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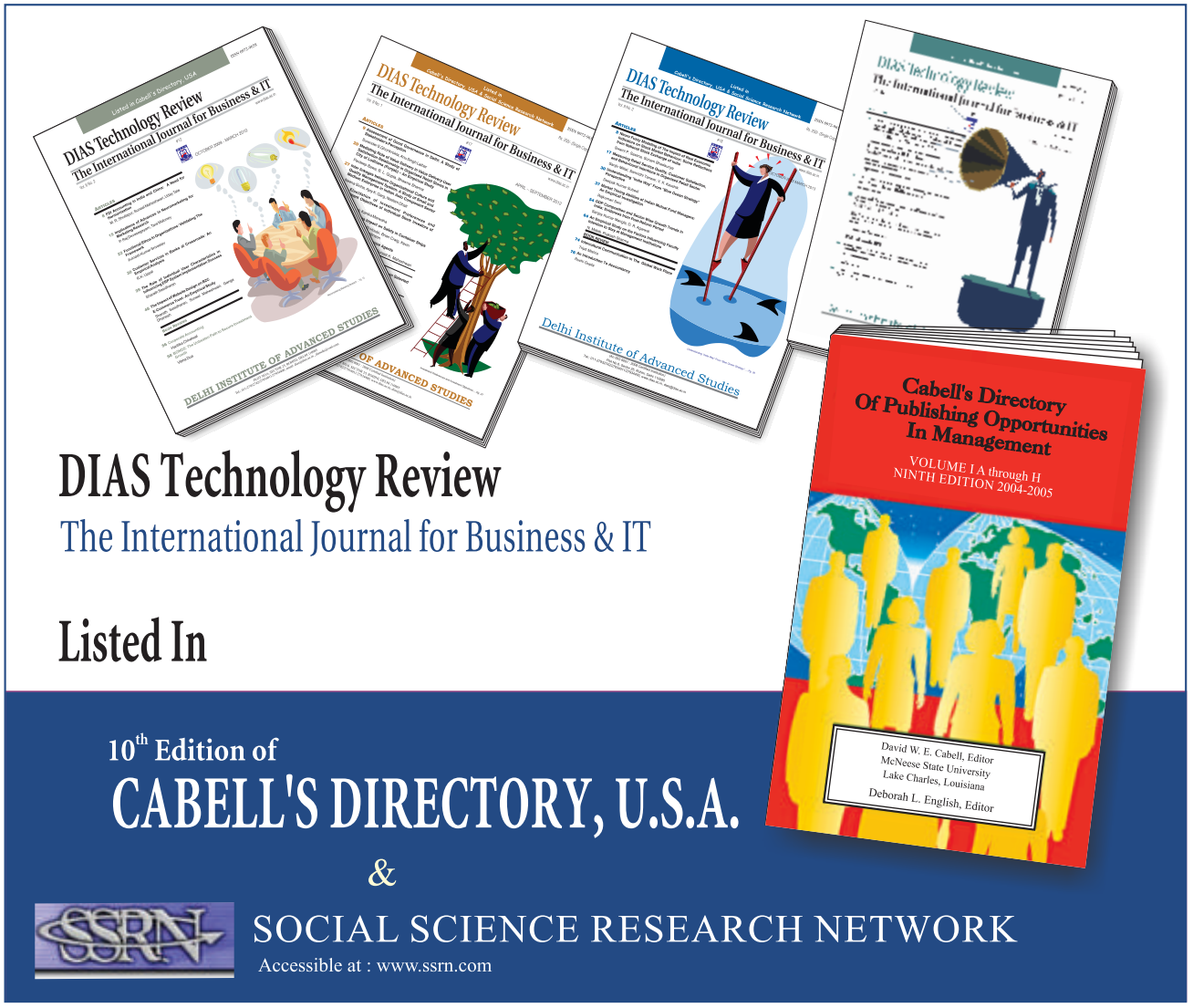
PLOT NO.6, SECTOR 25, ROHINI, DELHI 110085
Tel.: 011-27932742/27934011/27934400, www.dias.ac.in, dias@dias.ac.in



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37 **Status of Women Empowerment in India: A Conceptual Perspective**

Dr. Varsha PS, Dr. Gayathri Reddy, Dr. Basanna Patagundi, Dr. Uday Tate, Dr. Deepak Subedi

Women Empowerment movement and the society's ability to manage cultural, social, legal and economic challenges have been discussed in this research article.

46 **Empirical Analysis of the Stock Markets of BRICS Economies**

Ms. Tanuja Puri

The author has explored the relationship amongst the stock markets of the five emerging economies of the financially integrated world.

DOCTORAL ABSTRACT

54 **Development of Students' Academic and Employability Model through Data Mining**

Dr. Tripti Mishra

The researcher through a data-mining model has examined the academic performance of MCA students and their viability in job market.

From The Editor's Desk

It is our immense pleasure to present to our readers the 34th issue of DIAS Technology Review.

Financial integration of world economies under the wake of globalization has promoted economic trade, growth and prosperity, worldwide. The Stock markets and institutionalized formal exchanges, act like barometers to monitor the business trends of not only one country under study, but other associated countries as well. In the research article **An Analysis of Relationship between the US and Japanese Stock Market Over Time**, authors have tried to investigate an integrating relationship between the stock markets of US and Japan. The nature and strength of the relationship between Nikkei Index and the US market has been examined over two time periods to find a positive effect leading to higher unification. Similarly, in her study **Empirical Analysis of the Stock Markets of BRICS Economies**, the author by scrutinizing monthly price histories of BOVESPA Index, MOEX Russia Index, BSE Sensex, SSE Composite Index and JSE Index for BRICS economies, has delineated a strong relationship amongst them, which facilitates foreign institutional investors in better portfolio designing and diversifying investment risk.

To survive in competitive and volatile business environment today, a firm needs to identify its innovation capabilities, resources and strengths through an inside-out view. It must reconnoiter new product, new administrative practices or new strategies to gain competitive advantage. The article **Determinants of Innovation Capabilities at Firm Level: Auto Components Sector** highlights the key determinants of innovation capabilities present in an auto components cluster firm. Taking it further in the study **Exploring relationship between Personal Innovativeness, Technological Innovativeness, Gadget Lover and Technological Opinion Leadership among Millennials**, authors have tried to find out factors driving technological innovativeness and technological opinion leadership among millennials. Testing through a model, they have demarcated the mediating relationship of technological innovativeness between gadget lover and technological opinion leadership.

Along with innovation and technology, the operational efficiency and effectiveness of an organization propels its profitability and performance. In the research paper **Efficiency of Operations: Case Study of United Technologies Corporation**, authors using Johansen's cointegration and Granger's causality tests have highlighted the double-pronged effect of operational efficiency leading to cost effectiveness, quality enhancement and better operating performance of the organization.

The fruit of development should be savored by all, irrespective of gender, class and creed. It has been observed that women, especially in developing nations have been kept away from mainstream, mostly deprived to embrace financial independence, make their choices and decisions. But in recent times changes in government policies and legislations are contributing to Women Empowerment. In the article, **Status of Women Empowerment in India: A Conceptual Perspective**, authors have analyzed economic, political, social, legal, and psychological dimensions of women Empowerment in India. These will not only help their financial upliftment but will enhance women's contribution to the society.

This issue also has a doctoral abstract **Development of Students' Academic and Employability Model through Data Mining**, in which the author has quizzed upon the academic performance of students of an educational institute and their viability in job market. A prediction of academic performance and employability can help the management identify the students at the risk of remaining jobless. The author through classification algorithms of data mining has used predictive modeling for academic performance and employability of students.

In our attempt of enlightening our valued readers with up to date knowledge, we are confident that this new edition of DIAS Technology Review will, as usual, prove captivating and informative.

Regards,

Dr. Anju Batra

ABOUT THE CONTRIBUTORS

Prof. Mukesh Chaudhry

Dr. Mukesh Chaudhry is currently a Professor of Finance at Eberly College of Business and Information Technology, Indiana University of Pennsylvania. He has extensive experience in teaching graduate and undergraduate courses in the areas of investments, financial management, derivative securities, banking and financial institutions, and financial theory. His primary areas of research include market microstructure, options and futures markets, banking and institutions, investments, and portfolio analysis. He has co-authored a number of research papers examining the impact of macroeconomic news announcements on various interest-rate futures contracts. He has several publications in Journal of International Money and Finance, Journal of Banking and Finance (lead article), Financial Review, Journal of Financial Research, Journal of Derivatives, Journal of Empirical Finance, Journal of Real Estate Finance and Economics, Journal of Business, Finance, and Accounting, and Financial Practice and Education. He has received The Lewis College of Business outstanding researcher award at Marshall University (2001), and the outstanding faculty award by College of Business Student Advisory Council, Indiana University of Pennsylvania (2002).

Email: chaudhry@iup.edu

Prof. Rajendar K. Garg

Dr. Rajendar K. Garg is a Professor of Marketing at Eberly College of Business and Information Technology, Indiana University of Pennsylvania. He received his Ph.D. in Marketing from University of Massachusetts, Amherst. His primary research area is in the field of Affective and Attitudinal response to Advertising using varying types of affective cues under different cultural contexts. Recently, he has focused his work on E-Business/E-Commerce as a tool for globalization. His recent work has been published in journals, such as, Benchmarking: An International Journal, International Journal of Commerce and Management, Journal of E-Business and Services Marketing Quarterly. He has received several prestigious awards/scholarships from professional organizations including Senior Fulbright Scholarship to China for teaching/research. Recently, he was awarded Fulbright Senior Specialists grant to guide curriculum development in E-Commerce in China. During the three years, he co-authored two books, Bridging Digital Divide; and Enterprise Systems and Business Process Management: Global Best Practices; both of these were published by McMillan. He served as Editor of the Journal of E-Business for 5 years, and currently serves as Editor for the Journal of Digital Business. He has held several prestigious positions in professional organizations, such as, Program Chair for the International Digital Business Academy. He is currently serving as President of the Global Digital Business Society.

Email: Garg@Iup.Edu

Dr. Suneel K Maheshwari

Dr. Suneel K Maheshwari holds a Ph.D. Degree in Business Administration from Florida Atlantic University, USA. He also obtained his Master's in Accountancy from Miami University, Oxford, Ohio, USA. He was formerly, Professor of Accounting in the Division of Accountancy and Legal Environment, Marshall University, USA. At present, he is Professor of Accounting at Eberly College of Business and Information Technology, Indiana University of Pennsylvania, U.S.A. Dr. Suneel Maheshwari has also been a management consultant to many corporate-sector giants, like Holiday Inn and TCS. His research interests include Executive Compensation, Activity-based Costing, Ethical issues and interdisciplinary applications. He has around 30 years of experience in teaching, research and industry. He has also authored around 50 books and contributed over 40 articles in refereed national and international journals, besides attending/chairing several national and international conferences.

Email: suneel@iup.edu

Ms. Swadha Agarwal

Ms.Swadha Agarwal, is currently a research scholar at University School of Management Studies, GGS Indraprastha University, Delhi, India. Her research interests include innovation capabilities, innovation management, global competitiveness. She has published eight research papers in reputed journals of management and business studies. She was also selected as the sole candidate from GGSIPU, for the Erasmus Plus Mobility Program for 6 months at Slovak University of Agriculture, Nitra, Slovakia as a part of a research training program.

Email: Swadha90@gmail.com, swadha_usms2012@yahoo.com

Prof. R. K. Mittal

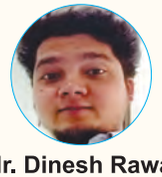
Dr. Raj Kumar Mittal, Vice Chancellor, Chaudhary Bansi Lal University is a noted economist and management educationist having thirty years of experience in teaching, research and academic administration. He has been the founder Vice Chancellor of Teerthanker Mahaveer University, Moradabad (2008-13), Director – Development & NAAC/UGC Co-ordinator (2014-18) and Dean, University School of Management Studies (2005-08) at Guru Gobind Singh Indraprastha University, Delhi. He has 110 research papers published in various national, international journals and conference proceedings. He has handled two consultancy projects and has organisedmore than fifty prestigious workshops/conferences. He has also co-edited six books on publication of proceedings of prestigious conferences in management and economics.

Email: dr123mittal@yahoo.com

Prof. Neena Sinha

Dr. Neena Sinha is Professor and Dean at University School of Management Studies, GGS Indraprastha University, Delhi, India. Her research interests include strategy, business excellence and development informatics. She has published over ninety research papers in journals such as International Journal of Information Management, Technological Forecasting and Social Change, Journal of Retailing and Consumer Services, Total Quality Management and Business Excellence and Management Decision. She has also authored two edited volumes and seven modules of Strategic Management. She is a member of Strategic Management Society.

Email: dr_neenashinha@yahoo.com, neena@ipu.ac.in



Mr. Dinesh Rawat

Mr. Dinesh Rawat is pursuing Ph.D from USMS. GGSIP University, Dwarka, Delhi, India. He has worked as Assistant professor at Delhi Institute of Advanced Studies. He is currently working as an Assistant Professor with the L.S.M. Government PG College, Pithoragarh, India. He has published more than 7 research articles in national and international journals and 7 research articles in conference proceedings.

Email: dini.rawa@gmail.com

Prof. Prashanth N. Bhardwaj

Dr. Bharadwaj is the architect and director of IUP's unique MBA program in India, offered in partnership with the PES institutions since 2005. His areas of research include production planning, inventory management, supply chain management, operations strategy, service quality, developmental entrepreneurship, and spirituality & learning in organizations. He has published nearly two dozen journal articles and presented over fifty conference papers.He was the 2001 recipient of IUP's Distinguished Research Award and the Best Applied Paper awards by the Small Business Institute in 2002 and 2004.He currently serves as the Editor/Associate Editor of four scholarly journals in the international management area–International J. of Commerce and Management, Competitiveness Review, Advances in Competitiveness Research, and Competition Forum.

