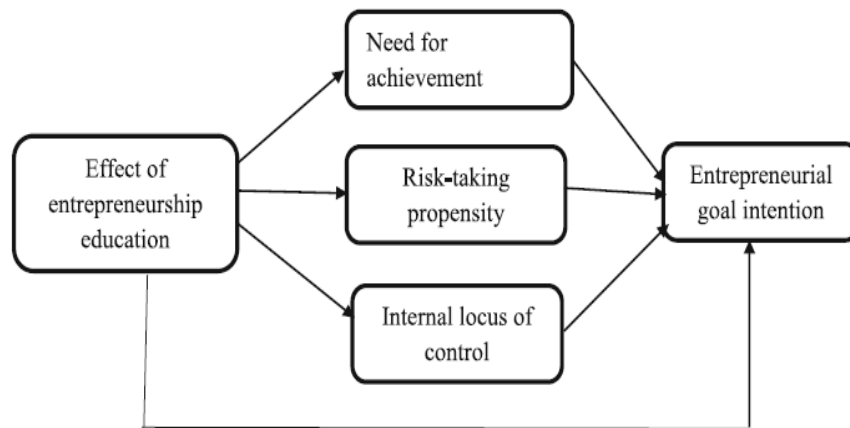


Figure 4: Entrepreneurial goal intention and entrepreneurial education effect

The study showed that the most important trait among the Need for Achievement, Risk-Taking Propensity, and Internal Locus of Control is the Need for Achievement trait. Hence, it is highly affected by entrepreneurship education [38].

In 2017, Sari Pekkala Kerr, William R. Kerr, and Tina Xu from Harvard Business school published a study named “Personality Traits of Entrepreneurs: A Review of Recent Literature” reviewing the entrepreneurial personality traits published in reviews since 2000. It includes the most famous Big Five model with its main elements, Self-Efficacy, Innovativeness, the need for achievement, and locus of control. The researchers propose that the most accurate study of entrepreneurs is the one that includes a study of a large sample of individuals with no predetermination of their personal traits, hence the study must accurately measure the tendency in these personal traits [28].

Starting with the Big Five Model, a good number of conducted studies took the managers as a reference point to measure the traits’ tendency. Hence, the studies show that the entrepreneurs are more open to accepting new experiences than managers, this can be explained as managers are selected due to their abilities in delivering the required high quality and less divergent results, on the other hand, entrepreneurs are more into providing creative and original solutions that are most of the time, different than the normal solutions and follow different practices which maybe sometimes more costly.

Moving to the second trait in the Big Five Model which is conscientiousness, comparing again the entrepreneurs with managers, the studies show that it is the most significant trait that differentiates between them. Managers and entrepreneurs are similar in dependability, yet the entrepreneurs score higher on the achievement side. This means that the entrepreneurs are more achievement-oriented than others, also they are more attracted to environments where success and development are more related to their achievements than other environments, where the success and failure of a certain company for example are more related to the success of the whole members' efforts and achievements rather than the single individual's efforts and achievements [28].

Regarding the third trait which is "Extraversion", the conducted study showed that some entrepreneurs are more extraversion than managers as they may act as promoters of their ideas, efforts, and achievements to the people around them such as colleagues, partners, and sponsors. On the other hand, other conducted studies showed that some other entrepreneurs are less extraversion as they tend to start their small businesses away from big organizations that demand people to be persistently sociable in these organizations [34].

Finally, for the agreeableness and neuroticism, entrepreneurs were found to be slightly less agreeable and neurotic than managers, which is due to two reasons, the first one is that entrepreneurs are more concerned about satisfying their own achievement needs than pleasing other people as managers do, and secondly, entrepreneurs are more likely to take the risk of starting their own business than relying on employers to achieve their financial needs besides the other needs.

Another crucial trait mentioned in the previous literature is the Locus of Control (LOC) whether it is internal or external. People who believe in an internal locus of control, highly consider their own decisions and actions as they control their achievements, hence their life. Conversely, people who believe in external locus of control, suppose that they do not control their own life, thus it is more controlled by chance, fate, or the surrounding environment. surrounding environment such as the economic status of the country and individual, education, social fabric, and social support encourages the culture of entrepreneurship. As in some countries such as UK, and USA, there is a high personal self-dependency, good educational

system, and supportive culture of entrepreneurship, people tend more to be self-employed by starting their own business. Then again, developing countries and third world countries suffer from underdeveloped educational systems, critical economic status and complicated social fabric with high family-supporting dependency tend to force people to look for being hired with a fixed and secured income, hence less entrepreneurship supporting culture. However, these hypotheses are still debatable as there are environmental effects, i.e., external factors, over the internal locus of control. to sum up, their studies showed that entrepreneurs have a higher internal locus of control than non-entrepreneurs who are more into the external locus of control. [35]

Another significant role is the Need for Achievement; thus, it is highly supported in the previous studies. Usually, entrepreneurs have a high appetite for achieving significant accomplishments such as starting their own business from scratch, coming up with a whole new applicable idea to solve certain obstacles, or even mastering a specific skill. They also prefer not to waste their efforts in big and complex organizations where their goals may be cast and not concentrated, also their efforts might be credited to others such as reporting managers or teams rather than themselves [37].

Following that, the study of entrepreneurial traits is very complex, and researchers need to be very careful in studying this topic. This recommendation comes from the diversity of the traits that affect the successfulness of entrepreneurship, this includes for all reasons related to personality, human capital, achievement, and environment, which are all sensitive and crucial to the following model which is the complex process model of entrepreneurship has been adopted by Frese (2009) and Brandstätter (2011) to highlight this complexity as shown in Figure 5 [28]:

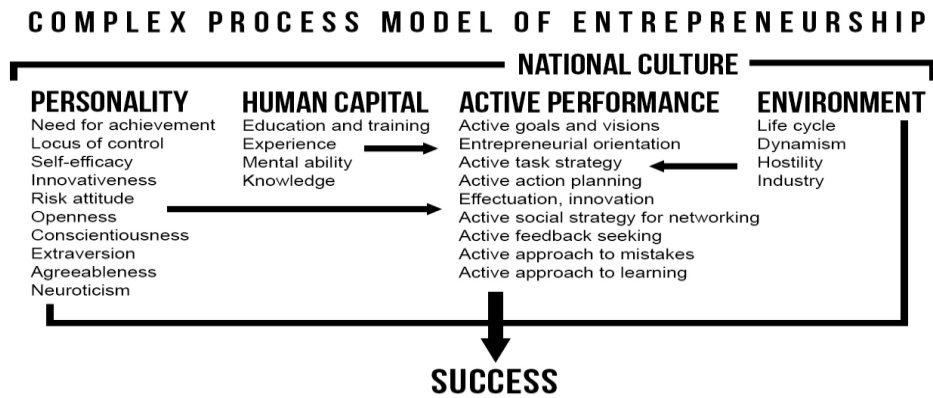


Figure 5: Entrepreneurship Complex Process Model [28]

Another study is focusing on two indices to identify the entrepreneurial traits, the first index is the Global Entrepreneurship Index which highlights fourteen different pillars divided into two main groups [54]. The first group is the Entrepreneurial Attitude which includes opportunity perception, startup skills, risk acceptance, networking, cultural support, opportunities for startup, technology absorption, human capital, and competition. These attitude traits are mostly related to the attitude of the participant who is a possible subject for innovation and entrepreneurship. The second group is the Entrepreneurial Aspirations. This category includes product innovation, process innovation, high growth, internationalization, and risk capital. Which mainly related to the products and processes related to innovation and entrepreneurship. These mentioned fourteen pillars are put together in one diagram to show how developed countries such as the United States, Canada, United Kingdom, Switzerland, and UAE perform in these pillars, hence we can notice that the developed countries which include the countries with the biggest economies and GDPs scored significantly high in these pillars. Nevertheless, it is worthy to mention that the United Arab Emirates landed in the 25th position out of 137. This position gives a good indicator of the entrepreneurial supporting system in the United Arab Emirates in comparison to the countries in the region surrounding the United Arab Emirates such as Oman, Bahrain, Saudi Arabia, Qatar, and Jordan. Figure 6 shows these related pillars in a simple and informative way:

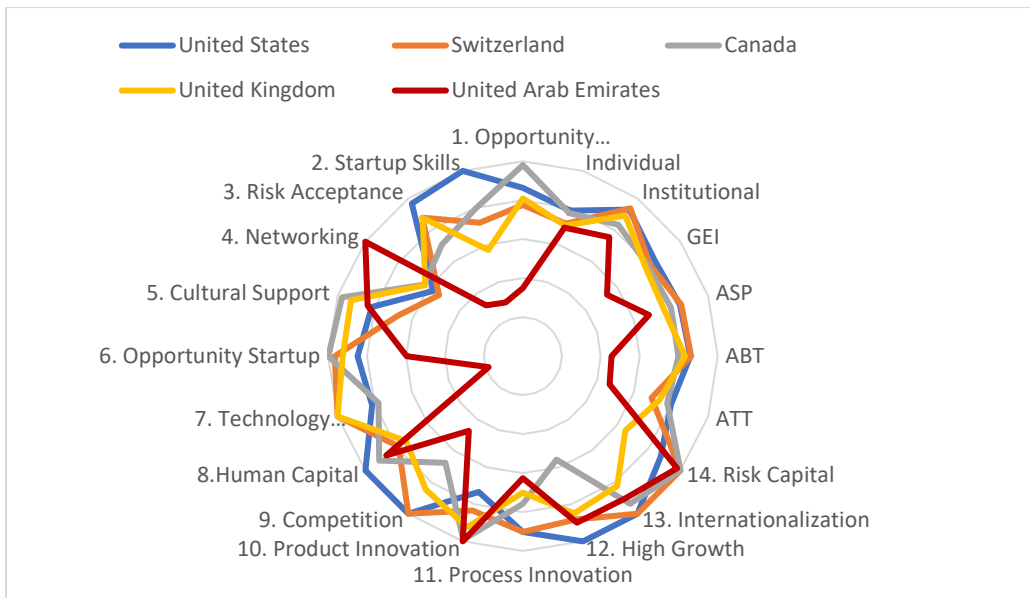


Figure 6: Global Entrepreneurship Index pillars - International [54]

Comparing these pillars domestically, Figure 7 shows how the United Arab Emirates performs compared with Qatar, Oman, and Bahrain.

