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Emerging Role of Nanotechnology in Engineering Education

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Abstract : The present research comprehends role of nanotechnology in providing career opportunities for engineering graduates. This study was essential as Nanotechnology has multiple applications in the field of engineering science. Therefore, perception of the engineering students was captured in the study.

Structural equation modeling is adopted in the study to understand the perception of the respondents. The research findings indicate that nanotechnology provides a direction for engineering graduates in enhancing the career opportunities. The findings of this study are also useful and supports policymakers and education institutes in the domain of engineering education.

Keywords : Nanotechnology, Career Choice, Technology Management, Engineering Education, Industry 4.0, Career Growth

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1. Introduction

In the current competing world, various modern technologies have emerged and are in the process of being adopted in industry.

One of the most promising technologies that have emerged is nanotechnology (Mishra et al., 2017). Nanotechnology holds the potential to find a solution to complicated problems in 21st century (Afsaneh et al., 2016). Hence, nanotechnology is being widely applied in the field of science, energy sector, medicine, biotechnology, and engineering (Jackman et al., 2016).

Therefore, it is utterly necessary to educate engineers about nanotechnology. The new generation of students accomplished with the knowledge of nanotechnology could be competent enough in solving problems in the industry and provide innovative solutions to industry.

Orgill and Wood (2014), in their pursuit of identifying significance of nanotechnology in technical education, remark that nanotechnology has found its due acceptance in fields like physics, chemistry, mechanical engineering, etc. Hence, engineering graduates with the knowledge of nanotechnology could add value to the growth of industry.

Further, the extant literature (Ernst, 2009; Zheng et al., 2009; Balakrishnan et al., 2018) amply demonstrates how nanotechnology would engage in providing innovative solutions to industry such as additive manufacturing, chemical engineering, and environmental engineering. Therefore, understanding the perception of engineering graduates towards nanotechnology is critical to providing an effective roadmap for career growth for these graduates.

However, selection of courses and careers by graduates is influenced by certain factors namely career growth opportunities and industry acceptance of the course (Jone et al., 2015; Balakrishnan et al., 2018).

So, in the light of the above discussion, research is needed to understand perception of engineering graduates towards nanotechnology.

In this context of research, the 'Technology Readiness Index' proposed by Parasuraman, (2000) is applied to understand the perception of engineering graduates towards nanotechnology.

The finding from this study provides directions to policymakers, universities, technical institutes, and faculty members to prepare engineering graduates' competencies related to nanotechnology.

The study presents the inference with regards to perception of engineering graduates from mechanical, civil and electronic, and electrical engineering, the study has also included inference with regards to urban and rural engineering graduates.

2. Literature Review

This section delineates growth and development of nanotechnology, followed by analysis of how the study of nanotechnology opens up career opportunities to engineering students. Finally, technology readiness and behavioral theory towards technology are detailed in this section.

Growth of Nanotechnology

The concept of nanotechnology was first by Japanese scientist Norio Taniguchi in the year 1974, this concept was further popularized by American Engineer K. Eric Drexier in the year 1955 (Ramsden, 2016).

In India nanotechnology was popularized by Dr.C.N. R Rao through application in various fields such as medicine, electronics, food, fuel cells, solar cells, batteries, space, fuels, water treatment, air purification chemical process, sports, and fabric. (Rao et al.,2006; Jackmanet al., 2016; Nobile and Nobile 2016).

Besides the growth of this technology in various fields, nanotechnology is gaining popularity in emerging technology sectors such as Industry 4.0, especially in the area of three-dimensional printing (3D) (Mobasser and Firoozi 2016). These developments in the engineering sector with the support of nanotechnology have improved product quality and enhanced the manufacturing process in the industry (Rana et al., 2017).

The above discussion points out that nanotechnology has been contributing to the growth of manufacturing and electronics. Hence, nanotechnology provides a promising opportunity for career development for engineering graduates.

A career in Nanotechnology for Engineers

Career opportunities for engineering graduate are emerging in the domain of emerging technologies (Brainard et al., 2014; Elnashaie et al., 2015). Nanotechnology is an emerging technology and has wide employment opportunities for engineering graduate . Employment to engineering graduate with nanotechnology domain supports in employment in the organizations such as chemical firms, environment science and food technology industry (Shabani et al., 2011; Roco et al., 2011; Mohammad et al., 2012).