Dr. Varsha

Dr. Varsha is research scholar in Cambridge Institute of Technology Bengaluru. Currently, she is working as an Assistant Professor in the Department of Management and has completed her Ph.D. from Visvesvaraya Technological University, INDIA. She has done her Master of Business Administration in Marketing Management and Human Resource Management from Bangalore University. She has done her graduation in Computer Science from Bangalore University, INDIA. She has been a part of Executive Education Programme –Strategic Management of Digital Technologies and Executive Education Programme-Empirical Methods in Operations Management at Indian Institute of Management (IIMB), Bangalore. She has 10 plus years of experience in academics and one year in industry. Her various articles got published in ABS ranked Journals, ABDC listed journal and Scopus Indexed Journal, Global research collaboration in US, Australia, Germany, UAE, France and London. Her areas of interest include Artificial Intelligence, Business Analytics, Digital Marketing, Social Media Marketing, Advertising Management, Branding Management, Social Business and Social Entrepreneurship

E-mail :smiracle2@gmail.com

Dr. Gayathri Reddy

Dr. Gayathri Reddy is Regional Director and Associate Professor at Visvesvaraya Technological University, Banglore. She has graduated in Commerce from St. Francis College, Osmania University, Hyderabad and did her Masters in Business Administration in Vignana Jyothi Institute of Management, Secunderabad, with HR & Marketing Specialization. She obtained Ph.D from University of Hyderabad in the area of Total Quality Management. In addition to that she has completed Diploma in Training & Development from Indian Society for Training and Development, New Delhi. She is a Certified Occupational Test User in Ability and Personality by the British Psychological Society and University of Cambridge, London.

Her areas of interest include Human Resource Management, Total Quality Management, and Marketing & General Management. She has presented more than 25 papers in National and International conferences. She has published nearly 30 papers in peer reviewed National and International Journals. She has contributed many chapters for ISBN Edited books related to Management.

She has undertaken many consultancy works as empanelled Independent Assessor of Karnataka Evaluation Authority (KEA), Government of Karnataka for the period from 2014 to 2020. She has been nominated by VTU as Nodal Officer for the State Centre on Universal Values from 26th May 2020.

E-mail: gayathrikumbham@yahoo.com

Dr. Basanna Patagundi

Prof. Basanna Patagundi is a MBA and PhD in Management. He has over fifteen years of Industry, Academic and Global Teaching Experience. His areas of interest are Application of Analytics, Technology Management, Strategic Management and Project Management. He was a Visiting Professor at Marshall University, USA and Mzumbe University, Dar-Es-Salaam, Tanzania. Earlier, he has worked with Honeywell Technology Solutions Lab, Bangalore, Bhavan-Marshall MBA Programme and M P Birla Institute of Management. His previous assignment was with CMR University, Bangalore where he worked as Director(i/c) for School of Management. He is with CiTech from March 2019 onwards. He has successfully completed three consultancy projects and has been invited speaker at various places on technology management and pedagogical tools. He has successfully set up IBM Business Analytics Lab at CMR University and is a certified trainer of IBM Cognos, SPSS and Big data infosphere. He is also a certified trainer in Marketplace Simulation. He was member and convener of Board of Studies, Member of Academic Council at CMR University, Bangalore.

E-mail: basanna.p@gmail.com

Dr. Uday Tate

Dr. Uday Tate received his Doctor of Business Administration in Marketing from the University of Tennessee-Knoxville in 1983. Currently he serves as tenured Professor of Marketing in the MGT-MKT-MIS Division and past Director of Executive MBA Program of the Lewis College of Business Marshal University, USA. His areas of teaching/research include global marketing, social marketing, consumer behavior, experiential education and learning.

E-Mail: tateu@marshall.edu

Dr. Deepak Subedi

Dr. Deepak Subedi received his Ph.D. in Manufacturing Management from University of Toledo in 2004. He joined Marshall University as a faculty of management in 2004. He is currently a Professor of Management and the Head of Division of Management and Health Care Administration. He has taught courses on business statistics, quantitative methods, operations management and supply chain management to undergraduate and graduate students. Dr. Subedi has published research on areas of applications of spreadsheet in teaching quantitative methods and supply chain, supply chain and risk management. He has participated in several conferences over the years and presented papers in areas of his research interest.

E-mail:subedi@marshall.edu

Ms. Tanuja Puri

Ms. Tanuja Puri is working as an Assistant Professor at Delhi Institute of Advanced Studies, college affiliated to Guru Gobind Singh Indraprastha University. She has done B.Com(H) from Daulat Ram College, University of Delhi and M.Com from PGDAV College, University of Delhi. She has cleared DOEACC 'O' Level examination from National Institute of Electronics and Information Technology, Ministry of Electronics & Information Technology, Government of India. Her areas of specialization are finance and international business. She has written papers for national & international conferences and journals as well.

E-mail: ganesh_ji21@rediffmail.com

Dr. Tripti Mishra

Dr. Tripti Mishra has completed her Ph.D. from Mewar University, Chittorgarh, India. Currently she is working as a Professor in Department of Management at Delhi Institute of Advanced Studies. Her diverse qualification includes B.tech. (Electronics and Telecommunication), M.tech (IT), PhD (Computer Science) and MBA. She also holds an International post graduate diploma in counselling skills. She has presented papers in national and international seminars and conferences. She has also published her research work in national and international journals which have got good citations.

mishratripti2007@gmail.com

An Analysis of Relationship between the US and the Japanese Stock Market Over Time

*Mukesh Chaudhry,
**Rajendar K. Garg
***Suneel Maheshwari

ABSTRACT

This study attempts to investigate and analyze whether there exists an integrating relationship between the stock markets of US and Japan. The nature and strength of the relationship and how it has changed over time is analyzed to study the linear paradigm that is often suggested. Theoretically, there is no reason to believe that the economic systems are intrinsically linear, however, the results show a surprisingly strong relationship over time.

Key Terms: *Return, Risk, Diversification, Japanese Stock Market, Contagion, Correlations*

*Professor of Finance, Indiana University of Pennsylvania, USA
** Professor of Marketing, Indiana University of Pennsylvania, USA
***Professor of Accounting, Indiana University of Pennsylvania, USA

INTRODUCTION

For the last few decades a considerable amount of research has been done to investigate long-term relationships between stock markets of US with many other international markets (Taylor and Tonks, 1989; Chowdhury, 1994; Kanas 1999; Chang and Caudill, 2006; Chang, Mo and Liu, 2009). Empirically, many studies show that financial time series such as stock prices exhibit non-linear dependencies (Barkoulas and Travlos, 1998). Since Japan has been a major trading partner of the United States since 1970s, spanning over a period of almost five decades, it is interesting to see the relationship between the stock markets of US and Japan. Japan continues to be a major trade partner of the United States even though the trade relationship between the two weakened, since the 1990s when China emerged as a leading player.

The purpose of this study is to investigate and analyze the relationship between US and Japanese stock markets over time as the trading relationship between these two countries changed over time. Specifically, interdependency and/or integrating tendencies between the stock markets is analyzed to reflect on the nature and strength of the relationship.

BACKGROUND LITERATURE

Relationships between the returns of national stock markets have been an important area of interest for business area academics and investors for over 30 years (Durand, Kee and Watson, 2001). Correlating international markets generally assumes that the observations are independent; however, this assumption does not hold based on a growing body of evidence presented in the literature. US stock market returns seem to influence the returns of other markets (Eun and Shim, 1989; Phylaktis, 1997; Ghosh, Saidi and Johnson, 1999; Arshanpalli and Kulkarni, 2001; Rafiqul et al., 2016). Ghosh et al. (1999) show that Japan is found to influence non-Japanese capital markets.

Previous research in the area of market interrelationships shows that markets do move together. For example, Eun and Shim (1989) investigated the international transmission mechanism of stock market movements by estimating a vector autoregression for nine markets using daily data from December 31st, 1979 to December 20th, 1985 and found that variations in the US are rapidly transmitted to other markets in a clearly recognizable fashion. Their research shows that the US market is the most influential and Japanese stock market acts like a follower in international stock markets.

To further study the expansive role of US and Japanese stock markets in influencing other international markets, Durand, Kee and Watson (2001) utilized the daily stock price indices of seven difference markets of Asia and Pacific Rim countries such as Australia, Hong Kong, Korea, Malaysia, Singapore, Taiwan and Thailand. Their results suggest that even though less developed markets are prone to take their lead from the US, the effect of the US market on Australian and Singapore markets was the strongest. The Japanese market also had a statistically significant impact on Hong Kong, Korea, Malaysia and Taiwan markets.

Ishii (2008) specifically used the time series of US and Japanese equity market indexes and found that the contemporaneous transmission from the US to Japanese markets is significant, but not from the Japanese to the US stock market.

This study uses the monthly data starting from January 1, 1988 to September 1, 2019 to analyze the nature and strength of US-Japanese stock market and how the relationship between these two markets has changed.

ODEL

Monthly data were obtained from Yahoo Finance for Nikkei, S&P 500 and Russell 2000 Index spanning time period from January 1, 1988 to September 1, 2019. Following model was used to compute monthly return mean, variance, skewness and kurtosis:

Monthly Return $r_t = (P_t - P_t\text{-}1) / P_t\text{-}1$

Monthly Mean $\alpha = (r_1 + r_2 + \ldots . r_N) / N$

Monthly Variance $\sigma^2 = \Sigma (ri - \alpha)^2 / (n-1)$

Monthly Skewness $sk^3 = n / (n-1)(n-2) \times \Sigma (ri - \alpha)^3 / \sigma^3$

Monthly Kurtosis

$k = n(n+1) / (n-1)(n-2)(n-3) \Sigma [(ri - \alpha) / \sigma]^4 - 3(n-1)^2 / (n-2)(n-3)$

The relationship between Nikkei Index and S&P 500 and Russell 2000 Index were identified using the following correlation model:

$$Correl(X,Y) = \frac{\sum (x-\bar{x})(y-\bar{y})}{\sqrt{\sum (x-\bar{x})^2 \sum (y-\bar{y})^2}}$$

Regression Model: Returns of Nikkei and S&P 500 Index and Nikkei and Russell 2000 were regressed with Nikkei Index return as the dependent variable.

rnikkei = a + b rSP500

rnikkei = a + b rRussell

ESULTS

Table 1 provides descriptive statistics for Nikkei, S&P 500 and Russell 2000 Index for overall data from January 1, 1988 to September 1, 2019 and two sub-periods. Sub-Period 1 covers data from January 1, 1988 to December 31, 2003 and Sub-period 2 covers data from January 1, 2004 to September 1, 2019.

Table 1 :Descriptive Statistics for Nikkei, S&P 500 and Russell 2000 Index

	Mean	Standard deviation	Skewness	Kurtosis
Nikkei				
Overall Period	-0.027	6.013	-0.573	1.225
Sub-period 1	-0.418	6.505	-0.271	0.354
Sub-Period 2	0.368	5.461	-0.996	2.818
S & P 500				
Overall Period	0.661	5.310	-0.764	1.737
Sub-period 1	0.781	5.380	-0.749	1.541
Sub-Period 2	0.539	5.249	-0.790	1.990
Russell 2000				
Overall Period	0.645	4.098	-0.782	1.777
Sub-period 1	0.767	4.232	-0.599	0.891
Sub-Period 2	0.521	3.966	-1.025	2.957

Overall Period covers data from January 1, 1988 to September 1, 2019.

From Table 1 it is evident that for the overall Nikkei 225 Index is more volatile than S&P 500 and Russell 2000 Index. Nikkei 225 Index is a price-weighted stock index in Japanese Yen for the Tokyo Stock Exchange consisting of companies from Foods, automotive, textiles and apparel, paper and pulp, banking, steel, insurance and other financial services, real estate, electrical machinery, warehousing, communication, electrical power, gas, shipbuilding and other services. This index has been very volatile as it stood at 38,957 on December 29, 1989. The current Index value as of September 19, 2019 is 22,044 which is much lower than its peak in 1989. As of March 10, 2009, this index reached the bottom at 7,055 about 82% below its peak. Obviously, this index has average-values that are negative for the overall period (January 1, 1988 to September 1, 2019) and sub-period 1 which covers time period from January 1, 1988 to December 31, 2003. The Index however became positive for the second sub-period spanning from January 1, 2004 to September 1, 2019. This index is negatively skewed and kurtotic for the second sub-period. However, stocks were less kurtotic for the first sub-period.

S&P 500 Index is a stock market index of 500 large US companies and has generated an average return of about 9.8 percent since its inception in 1926. As expected, this index has witnessed volatility over different time periods. For the overall period, the mean monthly return is 0.661. Unlike Nikkei Index, the returns were higher for the first sub-period when compared to the second sub-period. But, volatility for the first sub-period is slightly above the second sub-period. For all periods, S&P 500 displayed negative skewness. Hence, there is a greater tendency for the stocks to decline than to go up. The excess kurtosis is higher for the second period implying tendency for the stocks to either generate high positive or negative returns. On the other hand, Russell 2000 Index which is a benchmark for small capitalization US small stock returns is maintained by FTSE Russell, a subsidiary of London stock Exchange. The weighted average market capitalization of the companies in this index stood at $2.43 billion. Nikkei225 index has displayed elevated negative skewness and excess kurtosis for the second sub-period. Its average values are significantly higher for the first sub-period when compared against second sub-period. Surprisingly its monthly volatility is much less than both Nikkei and S&P 500 index.