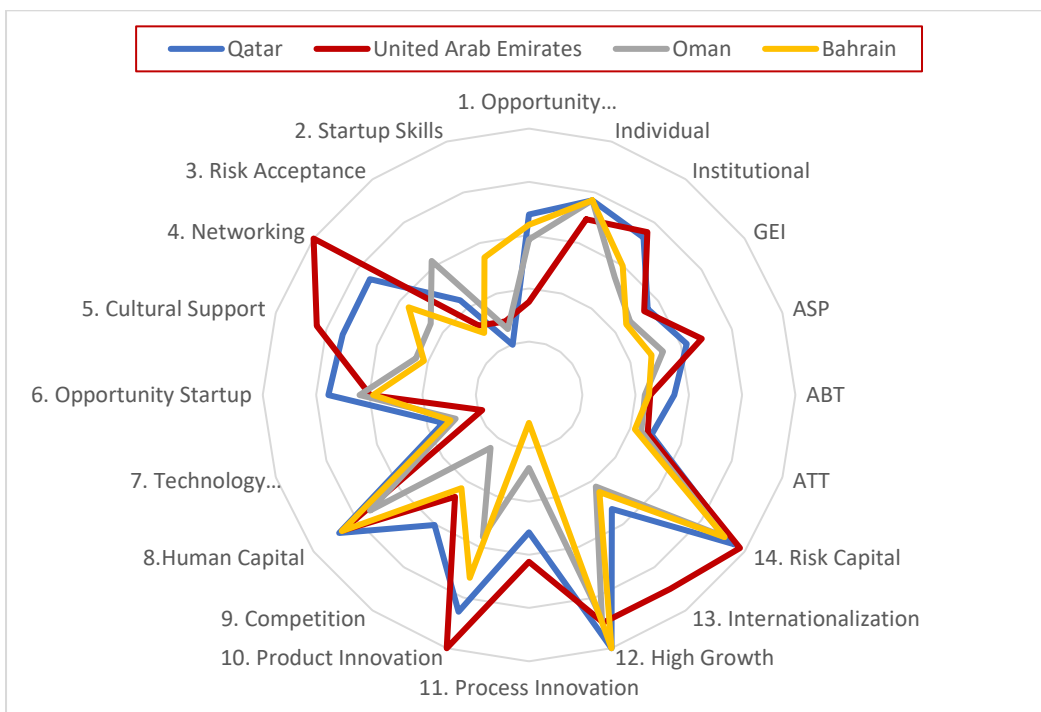


Figure 7: Global Entrepreneurship Index pillars - Arab Countries [54]

We can notice that UAE is performing well in the Product Innovation pillar and networking than other domestic countries which supports its Innovation and Entrepreneurship culture.

Daniel P. Smith from the University of North Carolina published “Characteristics of Innovative Entrepreneurs: An Analysis at the Level of the Individual, the Firm and the Business Environment” examining and characterizing the innovative entrepreneurs from different angles, individual wise, firm wise, and business environment wise. Hence, the focus will be on the discussed psychological traits [45]. Daniel also highlighted the preference for innovation, need for achievement, positively handling challenging situations, and higher risk-taking propensity. Daniel clearly states that entrepreneurs have a higher appetite for achievement and risk-taking propensity. Aside from those traits, entrepreneurs develop their skills with the help of situations that need high rational thinking and decision making.

A study has been carried out in 2016 named “Understanding Entrepreneurial Process and Performance: A Cross-National Comparison of Alumni Entrepreneurship Between MIT and Tsinghua University” to answer two main questions, who would become an entrepreneur, and how to compare their performance. The study has been carried out by studying graduate entrepreneurs from two universities, Tsinghua University in China, and MIT in the United States [24]. What is interesting in this study, is that emerging entrepreneurs who graduated from the engineering school in both universities (MIT and Tsinghua) are forming 51.28% and 69.72% respectively, of the total entrepreneurs with 16.04% and 25.75%, as founders. Going deeper reveals to us that the highest percentages go to the graduates of Electrical and Computer Engineering graduates, Civil and Environmental Engineering graduates, Mechanical Engineering graduates, and Chemical Engineering graduates. This encourages us to focus our study on these students to see the possibility of having entrepreneurs emerge from these specializations.

2.2. Shortcomings of Current Practices and Initiatives

Innovation and entrepreneurship field is a rich field, both developed and developing countries are working hard to support as the results may be very fruitful to any society, hence the studies which are carried out to identify the entrepreneurs depends on the psychological or personal factors, as well as the environmental factors in general. It is obvious that the publications and studies on this field try to

highlight the practices that the governments should follow to support the innovative people as well as the entrepreneurs.

To sum up, the main traits that have been considered in most of the recent studies in this field, we can divide the factors into three different main factors, the personal factors, the achievement factors, and the environmental factors. For the personal factors, most of the studies try to benefit from the Big Five Model which includes the five main traits as Conscientiousness, Extraversion, Agreeableness, Openness, and Neuroticism, as well as the Entrepreneurial Characteristics, many scholars use the Big Five Model to try to identify innovative people and entrepreneurs based on their psychological status, which is by fact can be obtained by any individual by practicing and learning from either their personal experiences or by others experience. For example, in the conscientious personal trait, people who are wasteful, careless, imprecise, aimless, and disordered, maybe not possible subjects for being entrepreneurs, however, if it can be managed to rectify these behaviors in a way from an early age for them to be more economical, careful, precise, ambitious, hardworking, and ordered, they can be possible subjects to be innovative and entrepreneurs. The same goes for the rest of the four remaining traits. Bypassing the second main factor, “Performance”, which will be discussed later, the main third factor discusses the environment that supports innovative people and entrepreneurs. The environment factor is divided into two main groups which are entrepreneurial attitudes and entrepreneurial aspirations. The entrepreneurial attitude in society includes many different traits such as opportunity perception, startup skills, risk acceptance, networking, cultural support, opportunity startup, technology absorption, human capital, and competition. These traits are consequently discussed in many articles to support governments or organizations to set their goals to meet or to enhance these traits internally, which may support the entrepreneurial practices in general. The second category is entrepreneurial aspirations, which include the product innovation trait, process innovation trait, high growth, internationalization, and risk capital. These traits and factors can support innovative people and entrepreneurs in societies and organizations if they were found and developed properly. Internationally, scholars and researchers try to investigate if the different environments in different

countries are supporting innovation and entrepreneurship, one of the main indexes is the global entrepreneurship index, which measures fourteen different pillars to identify the tendency of a country's innovation and intrapreneurship support.

Table 3 sums up the main innovation and entrepreneurship factors as per the discussed studies.

Table 3: Entrepreneurship Main Factors and Traits

Factor	Main Traits	Measurement
Personal	Conscientiousness	Personal Interviews / GET Examination
	Extraversion	
	Agreeableness	
	Openness	
	Neuroticism	
	Entrepreneurial characteristics	
Performance	intellectual	Academic Performance
	creative	
Environment	Entrepreneurial attitudes	Global Entrepreneurship Index
	Entrepreneurial aspirations	

Going back to the second main factor which is the performance factor, which is concerned with intellectuality and creativeness, the main associated traits in intellectuality, are discussed earlier such as general intelligence, fluid reasoning, crystallized reasoning, verbal memory, numerical memory, special memory, and procedural trait. For creativeness, the performance factor is concerned with the problem-solving ability and the logical thinking ability. These traits can be easily measured in the case of following the academic achievement of the students in both general education and higher education.

Hence, in the field of innovation and entrepreneurship, there is no solid study that links the students' performance in different subjects such as mathematics, physics, and chemistry with innovation and entrepreneurship traits. people usually start gaining their knowledge and skills from an early age, by taking different subjects such as mathematics from grade one and they start building on it the other subjects such as physics, chemistry, etc., the academic performance of a person is measured based on the examinations scores in the school and other measurement criteria.

these records are saved and stored with no extensive use of them towards identifying gifted and talented students, which as discussed previously have a strong bond with innovation and entrepreneurship possibility. When the student moves toward secondary school, he/she takes different topics and subjects that are very related to the personal factor. As an example, in the United Arab Emirates, Great ten students choose to take from different streams such as the elite stream, applied stream, and advanced stream. in the elite stream, some subjects such as biology, mathematics, physics, computer science, and chemistry can be used to measure different personal and performance traits. also, in grade 11 students who are taking their latest stream take biology, creative design and innovation, calculus, physics, and chemistry. in grade 12 the advanced stream students take subjects related to innovation and entrepreneurship such as creative design and innovation, mathematics, calculus-based physics, and chemistry. Hence, linking innovation and entrepreneurship to the educational journey has not been highlighted from that angle, which is studying the relationship between academic performance and the possibility of having innovators and entrepreneurs in society. Using the actual grades of the students in the previously proposed subjects in both higher education and general education to predict the evolving possibility of entrepreneurs and innovators is an interesting field of study. It can be used to predetermine and equip the possible students with the needed skills to be innovative or to become future entrepreneurs.

From the above studies, it is clear that there are major shortcomings in the identification of innovators and entrepreneurs. The innovation and entrepreneurship fields are evolving progressively, yet still suffering from a solid identification system that can be followed. It is noticeable that the studies are focusing on the environmental factors that affect innovation and entrepreneurship as well as the personal or the psychological factors. Hence, no major studies have been carried out on students' academic achievement who are in general education or higher education for the sake of early identification of these students as well as developing their entrepreneurial abilities and skills. These shortcomings will be discussed in the following section.

2.3. Research Gap and Thesis Objectives

From an extensive literature review (in sections 2.1 and 2.2) it is shown that most of the studies address the personal, achievement, and environmental factors and traits for innovation and entrepreneurship. Yet, no major studies have been carried out to measure the relationship between these three factors dependently and independently in one society, and how they are affecting the innovation and entrepreneurship tendency of related individuals. The innovation and entrepreneurship traits relationship study is important as it gives an idea about possible students as well as possible subjects to target in our study. There is a noticeable gap between the theoretical frameworks behind the evolving entrepreneurs and their actual academic performance. Hence, it is important to link innovation and entrepreneurship, with the academic performance of the students in both general and higher education in the United Arab Emirates. This link must be established based on the real and tangible performance achievements of the students. Then it can be improved by using the available data and the data analysis and machine learning algorithms.