Since nanotechnology has varied applications, engineering students need to be trained and educated in nanotechnology (Karim et al., 2017; Gul, 2017; Hess et al., 2017).

In the light of this, students' awareness and acceptance of this technology are of cardinal importance in incorporating nanotechnology in engineering education.

Understanding the readiness and positive behavior of individuals is captured through two theories. Firstly, theory of planned behavior proposed by Aizen and Fishbeing in 1977 mentions that the behavior of an individual is through a combination of attitudes and subjective norms.

Further, Robbins (1998) defines attitude as belief towards an object, person, or situation. Subjective norms are defined as beliefs towards behavior (Ajzen and Fishbein1977; Bagozzi et al. 1992). The theory is further extended by Aizen (1991) by including perceived behavioral control that includes self-sufficiency and its influence on behavior. Secondly, technology readiness index provides insights into readiness of individuals towards accepting innovative technologies. This theory has four constructs namely, optimism, innovativeness, discomfort, and insecurity (Parasuraman, 2000).

The above discussion shows that there is a need to understand engineering graduate's perception and behavior towards nanotechnology and device measures to encourage these graduates for a career in nanotechnology.

3. Research Model And Hypothesis For the Study

The above literature review in section II of the study provides an insight into developing a research model. Hence, the research model is developed on these constructs are as under;

1. Technology Readiness of engineering graduates towards nanotechnology
2. Behavioral intentions of engineering students towards nanotechnology
3. Barriers in accepting nanotechnology as a Career opportunity.

Technology Readiness Index towards nanotechnology by Engineering Students

Technology readiness index is a well-established model to understand readiness of individuals towards technology. (Lai, 2008; Nugroho et al., 2017). Hence, adopting this index as a research construct would give an insight into understanding readiness of engineering students towards nanotechnology.

Behavioral Intentions of Students towards nanotechnology

Behavioral intention theory consists of subjective norms and perceived behavior control acts as a control. (Ghoochani et al., 2018; Yadav et al., 2018). In the present research, behavioral intentions theory is adopted to evaluate the attitude, perception, and intentions of students towards adopting nanotechnology as a career opportunity.

These two models are a befitting combination for the present research. As it provides significant insight on perception and its impact on accepting nanotechnology technology by engineering graduates. However, research would gain clarity by understating challenges influencing engineering students in accepting nanotechnology as a career opportunity.

Challenges in accepting nanotechnology as a career opportunity for engineering students

Nanotechnology is an emerging technology there is a wide opportunity for innovation in this field of science. (Foley et al., 2017).

However, there are challenges in adopting this technology by engineering students. (Foley et al., 2017). These challenges influencing nanotechnology include a lack of technical support for innovation. (Rahmi et al., 2015).

Another factor influencing adopting this technology is academic involvement for developing skill-set of students in this technology. (Shu-Fen Lin and Huann-shyang Lin, 2016).

Hence, these major challenges influence the adoption of nanotechnology namely technical support and a strong learning platform for students of engineering.

The above discussion and literature review gives insights into perception and challenges influencing engineering students in adopting this technology.

Hypothesis for the Study

The study proposed hypothesis based on the Theory of Planned Behavior and the Technology Readiness Index.

Theory of Planned Behaviour towards Nanotechnology

The Theory of Planned Behavior includes attitude and beliefs towards behavior. Attitude and beliefs influence students' selection of courses. (Lakin and Davis 2016).

Hence, attitude and beliefs play a vital role in influencing acceptance of modern technology. (Sahin et al., 2015). Social factors influence attitudes and beliefs of individuals. These social factors include family, friends, and peers. (Fishbein and Ajzen 1980).

Apart from social factors career opportunities in the field of technology also influence an individual's attitude. (Ahmadi et al., 2001).

Study through the theory of planned behavior understands influence of attitude and beliefs on individuals. (Miller et al., 2018). The hypothesis for the study is as under;

H1. Attitude towards nanotechnology has a significant relationship with subjective norms of the course.

H2: Subjective norms will have a significant relationship with perceived behavioral control.

H3: Intentions of the student influence Perceived Behavioral control to undertake a course in nanotechnology.

H4: Perceived Behavioral Control has a significant relationship with the behavior of students.