Correlation analysis is shown in Table 2 between Nikkei and the two US indices S&P 500 and Russell 2000. As expected, the correlation is very high (0.83) between S&P 500 and Russell 2000. With the Japanese market the correlation between S&P 500 stood at 0.409 for the first sub-period but it became much higher at 0.656 for the second sub-period implying that Japanese stock market became more highly correlated with the US equity market. Similar results can be seen if we examine correlation between Nikkei and Russell 2000 Index.

Table 2 : Correlation Analysis between Nikkei, S&P 500 and Russell 2000 Index

	Nikkei	S&P 500	Russell 2000
Overall Period			
Nikkei		0.515	0.535
S&P 500	0.515		0.810
Russell 2000	0.55	0.810	
Sub-Period 1			
Nikkei		0.409	0.418
S&P 500	0.409		0.738
Russell 2000	0.418	0.738	
Sub-Period 2			
Nikkei		0.656	0.696
S&P 500	0.656		0.889
Russell 2000	0.696	0.889	

Overall Period covers data from January 1, 1988 to September 1, 2019. Sub-Period 1 covers data from January 1, 1988 to December 31, 2003 and Sub-period 2 covers data from January 1, 2004 to September 1, 2019.

From Table 3 we can see the bivariate regression results with Nikkei Index as the dependent variable. Although the Nikkei Index comprises 225 biggest Japanese companies, however, out of the two sub-periods the Nikkei Index displays a stronger relationship with Russell 2000 Index with R-square that stood at 47%. Even with S&P 500 Index, the relationship is stronger as the R-square went up to 30% versus 17% in the previous period.

Table 3 : Regression Analysis between Nikkei as Dependent and S&P 500 and Russell 2000 Indices as Independent Variables

S&P 500	Coefficient	t-stat	Russell 2000	Coefficient	t-stat
Overall Period					
Constant	0.673	2.88	Constant	0.880	3.15
Nikkei	0.455	11.69	Nikkei	0.272	6.32
F-stat		136.72	F-Stat		39.90
R-Square		0.27	R-Square		0.29
Sub-Period 1					
Constant	0.922	2.59	Constant	0.654	3.68
Nikkei	0.339	6.16	Nikkei	0.365	12.32
F-stat		38.05	F-Stat		39.90
R-Square		0.17	R-Square		0.17
Sub-Period 2					
Constant	0.203	0.47	Constant	0.495	1.68
Nikkei	0.519	5.61	Nikkei	0.499	7.86
F-stat		31.48	F-Stat		61.80
R-Square		0.31	R-Square		0.47

Overall Period covers data from January 1, 1988 to September 1, 2019. Sub-Period 1 covers data from January 1, 1988 to December 31, 2003 and Sub-period 2 covers data from January 1, 2004 to September 1, 2019

ONCLUSION

The relationship between the US and the Japanese markets has been analyzed over two time periods. The Japanese market during the two sub-periods starting from January 1, 1988 to December 31, 2013 and January 1, 2004 to September 1, 2019 has witnessed major changes due to aging of population and emergence of China in the second sub-period. As a result, although Nikkei Index has not regained its past glory, but the index has shown improved performance in the recent time period. This is primarily due to favorable Japanese monetary and fiscal policy. This is one of the explanations why the Nikkei Index has become more correlated with the US market in the second sub-period. In the first sub-period however, the Japanese market was less correlated with the US markets. This implies that the Japanese monetary and fiscal policies have had a positive effect on their stock market leading to higher integration with US stock market.

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Determinants of Innovation Capabilities at Firm Level: Auto Components Sector

*Ms. Swadha Agarwal
**R. K. Mittal
**Neena Sinha

ABSTRACT

Firm characteristics are defined by rapid changes, extensive impact of globalisation, hyper innovative competitors, etc and recent studies have stipulated that one of the most dynamic capabilities that leads to strongest level of competitiveness in any organisation is innovation capability. A firms' capabilities are important in providing and sustaining its competitive advantage, and in the implementation of the entire strategy. As innovation is becoming increasingly complex, therefore a wide variety of assets, resources, and capabilities are required to make such innovation capabilities successful. Therefore, innovation capability should be defined in a wide disperse scopes and levels in order to accord with the requirements of firm strategy and accommodate to the special conditions and competition environment. The need of the hour is, that many organisations have now begin to focus on the need to identify innovation capabilities, resources and strengths through an inside-out view. Innovation capabilities are not necessarily defined by a new product or service, but also through new administrative practice or process, new strategies in place to improve process performance, etc. The objective of this research paper is to identify key determinants of innovation capabilities present in an auto components cluster firms.

Keywords: *Technological innovation capabilities, Auto component cluster, Firm level innovation capabilities*

*Research Scholar, USMS, GGSIPU, Delhi, India
**Professor, USMS, GGSIPU, Delhi, India
***Professor, USMS, GGSIPU, Delhi, India

INTRODUCTION

Owing to the rapid changes in the international trade and the recent developments of the World Trade Organisation, industries worldwide are forced to face a new era of intense global competition. With the increase in level of competition, there arises a need to continuously adapt, develop and innovate to attain organisational excellence. Without the capability to adapt and innovate with change in a dynamic environment, businesses tend to stagnate and go out of business. Multiple studies have shown that a positive impact can be measured due to the presence of technological innovation which thereby enhances the competitiveness of firms [Dierickx and Cool, 1989; Guan, 2002]. So far we have seen a growing amount of interest from industry, academics and governments on how innovations could be better managed. For example, the UK Department of Trade and Industry (DTI) finds technical innovation as one of the drivers of national competitiveness and explore means to encourage companies to develop and improve their innovation management processes and performance.

With the changing technology scenario, global competition, with increasing customer needs and expectations, the product life cycles have gone shorter. Firms are now needed to adapt to dynamic market structure and have the capability to effectively respond with the innovative outputs in order to stay in the market, provide a sustainable competitive advantage, and to be able to maintain and increase their market share. To accomplish all these tasks, innovativeness is imperative. Innovation is defined from a broad viewpoint that consists of both new business conduction methods and new technologies. Innovation does not describe quantifying and commercializing a technologically significant improvement (radical innovation) alone, but also aims to focus on small scale improvements in technological knowledge (incremental innovation). While technology can be defined through the means of information, organisation and techniques needed for the manufacturing of a product/ service, it can also be viewed as the ending source of the knowledge, capabilities and tools required for monitoring the production factors in order to produce, maintain and distribute to the users, the economic and/or socially demanded products and services [Robock, 1980]. Therefore, innovation and technology, are critical for developing basic capabilities and putting in place a mechanism that effectively transforms input to output in the industry. [Tirupati, 2008].

A firm's competitive advantage stems from the capability and efficiency of new product developments [Lawless &Fisher 1990 ; Guan,2002]. The improvement in product innovation is accounted for due to the accumulation of capabilities and contributed to innovation outputs. In majority of the cases, high performance firms would prove to have stronger capabilities in comparison to the low performance firms. Innovation capability is the skills and knowledge needed to effectively absorb, master and improve existing technologies, and to create new ones [Lall, 1992]. Technological innovation capability (TIC) is a comprehensive set of characteristics of an organization that facilities and supports its technological innovation strategies [Burgelman, &Wheelwright, 2004]. They are a kind of special assets or resources that include technology, product, process, knowledge, experience and organization [Guan & Ma, 2003].

There have been multiple approaches to audit a firm's Innovation capabilities. For instance, Christensen [1995] defined IC in terms of science research asset, process innovation asset, product innovation asset and esthetics design asset. Chiesa et. al. [1996] applied 2 methods to measure innovation capability of a firm- through a process audit and a performance audit. The process audit focused on the individual processes necessary for innovation which includes concept generation, process innovation, product development, technology acquisition, leadership, resourcing, system and tools. Drawing from various literature, Yam et al. [2004] designed an empirical survey on technological innovation for firms in manufacturing in the region of Beijing [Guan et al., 2005, 2006; Guan and Ma, 2003]. This survey incorporated the findings of innovation capability studies [OECD, 1992;1997] which has measured the technological innovation capabilities (TIC) that each technological capability represents a separate business function of an organization (i.e. R&D, manufacturing, and marketing capabilities) or a cross-functional business process (i.e. learning, organizing, strategic planning, and resource allocation capabilities).

The aim of the following paper is to identify the key determinants of Innovation Capabilities at firm level. We conducted a survey on 165 firms within the auto components cluster in Gurgoan-Manesar in Haryana. The respondents were asked to identify the key areas that would constitute the innovation capabilities of the firm.

EVIEW OF LITERATURE

Innovation Capabilities

In recent times, a competitive business environment push firms to enhance their capabilities for working on and commercializing newer technologies, while staying ahead of their competitors is also facilitating the process of innovation and diffusion of internal innovation for strengthening competitive advantage. In this working environment, if the firms lacks the ability to innovate it can cause business stagnation and eventually going out of business [Yam et al, 2004]. Scholl [2005] stipulates that without the presence of innovation, a firm cannot seek growth and competitiveness. The evolution of resource-based view (RBV) in management and economics resulted in the development of the concept of technological innovation capability (TIC). Based on RBV, output discrepancies between firms are resulted from discrepancies in valuable, rent-generating, and difficult to be substituted resources or so called capabilities [Hamel & Prahalad, 1994]. In order to stay consistent and compete for new products, firms should aim at developing their own TIC. By developing their own TIC, it proves to be helpful for firms to enhance their competitive performance [Romijn & Albaladejo, 2002]

TIC (Technological Innovation Capabilities) are defined by Burgelman et al. [2004] as a comprehensive set of characteristics of an organization that facilitates and supports its technological innovation strategies. They are a special kind of assets or resources that include product, technology, assets, or knowledge, experiences, and organisation [Guan and Ma,

2003]. Lall [1992] states TIC as the knowledge and skills required to effectively absorb, master, and improve already existing technologies, and to focus on creating new ones. Evangelista et al. [1997] states that R&D activities are a central component of the technological innovation activities within a firm and considers it as the most essential intangible innovation expenditure. It is also observed that successful technological innovation does not only depend on technological capability, but it also requires to focus on other innovation capabilities in terms of manufacturing, organisation, marketing, strategy planning, resource allocation and learning [Yam et al., 2004; Romijn and Albaladejo, 2002]. As stated by Adler and Shenbar [1990], four types of TICs are identified, including:

(1) The capacity of satisfying market requirement by developing new products.

(2) The capacity of manufacturing these products by using appropriate process technologies.

(3) The capacity of satisfying future needs by developing and introducing new products and new process technology.

(4) The capacity to respond to an unanticipated technology activity brought about by competitors and unforeseen circumstances.

The above-mentioned capabilities already exist within a firm.

In the words of Peteraf [1993] a firm's heterogeneous resource portfolios (including human, capital, and technology resources) are accountable for observed variability in its financial returns. These are defined as a firm's specific capabilities that contribute extensively to the sales growth and competitive advantage. There would have to be a causal connection between a firm's resources and performance. Dierickx and Cool [1989] state that a firm must either strive to imitate high performing resources or should develop alternative capabilities that could reap similar results. Therefore, the development and improvement of TIC as a key resource of a firm, can prove to be competitively advantageous to a firm [Guan and Ma, 2003]. For example, Lawless and Fisher [1990] found that successful technological innovation helps firms to gain market position and realize more long-term returns and, Yam et al. [2004] found that TIC is positively related to the introduction of new product and innovation in sales.

A Study Framework for Innovation Audit

Drawing on the existing literature on innovation management, there has been some research to audit technical innovation. Studies which identified characteristics of technically progressive firms and factors associated with success or failure in innovation contributed to the audit framework to be developed. Cooper [1980; 1996] identified 3 variables to define innovation, namely- the nature of the product, the market environment and the existence of potential product–technology synergy. A concise summary of key factors that are identified in many innovation management studies, was provided by Rothwell [1992], which are highlighted below-

- Good internal and external communication.
- Providing good technical service to customers.
- Treating innovation as a corporate wide task.
- Strong market orientation.
- Presence of certain key individuals as technological gatekeepers.
- Efficiency in development work and high quality production.
- Implementing careful planning and project control procedures.
- High quality management.

Cooper (1996) further established that there were three critical success factors for drivers of new product performance:

- A clear and well-communicated new product strategy.
- High quality new product process.
- Adequate resource commitment.

A vast variety of researchers adopted multiple perspectives and components to audit a firms's TIC. For example, Burgelman et al. [1988] stated five dimensions while defining the innovative capabilities audit framework:

- Resource availability and allocation.
- Capacity to understand competitor's innovative strategies and industry evolution.
- Capacity to understand technological developments.
- Structural and cultural context.
- Strategic management capacity.

Christensen [1995] segregated the TIC's into product innovation asset, process innovation asset, science research asset and aesthetics design asset. These assets correlate with internal accumulation, experimental acquirement, and disquisition. A firm's competitiveness roots in its possession of special assets and resources that are valuable, heterogeneous, and difficult to be imitated and substituted. These would safeguard the firms' position in the areas of strategy and technology management. Bobe and Bobe [1998] manifested a checklist method to benchmark innovation processes and practices in three European Union countries, namely, Germany, the UK and France. Similar to that advocated in the OSLO manual (OECD, 1997), the method addresses:

- The national innovation systems context.
- Management of human resources
- Innovation and firms' strategy.
- Global innovation trends.
- Organizational structures and the organizational moves linking production, marketing and design.
- Origin of technological resources.

A technical innovation audit framework encompassing several main parts, such as technology acquisition, product development, leadership, process innovation, product innovation, and resourcing, was given by Chiesa et al. [1996]. That framework focused on core processes and enabling processes to delineate technological innovation. However, as Chiesa et al.'s (1996) suggest, more evidences are needed to test the validity of the framework (e.g. overlapping between product innovation and development). Other areas such as learning, organizing, and strategic planning that were important for a firms' innovation capability should also be stressed.