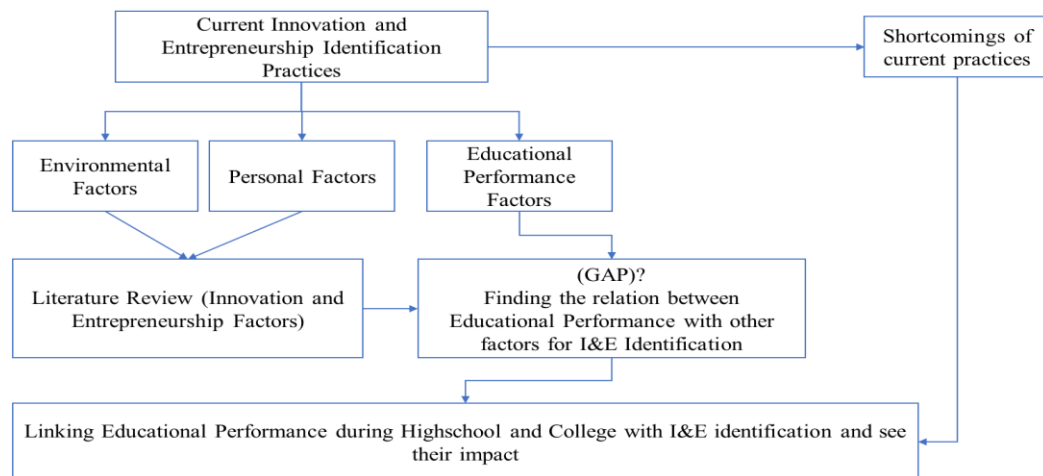


Figure 8: Research Gap Flow Chart

The flowchart in Figure 8 shows that the carried studies on entrepreneurship factors and traits have been done based on either the personal traits or environmental traits, yet, to have these studies more beneficial, we must consider the nature of developing those skills from an early age during high schools and college, where students are less affected by the environmental traits. Also, their personal traits can be crafted and shaped more easily at an early age during their academic life in high

school and university. Hence, more attention must be paid to the students' performance in innovation and entrepreneurship-related subjects with the help of data.

Chapter 3. Research Methodology

The proposed solution is to integrate the personal performance factor into the two other factors which are the personal/psychological factor and the environment factor. Students are the most important capital of any country; thus, more attention must be paid to them during their academic life in both general education and higher education. Hence, as discussed in section 2.3, the student's performance will be used to develop an index for the entrepreneurial traits to support both the personal/psychological factors as well as the environmental factors. Data science will be very handy as it will use the collected data of the individuals in the United Arab Emirates. This will allow the interested stakeholders to enhance potential innovative and entrepreneurs' traits.

Our research aim is to develop an index that incorporates the students' performance factors in innovation and entrepreneurship-related subjects into one instrument besides the environmental and personal traits to improve the early discovery and follow up with the possible innovative and entrepreneurs. The research approach will follow the "Research Onion" model published by Saunders in 2007. Hence, the followed philosophy will be pragmatic as it will be a matching combination of interpretivism and positivism. However, the research will follow an inductive research approach to validate the results. The study will start with initial qualitative and quantitative methods which will be used as a survey. Also, a questionnaire will be created based on the literature review and through interviews with experts in the field of innovation and entrepreneurship in both structured and semi-structured interviews. This will help us to have an idea about their opinion regarding the related subjects in general and high education in innovation and entrepreneurship. Finally, SEM analysis will be conducted on the results of the surveys to create the innovation and entrepreneurship tendency index based on the three main factors mentioned earlier.

To achieve the research objectives, adopting a structured research methodology approach is a must. A high-level flow chart is shown below to demonstrate the main steps needed to fulfill the objective of the study represented in Figure 9.

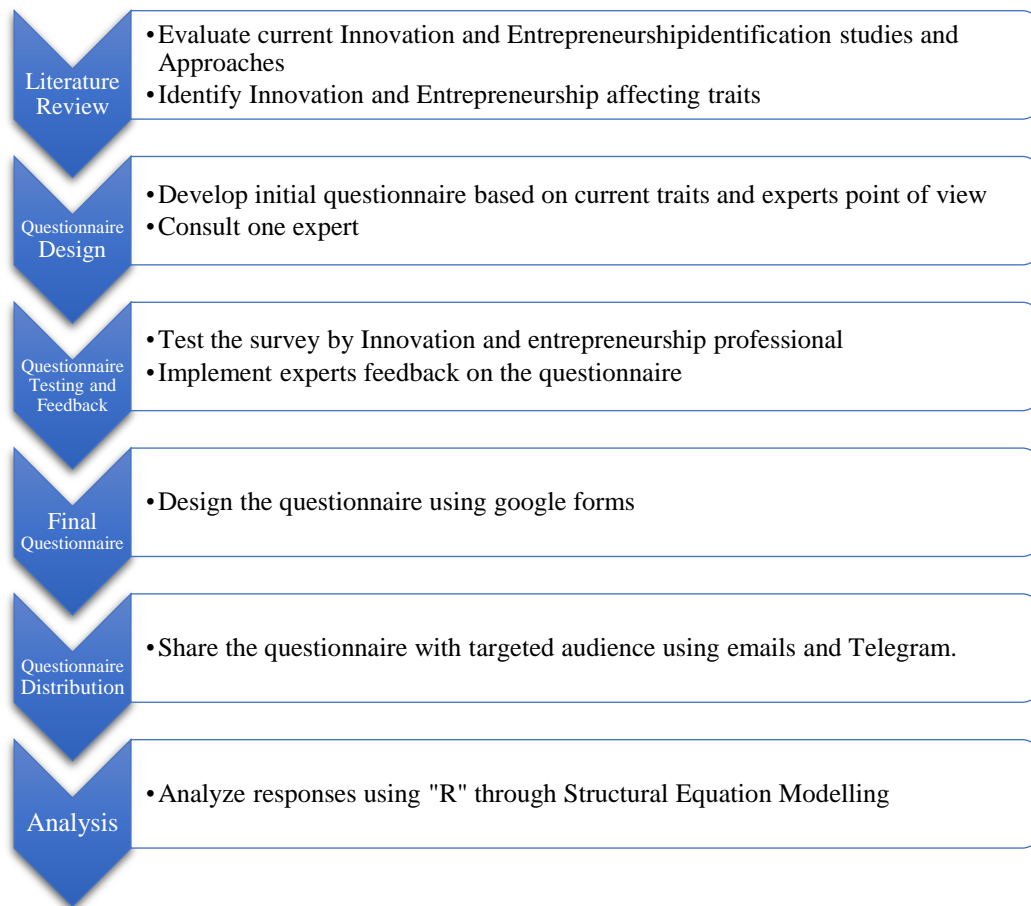


Figure 9: Research Methodology Flow Chart

Based on the previous literature review related to innovation and entrepreneurship factors, as well as the subject matter experts' input, the main three factors have been identified. Also, to understand how individuals relate to the main innovation and entrepreneurship traits a questionnaire has been designed, formulated, and distributed to collect the required responses and data. The questionnaire used is a digital questionnaire built using Microsoft Office Forms. It is also important to mention that this research has been conducted in a non-interventional procedure. Besides that, approval to the questionnaire was sought by subject matter experts who are aware of the traits of innovation and entrepreneurship. Alongside, the participants in this questionnaire, who participated anonymously were from the pool of individuals with the desired relative traits of innovation and entrepreneurship. Finally, collected responses and data were later analyzed using R studio software, more precisely, R language through Structural Equation Modelling.

3.1. Questionnaire Design

The Questionnaire consists of five sections: General Information, Environmental Indicators, Personal Indicators, Performance Indicators, and Last Section which is about the outcome of the whole questionnaire. Each section of these five sections consists of questions related to a certain trait and factor with a total number of 59 Questions, which are closely related to measuring the innovation and entrepreneurship tendency of individuals.

Starting with the first section, the General Information Section consists of 6 questions related to the respondent's educational information such as year of studying, major of studying, study funding, and studying curricula. Also, it includes questions related to gender and ethnicity. The second section includes 18 questions related to the environmental traits such as, but not limited to the economic status of the country, quality of provided service, industrial standing of the country, and adoption and encouragement for innovation and entrepreneurship. The third section is about the personal traits of the respondent, this section includes 20 questions related to the personal preferences related to innovation and entrepreneurship such as the adoption of new technology, tendency to pursue goals, and the possibility of starting new businesses. The fourth section records the educational performance of the respondents in specific STEM subjects such as computer science, mathematics, physics, creative design, and innovation, and participation in science fairs with a total number of 11 questions in both general and higher education. The fifth section is the final section where we measure the resulting innovation and entrepreneurship traits for respondents by an overall 4 questions related to the number of owned projects based on innovation, the number of participations to introduce new ideas and solutions, and finally the number of applied proposed ideas and solutions. Figure 10, demonstrates the questions and the related traits:

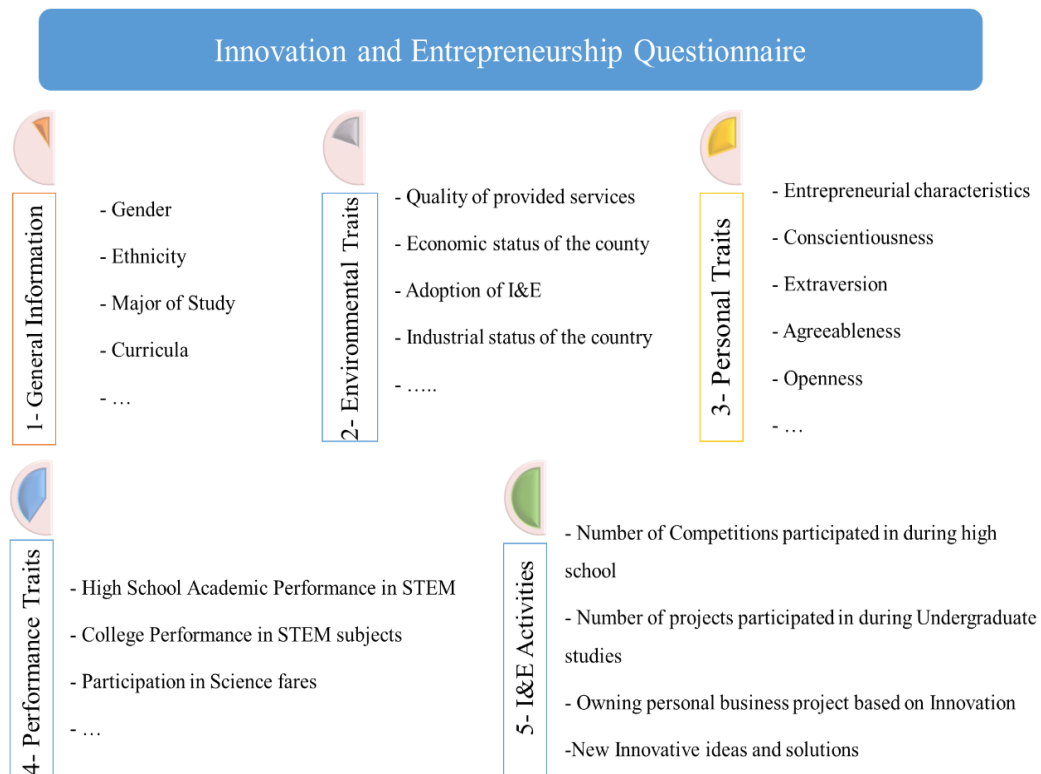


Figure 10: Questions and Related Traits to Innovation and Entrepreneurship

A first draft, as well as the included traits and related questions, were reviewed by an innovation and entrepreneurship expert. Then, the received feedback included deletion of certain questions included some redundancy, repetition, and insignificant details to the topic. Then after that, the questionnaire was distributed using two different channels:

- 1- Official invitation by email to participate in the questionnaire by different universities.
- 2- Social media channels to random participants in the country.