Students Technology Readiness towards Nanotechnology

Technology readiness is a crucial factor for accepting modern technology. (Parasuraman, 2000). Four constructs influence technology readiness namely Optimism, Innovativeness, Discomfort, and Insecurity. (Parasuraman, 2000).

These four constructs influence the impact of technology acceptance. (Wook et al., 2017; Mishra et al., 2017). Therefore, the under-standing readiness of students towards nanotechnology gives an insight on acceptance of this technology. Hence, we frame the following hypothesis for the study.

H5: Insecurity of future influences on accepting nanotechnology by engineering students.

H6: Discomfort towards learning the courses in nanotechnology influences engineering students in selecting the course in Nanotechnology.

H7: Innovation opportunity in the field of nanotechnology.

H8: Engineering students are optimistic towards better career growth in nanotechnology.

This study investigated engineering students' readiness towards accepting nanotechnology as a career choice and their perception of nanotechnology. The study was conducted at an engineering college where the Center for Nanotechnology was established to provide career opportunities in nanotechnology. The study respondents were engineering students in the third year of engineering. The personal interview and questionnaire method collected information from respondents. The study examined student's perception and readiness towards nanotechnology.

Participants

Respondents were 325 students from engineering college. 325 respondents are satisfactory for structural equation modeling. (Close et al., 2018; Willis et al., 2016; Sideridis et al., 2014). The profile of the respondents is presented in Table.1

Instrument Development and Data collection

The variables for the study are enough to address the research problem. (Nunnally and Bernstein, 1979). Previous literature reviews gave the basis for development of research instruments. Technology Readiness Index and Theory of Planned Behavior constructs were applied for developing items in the scale.

A five-point scale was adopted in the study 325 engineering students took part in data collection. A pilot study on 40 engineering students was tested for analysis of scale. Details with regards to variables in the scale are presented in Table. 2.

Table 2 presents a reliability analysis of the scale. The score on reliability of more than 0.65 is an acceptable score to consider scales reliability. (Henseler et al., 2009; Santos 1999). Reliability analysis in the present study showed a score of more than 0.65, hence acceptable for measurement of the research model.

A total of 325 students have undertaken the course in nanotechnology. The study survey response was 72.2% Hence the total respondents are 238. The non-response for the is due to a lack of awareness and lack of clarity with regards to a career in nanotechnology.

Table.1: Profile of the respondents

Gender	N	%
Male	110	46.22
Female	128	53.78
Total	**238**	**100.00**
Age	**N**	**%**
20-22 Years	102	42.86
22- 24Years	113	47.48
25 Years and above	23	9.66
Total	**238**	**100.00**
Department	**N**	**%**
Mechanical Engineering	22	9.24
Civil Engineering	52	21.85
Chemical Engineering	76	31.93
Metallurgy Engineering	64	26.89
Electronic and Electrical Engineering	24	10.08
Total	**238**	**89.92**

Table.2: Measurement Variables for the Study

Construct	Code	Measurement Items	Source
Attitude	AT1	Nanotechnology has a better future for building the career	Miller et.al ,2018
	AT2	Nanotechnology gives an opportunity for innovation	Miller et.al ,2018
Subjective Norms	SN1	Nanotechnology requires extra skill-sets to undergo the course	Ajzen, I., & Fishbein, M. 1977
	SN2	Opinion of my friends and family is important to choose nanotechnology as a course	Ajzen, I., & Fishbein, M. 1977
Perceived Behavioural Control	PBC1	Opinion with regards to course content is important to select nanotechnology Course	Miller et.al ,2018
	PBC2	I am confident that nanotechnology provides better career opportunity	Miller et.al ,2018
Intentions	IT1	I have the intention to undertake the course in nanotechnology	Ajzen, I., & Fishbein, M. 1977
	IT2	My intentions are not influenced by friends and family while selecting a course in nanotechnology	Ajzen, I., & Fishbein, M. 1977
Behaviour	BE1	My behaviour is influenced by intentions to undertake the course in nanotechnology	Ajzen, I., & Fishbein, M. 1977
	BE2	Behaviour of my is related to intentions to develop my career in nanotechnology	Ajzen, I., & Fishbein, M. 1977
Optimistic	OP1	The role of the effective academic process is important for nanotechnology	Parasuraman, A. 2000
	OP2	Learning nanotechnology is rewarding for students	Parasuraman, A. 2000