Determinants of Innovation Capabilities

Multiple researchers have defined the determinants of innovation capabilities within a firm.

Learning capability is a firm's ability to identify, assimilate, and exploit knowledge from the environment. It is the firm's ability to internalize new knowledge essential to gain competitive advantage [Guan & Ma, 2003).]

R&D capability refers to a firm's ability to integrate R&D strategy, project implementation, project portfolio management, and R&D expenditure. The firm develops new products by using new approaches and technologies (Guan & Ma, 2003)

Resources allocation capability is a firm's ability to acquire and to allocate appropriately capital, expertise and technology in the innovation process. It is also the firm's ability to compile appropriate resources for innovation process (Yam et al., 2004)

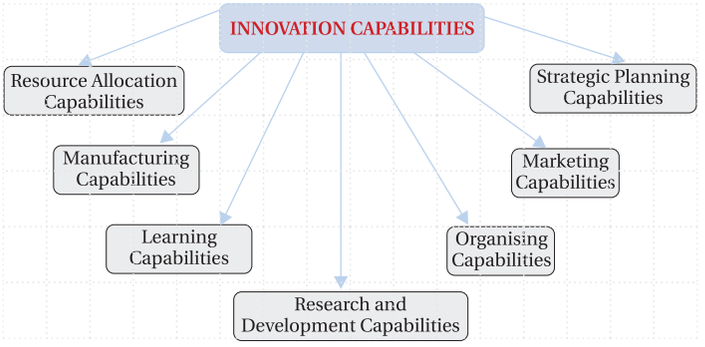
Manufacturing capability refers to a firm's ability to transform R&D results into products, which meet market needs, accord with design request and can be manufactured. It is also the firm's ability to produce products to adapt market conditions by using R&D outputs (Yam et al., 2004).

Marketing capability is a firm's ability to publicise and sell products on the basis of understanding consumer needs, the competitive environment, costs and benefits, and the acceptance of the innovation. It focuses on the firm's ability to make a difference in marketing activities in order to differentiate own's products (Cheng & Lin, 2012).

Organising capability refers to a firm's ability in securing organizational mechanism and harmony, cultivating organization culture, and adopting good management practices. The firm must organise all activities in order to speed up innovation processes (Guan & Ma, 2003)

Strategic planning capability is a firm's ability to identify internal strengths and weaknesses and external opportunities and threats, formulate plans in accordance with corporate vision and missions, and adjusts the plans for implementation. It is also the ability of the firm to make strategic plans which is compatible with firm's vision and mission by taking into consideration firm's specifications objectively (Yam et al., 2004).

Figure 1. Proposed Research Model



Source: Yam et al., 2004

OBJECTIVE OF THE STUDY

To explore and confirm the determinants of innovation capabilities of companies in auto component cluster sector.

RESEARCH DESIGN

The auto component cluster was identified through the cluster observatory as the Gurgoan- Manesar cluster. The sampling frame was developed by enlisting firms registered in the database of various directories such as the Gurgaon Udyog Association, Industrial Development Association, Gurgaon Industrial Association, Manesar Industries Welfare Association, Gurgaon Chamber of Commerce and Industry.

In order to ensure a high level of content validity, three academic staff in the field of technological innovation were consulted in advance in order to improve the survey instrument. A pre-test was then carried out with a convenience sample of 10 managers working in auto component industries in the Gurgaon cluster region. They were requested to complete the questionnaire and give their comments on the clarity and the appropriateness of the items in the formulated questionnaire. Simple statistical analysis were used to test the reliability of the scales. The readability of items measurements was confirmed. The results of the pilot test kept the questionnaire concise (Dillman, 1978). The revised questionnaire was sent to the targeted companies by post.

SAMPLING TECHNIQUE

Since the nature of study was purely exploratory in nature, a structured questionnaire was served to middle level and senior level employees. A web-enabled version of the questionnaire was developed and sent through mails, by tracking the LinkedIn profiles of the Director of engineering, the R&D manager, Engineering managers, HR managers and Communication Managers, the websites of the companies and few of them were contacted telephonically. We used convenience sampling technique for this study. A total of 344 firms were identified, that worked exclusively and extensively in the auto component sector, and then they were

contacted. Out of these 165 firms responded back and contributed in the study. The targeted respondents included the owner(s), the general manager, the director of engineering, the R&D manager or the engineering manager. In the sampling frame there were:

90 small sized firms, 71 medium sized firms and 4 large sized firms. We received a total of 307 responses from these firms, in which 145 responses were from small sized firms, 142 responses were from medium sized firms and 20 responses from large sized firms. Out of the 307 responses collected, a total of 300 responses were valid and could be used for analytical purposes. In the identified clusters, majority of the small sized firms did not have a clear distinction between the top and middle level managers. In such scenarios, the firm owner was contacted as the decision-making power in terms of technology and research, resided with him.

managers of the sample auto component cluster companies on a 5-point Likert Scale (1: Strongly disagree; 2: disagree; 3: neutral; 4: strongly agree; 5: strongly agree). Likert scales were used for all applicable items. Higher scores denote a higher ability in the IC. The scales of measuring innovation capabilities were adopted from Yam et al. (2004). The seven Innovation Capabilities (IC)'s including strategic planning , learning, research and development, resource allocation, organising, manufacturing and marketing capability were revised and then enlisted into the questionnaire.

The items for designed to measure the determinants of innovation capabilities are enlisted in Table 1. There are 26 items in the questionnaire.

Table 1. Dimensions For Measuring Innovation Capabilty

Your company encourage work teams to identify opportunities for improvement	IC1
Your company systematically monitors technology development trends	IC2
Your company has the capacity to assess technologies relevant to firm's business strategies	IC3
Your company has high-level integration and control of the major functions with the company	IC4
Your company has good coordination and cooperation of amongst all the department such R&D, marketing and manufacturing	IC5
Your company can handle multiple innovation projects in parallel	IC6
Your company trains for human resources in programmed phases	IC7
Your company selects key personnel in each functional department into the innovation process	IC8
Your company provides steady capital supplement fo innovation activity	IC9
Your company has flexibility and diversity of capital origins	IC10
Your company adjusts the production process according to the requirement of R&D process designing	IC11
Your company has capable equipment operating skilled manufacturing personal	IC12
Your company has system in place for continuous improvement of existing manufacturing system	IC13
Your company selects and tests innovation ideas, product concepts, product prototypes and customer preferences according to customer requirements competitive goals	IC14
Your company has an effective marketing intelligence system	IC15
Your company tracks customer satisfaction levels	IC16
Your company links the R&D plans to the corporate plan and technoloy competence	IC17
Your company has cross sectional screening of R&D project plans	IC18
Your company establishes project targets, phase standards and project managing regulations	IC19
Your company is highly adapted and responsive to changes in external environment	IC20
Your company has accurate connection between technological strategy and business strategy	IC21
Your company has high capability in identifying external opportunities and threats	IC22
Your company has high capability in identifying internal strengths and weaknesses	IC23
Your company has a clear road map	IC24
Your company adopts accessed knowledge into your daily activities	IC25
Your company provides after sales service and technological assistance	IC26

Source: Yam et al, 2004.

DATA ANALYSIS

A total of 26 dimensions were selected based on literature. The information was collected through a sample of 300 middle and high level

SCALE VALIDITY AND RELIABILITY

Following the data collection, the measures were subjected to a purification process to assess their reliability, content validity, convergent validity, discriminant validity and scale dimensionality (Gerbing and Anderson 1988; Akgün et al., 2007; Alegre and Cheeva, 2008). The ratio of the true score's variance to the observed variable's variance indicates

reliability. The studies in the literature does not recommend the use of the Cronbach's alpha coefficient in isolation to evaluate the reliability of a measurement scale, our study following Alegre and Cheeva (2008), evaluate reliability through three indicators including; the Cronbach's alpha coefficient, Composite Reliability (CR), and Average Variance Extracted(AVE).

ONTENT VALIDITY

When the phenomenon to be observed is communication, then content analysis is an appropriate method (Malhotra and Birks, 2006). As per Malhotra and Birks (2006), content analysis includes observation as well as analysis where the unit of analysis may be words, characters or themes; they also stated that it is one of the classical procedures for analysing textual material in qualitative research. Content analysis involve the following steps, firstly, giving words, sentences and paragraphs meaning then secondly, the researcher codes the text into various themes and finally those themes can be quantified as to how frequently specific themes appear and in what context in the text (Kvale, 2007). Researcher can decide the themes before analysing the text or new emerging themes can also be added to it.. Content validity is not evaluated numerically rather it is subjectively judged by the researchers. In this study, the developed instrument have content validity since selection of measurement items were based on detailed evaluation by academicians, firm owners and managers.

The 26 dimensions were reduced to 23 after content analysis and successful pilot testing. Maximum likelihood method was used with promax rotation and generated four components with eigen values above 1. The clubbed items in Seven components along with their factor loadings and the Cronbach alpha values are shown in the table 3 below:

Table 3. IC Dimensions with Factor Loadings and Cronbach Alpha Values

IC Dimensions	Variables	Factor Loadings	Cronbach Alpha Values
IC-LC	IC3	0.811	
	IC1	0.697	0.758
	IC2	0.668	
IC-OC	IC6	0.835	
	IC5	0.82	0.774
	IC4	0.753	
IC-RAC	IC9	0.859	0.871
	IC8	0.802	
	IC7	0.787	
	IC10	0.78	
IC-MFC	IC13	0.852	0.8
	IC12	0.843	
	IC11	0.64	
IC-MKC	IC15	0.885	0.88
	IC16	0.88	
	IC14	0.815	
IC-RDC	IC18	0.908	0.889
	IC17	0.831	
	IC19	0.824	
IC-SPC	IC21	0.83	0.814
	IC20	0.719	
	IC22	0.707	
	IC23	0.646	

Source: Ownresearch

It can be observed that Cronbach's alpha coefficients of all constructs are more than 0.7, which is a very acceptable amount for reliability of construct (Kline, 1998) .After the internal reliability of the construst, a diagram depicting the preliminary measurement model was designed. The model displayed 23 measured indicator variables and 7 latent variables which were subject to CFA with AMOS22, a computer program through which all interactions between variables represented in the conceptual model are captured and examined as a single statistical test.

The latent variables were identified and defined as follows:

1. The dimensions IC3, IC2, IC1 were combined together under the factor titled **"IC_LC"** which comprised of the **Learning Capabilities** under the innovation capabilities of the firm.

2. The dimensions IC6, IC5, IC4 were clubbed together under the factor titled **"IC_OC"** which comprised of the **Organising Capabilities** under the innovation capabilities of the firm.

3. The dimensions IC9, IC8, IC7 and IC10 were bundled together under the factor titled **"IC_RAC"** which comprised of the **Resource Allocation Capabilities** under the innovation capabilities of the firm.

4. The dimensions IC13, IC12, IC11 were combined together under the factor titled **"IC_MFC"** which comprised of the **Manufacturing Capabilities** under the innovation capabilities of the firm.

5. The dimensions IC15, IC16, IC14 were clubbed together under the factor titled **"IC_MKC"** which comprised of the **Marketing Capabilities** under the innovation capabilities of the firm.

6. The dimensions IC18, IC17, IC19 were combined together under the factor titled **"IC_RDC"** which comprised of the **Research and Development Capabilities** under the innovation capabilities of the firm.

7. The dimensions IC21, IC20, IC22 and IC23 were combined together under the factor titled **"IC_SPC"** which comprised of the **Strategic Planning Capabilities** under the innovation capabilities of the firm.

ONFIRMATORY FACTOR ANALYSIS

Confirmatory factor analysis (CFA) is a multivariate statistical procedure that is used to test how well the measured variables represent the number of constructs. In CFA, convergent and discriminant validity examine the extent to which measures of a latent variable shared their variance and how they are different from others. It is a process that decreases a large number of variables into a smaller set of variables. It ascertains underlying dimensions between

measured variables and latent constructs, thus allowing the construction and refinement of theory [Kline, 1998].

CONVERGENT VALIDITY OF CONSTRUCT

The average variance extracted (AVE) and composite reliability (CR) were measured to assess convergent validity of the measurement. AVE measures the level of variance captured by a construct versus the level due to measurement error, values above 0.7 are considered very good, whereas, the level of 0.5 is acceptable. For Composite reliability values above 0.7 are considered good and acceptable. Based on table 5, the AVE of all constructs exceed exceeded the acceptance threshold value of 0.5 and the CR of all constructs exceeded the threshold value of 0.70 (Hair et al., 2010). Therefore, as the average variance values are well defined, we can state that the current data has acceptable convergent validity.

DISCRIMINANT VALIDITY OF THE CONSTRUCT

Discriminant validity refers to the extent to which factors are distinct and uncorrelated. It determines whether the constructs in the model are highly correlated among them or not. The rule is that variables should relate more strongly to their own factor than to another factor. It explains the extent to which the items/indicators of one factor are more related to each other, than the items/indicators of other factors in the model. The discriminant validity is ascertained through AVE (Average Variance Explained), MSV (Maximum Shared Variance) and ASV (Average Shared Variance). For discriminant validity to hold true the following conditions must be met:

- AVE> MSV
- AVE> ASV

Table 4. Goodness of Fit Model for Determinants of IC

Metric	Value	Base Value	Acceptance
CFI (Comparative Fit Index	0.926	≥ 0.9	Acceptable
AGFI (Adjusted Goodness of Fit Index	0.84	≥ 0.9	Acceptable
RMSEA (Root Means Square of Approximation)	0.054	≥ 0.08	Acceptable
RMSR (Root Mean Squared Resideual)	0.089	≥ 0.08	Acceptable
NFI (Normal Fit Index)	0.875	0 to 1	Acceptable

Source: Kline, 2005; Hooper et al., 2008.