The collected responses and the distribution of the questionnaire was online and with no direct contact with the participants. Also the questionnaire didn't include any sensitive personal information questions, and responses have been collected anonymously as recommended by the participating experts' feedback on the questionnaire design and development.

3.2. Structural Equation Modelling – SEM

As mentioned previously in chapter 1, section 2, part 1, the Structural Equation Modelling will be used due to its advantages over other analysis methods. SEM will depend on applying different analytical approaches such as but not limited to regression analysis, and confirmatory factor analysis. The following diagram,

Figure 11 illustrates the SEM framework including both the structural model and measurement model.

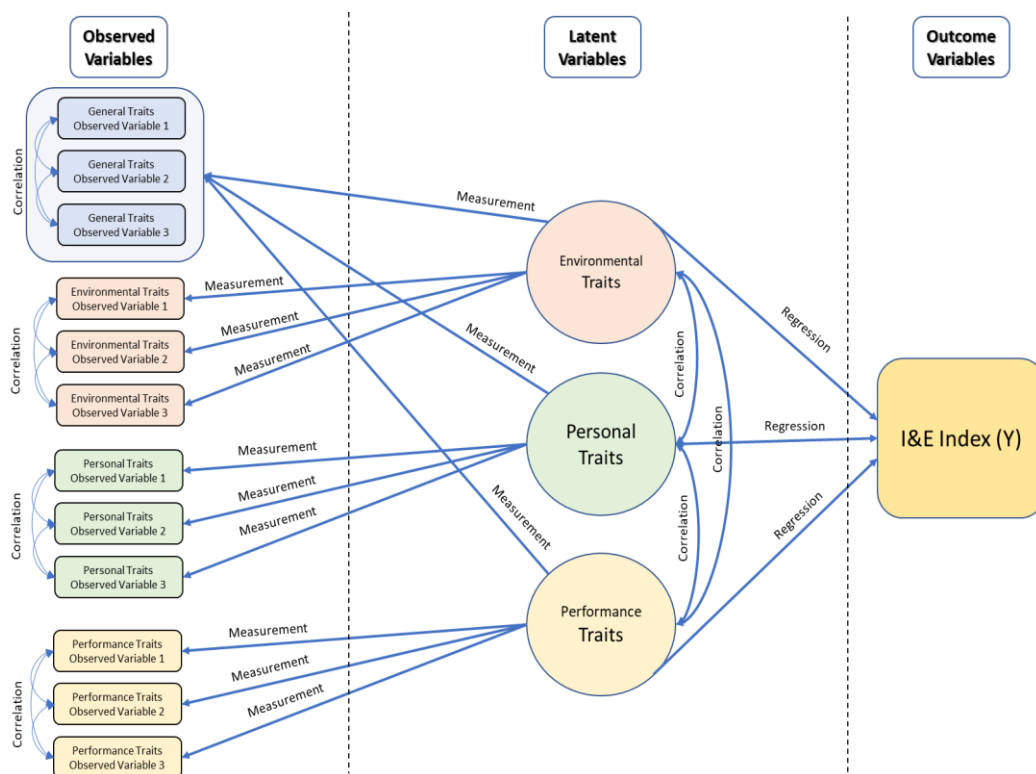


Figure 11: The SEM framework including Structural Model and Measurement Model

To explain more, the first section of

Figure 11 on the left is related to the observed variables represented by squares, which represent the questions in the questionnaire related to all measured traits, the General traits, the environmental traits, the personal traits, and finally the educational performance traits. The second section represents the latent variables also known as hidden or unobserved variables. the third section represents the

outcome variable that we are trying to measure which is the innovation and entrepreneurship index. The one-headed arrows from left to right, i.e., from the Latent Variables to the Outcome Variable arrows refer to the regression effect between the different variables, on the other hand, the one-headed arrows from right to left, i.e., from the Observed Variables to the Latent Variables refer to the loadings or measurements between the different variables. Lastly, the double-headed arrows represent the correlation or the variances between two variables. To explain more, when the double-headed arrow is drawn from one variable to itself, we measure the variance, while when the double-headed arrow is drawn from one variable to another different one, we measure the covariance or the correlation between these two variables. This diagram will be used later to represent the SEM model over our collected data to try to simplify our complex model. It is worthy to mention that the latent variable holds no initial measurement or data, in the mentioned case, the general, environmental, personal, and performance latent variables are suggested themes to the included observed variables with no initial data or measurement. The SEM model will then try to relate all measured variables (observed variables) with the latent variables and finally the outcome variable which is the innovation and entrepreneurship index by presenting a numerical value that represents the covariance between the different factors.

3.2.1. Model fit statistics

3.2.1.1. Statistical significance

As this study is examining the causal effect between the different traits mentioned earlier, the relation must be sought in the analysis. Hence, the statistical value that will be examined is the P-Value. To explain more, the higher the P-Value obtained indicated the lower correlation between the examined factors, and the lower value obtained refers to more correlation between the examined factors. The Null Hypothesis states that in case of no relationship between the studied variables, then the Null Hypothesis applies, alternatively, in case of any relation or correlation between the studied variables, then the Null Hypothesis is rejected. Hence, the correlation between the examined factors is sought with a P-Value closer to 0.00.

3.2.1.2. Goodness-of-fit indices:

Usually, the developed user model is examined against a baseline model that accepts variance, yet no correlation is accepted or desired. Therefore, during examining the developed user model against the baseline model, a higher correlation score is sought to monitor the improvement of the developed model. Such differences can be measured using indices such as Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI), which usually hold values between 0% and 100%. Meanwhile, these fit indices will examine the model by comparing it to the baseline model through the chi-square values and the degree of freedom.

However, if the developed user model is not desired to be compared to a baseline model, yet desired to be compared to the collected data, Chi-Square – Degree of freedom is calculated, which is a non-centrally parameter used to record the level of disagreement between the factors. The equation which can be used is the Root Mean Square Error of Approximation (RMSEA) is represented in Equation No. 1:

$$RMSEA = \sqrt{\frac{X^2 - df}{df(N - 1)}}, (N: Sample Size) \dots \dots \dots (1)$$

In the RMSEA formula, X^2 represents the Model Chi-Square, df represents the Degree of Freedom, and N represents the Sample Size.

3.3. Questionnaire Data Collection

The questionnaire data were exported from Microsoft Office Forms into a CSV file with rows representing the questions and rows representing the participants' responses. The questions are a combination of scaled questions from 1 to 5, as well as other questions with multiple choices and finally questions with yes or no answers and numeric answers. The data then, has been analyzed and processed using the R language in RStudio to obtain the results and findings.

Chapter 4. Findings, Results, and Discussion

This chapter presents the steps that have been taken to prepare the collected data for analysis and processing. This includes the data pre-processing steps, questionnaire results after pre-processing in each section, the interpretation with the SEM model, building of the structural equation model using R Language, evaluation of the SEM model, and finally the model estimate parameters

4.1. Data Pre-processing and Preparation

4.1.1. Data pre-processing steps:

A total number of 513 responses have been collected from different individuals who are currently enrolled in higher education or graduated. After the collection of the data, the following steps have been conducted to prepare the data to be then processed:

1- Grouping:

- a. The responses for Section1 question 1 (S1Q1) related to the major of study have been grouped into 5 categories instead of 21 categories to reduce dimensionality. The new groups are named Business, Engineering, Humanities, Medical, and Sciences, and assigned as a factor.
- b. The responses for Section 1 Question 2 (S1Q2) related to year of study have been grouped into two groups instead of six, to be Undergraduate (UG) and Graduate (GR), and assigned as a factor.
- c. The responses for Section 1 Question 4 (S1Q4) related to Ethnicity have been grouped into two groups instead of eight, to be Arab and Non-Arab.
- d. The responses for Section 1 Question 6 (S1Q6) related to studying curricula have been grouped into three groups instead of nine, to be American Curriculum, British Curriculum, and MoE/UAE Curriculum, and assigned as a factor.

2- Normalization

Normaized Value

$$= \frac{\text{Observed Value} - \text{Minimum Value}}{\text{Maximum Value} - \text{Minimum Value}} \dots \dots \dots (2)$$

- a. The responses for Section 5 Question 1 (S5Q1) related to the number of high school projects participations with numeric responses varied from 0 to 8 have been normalized.
- b. The responses for Section 5 Question 1 (S5Q2) related to the number of undergraduate projects participations with numeric responses varied from 0 to 6 have been normalized.

3- Converting to binary

- a. The responses for Section 5 Question 3 (S5Q3) related to owning a personal project based on innovation with responses as “YES” and “NO” have been changed to be “1” if “YES” and “0” if “No” and assigned as numeric.
- b. The responses for Section 5 Question 4 (S5Q4) related to adopted innovative ideas with responses as “YES” and “NO” have been changed to be “1” if “YES” and “0” if “No” and assigned as numeric.

4- Assigning Wights to the output “Y”

- a. Weights have been given to the questions in section 5 based on impact after graduation on innovation and entrepreneurship tendency index. Question 1 and question 2 (S5Q1, S5Q2) have been assigned a value of 10 each with a total maximum value of 20, and Question 3 and question 4 (S5Q3, S5Q4) have been assigned a value of 40 each with a total maximum value of 80 as follows:

$$Y = (10 \times S5Q1) + (10 \times S5Q2) + (40 \times S5Q3) + (40 \times S5Q4) \quad (3)$$

- b. To elaborate more, the following questions have been introduced in the questionnaire in section 5:
- c. How many Competitions Have you participated in during your High School to showcase your business ideas?
- d. How many projects Have you participated in during your Undergraduate studies to showcase your business ideas?
- e. Do you have currently a personal business project based on Innovation?

- f. During the past couple of years, have you come up with new innovative ideas and solutions that have been adopted by management, companies, accelerators, or incubators?

The first two questions are meant to measure the person’s participation in competitions and projects related to business ideas during the general and higher education journey. However, as the person moves from the educational environment to the business environment with all its different challenges, his/her ability to stay productive as an innovator and entrepreneur is the closest and strongest indicator to the Innovation and Entrepreneurship Index according to the I&E experts. Hence, such an indicator is measured by observing the state of owning or participating in an I&E-based business, and by observing the participation with new innovative ideas and solutions to the I&E-based business community. Therefore, the 40% weight has been given to the responses to the third and fourth questions, while the 10% weight has been given to the first and second questions in section five.