Innovativeness	IN1	Nanotechnology allows solving large problems for science and technology	Parasuraman, A. 2000
	IN2	Nanotechnology allows sharing of new ideas	Parasuraman, A. 2000
Discomfort	DS1	Technical support is required to learn nanotechnology	Parasuraman, A. 2000
	DS2	Nanotechnology is too complicated for application in practice	Parasuraman, A. 2000
Insecurity	IS1	I feel risky to accept a nanotechnology course for my academics	Parasuraman, A. 2000
	IS2	I feel worried about the future of nanotechnology	Parasuraman, A. 2000

Table 3: Reliability Analysis

Items	Acceptable Score	Cronbach Alpha	Outcome
AT1	> = 0.65	.713	Supported
AT2	> = 0.65	.676	Supported
SN1	> = 0.65	.684	Supported
SN2	> = 0.65	.688	Supported
PBC1	> = 0.65	.823	Supported
PBC2	> = 0.65	.709	Supported
IT1	> = 0.65	.815	Supported
IT2	> = 0.65	.667	Supported
BE1	> = 0.65	.748	Supported
BE2	> = 0.65	.812	Supported
OP1	> = 0.65	.901	Supported
OP2	> = 0.65	.732	Supported
IN1	> = 0.65	.725	Supported
IN2	> = 0.65	.704	Supported
DS1	> = 0.65	.857	Supported
DS2	> = 0.65	.757	Supported
IS1	> = 0.65	.779	Supported
IS2	> = 0.65	.828	Supported

Methods of Measurement

Preliminary analysis was conducted were in normality, missing values, and multi-collinearity of data were evaluated and checked. Further, factor analysis was conducted using AMOS 23 to understand the psychometric results of the scale. Psychometric test results were conducted for convergent discriminant validity. Further, structural equation modeling was applied to test the study model and understand the relationships between the variables of the construct. Factor loading, Cronbach Alpha, Composite Reliability, and Average Variance Extracted are presented in Table 5. Factor loading less than 0.50 was not considered for future analysis, only factor loading above 0.60 was considered for the analysis (Bagozzi et al. 1992) which is acceptable for convergent validity analysis. Composite Reliability (C. R) results must be more than 0.70 (Fornell and Larcker,1981). The Average Variance Extracted

Table 4: Acceptable range for results on Structural Equation Modelling

Sr. No	Parameters	Acceptable Range	Source
1	Factor Loadings	>= 0.50	Bagozzi and Yi, 1988
2	Composite Reliability (C.R)	>= 0.70	Fornell and Larcker, 1981
3	Average Variance Extracted (AVE)	>=0.50	JoreskogandSorborm(1989)
4	Comparative fit index (CFI)	0.9	Joreskog and Sorborm(1989)
5	Normed fit index (NFI).	0.9	Joreskog and Sorborm(1989)
6	Goodness of Fit Index	0.9	Joreskog and Sorborm(1989)
7	Root Mean Square Error of Approximation (RMSEA)	0.08	Browne and Cudeck, 1993

(AVE) is acceptable when the value is more than 0.50 (Fornell and Larcker,1981). Discriminant validity provides the degree to which concepts are different from each concept (Bagozzi et al,1992). The results are achieved by comparing the squared root of Average Variance Extracted (AVE) of each construct through correlations (Fornell and Larcker (1981). To understand model fit following estimates are included in the analysis $\chi2$-statistic, the Goodness of Fit Index (GFI), the Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), and Normed Fit Index (NFI). The acceptable value of more than 0.9 for Goodness of Fit Index (GFI), Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), and Normed Fit Index (NFI). Root Mean Square Error of Approximation (RMSEA) is 0.08 (Browne et al., 1993) (Joreskog and Sorbom, 1989). The summary of the acceptable range of results for the structural equation model is presented in Table 4.

The research results were analyzed in three levels. Firstly, the psychometric properties of the results were evaluated. Secondly, structural equation modeling process was administered on the results and thirdly, hypothesis testing was conducted through regression analysis to investigate challenges for acceptance of nanotechnology as a career for engineering students. The model of the research through a structural equation is presented in Figure.1.