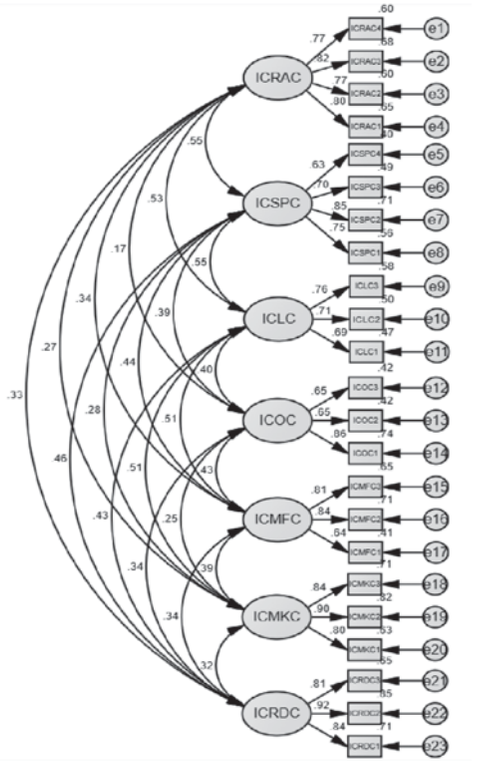


Figure 2. CFA Model for Determinants of IC

- Square root of AVE greater than inter-construct correlations: It compares the Square Root of AVE of a particular construct with the correlation between that construct and the remaining other constructs. The value of Square Root of AVE should be higher that the correlation.

As depicted in Table 5, for all the seven constructs, i.e. IC_MKC, IC_LC, IC_SPC, IC_RDC, IC_RAC and IC_MFC, the AVE values are greater than both their respective MSV and ASV values. Moreover, the square root of AVE which is depicted in bold in the diagonal matrix line for each construct, is higher than the inter-correlation values with other constructs (also depicted in the table below each construct). Therefore, it can be clearly stated that the items of one construct are not correlated with the items of remaining other constructs. Hence, discriminant validity holds to be true.

The principal task in CFA model was to determine the goodness of fit between the hypothesized model and model determined by the sample data. The adequacy of model fit was evaluated using the CFI (Comparative Fit Index), AGFI (Adjusted Goodness of Fit Index), RMSEA (Root Mean Square of Approximation), RMSR (Root Mean Squared Residual) and NFI (Normal Fit Index). The preliminary model was amended to improve the model fit. Modification indices and standardized residuals calculated throughAMOS22 were used to modify the model resulting in the final model.

The table with all the values is below:

Table 5. CFA Analysis for Determinants of IC

IC Determinants	CR	AVE	MSV	ASV	ICMKC	ICRAC	ICLC	ICSPC	ICOC	ICMFC	ICRDC
ICMKC	0.885	0.719	0.261	0.120	**0.848**						
ICRAC	0.872	0.630	0.301	0.153	0.269	**0.794**					
ICLC	0.762	0.517	0.308	0.243	0.511	0.535	**0.719**				
ICSPC	0.823	0.540	0.308	0.209	0.281	0.549	0.555	**0.735**			
ICOC	0.767	0.528	0.186	0.118	0.245	0.170	0.401	0.394	**0.727**		
ICMFC	0.811	0.591	0.258	0.170	0.387	0.342	0.508	0.444	0.431	**0.769**	
ICRDC	0.894	0.739	0.213	0.140	0.316	0.334	0.430	0.462	0.339	0.338	**0.860**

Source: own research

The model fit of the final model with all the indices' values beyond the threshold limits is indicative of the fact that the model is offering an adequate approximation of empirical data, hence it is acceptable. The standardized factor loadings of the dimensions of IC determinants (IC_LC, IC_OC, IC_RAC, IC_MFC, IC_MKC, IC_RDC, IC_SPC) ranged from 0.646 for IC_23 to 0.908 for IC_18.

Table 6 depicts the mean values and standard deviation values of the determinants of innovation capabilities.

within a firm. We proposed the seven innovation capability dimensions, which are thought to influence, export growth of firms, and then analyze the survey data from the 165 industrial firms. Traditionally, only R&D activities are considered by practitioners to be a major focus of innovation. Recently, other previous researchers have found that by emphasizing on R&D alone and by investing on R&D activities heavily cannot sustain innovation performance and firm's competitiveness (Yam et al., 2004; Guan and Ma, 2003).This study theoretically

Table 6. Descriptive Statistics

IC Determinants	N	Minimum	Maximum	Mean	Std. Deviation
ICOC	300	1.0000000000001000	5.0000000000001000	3.981111111111208	.898827980145209
ICMFC	300	1.0000000000001000	5.0000000000001000	3.827777777777877	.935869437535312
ICMKC	300	1.0000000000001000	5.0000000000001000	3.815555555555656	1.087093067107947
ICRDC	300	1.0000000000001000	5.0000000000001000	3.696666666666769	1.224755490959299
ICSPC	300	1.00	5.00	3.5650	1.09725
ICLC	300	1.0000000000001000	5.0000000000001000	3.395555555555653	.899553270083548
ICRAC	300	1.00	5.00	3.1583	1.01490
Valid N (list wise)	300				

Source: own research

As visible from the table the highest mean scores lie with Organising capabilities (IC_OC), Manufacturing capabilities (IC_MFC), Marketing capabilities (IC_MKC) and Research & Development capabilities (IC_RDC), wherein the mean scores are above the average value of 3.5 (on a 5 point likert scale). The medium mean scores value lie with Strategic Planning capabilities (IC_SPC) and Learning Capabilities (IC_LC). Lastly, the lowest mean scores value reside in Resource allocation capabilities (IC_RAC) , as depicted in the identified sample frame.

ONCLUSION

Technological innovation plays a critical role in predicting the long-term survival of organizations (Ancona and Caldwell, 1987). Many well-known leading authorities have discussed the importance of innovation in determining an organization's success and global competitiveness (Higgins, 1995; Porter, 1990). The objective of the current research study was to identify the key determinants of innovation capabilities and empirically verifies that technological innovation capabilities cannot solely be sustained by research and development. The other dimensions of innovation capabilities need to be focused on for a holistic growth for the firm to attain a competitive advantage.

For managers in the region, this finding is important as it identifies that a more balanced development of multiple TIC is required. While R&D capability is essential to the success of innovation, our findings show that firms should also emphasize other innovation capabilities (i.e. learning, organising, and strategy planning) for better coordination of R&D activities. For instance, in order to enhance the percentage of sales due to technologically innovative products, manufacturers should aim to improve their strategic planning by identifying internal strengths and weaknesses as well as external opportunities and threats to formulate innovative and effective plans. For firms aiming to launch new goods in the markets, they must identify customer needs, expectations through their effective marketing capabilities, to innovate new additions to existing product line. Not only can

the capability allow a firm to exploit their technology resources, including the acquisition of external technologies, technology information about competitors' core technology competence and the prediction of new technology trends, but it also enables the firm to attach and allocate sufficient human resources for innovation processes. Most essential for a long-term development of innovation capabilities within the firm, it is crucial that the management inculcates an organised learning culture towards innovation.

UGGESTIONS

Firms need to i-) develop a strong ability to transform knowledge gained from internal and external resources, ii-)convert the innovative ideas into new products/processes by allowing the collective contribution of various functions, iii-) allocate the resources required to make it happen, iv-) manufacture the product, v-) develop strong relationships and good after-sales services, and ultimately complete the cycle by long-term planning regarding the external environment and SWOT analysis. There is an evidence in the literature that the competitiveness of an enterprise is based on a complex capability hierarchy. Successful new product introductions could provide the potential for firms to gain market position and realize more durable returns than otherwise possible. As a part of the study it was concluded that to attain innovative competitive advantage in the market, the firm must aim to focus on each of the seven dimensions identified and defined in the study. All the dimensions do not function in isolation, rather give better results, when they are complemented with each other.

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Exploring Relationship between Personal Innovativeness, Technological Innovativeness, Gadget Lover and Technological Opinion Leadership among Millennials

*Dinesh Rawat

ABSTRACT

The purpose of this study is to contribute to the existing literature by testing a model consisting of factors driving technological innovativeness and technological opinion leadership among millennials. This study aims to test (a) relationship between personal innovativeness, technological innovativeness, gadget lover and technological opinion leadership, and (b) mediating role of technological innovativeness between gadget lover and technological opinion leadership. The study indicates the following results, firstly, technological innovativeness and gadget lover have a positive and significant impact of technological opinion leadership, secondly, personal innovativeness is not positively related to technological innovativeness, and lastly technological innovativeness partially mediate the relationship between gadget lover and technological opinion leadership.

*Assistant Professor, L.S.M. Government PG College, Pithoragarh, India.

INTRODUCTION

India is one of the largest and fastest-growing markets for digital consumers, with 560 million internet subscribers in 2018, second only to China (Kaka et. al, 2019). Digital consumers mostly consist of millennials and it is predicted that nine out of ten millennials will be online by 2030(World Economic Forum and Bain & Company, 2019).Millennials' contribution in India is particularly noteworthy and it is projected to have 410 million millennials, with an annual spending of $330 billion by 2020 (Morgan Stanley, 2017).Companies are targeting millennials for their products in India. A key issue of consumer marketing is to please customers (Bagozzi&Nataraajan, 2000) thus it is necessary for the marketer to understand the characteristics of millennials as it can help or hinder the adoption of innovation when promoting an innovation to millennials. Once a company understands the desires of millennials completely, then impressive strategies can be easily formed.

Millennials are always connected to the internet, via smartphones, seeking instant gratification for almost everything–from education to entertainment. With the advancement in technology, the acceptance of new innovations by millennials also advances in the marketplace. However, adoption of innovation does not happen simultaneously in a social system; rather it is a process whereby some people are more apt to adopt the innovation than others(Rogers E.M., 1995). People who adopt an innovation early have different characteristics than people who adopt an innovation later (Bruner & Kumar, 2007). Some consumers are sceptical towards the adoption of new technology whereas some consumers are excited and cannot resist switching from old to new devices (Bruner & Kumar, 2007).

This study tries to understand the behaviour of millennials in India by integrating and testing a model consisting of constructs like personal innovativeness, technological innovativeness, gadget lover, and technological opinion leadership. It is important to study these constructs as it is commonly believed that consumers are reached via technologically and socially influential people (Bruner & Kumar, 2007) and the marketer should target the innovators and early adopters first as they are the opinion leaders and thus helps in spreading the word-of mouth to individuals who are sceptical about adopting new technologies (Peck & Childers (2003).

This paper consists of five sections. Section 1 is the introduction. Section 2 consists of literature review and hypotheses development related to factors like personal innovativeness, technological innovativeness, gadget lovers, and technological opinion leadership. Sections 3 is related to objectives and research methodology used in the study. In the next section, the results are discussed. The last part of the paper closes with conclusions, implications, limitations and future scope of research.

ITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Technological Opinion Leadership

The idea of opinion leaders as given by Lazarsfeld, Berelson, & Gaudet (1948) has been placed in the context of diffusion on innovation by Rogers & Cartano in 1962. Rogers & Cartano (1962) defined opinion leaders as individuals who have a high influencing power over the decision of others. Childers (1986) defined opinion leaders as individuals who can exert an unequal amount of influence on the decisions of others by offering information to them during their consumption decisions. Other people turn towards opinion leaders for their opinions and advices as they are the influential members of a community, group, or society. Opinions leaders thereby are not only knowledgeable but also highly respected for their expertise (Goldberg, Lehmann, Shidlovski, & Barak, 2006; Katz & Lazarsfeld, 1955).

However, Rogers (2003) states that technological opinion leadership is a more domain specific construct related to an individual's leadership in the domain of technology. Technological opinion leaders are more innovative and less dogmatic and have affinity towards technology making them experts in this field (Goldsmith & Goldsmith, 1980; Myers& Robertson, 1972; Geissler & Edison, 2005). Technological opinion leaders are defined as consumers who offers information to other consumers and thereby influence their consumption decisions for technological products (Bruner & Kumar, 2007).

Not much research has been done on this newly emerging context of Technological Opinion leadership as excluding the Bruner & Kumar (2007) and Rogers (2003) studies, not much is found in the literature which addresses the construct of technological opinion leadership.

Technological Innovativeness

Technological Innovativeness is the extent to which the consumer is motivated to be an early adopter of a new technology (Bruner & Kumar, 2007). Technological innovativeness measures innovativeness within a specific domain of interest (Flynn & Goldsmith, 1993; Goldsmith & Hofacker, 1991). Domain specific innovativeness is taken to be an important construct as it predicts the innovative behaviour of the consumer more accurately within a specific domain of interest (Leavitt & Walton, 1975; Roehrich, 2004). Literature in consumer behavior and innovation shows a significant correlation between product involvement and opinion leadership (Richins & Root-Shaffer, 1988; Feick & Price's, 1987; Bartels & Reinders, 2011; Shoham & Ruvio, 2008; Goldsmith & Hofacker, 1991). This states that with the increased product involvement, consumers gains knowledge about the new technology and this will make the consumers confident in sharing their experiences and information with others. Thus, we hypothesize the following:

H1. Technological innovativeness is positively related to Technological opinion leadership

Personal Innovativeness

Personal innovativeness as defined by Agarwal & Prasad (1998) is the risk-taking behaviour of certain individuals which is not found in others. These individuals are willing to take high risk, tries new things and cope with high levels of uncertainty easily (Bruner, Hensel, & James, 2005). The risk-taking propensity and ability to cope with uncertainties encourage people with personal innovativeness to take chances and to try new

gadgets (Thakur, Angriawan, & Summey, 2015). Personal innovativeness has extensive presence in innovation diffusion research and is seen as a key variable in the innovation adoption process as it helps in segmenting consumers into innovators and non-innovators. (Rogers, 1995; Midgley & Dowling, 1978; Flynn & Goldsmith, 1993; Agarwal & Prasad, 1998). Midgley & Dowling (1978) states innovativeness as a function of dimensions of human personality which is possessed by all individuals in higher or lesser degree. Leonard-Barton & Deschamps (1988) stated that individuals who are willing to take challenges are more likely to adopt and use new products.