4.1.2. Questionnaire results after pre-processing

4.1.2.1. Section 1 – general traits

In this section, the questions provided were about building a profile for the respondent, more to know the background of the respondent, and the education exposure, Table 4 contains the provided questions:

Table 4: General Traits Questions

Section	Question identifier	Question Text
Section 1	S1Q1	Major of study
Section 1	S1Q2	Studying year
Section 1	S1Q3	Gender
Section 1	S1Q4	Ethnicity
Section 1	S1Q5	Studying Funding
Section 1	S1Q6	General Education Studying Curriculum

From the questions in Table 4, follows the summary of the collected and pre-processed responses represented in Table 5:

Table 5: General Traits Responses Analysis

NO	QUESTION	STATS / VALUES	FREQS (% OF VALID)	GRAPH
1	Major of study	1. Business 2. Engineering 3. Humanities 4. Medical 5. Sciences	38 (7.4%) 155 (30.2%) 177 (34.5%) 111 (21.6%) 32 (6.2%)	
2	Studying year	1. GR 2. UG	209 (40.7%) 304 (59.3%)	
3	Gender	1. Female 2. Male	313 (61.0%) 200 (39.0%)	
4	Ethnicity	1. Arab 2. Non-Arab	351 (68.4%) 162 (31.6%)	
5	Studying Funding	1. Full Scholarship 2. Full Self/Family Funded 3. Partial Scholarship	65 (12.7%) 174 (33.9%) 274 (53.4%)	
6	General Education Studying Curriculum	1. American Curriculum 2. British curriculum 3. MoE/UAE curriculum	95 (18.5%) 190 (37.0%) 228 (44.4%)	

From Table 5, it is obvious that for the major of study, most respondents are from Humanities and Engineering educational backgrounds with 34.5% and 30.2% respectively, followed by respondents with Medical educational background with a percentage of 21.6%. However, the lowest participation was from respondents with Sciences and Business educational backgrounds with percentages of 7.4% and 6.2% respectively. On the other hand, 59.3% of the participants are Undergraduates, while the rest 40.7% are Graduate students. We can notice that most of the respondents are females with a percentage of 61.0% and the remaining

39.0% are males. Also, when it comes to ethnicity, 68.4% are Arab participants and the remaining 31.6% are non-Arab. When it comes to educational funding, most of the participants were granted partial scholarships with 53.4%, followed by Full Self/Family Funded and finally Full scholarship funding with the lowest percentage of 12.7%. finally, 44.4% of participants studied the MoE/UAE curricula, 37.0% studied British curricula and only 18.5% studied American curricula.

4.1.2.2. Section 2 – environmental traits

In this section, the questions provided were about measuring how the environment in the UAE supports innovation and entrepreneurship, as well as the general idea in the community regarding the laws and legislations in supporting innovation and entrepreneurship. As mentioned earlier in the literature review, the environment, the governmental laws, and legislation coupled with the academic directions, and provided infrastructure, all together play an important role in supporting innovation and entrepreneurship in the community. The following questions related to the environmental traits are tailored from the intensive literature review to best measure the respondent’s point of view regarding how well the environment in the United Arab Emirates, is an effective way. Table 6 contains the related questions:

Table 6: Environmental Traits Questions











Question identifier	Question Text
S2Q1	The UAE provides high quality main services such as Education, Health, and Social Security.
S2Q2	The Educational System (General and Higher Education) in the UAE Satisfies the current global needs.
S2Q3	The Higher Education Institutes offers a huge variety of majors in comparison with other countries
S2Q4	The Educational Institutes offer Professional Development for the students during their study and/or after they graduate based on the current needs
S2Q5	"The Economical and Industrial Environment in the UAE is efficient





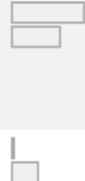


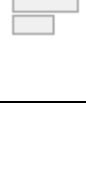
S2Q6	The Economical and Industrial Environment in the UAE is competitive
S2Q7	The UAE adopts new technologies to help in its development
S2Q8	The UAE encourages the students to come up with new Innovative ideas
S2Q9	The Educational Institutes encourages their students to start their own business during/after their graduation
S2Q10	The Educational Institutes encourages the students to turn their Graduation projects to business
S2Q11	The Educational Institutes offers seminars/courses/lectures related to innovation and entrepreneurship
S2Q12	"There are business incubators and accelerators in my Educational Institute
S2Q13	The Governmental Regulations encourages the students to launch their own start-ups
S2Q14	"The Educational Institutes and/or the government entities in the UAE adopts the students who come up with new ideas.
S2Q15	The market in the UAE is challenging
S2Q16	The market in the UAE is sophisticated
S2Q17	The market in the UAE is industrial more than consumer market

From the questions above, follows the summary of the collected and pre-processed responses are represented in Table 7:

Table 7: Environmental Traits Responses Analysis

NO	VARIABLE	STATS / VALUES	FREQS (% OF VALID)	GRAPH
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7	S2Q1	Mean (sd) : 4.2 (0.8) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	1 : 1 (0.2%) 2 : 19 (3.7%) 3 : 73 (14.2%) 4 : 204 (39.8%) 5 : 216 (42.1%)	
8	S2Q2	Mean (sd) : 3.9 (0.7) min ≤ med ≤ max: 2 ≤ 4 ≤ 5 IQR (CV) : 0 (0.2)	2 : 8 (1.6%) 3 : 116 (22.6%) 4 : 290 (56.5%) 5 : 99 (19.3%)	
9	S2Q3	Mean (sd) : 4.1 (0.8) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	1 : 1 (0.2%) 2 : 19 (3.7%) 3 : 106 (20.7%) 4 : 212 (41.3%) 5 : 175 (34.1%)	
10	S2Q4	Mean (sd) : 4.2 (0.7) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	1 : 1 (0.2%) 2 : 7 (1.4%) 3 : 63 (12.3%) 4 : 278 (54.2%) 5 : 164 (32.0%)	
11	S2Q5	Mean (sd) : 4.1 (0.8) min ≤ med ≤ max: 2 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	2 : 12 (2.3%) 3 : 96 (18.7%) 4 : 238 (46.4%) 5 : 167 (32.6%)	
12	S2Q6	Mean (sd) : 4 (0.8) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 2 (0.2)	1 : 1 (0.2%) 2 : 18 (3.5%) 3 : 110 (21.4%) 4 : 213 (41.5%) 5 : 171 (33.3%)	
13	S2Q7	Mean (sd) : 4.2 (0.7) min ≤ med ≤ max: 2 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	2 : 9 (1.8%) 3 : 74 (14.4%) 4 : 256 (49.9%) 5 : 174 (33.9%)	
14	S2Q8	Mean (sd) : 4.1 (0.8) min ≤ med ≤ max: 2 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	2 : 12 (2.3%) 3 : 101 (19.7%) 4 : 242 (47.2%) 5 : 158 (30.8%)	
15	S2Q9	Mean (sd) : 4 (0.8) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 2 (0.2)	1 : 1 (0.2%) 2 : 15 (2.9%) 3 : 114 (22.2%) 4 : 223 (43.5%) 5 : 160 (31.2%)	
16	S2Q10	Mean (sd) : 4.1 (0.8) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	1 : 1 (0.2%) 2 : 8 (1.6%) 3 : 85 (16.6%) 4 : 240 (46.8%) 5 : 179 (34.9%)	

17	S2Q11	Mean (sd) : 4.1 (0.8) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	1 : 4 (0.8%) 2 : 10 (1.9%) 3 : 95 (18.5%) 4 : 235 (45.8%) 5 : 169 (32.9%)	
18	S2Q12	Mean (sd) : 4 (0.8) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	1 : 2 (0.4%) 2 : 15 (2.9%) 3 : 109 (21.2%) 4 : 234 (45.6%) 5 : 153 (29.8%)	
19	S2Q13	Mean (sd) : 4.1 (0.8) min ≤ med ≤ max: 2 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	2 : 13 (2.5%) 3 : 100 (19.5%) 4 : 242 (47.2%) 5 : 158 (30.8%)	
20	S2Q14	Mean (sd) : 4.1 (0.7) min ≤ med ≤ max: 2 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	2 : 12 (2.3%) 3 : 85 (16.6%) 4 : 257 (50.1%) 5 : 159 (31.0%)	
21	S2Q15	Mean (sd) : 4.1 (0.8) min ≤ med ≤ max: 2 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	2 : 10 (1.9%) 3 : 88 (17.2%) 4 : 247 (48.1%) 5 : 168 (32.7%)	
22	S2Q16	Mean (sd) : 4.1 (0.7) min ≤ med ≤ max: 2 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	2 : 7 (1.4%) 3 : 93 (18.1%) 4 : 249 (48.5%) 5 : 164 (32.0%)	
23	S2Q17	Mean (sd) : 3.2 (1.2) min ≤ med ≤ max: 1 ≤ 3 ≤ 5 IQR (CV) : 2 (0.4)	1 : 24 (4.7%) 2 : 164 (32.0%) 3 : 92 (17.9%) 4 : 165 (32.2%) 5 : 68 (13.3%)	
24	S2Q18	Mean (sd) : 3.9 (0.9) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 2 (0.2)	1 : 8 (1.6%) 2 : 37 (7.2%) 3 : 104 (20.3%) 4 : 223 (43.5%) 5 : 141 (27.5%)	

As the questions in this section are formed to measure the respondents' point of view about different environmental aspects closely related to innovation and entrepreneurship catalysts in the United Arab Emirates, the responses for all questions in this section have a normal forward scale from "1" to "5", where "1"

represents “totally disagree” with the lowest scoring point, and “5” represents “totally agree” with the highest score.

From Table 7, it is obvious that the responses to most of the questions carried almost the same nature. More precisely, questions “1” to “16” and “18” in this section, are numbered as “7” to “22” and “24”, respectively. For these questions, respondents chose mostly score No. 4 out of 5 with a mean value around “4.1” and a standard deviation score of “0.7” which indicates that respondents believe that the environmental catalysts are positive in the UAE, including technology adoption, students’ stimulation in education towards innovation and entrepreneurship, availability of incubators and accelerators, government regulations, and the existence of challenging and sophisticated market in UAE. However, respondents showed that they have different points of view when it came to the existence of an industrial over-consuming environment in the UAE, which is represented in question “17” in this section, numbered as “23”. With a closer look at the responses, 24 responses scored “1”, 164 responses scored “2”, 92 responses scored “3”, 165 responses scored “4”, and 68 responses scored “5”, with a mean equal to a lower 3.2 value and a comparably high standard deviation equals to 1.2. this means that respondents have different opinions regarding whether the environment in UAE is industrial or consuming.