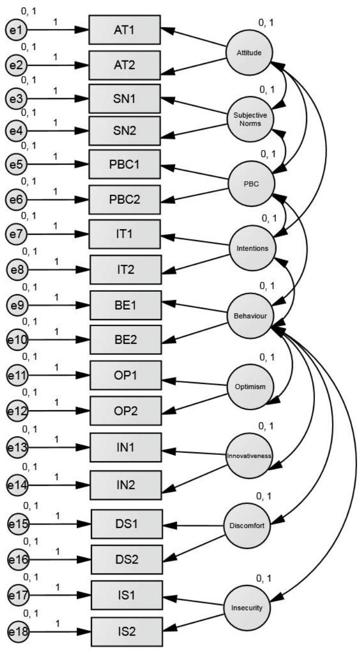

Fig.1: Research Model for Analysis

Results of psychometric properties are presented in Table.5 and descriptive statistics are presented in Table 6. While results of structural equation modeling are presented in Table.7 and results of regression analysis for evaluation the hypothesis are presented in Table.8.

Table 5: Psychometric Properties of the Results

Construct	Items Factor	Loadings	Cronbach α	Composite Reliability	AVE
Attitude	AT1	.913	.713	0.74	0.85
	AT2	.809	.676		
Subjective Norms	SN1	.847	.684	0.71	0.82
	SN2	.837	.688		
Perceived Behavioural Control	PBC1	.953	.823	0.80	0.88
	PBC2	.834	.709		
Intentions	IT1	.845	.713	0.82	0.90
	IT2	.966	.853		
Behaviour	BE1	.817	.945	0.76	0.85
	BE2	.922	.722		
Optimistic	OP1	.954	.901	0.78	0.87
	OP2	.814	.732		
Innovativeness	IN1	.895	.725	0.77	0.85
	IN2	.881	.704		
Discomfort	DS1	.927	.857	0.84	0.91
	DS2	.913	.757		
Insecurity	IS1	.909	.779	0.77	0.86
	IS2	.847	.828		

Table 6: Results on Descriptive Statistics

Constructs	Items	N	Mean	Std. Deviation	Average Mean
Attitude	AT1	325	4.529	0.5526	4.6507
	AT2	325	4.772	0.5126	
Subjective Norms	SN1	325	4.366	0.7962	3.8185
	SN2	325	3.270	1.1057	
Perceived Behavioral Control	PBC1	325	3.720	0.8949	4.0446
	PBC2	325	4.369	0.6375	
	IT1	325	4.076	0.6113	

Intentions	IT2	325	4.670	0.5977	4.3738
Behaviour	BE1	325	4.095	1.0123	3.6277
	BE2	325	3.16	1.0652	
Optimistic	OP1	325	4.076	0.6113	3.6184
	OP2	325	4.566	0.5606	
Innovativeness	IN1	325	4.313	0.6235	4.4400
	IN2	325	4.708	0.5977	
Discomfort	DS1	325	4.095	1.0123	3.6277
	DS2	325	3.16	1.0652	
Insecurity	IS1	325	2.550	1.1525	2.4538

Fig. 2: Results of Descriptive Statistics

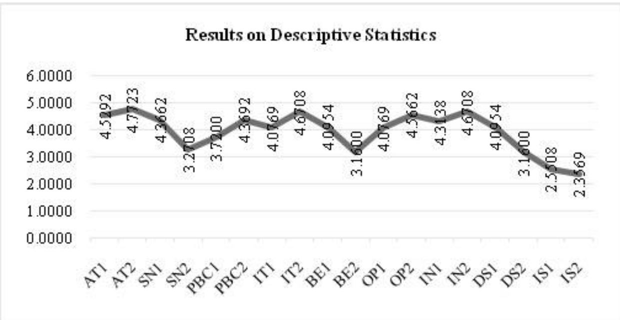

Table 7: Model Fit through Structural Equation Modelling

Details	Acceptable Range	Actual Results
Chi-square statistics		952
Degree of freedom		41
Significance	p-value less than 0.05	.000
Chi-square / degree of freedom	Value less than 5.0	2.578
Comparative fit index	Value greater than .90	.92
Normed Fit Index	Value greater than .90	.95
Tucker-Lewis coefficient	Value greater than .90	.93
Comparative fit index	Value greater than .90	.94
Root Mean Square Error of Approximation	Value Less than 0.05	.031