Consistent with the literature (Thakur, Angriawan, & Summey, 2015) suggested that an individual's inclination towards risk taking and trying out new things should lead to his/ her desire for innovativeness toward technological goods. In this study, as shown by literature, Personal traits like individual's inclination to take chances, may be a better indicator of their innovativeness. Therefore, it is expected that individuals who experiment with new ways of doing things and are receptive to risks should be the first to adopt a new technology, a concept known as technological innovativeness (Bruner & Kumar, 2007). Thus, we hypothesize:

H2. Personal innovativeness is positively related to Technological innovativeness.

Gadget lovers

The term "Gadget Lovers" was originally coined by Marshall McLuhan (1964) but in this study the definition given by Bruner &Kumar(2007) is emphasized on. Bruner &Kumar(2007) defined gadget lovers as consumers with high intrinsic motivation to adopt and use new technological products. Through a focus group study, they identified that gadget lovers are those individuals who enjoy playing with gadgets, they spend a considerable amount of time in gaining knowledge about gadgets. Therefore, the key characteristics of gadget lovers are that they have high intrinsic motivation and are more knowledgeable about high-technology products.

Bruner & Kumar (2007) defined Gadget lovers as those adopters who influences the opinions of others and at the same time are relatively early adopters of innovations. Thus, Bruner & Kumar (2007) noted that Gadget lovers and Technological opinion leadership share a positive relationship. Leonard-Barton & Deschamps (1988) noted that individuals who are high risk takers are more likely to adopt new technologies. Gadget lover are willing to take chance, the use of new technology gives them enjoyment and thus motivates them to adopt new technology earlier than others (Shoham & Pesamaa, 2013; Thakur, Angriawan, Summey, 2015). Thus, we hypothesize the following:

H3. Gadget lovers are positively related to technological innovativeness.

Shoham & Pesamaa, (2013) states that gadget lovers are enthusiastic about taking a chance with using novel products which makes them early adopters of the novel technology. They also tend to influence others by discussing the key attributes of gadgets with others, thus increasing the adoption of new high-tech products in the market place. Excitement to use new technology and to know more about it makes gadget lovers more knowledgeable about technology. This increases the value of their opinion among individuals who are sceptical about trying new technology. Bruner & Kumar (2007) and Thakur, Angriawan, & Summey, (2015) in their study claims a positive correlation between gadget lover and technological opinion leadership. Gadget lovers therefore are considered to be credible as their in-depth knowledge about the new technology makes them expert on gadgets, enhancing their self-efficacy and making them technological opinion leaders (Shoham & Ruvio, 2008). Based on the above literature review, we hypothesize the following:

H4. Gadget lovers are positively related to Technological opinion leadership

OBJECTIVES OF THE STUDY AND RESEARCH METHODOLOGY

The present study aims to find out:

- The impact on personal innovativeness and technological innovativeness.
- The impact of technological innovativeness on technological opinion leadership
- The impact of gadget lovers on technological innovativeness
- The impact of gadget lovers on technological opinion leadership
- To identify the mediating role of technological innovativeness between gadget lover and technological opinion leadership

The study involve quantitative research where descriptive research design has been used. Survey research method has been used in this study where data was collected through a questionnaire. The questionnaire was designed after detailed literature review and careful selection of items for measuring various constructs. The questionnaire consist of 4 constructs .i.e. personal innovativeness, technological innovativeness, gadget lover, and technological opinion leadership. The questionnaire consist of 16 items under these 4 constructs based on the literature. Each of these items was evaluated on a seven point Likert scale ranging from 1 (Strongly Disagree) to 7 (Strongly Agree). Finally after modification the data was collected from a sample of 148 college students in the age bracket of 18-25. College students are taken as sample respondents because they use gadgets as their primary source of communication (Gallagher, Parsons, & Foster, 2001). Convenience and judgemental sampling technique were used to collect data. The study used confirmatory factor analysis and structural equation modelling (SEM) to test the proposed model.

Figure 1 shows the theoretical model used in this study.

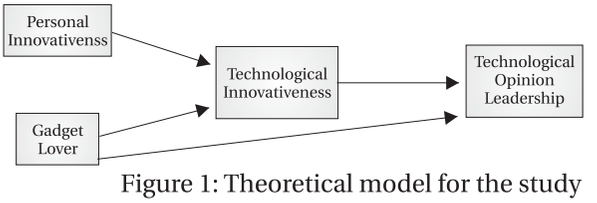

Figure 1: Theoretical model for the study

NALYSIS AND RESULTS

Pilot study

A pilot study with sample size of 50 was conducted. Reliability was checked through Cronbach's alpha on this sample of 50 respondents and it was found that all alpha coefficients were above 0.6 which indicated good reliability. During the pilot study, comments from the respondents on clarity of items were obtained to confirm the face validity of the questionnaire.

Exploratory Factor Analysis

Since the survey questionnaire was self- developed ,thus an exploratory factor analysis (EFA) was carried out to ensure the rightness of newly created questionnaire. Table 1 provide summary of EFA applied to the questionnaire. Prior to applying exploratory factor analysis, the study first calculated KMO value. The KMO value was 0.851 suggesting that data was suitable for factor analysis.

As expected, it can be seen from Table 1 that four factors were extracted with a cumulative explanatory variation of 70.57 percent. Factor I (Gadget Lover) contain five questions, Factor II (Technological Innovativeness) contains four questions, Factor III (Personal Innovativeness) contains four questions and Factor IV (Technological Opinion Leadership) contains three questions.

Confirmatory Factor Analysis

According to Ahire, Golhar& Waller (1996), confirmatory factor analysis (CFA) provides enhanced control for assessing unidimensionality as compared to exploratory factor analysis (EFA) and is more in line with the overall process of construct validation.

Reliability Analysis

Assessing reliability is a critical step in the development of a measurement scale. The reliability of the items can be assess by coefficient alpha (Cronbach, 1951). Cronbach's alpha should be above 0.70 (Nunnally, 1978). Table 2 shows the Cronbach's alpha values of all constructs. In the study, all alpha coefficients were above 0.7 which indicate good reliability. Composite reliability (CR) is recommended as more appropriate since it considers the indicators' differential weights (Chin, 1998; Dijkstra &Henseler, 2015).

Table 1: Summary of Exploratory Factor Analysis

Items	Construct			
	Gadget Lover	Technological Innovativeness	Personal Innovativeness	Technological Opinion Leadership
C3 - I like learning to operate gadgets, despite of them being old or new	0.833			
C2 - Exploring how new gadgets will work excites me.	0.723			
C4 - When alone, I like playing with gadgets	0.723			
C1- Despite of gadgets being old or new, I enjoy playing them.	0.711			
C5- I am thrilled to play with high-tech gadgets.	0.683			
B3- Being first to buy high-tech gadgets is cool.		0.854		
B2- Buying new high-tech gadgets before others excites me.		0.841		
B4 - Being first to buy high-tech gadgets is important to me.		0.828		
B1 - I like buying new gadgets.		0.589		
A3 - I like new ideas and experiences.			0.773	
A2 - New ways of doing things excites me.			0.766	
A1 - Unpredictable life interests me.			0.696	
A4 - Buying locally available products interests me.			0.644	
D3 - I often influence people's opinions about gadgets.				0.788
D2 - I often persuade other people to buy the gadgets I like				0.787
D1- Friends and Family takes my suggestions while buying new gadgets.				0.654

Table 2: Cronbach alpha values

Constructs	Cronbach alpha value
Overall Questionnaire	.891
Personal Innovativeness	.733
Technological Innovativeness	.864
Gadget Lover	.851
Technological Opinion Leadership	.832

VALIDITY ANALYSIS

The content validity of a construct can be defined as the degree to which the measure spans the domain of the construct's theoretical definition (Rungtusanatham, 1998). In this study the developed questionnaire had content validity since selection of measurement itemswere based on an exhaustive review of literature and it was also checked by pre-testing of the questionnaire by professionals and academicians.

Construct validity involves the assessment of the degree to which an operationalization correctly measures its targeted variables (O'Leary-Kelly & Vokurka, 1998). According to O'Leary-Kelly & Vokurka, establishing construct validity involves the empirical assessment of convergent and discriminant validity.

The convergent validity of a construct is established when the following three conditions are met (Hair, Black, Babin& Anderson, 2010).

CR (Composite Reliability) > 0.7

AVE(Average Variance Extracted) > 0.5 and

CR> AVE

Discriminant validity is ensured if a measure does not correlate very highly with other measures from which it is supposed to differ (O'Leary-Kelly &Vokurka, 1998). A common approach to assess discriminant validity is the Fornell-Larcker criterion (Fornell & Larcker, 1981), which compares the AVE (shared variance within) of the constructs to the squared correlation between the constructs (shared variance between). The discriminant validity of a construct is established when the following two conditions are met (Hair, Black, Babin& Anderson, 2010).

MSV (Maximum Shared Variance)< AVE (Average Variance Explained)

ASV (Average Shared Variance)< AVE (Average Variance Explained)

In this study, convergent and discriminant validity is calculated for first order CFA model. Figure 2 shows the first order CFA model. The results of composite reliability, convergent validity and discriminant validity are given in table 3.

Table 3: Reliability and Validity results of First order CFA model

	CR	AVE	MSV	ASV
GL	0.859	0.555	0.365	0.318
PI	0.782	0.505	0.353	0.186
TI	0.871	0.632	0.396	0.231
TOL	0.841	0.641	0.396	0.302

It is clear from table 3 that the conditions of convergent and discriminant validity are satisfied.

TESTING MODEL FITNESS

Goodness of fit (GOF) is the appropriate measure to evaluate the measurement and structural models. GOF is measured by the Chi-square statistic, which indicates the difference between the sample covariance matrix and the estimated covariance matrix. Other means of assessing GOF when using CB-SEM are the various heuristics such as CFI, GFI and RMSEA. The overall fit indices for the first order model is given in Table 4.

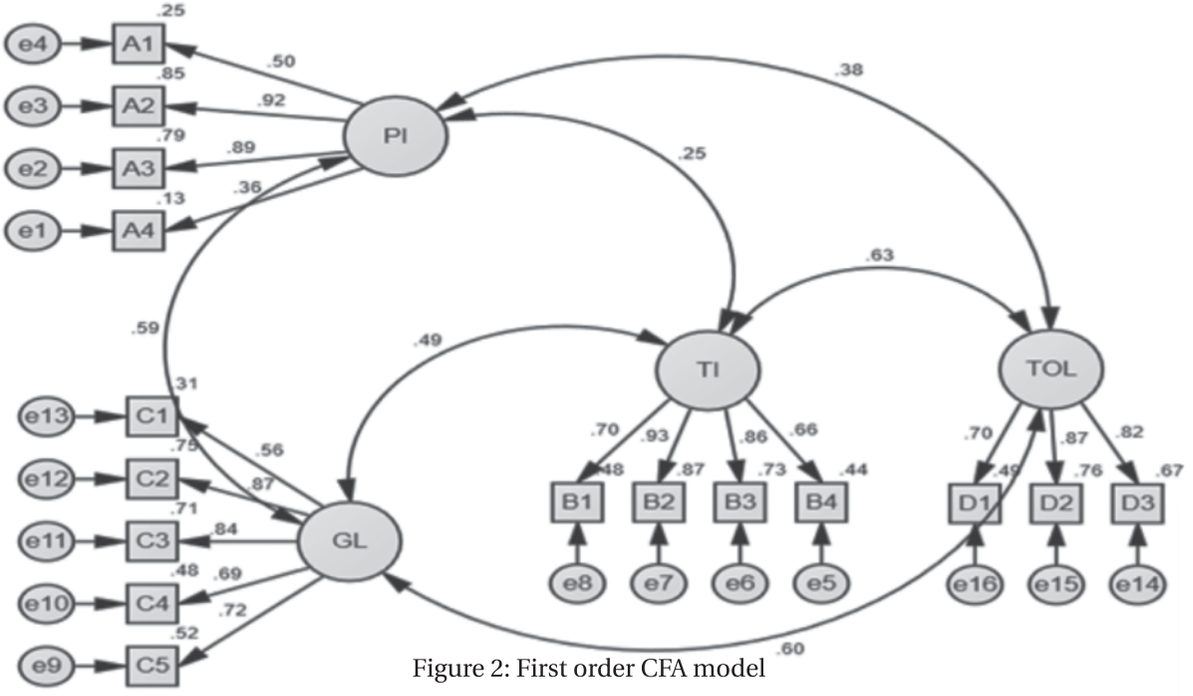

Figure 2: First order CFA model

Table 4: Model fitness

Model Element	Values	Acceptable range
CMIN / DF	2.298	CMIN/DF < 3 good; < 5 sometimes permissible (Hair et al., 2010)
GFI	0.838	GFI >0.8 is acceptable (Baumgarther & Homburg, 1996)
AGFI	0.775	AGFI > 0.8 is acceptable (Baumgarther & Homburg, 1996)
CFI	0.902	CFI > 0.95 great; 0.90 traditional; >0.80 sometimes permissible (Hair et al., 2010)
RMSEA	.094	RMSEA <0.05 good; 0.5-0.10 moderate; > 0.10 bad (Hair et al., 2010)

As it is clear from table 4 values that various fit indices are in acceptable range. This means that the said model is a good fit.