4.1.2.3. Section 3 – personal traits

In this section, as personality affects the tendency of innovation and entrepreneurship as per the literature review, the questions provided were about collecting more information about the respondents’ personality, more precisely, the main traits considered in the General Enterprise Tendency Test which is related as well to innovation. The main traits targeted in this section are:

- Conscientiousness
- Extraversion
- Agreeableness
- Openness
- Neuroticism
- Entrepreneurial characteristics

Table 8 contains the related questions:






Table 8: Personal Traits Questions










Question identifier	Question Text
S3Q1	I prefer challenging work environment more than unchallenging one
S3Q2	I like to adopt new ideas and theories, test them, and see the results more than the used methodologies at work
S3Q3	I think successful people take challenges and risks more than others
S3Q4	I have a dream wish to achieve
S3Q5	I can't leave an unsolved problem and move to new problem before solving the first one
S3Q6	I prefer to have a high-level idea before working on specific tasks
S3Q7	I prefer to take direct and clear approach to solve a problem rather than discussing the problem with my colleagues.
S3Q8	I love to have an unexpected event in my day than having the same daily routine
S3Q9	I prefer to think of myself as a changer
S3Q10	Attending on time is crucial to me
S3Q11	I buy new gadgets whenever possible
S3Q12	I prefer to have intensive training before doing any task
S3Q13	I don't rely on other people to participate in my project.
S3Q14	To me, luck plays an important role in success
S3Q15	The decisions we took in the past are more effective than what decision we will take for the future
S3Q16	I prefer having low salary for a long period than having high salary for short or uncertain period

S3Q17	My family encourages me to start my own business
S3Q18	I will start my own new company within the next 5 years.
S3Q19	I may rely on my family financially to start my own business
S3Q20	I already own a personal business right now

From the questions above, follows the summary of the collected and pre-processed responses represented in Table 9:

Table 9: Personal Traits Responses Analysis

NO	VARIABLE	STATS / VALUES	FREQS (% OF VALID)	GRAPH
25	S3Q1	Mean (sd) : 3.8 (1.1) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 2 (0.3)	1 : 6 (1.2%) 2 : 72 (14.0%) 3 : 88 (17.2%) 4 : 194 (37.8%) 5 : 153 (29.8%)	
26	S3Q2	Mean (sd) : 3.7 (0.9) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	1 : 3 (0.6%) 2 : 40 (7.8%) 3 : 144 (28.1%) 4 : 229 (44.6%) 5 : 97 (18.9%)	
27	S3Q3	Mean (sd) : 3.6 (1) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.3)	1 : 2 (0.4%) 2 : 67 (13.1%) 3 : 167 (32.6%) 4 : 169 (32.9%) 5 : 108 (21.1%)	
28	S3Q4	Mean (sd) : 3.6 (0.9) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.3)	1 : 2 (0.4%) 2 : 51 (9.9%) 3 : 179 (34.9%) 4 : 176 (34.3%) 5 : 105 (20.5%)	
29	S3Q5	Mean (sd) : 3.6 (0.9) min ≤ med ≤ max: 2 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	2 : 60 (11.7%) 3 : 169 (32.9%) 4 : 200 (39.0%) 5 : 84 (16.4%)	

30	S3Q6	Mean (sd) : 3.6 (0.9) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.3)	1 : 3 (0.6%) 2 : 61 (11.9%) 3 : 173 (33.7%) 4 : 182 (35.5%) 5 : 94 (18.3%)	
31	S3Q7	Mean (sd) : 3.5 (1) min ≤ med ≤ max: max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.3)	1 : 9 (1.8%) 2 : 56 (10.9%) 3 : 186 (36.3%) 4 : 168 (32.7%) 5 : 94 (18.3%)	
32	S3Q8	Mean (sd) : 3.5 (1) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.3)	1 : 3 (0.6%) 2 : 81 (15.8%) 3 : 170 (33.1%) 4 : 174 (33.9%) 5 : 85 (16.6%)	
33	S3Q9	Mean (sd) : 3.5 (0.9) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.3)	1 : 2 (0.4%) 2 : 71 (13.8%) 3 : 177 (34.5%) 4 : 181 (35.3%) 5 : 82 (16.0%)	
34	S3Q10	Mean (sd) : 3.6 (0.9) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	1 : 3 (0.6%) 2 : 45 (8.8%) 3 : 191 (37.2%) 4 : 184 (35.9%) 5 : 90 (17.5%)	
35	S3Q11	Mean (sd) : 3.5 (1) min ≤ med ≤ max: 1 ≤ 3 ≤ 5 IQR (CV) : 1 (0.3)	1 : 8 (1.6%) 2 : 66 (12.9%) 3 : 191 (37.2%) 4 : 157 (30.6%) 5 : 91 (17.7%)	
36	S3Q12	Mean (sd) : 3.5 (1) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.3)	1 : 7 (1.4%) 2 : 74 (14.4%) 3 : 162 (31.6%) 4 : 196 (38.2%) 5 : 74 (14.4%)	
37	S3Q13	Mean (sd) : 3 (1) min ≤ med ≤ max: 1 ≤ 3 ≤ 5 IQR (CV) : 2 (0.4)	1 : 32 (6.2%) 2 : 156 (30.4%) 3 : 155 (30.2%) 4 : 134 (26.1%) 5 : 36 (7.0%)	
38	S3Q14	Mean (sd) : 3.1 (1) min ≤ med ≤ max: 1 ≤ 3 ≤ 5 IQR (CV) : 2 (0.3)	1 : 30 (5.8%) 2 : 114 (22.2%) 3 : 188 (36.6%) 4 : 145 (28.3%) 5 : 36 (7.0%)	

39	S3Q15	Mean (sd) : 3.2 (1.1) min ≤ med ≤ max: 1 ≤ 3 ≤ 5 IQR (CV) : 2 (0.3)	1 : 40 (7.8%) 2 : 90 (17.5%) 3 : 170 (33.1%) 4 : 170 (33.1%) 5 : 43 (8.4%)	
40	S3Q16	Mean (sd) : 3.2 (1.1) min ≤ med ≤ max: 1 ≤ 3 ≤ 5 IQR (CV) : 2 (0.3)	1 : 40 (7.8%) 2 : 104 (20.3%) 3 : 156 (30.4%) 4 : 162 (31.6%) 5 : 51 (9.9%)	
41	S3Q17	Mean (sd) : 3.3 (1.1) min ≤ med ≤ max: 1 ≤ 3 ≤ 5 IQR (CV) : 1 (0.3)	1 : 23 (4.5%) 2 : 102 (19.9%) 3 : 153 (29.8%) 4 : 161 (31.4%) 5 : 74 (14.4%)	
42	S3Q18	Mean (sd) : 3.2 (1.1) min ≤ med ≤ max: 1 ≤ 3 ≤ 5 IQR (CV) : 2 (0.4)	1 : 32 (6.2%) 2 : 119 (23.2%) 3 : 159 (31.0%) 4 : 137 (26.7%) 5 : 66 (12.9%)	
43	S3Q19	Mean (sd) : 3.1 (1.3) min ≤ med ≤ max: 1 ≤ 3 ≤ 5 IQR (CV) : 2 (0.4)	1 : 77 (15.0%) 2 : 92 (17.9%) 3 : 111 (21.6%) 4 : 152 (29.6%) 5 : 81 (15.8%)	
44	S3Q20	Mean (sd) : 2.1 (1.6) min ≤ med ≤ max: 1 ≤ 1 ≤ 5 IQR (CV) : 2 (0.7)	1 : 322 (62.8%) 2 : 17 (3.3%) 3 : 54 (10.5%) 4 : 36 (7.0%) 5 : 84 (16.4%)	

In Table 9, as the questions in this section are more about measuring the traits of respondents' personality, the questions are mostly formed to have the answers in a normal forward scale from "1" to "5" which represent "totally disagree" and "totally agree" respectfully. However, some of the questions formed in a reversed structure to reduce redundancy and examine the nature of collected answers. Questions 13, 14,15,16, and 19 are the reverse structured questions where "1", which is "totally disagree" is supposed to affect the Innovation and Entrepreneurship Index positively, yet "5", which is "Totally Agree" is supposed to affect the Innovation and Entrepreneurship Index negatively.

Referring to the provided analysis, it can be noticed that answers scores for all the questions related to the personality traits have a lower mean and higher standard

deviation than in the previous section. More specifically mean for all the answers is around 3.4, the highest value is 3.8, and the minimum value is 2.1. Likewise, the standard deviation for all the answers is around 1 with a maximum value of 1.6 and the lowest value is 0.9. which means that the answers related to personality have more variance than the ones collected in the environmental traits section.

4.1.2.4. Section 4 – educational performance traits

In this section, the questions provided were about collecting more information about the respondents’ performance in Science, Technology, Engineering, and Mathematics during both high school and higher education, more precisely, their performance in Mathematics, Physics, Computer Science, and Design and Innovation subjects. Also, there are questions about their overall performance during their study and their participation in science fairs to showcase their ideas and projects. As one of this study’s objectives is to examine the relationship between educational performance and innovation and entrepreneurship, besides the environmental and personal traits, the following questions were provided to the participants in this section as shown in Table 10.





Table 10: Educational Performance Questions

Question identifier	Question Text
S4Q1	During my high school, my mathematics courses performance can be described best as:
S4Q2	During my high school, my physics courses performance can be described best as:
S4Q3	During my high school, My Creative Design and Innovation knowledge can be described best as:
S4Q4	During my high school, my Computer Science/Information Technology performance can be described best as:
S4Q5	During my high school, my overall performance can be described best as:
S4Q6	During my undergraduate studies, my overall performance can be described best as:

S4Q7	During my undergraduate studies, my mathematics courses performance can be described best as:
S4Q8	During my undergraduate studies, my physics courses performance can be described best as:
S4Q9	During my undergraduate studies, My Creative Design and Innovation knowledge can be described best as:
S4Q10	During my undergraduate studies, my Computer Science/Information Technology performance can be described best as:
S4Q11	During my undergraduate studies, my participation in scientific fairs and competitions to present my new ideas and projects participation can be described best as:

From the questions above, follows the summary of the collected and pre-processed responses represented in Table 11:

Table 11: Educational Performance Responses Analysis

NO	VARIABLE	STATS / VALUES	FREQS (% OF VALID)	GRAPH
45	S4Q1	Mean (sd) : 3.8 (1) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 2 (0.3)	1 : 2 (0.4%) 2 : 79 (15.4%) 3 : 75 (14.6%) 4 : 198 (38.6%) 5 : 159 (31.0%)	
46	S4Q2	Mean (sd) : 3.7 (0.8) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	1 : 1 (0.2%) 2 : 20 (3.9%) 3 : 192 (37.4%) 4 : 225 (43.9%) 5 : 75 (14.6%)	
47	S4Q3	Mean (sd) : 3.6 (1) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.3)	1 : 1 (0.2%) 2 : 68 (13.3%) 3 : 183 (35.7%) 4 : 142 (27.7%) 5 : 119 (23.2%)	
48	S4Q4	Mean (sd) : 3.7 (0.9) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	1 : 1 (0.2%) 2 : 46 (9.0%) 3 : 170 (33.1%) 4 : 194 (37.8%) 5 : 102 (19.9%)	