Table 8: Results of Hypothesis

Details	Statements	Regression Weight	Standard Error	Critical Ratio	P-Value	Results
H1	AT1 - PBC1	.150	.026	5.663	***	Supported
H2	AT2 – IT 1	.130	.031	4.166	***	Supported
H3	PBC 1 – IT 2	.087	.082	1.054	.292	Not Supported
H4	PBC2 - BE1	.380	.041	9.233	***	Supported
H5	BE 2 – IN 1	.160	.048	3.329	***	Supported
H6	BE 2 – DS1	-.388	.098	-3.955	.124	Not Supported
H7	BE 2 – IS 1	.216	.051	4.271	***	Supported
H8	BE2 - OP 1	-.029	.092	-.315	.753	Not Supported

4. Results

The study results with regards to descriptive statistics shows that engineering students perceive positively with regards to career in nanotechnology as mean value is (4.592), while they also mention that it allows innovation (4.772). However, engineering students also mention that they require additional skill-sets in area of nanotechnology (4.366). Engineering students while selecting the course on nanotechnology are moderately influenced by family and friends (3.270) and course content also influences the engineering students moderately while selecting the course in nanotechnology (3.720). The intention of engineering students to enroll in nanotechnology courses is positive as they mention that, nanotechnology provides better career opportunities (4.369) and also allows research in science and technology (4.313). However, engineering student respondents expressed that nanotechnology provides career growth (2.550) and a better future in nanotechnology for engineering students as they don't feel worried concerning future growth in nanotechnology (2.356).

Further, to understand the research results through other statistical interventions on acceptance of nanotechnology as a career option for engineering students. Results have indicated that factors selected for the study are well acceptable to the academic scenario of the study, hence, based on the analysis of the factors, we find the results through psychometric testing which has indicated a factor loading score range of 0.814 to 0.966. Hence, factor loading is in the acceptance range of 0.60. Therefore, results from factor analysis have fulfilled range of acceptance for the study. Results from Cronbach Alpha have been indicated in the range of 0.676 to 0.901. The analysis on Cronbach Alpha is also in acceptance range. Acceptance score for Cronbach Alpha is > = 0.60. Study results are well above the acceptance score on reliability analysis. Results from structural equation modeling indicated that Chi-Square of 952, P-Value < = 0.000, and degree of freedom (d.f) at 41. Result from Root Mean Square Error of Approximation (RMSEA) = 0.031 <=0.5, Comparative fit index (CFI) = 0.94 <=0.9, Normed fit index (NFI) = 0.95 <=0.9 and Goodness of Fit Index = 0.92 <=0.9. This indicates that results from structural equation modeling have been fulfilled and hence, the model fit is acceptable for the study.

The hypothesis testing results shows that 'Attitude towards nanotechnology as a future career and its relationship between course content of nanotechnology'. Study results have been supported. (Accept H1;0.00 < 0.05). This indicates that course content of nanotechnology influences in framing positive attitudes towards nanotechnology by engineering students. Study on 'Attitude of engineering students towards nanotechnology as an opportunity for innovation and their intention to undertake the course in nanotechnology'. Results have been supportive (Accept H2;0.00< 0.05), this indicates that nanotechnology provides an opportunity for innovation in engineering science.

Study on 'Nanotechnology course selection and influence of friends and family. Study has been negative (Reject H3;0.292 > 0.05). This indicates that family and friends don't influence engineering students in selection of the course. Study results on 'nanotechnology as a career opportunity for engineering students and intentions of engineering students towards nanotechnology' has shown positive results, hence (Accept H4;0.00< 0.05). Therefore, nanotechnology provides better career opportunities for engineering students. Results on 'opportunity for solving problems in science and nanotechnology' have indicated positive results, hence (Accept H5;0.00 < 0.05). Therefore, nanotechnology provides an opportunity to engineering students to solve large-scale problems of science and technology through nanotechnology. Results on 'intentions of engineering students towards technical support to learn nanotechnology' study results are negative (Reject H6;0.124 > 0.05). These results indicate that students expect a higher level of technical support to develop a career in nanotechnology in an engineering college. Study investigation on intention of engineering students towards nanotechnology and risk in accepting career in nanotechnology as a career, study results have indicated positively (Accept H7;0.00< 0.05). This indicates that nanotechnology course is not risky for engineering students. Study results on 'academic process in engineering in nanotechnology'. Study results have been negative (Reject H8;0.753> 0.05). This indicates that academic process in engineering college concerning nanotechnology is an evolving stage. Hence more support is expected in engineering college. The hypothesis testing has provided directions with regards to the response of the respondents towards nanotechnology in engineering college. Results are applied to understand the findings and discussion concerning the research model.