Impact of independent variables on dependent variables

Structural relationships in SEM are evaluated by the size and significance of the beta coefficients.Figure3 shows the path analysis diagram

Table 5 shows that personal innovativeness is not found to have a positive and significant impact on technological innovativeness. Thus H1 is rejected. Table 5 also shows that technological innovativeness and gadget lover has a positive and significant impact on technological opinion leadership. Finally, it also shows that gadget lovers are positively and significantly related to technological innovativeness as supported by H2, H3 ,and H4.

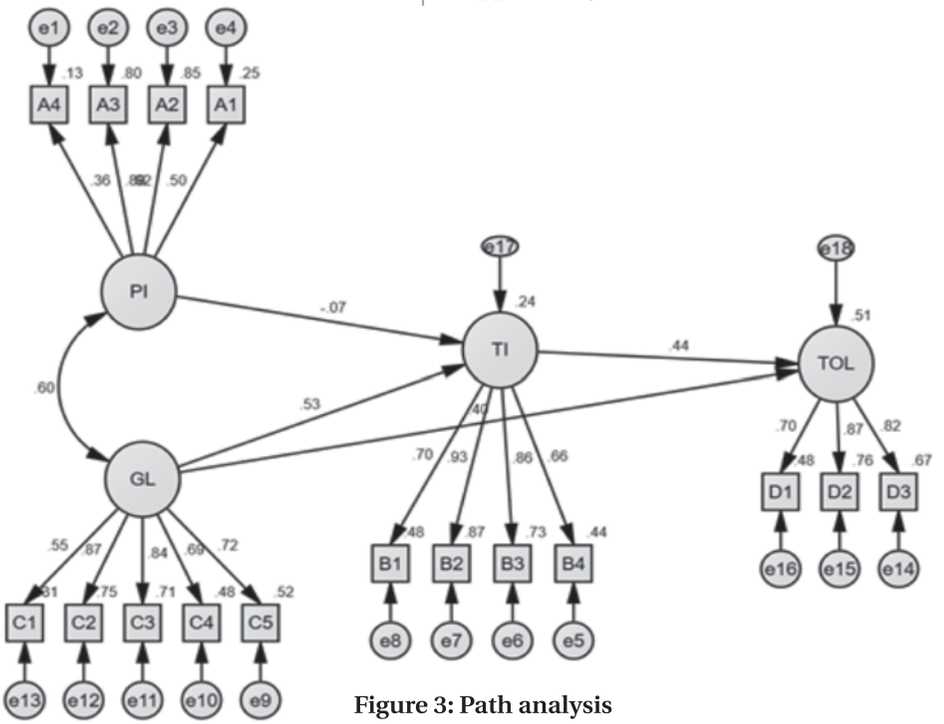

Figure 3: Path analysis

Table 5: Regression weights

			Estimate (Unstandardized)	Estimate (Unstandardized)	P
Technological Innovativeness	←	Personal Innovativeness	-.139	-.068	.529
Technological Innovativeness	←	Gadget Lover	.472	.528	***
Technological Opinion Leadership	←	Technological Innovativeness	.588	.435	***
Technological Opinion Leadership	←	Gadget Lover	.477	.396	***

EDIATION EFFECT

To test if technological innovativeness mediates the relationship between gadget lover and technological opinion leadership, we used direct-indirect approach recommended by Hayes (2017). Figure 4 explain the mediating role of technological innovativeness.

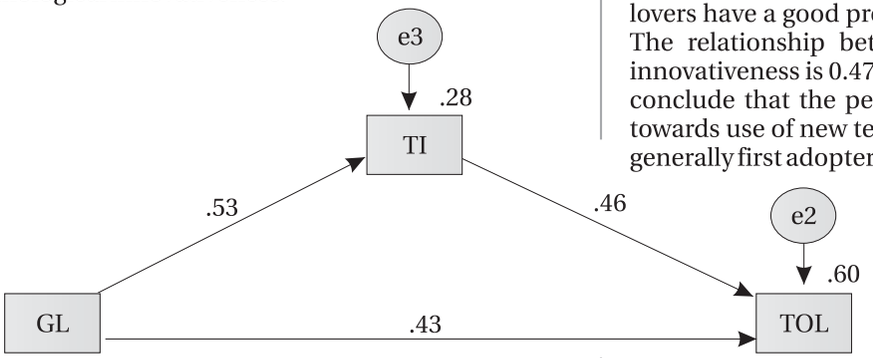

Figure 4: Mediating role of Technological Innovativeness(TI) between Gadget Lover(GL) and Technological Opinion Leadership (TOL)

Standardized total effect of GL on TOL was 0.672. Out of this total effect direct effect was 0.427 and indirect effect was 0.245 which was significant also. The significance of indirect effect suggested the presence of mediation. After regressing the predictors (GL and TI) on criterion variable (TOL), the results suggested the relationship between GL and TOL is 0.43 and significant. The strength of relationship between GL and TOL in presence of TI is weaker compared to direct effect (0.672) thus confirming TI partially mediates the relationship between GL and TOL. Table 6 shows the mediation results.

take chances and are not always attracted by new features of new technological products. These results are not consistent with R. Thakur et al. (2015) and Hartman and Samra (2008).

Gadget lovers have a positive and significant impact of technological innovativeness behaviour of millennials.

The results of structural equation model suggest that gadget lovers have a good predictor of technological innovativeness. The relationship between gadget lover and technological innovativeness is 0.472 (p value is 0.000). Through this we can conclude that the person who are gadget lovers are excited towards use of new technological products. Gadget lovers are generally first adopters of new technological products.

Gadget lovers have a positive and significant impact of technological opinion leadership behaviour of millennials.

The results of structural equation model also suggest that gadget lover is a good predictor of technological opinion leadership. The relationship between gadget lovers and technological opinion leadership is 0.477 (p value is 0.000).Since gadget lovers are fascinated by new technological products and are more involved in use of these products. Thus, gadget lovers become more knowledgeable about new technological products. People seek opinion of gadget lovers while using new technological products. Thus we can say, gadget lovers influence opinion of others while purchasing new gadgets.

Table 6: Mediation results

	Standardized Total Effects	Standardized Direct Effects	Standardized Indirect Effects	Regression Weights after including TI
	GL			
TOL	.672 (significant)	.427	.245 (.001)	
TOL← GL				.509 (significant)

ONCLUSION

The objective of this paper is to identify the factors that affect technological innovativeness and technological opinion leadership behaviour of millennials. This study answer this objective by investigating following research questions.

Does personal innovativeness has a positive and significant impact on technological innovativeness behaviour of millennials.

The result of structural equation model reveals that personal innovativeness is not positively related to technological innovativeness. The relationship between personal innovativeness and technological innovativeness is -.0139 (p value is 0.529). This suggest that innovative persons not always

Does technological innovativeness has a positive and significant impact of technological opinion leadership behaviour of millennials.

The results of this study suggest that technological innovativeness is positively related to technological opinion leadership. There is a positive and strong relationship (regression coefficient = 0.588and p value = 0.000) between technological innovativeness and technological opinion leadership. This conclusion suggest the technologically innovativeness people disseminate information about new products and also influence purchase decision of other people.

Does technological innovativeness partially mediate the relationship between gadget lover and technological opinion leadership.

The finding of this study conclude that technological innovativeness construct partially mediates the relationship between gadget lover and technological opinion leadership.

The study has some implications for marketing managers. Given the findings of the study, managers should focus on gadget lovers in development stages of new gadgets as they are good predictor of technological innovativeness and technological opinion leaders. Managers should take into consideration that technological opinion leaders are those people who have certain amount of influence on purchase decision of other people. Thus managers should take opinions of such people on new gadgets. The findings from this research will add academic value in the context of expanding knowledge in relation to relationship between technological innovativeness, gadget lovers, and technological opinion leadership behaviour. This study conclude that gadget lovers and technological innovativeness are strong predictors of technological the opinion leadership. The data collected for this study is from the students studying in colleges of Delhi-NCR thus it might not be appropriate to generalize the findings for entire country. Further research in this area needs to be done by taking students from other states in order to generalize the findings.

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APPENDIX

1. Unpredictable life interests me.
2. New ways of doing things excite me.
3. I like new ideas and experiences.
4. Buying locally available products interests me.
5. I like buying new gadgets.
6. Buying new high-tech gadgets before others excites me.
7. Being first to buy high-tech gadgets is cool.
8. Being first to buy high-tech gadgets is important to me.
9. Despite of gadgets being old or new, I enjoy playing them.
10. Exploring how new gadgets will work excites me.
11. I like learning to operate gadgets, despite of them being old or new
12. When alone, I like playing with gadgets.
13. I am thrilled to play with high-tech gadgets.
14. Friends and Family takes my suggestions while buying new gadgets.
15. I often persuade other people to buy the gadgets I like.
16. I often influence people's opinions about gadgets.

Efficiency of Operations: Case Study of United Technologies Corporation

*Prof. Prashanth N. Bhardwaj
**Prof. Mukesh Chaudhry
***Prof. Suneel Maheshwari

ABSTRACT

In this paper, efficiency of operations was examined for United Technologies which is a leading U.S.-based multinational corporation. Using both Johansen's cointegration and Granger's causality tests it is evident that efficient management of cost of goods sold is more important and if these expenses are managed well it could provide greater flexibility to United Technologies to bring about superior operating performance. For instance, if United Technologies deliberately increase SGA and RD expenses it would lead to higher future operating profitability.

Keywords: *Operating and financial efficiency; Cointegration; Granger's causality*

** Director, IUP India Programme , Indiana University of Pennsylvania, USA*
*** Professor of Finance, Indiana University of Pennsylvania, USA*
**** Professor of Accounting, Indiana University of Pennsylvania, USA*

INTRODUCTION

Performance measurement is the "holy grail" in applied business research. Operations and supply chain managers are constantly confronted with the arduous but important task of measuring the effectiveness of their workforce and equipment in financial terms. With the rapid deployment of expensive technology in operations, this has taken even more heightened importance. Operations and supply chain managers are in a unique position to impact both the bottom line as well as the top lime of firms. Operations can enhance quality, variety, speed, reliability, and dependability to help enhance the revenues of the company. On the other hand, operations can also cut costs by effectively managing inventory, workforce, and equipment. This double-pronged effect of operations is expected to increase overall profitability of firms. However, investors and other stakeholders are looking at tangible ways to quantify the financial impact and efficiency of operations.

Firms that operate efficiently are expected to increase sales and profitability, if costs are contained by the management of these firms. One way these costs can be contained by firms is by the use of latest and cost-efficient technology in their production systems. Another way could be through more productive, innovative, and efficient use of their workforce. From the accounting figures, one of the most important cost drivers is the selling, general and administrative expenses (SGA) where increase (decrease) in these expenses can adversely (positively) impact operating earnings both in the short- and the long-term. Hence, SGA cost management can help reduce manufacturing costs that may result in higher profitability. Furthermore, there is strong interdependence between SGA expense and cost of goods sold and the efficient management of these costs can strike an optimal balance between these two cost drivers (Baumgarten et. Al. 2010). Other cost efficiency indicators could be enhancement of IT systems, reorganization of operational procedures, investment in research and development (RD) and enhancement of supporting departments. A contrary suggestion is that sometimes higher SGA expenses can have a positive impact on future profitability when these expenses are made towards acquiring intangible assets (Banker et. al. 2006 and 2011), provided there is enough latitude available from future reduction in the cost of goods sold. This may imply that there may be a deliberate attempt by the management of the firm to increase SGA expense for improving operating efficiency through better manufacturing processes to increase future profitability. In that event, higher SGA could be a positive indicator of firms' performance. Alternatively, higher unintended SGA expense for inefficient firms could reflect costs going out of control with adverse impact on future profitability. Examination of the operating and financial efficiency in the long-term can shed light on this topic. The metrics that are used to study efficiency can be obtained from the financial data and annual statements of publicly traded companies.

ITERATURE REVIEW AND BACKGROUND

The chief objectives of most businesses are to increase market share, improve customer satisfaction, and enhance profitability. This set of related objectives is possible only with the help of managing activities that provide value. Porter (1985) and subsequently, many other authors, identified operations along with logistics, marketing, and sales/service as the primary value adding activities. Authors such as Friis et al. (2016), McPhee and Wheeler (2006) and Sakuramoto et al. (2019) have identified that managing these primary value adding activities will enhance the efficiency of their supply chains. There have been several streams of research and practice that have tried to quantify the relationship between operational efficiency and financial performance. Balanced Scorecard originally introduced more than two decades back by Kaplan and Norton (1996, 2001), showed companies a method of looking at the financial, customer, innovation, and operational metrics in a balanced way as opposed to focusing solely on financial measures. Ellinger et al. (2012) examined the relationship between operations and customer satisfaction as well as shareholder value. Bharadwaj (2015) examined the correlation between supply chain/operations competency and certain marketing and financial measures such as brand equity and stock prices. The Gartner Top 25 Supply Chain Management Companies list (2019) is based on operations and financial metrics such as inventory turns, return on assets, and revenue growth. Wisner et al. (2019) examines the impact of several operational performance metrics on that of financial measures. The SCOR model formulated by the professional organization APICS (2020) also examines the relationship between operational measures such as reliability, responsiveness and agility with financial metrics such as return on working capital, cash-to-cash cycle, and cost of goods sold.