49	S4Q5	Mean (sd) : 3.7 (0.9) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.3)	1 : 4 (0.8%) 2 : 44 (8.6%) 3 : 173 (33.7%) 4 : 189 (36.8%) 5 : 103 (20.1%)	
50	S4Q6	Mean (sd) : 3.6 (0.9) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.3)	1 : 2 (0.4%) 2 : 49 (9.6%) 3 : 186 (36.3%) 4 : 182 (35.5%) 5 : 94 (18.3%)	
51	S4Q7	Mean (sd) : 3.7 (0.9) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.2)	1 : 3 (0.6%) 2 : 43 (8.4%) 3 : 166 (32.4%) 4 : 193 (37.6%) 5 : 108 (21.1%)	
52	S4Q8	Mean (sd) : 3.6 (0.9) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.3)	1 : 2 (0.4%) 2 : 52 (10.1%) 3 : 186 (36.3%) 4 : 182 (35.5%) 5 : 91 (17.7%)	
53	S4Q9	Mean (sd) : 3.6 (0.9) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.3)	1 : 4 (0.8%) 2 : 62 (12.1%) 3 : 163 (31.8%) 4 : 190 (37.0%) 5 : 94 (18.3%)	
54	S4Q10	Mean (sd) : 3.7 (0.9) min ≤ med ≤ max: 1 ≤ 4 ≤ 5 IQR (CV) : 1 (0.3)	1 : 4 (0.8%) 2 : 44 (8.6%) 3 : 178 (34.7%) 4 : 185 (36.1%) 5 : 102 (19.9%)	
55	S4Q11	Mean (sd) : 3.5 (1) min ≤ med ≤ max: 1 ≤ 3 ≤ 5 IQR (CV) : 1 (0.3)	1 : 10 (1.9%) 2 : 61 (11.9%) 3 : 186 (36.3%) 4 : 160 (31.2%) 5 : 96 (18.7%)	

In Table 11, as the questions in this section are more about measuring the traits of respondents' educational performance in specific subjects, the questions are formulated to have the answers in a normal forward scale from "1" to "5" which represents "totally disagree" and "totally agree" respectfully.

Referring to the provided analysis, it is obvious that answers scores for all the questions related to the educational performance traits have a higher mean and lower standard deviation than the previous section, the personal traits section, yet

they have a lower mean and higher standard deviation than the environmental traits section. More specifically mean for all the answers is around 3.7, with the highest value of 3.8 and a minimum value of 3.5. Likewise, the standard deviation for all the answers is around 0.9 with a maximum value of 1 and the lowest value is 0.8. which means that the answers related to personality have less variance than the ones collected in the personal traits section, nonetheless, they have higher variance than the environmental traits section.

4.1.2.5. Section 5 – final section






In this section, the questions provided were about finding whether the respondent has already a tendency for innovation and entrepreneurship or not, by measuring the outcome. The outcome is simplified to include the number of projects done during high school and higher education, and whether the participant introduced innovative ideas adopted and applied by his employer in case the respondent is an employee, as well as if there are any current start-ups or innovation-based business done by the respondent. Table 13 and **Table 13** shows the included questions and the summary of the collected and pre-processed responses, respectively:

Table 12: Final Section Questions

Question identifier	Question Text
S5Q1	How many Competitions Have you participated in during your High School to showcase your business ideas?
S5Q2	How many projects Have you participated in during your Undergraduate studies to showcase your business ideas?
S5Q3	Do you have currently a personal business project based on Innovation?
S5Q4	During the past couple of years, have you come up with new Innovative ideas and solutions that have been adopted by management, companies, accelerators, or incubators?
S5Q5	Y (Innovation and Entrepreneurship Index)

From the questions above, follows the summary of the collected and pre-processed responses represented in Table 12:

Table 13: Final Section Responses Analysis

NO	VARIABLE	STATS / VALUES	FREQS (% OF VALID)	GRAPH
56	S5Q1	Mean (sd) : 0.2 (0.1) min ≤ med ≤ max: 0 ≤ 0.2 ≤ 1 IQR (CV) : 0.1 (0.7)	0.00 : 46 (9.0%) 0.12 : 201 (39.2%) 0.25 : 178 (34.7%) 0.38 : 52 (10.1%) 0.50 : 19 (3.7%) 0.62 : 12 (2.3%) 0.75 : 4 (0.8%) 1.00 : 1 (0.2%)	
57	S5Q2	Mean (sd) : 0.3 (0.2) min ≤ med ≤ max: 0 ≤ 0.2 ≤ 1 IQR (CV) : 0.2 (0.6)	0.00 : 31 (6.0%) 0.17 : 269 (52.4%) 0.33 : 139 (27.1%) 0.50 : 45 (8.8%) 0.67 : 19 (3.7%) 0.83 : 9 (1.8%) 1.00 : 1 (0.2%)	
58	S5Q3	Min : 0 Mean : 0.1 Max : 1	0 : 470 (91.6%) 1 : 43 (8.4%)	
59	S5Q4	Min : 0 Mean : 0.3 Max : 1	0 : 358 (69.8%) 1 : 155 (30.2%)	
60	S5Q5 (Y)	Mean (sd) : 20.2 (26.9) min ≤ med ≤ max: 0 ≤ 4.6 ≤ 96.2 IQR (CV) : 41.2 (206.1)	62 distinct values	

From Table 13, questions 1 and 2 in section 5 are numeric answered questions, while questions 3 and 4 are “YES” or “NO” answered questions. Finally, “Y” represents the weighted product of the first 4 questions’ scores. Interestingly, 43 respondents out of the whole 513 respondents, own an innovation-based business. While 155 respondents out of the 513 respondents have implemented and adopted innovative ideas by their employers. The result of “Y” indicates that the highest score is 96.2, the minimum score is 0 and the median is 4.6, while the mean equals 20.2 with a very high standard deviation equals 26.9.

4.1.3. Interpretation with SEM model

To find the relationship between the three main traits, environmental, personal, and educational performance using the covariance and regression, the Structural

Equation Model was developed in RStudio using R Language. The model included the main three traits' sections beside the sociodemographic section and the final section as explained previously. Hence, the following subsections are related to the SEM building steps, the evaluation, and finally results and interpretation.

4.1.3.1. Building the structural equation model using R language.

1- Building the SEM model

- a. Lavaan Library was used to build the model
- b. Identifying the latent variables (Environment, Personality, Performance) as (Env, Pers, Perf).
- c. Identifying the correlation between the latent variables
- d. Identifying the regression by sitting the output “y” as a function of (Env, Pers, Perf).
- e. Identifying the correlation between the questions in each factor
- f. Identifying the covariance between the latent variables and the sociodemographic questions in the General Section.

2- Fitting the SEM model

- a. Function “CFA” from the “Lavaan” library is used along with using the standardization method for identification
- b. Function “Modindices” used to provide suggestions to remove certain relations to improve the model.

3- Plotting results

- a. Function “semPaths” used to plot and visualize the whole model built.

4.1.4. Evaluating the SEM model

Using the SEM model has been run multiple times, each time applying the suggested enhancements by the function “modindicies” to improve the Comparative Fit Index and Tucker-Lewis Index factors. Finally, the three-factor model with (df = 513) has a value of Comparative Fit Index equal to 0.911 and a value of Tucker-Lewis Index equal to 0.905. this indicates that the model fits the data set almost perfectly as the value gets closer to 1. Additionally, the P-Value, also known as the Chi-Square, achieved a 0.000 value and RMSEA value of 0.036. This indicates that the results introduced are strongly supporting the theory being

investigated and the developed SEM model is a very close-fit model. Table 14 shows the resulted values:

Table 14: Resulted Model Fit Indices Measurements

	CFI	TLI	RMSEA	P-Value
Model of Fit Indices	0.911	0.905	0.036	0.000

4.1.5. Model estimate parameters

SEM estimate parameters are values that show the loading weight between the different variables. The following figure, Figure 12 represents the SEM model developed in this study with a desired end variable “Y” as follows:

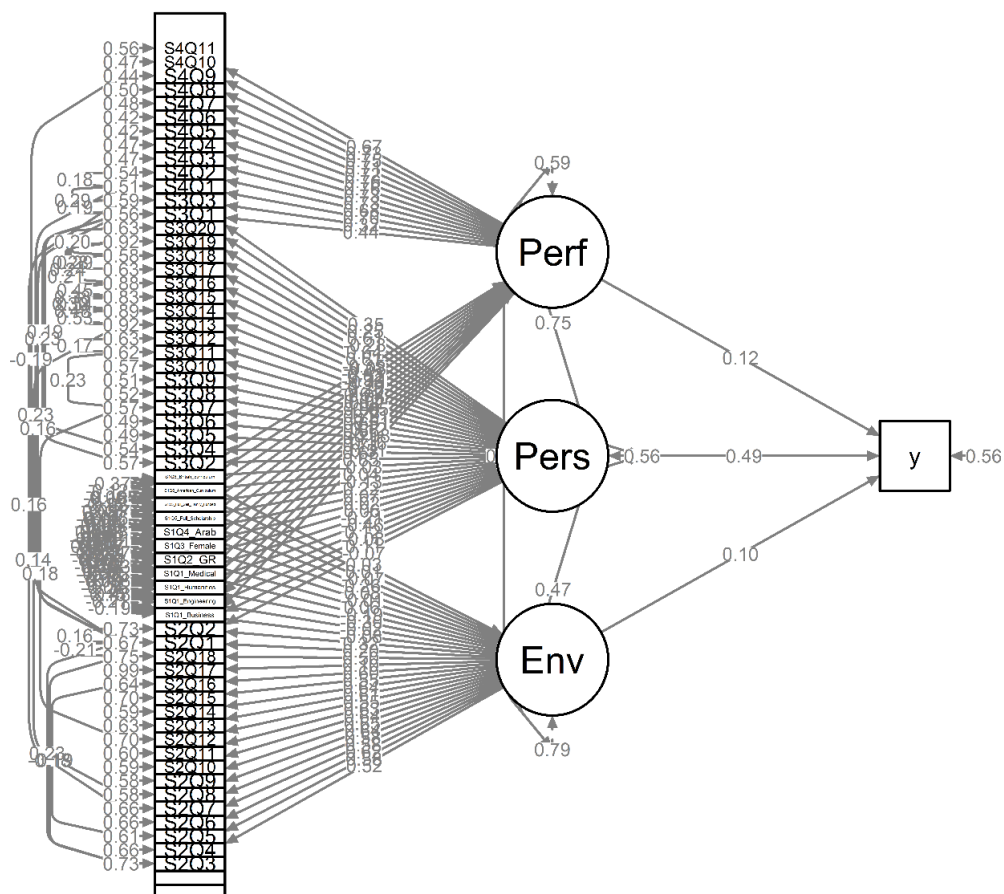


Figure 12: SEM Model Representation

The three latent variables are shown in the figure above as “Perf” for Academic Performance Factor, “Pers” for Personality Factor, and “Env” for Environmental

Factor. Also, it shows the linked associated variables. Additionally, the values of the relations weights (correlation) are presented.