Findings and Discussion

Research investigations on nanotechnology as a career for engineering students and students' opinions towards course and the study results are similar to previous study results. (Jean et al. 2017). Hence, study indicates that opinion towards nanotechnology is positive amongst the engineering students. Study results with regards to 'innovation opportunity' through nanotechnology and intentions of engineering students to undertake course have similar to the previous study undertaken in this area of research. (Hess et al. 2017). Therefore, nanotechnology provides an opportunity for innovation amongst engineering students. Study results on influence on family and friends in course selection and developing opinion towards nanotechnology. Research findings in this study have indicated that family and friends don't influence engineering students in the selection of courses in nanotechnology these finds are not similar to other research findings on course selection and family influence. (Anspach 2017; Hamshire et al., 2017). Intentions of engineering students and level of confidence towards career growth in nanotechnology have shown that engineering students are confident concerning career growth in nanotechnology. These findings are similar to the findings of previous research (Iverson et al. 2018; Willis et al. 2016). Opportunity for engineering students to undertake large-scale research in nanotechnology and career growth in research, the results of the study have indicated positively. Hence, nanotechnology provides opportunity to undertake research in nanotechnology for engineering students. These findings are not similar to the study undertaken in previous research findings. (Sorge et al., 2017; Davis et al., 2017). Technical support to learn Nanotechnology course in engineering college, study results have shown negative response in the present study. These findings are not similar to previous research findings on nanotechnology. (Hansen and Baun 2017; Usher and Barak 2018). Opportunity to share innovative ideas and solutions with regards to nanotechnology and developing a career in this field. Study results have shown positive results. These study findings are similar to previous studies. (Matošková and Smšná 2017; Kuo et al. 2017). Effective academic process and career development in nanotechnology, study results have indicated negative response. Therefore, it indicates that the academic process needs acceptance of nanotechnology in engineering courses. These study results are not similar to previous studies. (Zacher et. al.2018; Rogach et al. 2017). The above findings indicate that nanotechnology has been accepted by engineering students. However, there are factors associated with the academic process and technical support influence in selecting nanotechnology as a career opportunity.

Practical Implication of the Study

Study results have indicated factors associated with regards to selection of career in nanotechnology by engineering students. One of the key areas of findings of the study has indicated development of technical skill-set of students. This is possible through the establishment of laboratories in the field of environmental engineering to solve challenges with assignments in nanotechnology. Another, factor associated is with regards to academic process in nanotechnology. This can be achieved through building a learning environment in classroom that is based on real-time situations and providing an opportunity for students to learn through experimental learning. Engineering colleges need to introduce this course as a module in engineering curriculum. This method would provide an insight to students on the application of nanotechnology in various streams of engineering. Chemistry department in an engineering college with a dedicated center of nanotechnology for engineering research would provide an opportunity for engineering students to experiment with new concepts related to nanotechnology in engineering. This would be significant in improving the learning, as students would learn the real-time application of concepts of nanotechnology in engineering science.

Research and development have a significant impact on developing the skill- sets of engineering students. Therefore, students need to engage in research publications in the field of nanotechnology. This process would enhance their critical thinking towards nanotechnology and also provide a new dimension towards the application of nanotechnology in engineering science.

5. Conclusion and Future Research

The present research has been carried out to understand the readiness of engineering students to undertake a course in nanotechnology. The study findings indicate that role of academic process and technical support are critical for the success of courses in engineering science. Students have also indicated that nanotechnology also offers illustrious career growth in engineering science. Career opportunities for engineering graduates in the domain of nanotechnology includes product design and development, chemical manufacturing and also in emerging technologies such as Industry 4.0.

However, the present study was confined to engineering students from a college which may act as a limitation for the study. Hence, to understand the holistic and specific role of nanotechnology in engineering science, future research would be worth understanding in specific area of engineering science like the perception of mechanical engineering, civil engineering, electrical and electronic engineering students .

Overall, the study results indicate that the inclusion of nanotechnology in engineering education provides better employment opportunities for engineering graduates. However, the right ecosystem with regards to nanotechnology is needed in engineering institutes.

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