The correlation values, the estimated ones, between the 3 latent variables “Pers”, “Perf”, and “Env” and the observed indicators are presented in Table 15, where the higher values show that the correlation between the questions formed in the questionnaire and the variables which are not observed is higher.

Table 15: Observed Indicators Parameter Estimates

Item/Indicators	Factors	Parameter Estimate
S2Q1	Env	0.144
S2Q2	Env	0.198
S2Q3	Env	0.392
S2Q4	Env	0.362
S2Q5	Env	0.429
S2Q6	Env	0.436
S2Q7	Env	0.375
S2Q8	Env	0.443
S2Q9	Env	0.471
S2Q10	Env	0.432
S2Q11	Env	0.455
S2Q12	Env	0.395
S2Q13	Env	0.421
S2Q14	Env	0.427
S2Q15	Env	0.366
S2Q16	Env	0.393
S2Q17	Env	0.106
S2Q18	Env	0.419
S2Q1	Pers	-0.041
S2Q2	Pers	0.057
S3Q1	Pers	0.191
S3Q2	Pers	0.427

S3Q3	Pers	0.252
S3Q4	Pers	0.471
S3Q5	Pers	0.476
S3Q6	Pers	0.499
S3Q7	Pers	0.477
S3Q8	Pers	0.498
S3Q9	Pers	0.486
S3Q10	Pers	0.439
S3Q11	Pers	0.449
S3Q12	Pers	0.434
<u>S3Q13</u>	<u>Pers</u>	<u>-0.227</u>
<u>S3Q14</u>	<u>Pers</u>	<u>-0.245</u>
<u>S3Q15</u>	<u>Pers</u>	<u>-0.314</u>
<u>S3Q16</u>	<u>Pers</u>	<u>-0.281</u>
S3Q17	Pers	0.494
S3Q18	Pers	0.533
<u>S3Q19</u>	<u>Pers</u>	<u>-0.2733</u>
S3Q20	Pers	0.711
S2Q1	Perf	0.317
S2Q2	Perf	0.085
S3Q1	Perf	0.344
S3Q3	Perf	0.234
S4Q1	Perf	0.557
S4Q2	Perf	0.401
S4Q3	Perf	0.552
S4Q4	Perf	0.5
S4Q5	Perf	0.537
S4Q6	Perf	0.525
S4Q7	Perf	0.503
S4Q8	Perf	0.49
S4Q9	Perf	0.542

S4Q10	Perf	0.513
S4Q11	Perf	0.505

In Table 15, the measured indicator that holds the highest loading (Parameter Estimate) is Q11, which is the “The Educational Institutes offers seminars/courses/lectures related to innovation and entrepreneurship” question. Also, in Section 3 which is related to the personal Indicators, the question with the highest measured value is Q18, which is “The companies and the government entities reach out for Educational institutes help”. Also, what is interesting is that the questions formatted with a reversed scale as mentioned in the description of the questions are the same questions showing a negative measurement, which are Q13, Q14, Q15, Q16, and Q19. Which are “I don’t rely on other people to participate in my project.”, “To me, luck plays an important role in success”, “The decisions we took in the past are more effective that what decision we will take for the future”, “I prefer having low salary for a long period than having high salary for short or uncertain period”, and “I may rely on my family financially to start my own business” respectfully. This approves what has been mentioned previously in the literature, that entrepreneurs and innovators tend to get involved with teams more than working individually, they do believe in hard work to succeed, and they always can start working on a new project even if they previously failed, they tend to accept more uncertainty, and they don’t consider financial issues matter. Also, in Section 4 which is related to the Educational Performance Indicator, the question with the highest measured value in Q1, which is “During my high school, my mathematics courses performance can be described best as:”. On the other hand, we can see that some questions related to one section have some load on other sections, such as S2Q1 and S2Q2 affecting S3 as well as S4, likewise, S3Q1 and S3Q3 affecting S4 represented in Table 15 . which is about Observed Indicators Parameter Estimates in the developed SEM model related to innovation and entrepreneurship.

Table 16: Latent Variables Parameter Estimates

<i>Variable of Interest</i>	<i>Latent Variables</i>	<i>Parameter Estimate</i>
Innovation and Entrepreneurship Index “Y”	Environmental Factor	2.424
	<u>Personal Factor</u>	<u>9.820</u>
	Educational Performance Factor	2.547

As shown in Table 16, the three Latent Variables, which are the Environmental, Personal, and Educational Performance, affect the Innovation and Entrepreneurship Index positively with achieved measurements equal to (2.424), (9.820), and (2.547). Environmental and Educational Performance Traits are close to each other. However, the Personal Factor holds a higher value. This means that the Personal Factor is the one that affects Innovation and Entrepreneurship the most.

Table 17: Covariance Matrix of Latent Variables

	Environmental Factor	Personal Factor	Educational Performance Factor
Environmental Factor	-	0.475	0.374
Personal Factor	0.475	-	0.747
Educational Performance Factor	0.374	0.747	-

Likewise, the SEM model measures the covariance between the different variables in its model as mentioned previously. Table 17 shows the covariance measurements, and it is noticeable that the Personal Factor and the Educational Performance Factor have the strongest covariance among the other records with a value equal to 0.747.

Regarding the general aspects' questions provided in section 1, we can see the regression results in Table 18:

Table 18: Regression Results Between Latent Variables and Observed Indicators

Question Code	Question Trait	Environment	Personality	Performance
S1Q1	Business	- 0.337	- 0.407	- 0.412
S1Q1	Engineering	- 0.037	0.345	0.353
S1Q1	Humanities	- 0.700	- 1.309	- 1.406
S1Q1	Medical	- 0.516	- 0.668	- 0.676
S1Q2	Graduate	0.148	0.159	- 0.136
S1Q3	Female	-0.022	0.046	0.049
S1Q4	Arab	0.182	0.212	0.111
S1Q5	Full Scholarship	0.873	0.893	0.625
S1Q5	Self/Family Funded	- 0.173	- 0.354	- 0.315
S1Q6	American Curricula	0.037	0.140	0.068
S1Q6	British Curricula	0.065	-0.091	-0.208

From Table 18, the following can be noticed, regarding the major of study, the “Engineering” major scored the highest score amongst the other majors regarding regression with all three latent variables with scores equal to (-0.037) with Environment, (0.345) with Personality, and (0.353) with performance. Then followed by “Business” major with scores equal to (-0.337), (-0.407), and (-0.412). then the other two, “Medical” and “Humanities” majors landed last with the lowest values for “Humanities”. The Graduate students scored regression values of (0.148), (0.159), and (- 0.136) respectfully. Also, what seems to be interesting is that students with Full scholarships hold high regression values with “Environment” equal to (0.873), “Personality” equal to (0.893), and “Performance” equal to (0.625). On the other hand, when regression comes to the curricula of study, we can notice that all provided curriculum whether it is American, British, or MoE/UAE holds almost the same regression values close to (0) with Environment, which indicates no big difference between them, however, for personality, it can be seen that the American Curricula hold higher regression

than the other curriculums, with a value equal to (0.140). and finally, the British Curriculum holds the lowest regression value with the performance factor, with a value of (-0.208). These measurements indicate that the students who are or were studying Sciences, Business, or Engineering studies, affect the latent variables the most, also students who are on full scholarship affect the latent variables the most. Moreover, the American Curriculum affects the Personal Factor the most.

Chapter 5. Conclusion and Future Work

There is a huge impact of innovation and entrepreneurship on countries' economies, therefore, developed countries pay huge attention to innovation and entrepreneurship and keep encouraging students to get involved in related workshops and courses due to its personal, social, and economic impact on the society. Many studies have been conducted to identify the related traits from an early stage. There is no doubt that the surrounding environment and personality traits play an important role. However, early discovery for innovators and entrepreneurs is critical as decision-makers can support possible innovators and entrepreneurs with advisory services and financial support. One way to discover innovators and entrepreneurs from an early age is to monitor their performance and participation in science fairs and other related events to showcase their ideas.

In this research, the goal is to assess the influence of the environmental, personal, and performance traits on the discovery of innovators and entrepreneurs. The developed tool lies upon complex, yet related questionnaire data collected from random educated individuals in the United Arab Emirates, covering the areas of education, performance in STEM subjects, personal traits, economic and industrial standing of the country, and enterprise tendency. The developed three-factor model provided an excellent fit for the hypothesized model indicated by the fit indices CFI of 0.911, TLI of 0.905, RMSEA of 0.036, and p-value of 0.000. The introduced model with its strong and encouraging correlation values can be used to help concerned parties and entities in identifying innovators and entrepreneurs from an early stage by monitoring students' output of I&E-related projects and ideas during their high school journey besides their contribution during their higher education journey. On the other hand, the introduced model can be used by governments and entities to study and identify their strengths and weaknesses in any, or all the traits (Personal, Environmental, and Educational Performance) in a way to improve their performance to maximize the possibility of having more innovators and entrepreneurs in their community, which will lead to the improved economic performance of the community and the country in general.

The tool developed and introduced in this study requires more evidence of construct and validity. Also, a large sample size would be handy if coupled with real educational performance numerical data from education providers and numeric economic indicators. Nevertheless, measurement fit indices can be improved with help of actual data. On the other hand, the questions introduced (Observed Variables) might trigger higher regression loading values if written in a more precise way to match the aimed meaning of the proposed factors (Latent Variables). Any misinterpretation would have led to confusion and failure of understanding the meant objective of the question, which as a result, might affect the regression values as well as the measurement of indices. Finally, the developed tool can be used to align governmental support with targeted areas of improvement and early discovery of innovators and entrepreneurs.

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Vita

Mahmoud Ghandi Mahmoud Al Qawasmi was born in 1990, in Amman, the Hashemite Kingdom of Jordan. He received his primary and secondary education in Kalba City, which is part of Sharjah Emirate, UAE. He received his B.Sc. degree in Electronics and Telecommunications Engineering from Khalifa University in 2014. From 2014 to 2016, he worked as a Telecommunication Engineer in Etisalat, UAE, then in 2016, he moved to start a new career path as a specialist in the Ministry of Education in UAE. In 2018 he has been promoted to Senior specialist in the Research and Education Data Centre in the Ministry of Education.

In September 2019, he joined the Engineering Systems Management master's program at the American University of Sharjah as a part-time graduate student. His research interests during his master's study are in the fields of (Innovation and Entrepreneurship, Data Science, ML/AI, Operations Research, and Supply Chain Management).