Hussein and Davis (2018) showed how Cisco Systems, Inc. improved operational and financial efficiency using product ID rationalization. Cuthbertsonand Piotrowicz (2011) demonstrated that in order to understand performance measurement systems, one has to understand the context of the organization. They show that a case study approach helps in obtaining in-depth insights while losing the ability to generalize. The current article looks at operational efficiency in the case of a company that has been an industrial giant for over 100 years. United Technologies (UTC) is an American multinational conglomerate that is in the business of designing, manufacturing, and marketing elevators and escalators to aircraft engines and helicopters. Its most recent annual revenues were $66.5 billion, which was a 11.1% increase over the previous year (Market Line, 2019). We picked this company as an ideal company to study since: a) it is a conglomerate with a healthy balance of divisions and products: Carrier (heating, ventilation, and air-conditioning or HVAC equipment), Otis (elevators and escalators), Pratt and Whitney (aircraft engines), and Collins (helicopters); b) UTC serves a mix of global and American-based markets; c) it has some traditional businesses such as HVAC and elevators as well as some high-tech businesses such as aerospace; and d) the company is involved in the entire gamut of designing, manufacturing, selling, installing, and servicing a multitude of products worldwide. Some of the competitors of UTC are GE, Honeywell, Lockheed Martin, Boeing and Nortrop Grumman. A future study will be aimed at a competitive analysis of UTC with some of the industrial giants who are its competitors.

The next section details the methodology used in the study followed by the results, discussion, and conclusions.

ETHODOLOGY

The Bloomberg Terminal provides access to a variety of real-time and historical data for publicly traded companies. Bloomberg is deemed to be the most reliable and accurate source for financial data. The authors' university has a Bloomberg Financial Lab with access to Bloomberg Terminals using which the data was downloaded. The authors downloaded the income statements and balance sheets for each quarter for the years 2010 to 2019. For each quarter, metrics such as operating expenses, research and development expenses, selling and general administrative expenses, and operating income were gleaned.

This research uses the methodology developed by Johansen (1988). This method is preferred to alternatives since it enables testing for the presence of more than one cointegrating vector. The description that follows draws from Johansen (1988, 1991, 1994) and Johansen and Juselius (1990, 1991).

The Johansen method provides some distinct advantages. For example, identification of the number of cointegrating vectors is possible with the Johansen test. Such inferences are based on the number of significant eigenvalues. Also, according to Banerjee (1999) alternative Cointegration tests have low power as compared to Johansen's test. To check for stationarity arising from a linear combination of variables, the following AR representation for a vector VTS made up of n variables is used,

$$VTS_t = c + \sum_{i=1}^{s-1} \phi_i Q_{it} + \sum_{i=1}^{k} \pi_i VTS_{t-i} + \varepsilon_t \qquad (1)$$

where VTS is at most I(1), Q_{it} are seasonal dummies (i.e., a vector of non-stochastic variables) and c is a constant. It is not necessary that all variables that make up VTS be I(1). To find cointegration in the system, only two variables in the system need be I(1). However, if only two time series are examined (bivariate representation) then both have to be I(1). If an error-correction term is appended, then:

$$\Delta VTS_t = c + \sum_{i=1}^{s-1} \phi_i Q_{it} + \sum_{i=1}^{k-1} \Gamma_I \Delta VTS_{t-i} + \Pi VTS_{t-k} + \varepsilon_t \qquad (2)$$

which is basically a vector representation of equation (1) with seasonal dummies added. All long-run information is contained in the levels terms, $PVTS_{t-k}$, and short- run information in the differences ΔVTS_{t-i} . The above equation would have the same degree of integration on both sides only if 0=Π(the series are not cointegrated) ΠVTS_{t-k} , is (0), which infers cointegration. In order to test for cointegration, the validity of $H_1(r)$, shown below, is tested as:

$$H_1(r)\ \Pi = \chi\beta' \qquad (3)$$

where b is a matrix of cointegrating vectors and g represents a matrix of error correction coefficients. The hypothesis H_1 (r) implies that the process ΔVTS_t is stationary, VTS_t is nonstationary, and β' VTS_t is stationary (Johansen, 1991). The Johansen method yields the Trace and the λ_{max} statistics that enable determination of the number of cointegrating vectors.

ESULTS

This research used the Johansen's cointegration methodology as an alternative framework for investigating equilibrium price adjustments for long-run relationships. According to Engle and Granger (1987), if a system of variables is cointegrated, their economic forces interact to bind these variables together in a long-run equilibrium relationship. In effect, it indicates the level of integration between operating efficiency indicators for United Technologies.

Quarterly data for sales, cost of goods sold (COGS), operating expenses (OExp), research and development (RD), Selling and General Administrative (SGA) expenses and operating income (OInc) for United Technologies Corporation were collected using Bloomberg as the source. The data covered the period from Second Quarter 2010 to Third Quarter 2019. The choice of these efficiency indicators included variables that suggest effectiveness of managerial control on costs and its impact on the operating profitability of United Technologies Corporation. For example, higher SGA expense can suggest lack of management control on costs with adverse effect on future profitability. However, contrary explanation could be the potential to create intangible assets through SGA expenditure. There may also be "cost stickiness" of SGA expenses as indicated by Anderson et al., 2007.

Autocorrelations in the time series was reviewed and eliminated. Testing for stationarity in each equity market index time series was accomplished using the Philips-Perron unit root test. The lag length for each time series was computed by minimizing the Akaike Information Criteria (AIC) values for the various efficiency indicators of United Technologies.

To eliminate autocorrelations in the time-series, the appropriate lag length is found using the Akaike information criterion (AIC). The lag length is selected by minimizing the AIC over different choices for the length of the lag. The values of AIC are formulated by computing the value of the equation *T log (RSS) +2 K*, where *K* is the number of regressors, *T* is the number of observations and *RSS* is the residual sum of squares. These results are shown in Table 1 where it becomes clear that the time series require a range of lags to correct for the presence of autocorrelation.

Tests for Stationarity of Each Time Series Using the Philips-Perron (P&P) Test

As noted in Table 1, the P&P tests suggest that all the time series for the various efficiency indicators of United Technologies are nonstationary without trend (i.e., non-rejection of $\alpha_1 = 0$), and in most instances with trend. This indicates the need for cointegrated methodologies (critical values at the 10% level are provided in the last row of Table 2). The time-series more often reject the presence of drift ($\alpha_0 = 0$) than trend ($\alpha_2 = 0$). Thus, the inclusion of a drift term may not be as important. While it is reassuring to note the non-rejection of non-stationarity, this is not altogether surprising since many other

studies find non-stationarity in time series (Phillips and Perron, 1988, Brenner and Kroner, 1995, Doukas and Rahman, 1987).

Johansen Tests for Cointegration Rank for Systems (Efficiency Indicators of United Technologies)

The results for systems (composed of various efficiency indicators of United Technologies) using Johansen's method are presented in Table 2 & 3. Trace statistics are also reported. These are basically likelihood ratio tests where the null hypothes is $L_{r+1} = L_{r+2} = \ldots\ldots = L_P = 0$, indicating that the system has *p-r* unit roots, where *r* is the number of cointegrating vectors. The rank is then determined using a sequential approach starting with the hypothesis of *p* unit roots. If this is rejected, then the next hypothesis $L_2 = L_3 = \ldots\ldots = L_P = 0$ is tested and so on. For each system there can be at most n-1 cointegrating vectors (or common factors) that bind the assets in the system (n being the number of time-series in the system). For example, between sales and efficiency indicators and cost of goods sold and other indicators for oil price and equity indices, there can be at most 1 (2-1) common factor.

Cointegration between sales and operating efficiency indicators display one cointegrating vector for the following variables: COGS, SGA and OInc. No cointegration was found, however, for OExp and RD. Cointegration between COGS and other efficiency indicators provides similar results. In a system that includes all variables, there are two cointegrating vectors suggesting that there are two factors that binds these variables in the long-run.

In Tables 4 and 5, Granger Causality tests clearly indicate that causality flows from sales to cost of goods sold, operating expenses and research and development costs. However, bivariate causality exists between SGA versus sales and operating income and sales for United Technologies. It is noteworthy to observe that significance is much stronger with SGA expenses having a larger impact on the sales of United Technologies both in the short and long-term. Table 5 provides similar results when Granger causality tests are run between cost of goods sold and the other efficiency indicators. Results are even more significant as cost of goods sold Granger cause RD and SGA expenses. This implies that efficient management of cost of goods sold is more important, and, if these expenses are managed well it could provide greater flexibility to United Technologies to bring about superior operating performance. For instance, if United Technologies deliberately increase SGA and RD expenses it would lead to higher future operating profitability.

Discussion of the Results

Taken cumulatively, the results seem intuitive. While it is likely that the operating efficiency indicators for United Technologies Corporation are closely related, indicating how firms and their management can effectively control these expenses for higher future profitability. This case study uses the example of one of the most successful companies to illustrate how cost of goods sold can lead to superior operating performance.

Cointegration between assets suggests that their prices exhibit a long-run relationship with each other. Higher levels of cointegration, noted by the number of cointegrating vectors, suggest potential hedging candidates. Some of the cost drivers such as operating expenses do not have any effect on the cost efficiency for United Technologies. From the causality standpoint it is clear that causality flows from sales to cost of goods, selling, general and administrative expenses (SGA) and operating profitability. SGA expense, however, has a bivariate causality with sales indicating that this is one of the most important cost drivers for this firm. When causality tests are run between cost of goods sold and other efficiency indicators, for United Technologies, cost of goods sold in conjunction with SGA are the two most important efficiency determinants in order to achieve higher future profitability for this firm.

ONCLUSION

This paper examines efficiency of the firms by illustrating a case study of United Technologies Corporation which is a premier American multinational conglomerate that is in the business of designing, manufacturing, and marketing elevators and escalators to aircraft engines to helicopters. Quarterly data for operating expenses, research and development expenses, selling and general administrative expenses, and operating income were obtained from Bloomberg for United Technologies Corporation to see how this successful and diversified company achieves operating efficiency. Using both Johansen's cointegration and Granger's causality tests, it is evident that efficient management of cost of goods sold is significantly important and if these expenses are managed well, it could provide greater flexibility to United Technologies to bring about superior operating performance. For instance, if United Technologies deliberately increase SGA and RD expenses it would lead to higher future operating profitability. Future research will examine if these results hold good with other companies in the industrial, aerospace, and defense manufacturing sectors.

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ANNEXURES

Table 1: Tests of Stationarity of Sales and Operating Efficiency Indicators for United Technologies Using Phillips Perron (PP) test.

Series	Nlags	No Trend $\alpha_1 = 0$	Akaike Criterion (minimized)
Sales and Operating Efficiency			
Sales	4	-0.55	16.29
COGS	3	0.67	16.25
OExp	0	2.35	13.59
RD	0	-0.54	10.63
SGA	3	1.41	12.54
OInc	4	-1.69	13.06
Asymptotic Critical Values	-2.58 10% Level	-2.88 5% Level	-3.47 5% Level

P&P is computed with a constant term. The tests are conducted with and without linear trend. The Unit Root tests are performed with the appropriate lag length. For each time series the lag length are estimated by minimizing the Akaike Information Criterion (AIC) values. T-Values (single hypothesis) and F-values (multiple hypotheses) for tests of various hypotheses concerning equation no trend and equation with trend are estimated. Note, $\alpha 1=0$ is the unit root test, $\alpha 0=0$ tests for constant (drift), and $\alpha 2=0$ tests for linear trend. Asymptotic critical values are from Phillips and Perron (1986). COGS (Cost of Goods sold), OExp (Operating Expenses), RD (Research and Development), OInv (Operating Income)

Table 2: Long-Term Relationship between Sales versus Operating Efficiency Indicators for United Technologies Using Johansen's Cointegration Methodology

Group	r	Trace	Critical Value (%)	Prob.
Sales versus COGS				
	0	16.04**	15.49	0.0414
	1	0.80	3.84	0.3721
Sales versus OExp	0	12.52	15.49	0.1339
	1	0.54	3.84	0.4640
Sales versus RD	0	10.50	15.49	0.2441
	1	0.50	3.84	0.4787
Sales versus SGA	0	19.69***	15.49	0.0100
	1	0.11	3.84	0.2763
Sales versus OInc	0	24.06***	15.49	0.0020
	1	1.18	3.84	0.7351
Sales versus Efficiency Indicators	0	85.33***	69.82	0.0018
	1	53.05**	47.86	0.0150
	2	24.68	29.80	0.1731
	3	7.30	15.49	0.5432
	4	0.36	3.84	0.5492

The optimal lag length for Johansen cointegration model is obtained from an examination of the residual autocorrelation functions of the cointegrating regressions. Critical values for Johansen tests are taken from tables in Johansen and Juselius (1990) paper. The *** , **, * denotes significance levels of 1 percent, 5 percent, and 10 percent respectively.

Table 3: Long-Term Relationship between COGS versus other Operating Efficiency Indicators for United Technologies Using Johansen's Cointegration Methodology

Group	r	Trace	Critical Value (%)	Prob.
COGS versus OExp	0	11.93	15.49	0.1604
	1	0.15	3.84	0.7003
COGS versus RD	0	9.17	15.49	0.3496
	1	0.08	3.84	0.7746
COGS versus SGA	0	17.89**	15.49	0.0214
	1	0.46	3.84	0.4980
COGS versus OInc	0	23.38***	15.49	0.0026
	1	0.42	3.84	0.5163

The optimal lag length for Johansen cointegration model is obtained from an examination of the residual autocorrelation functions of the cointegrating regressions. Critical values for Johansen tests are taken from tables in Johansen and Juselius (1990) paper. The *** , **, * denotes significance levels of 1 percent, 5 percent, and 10 percent respectively.

Table 4: Pairwise Granger Causality Test between Sales and Efficiency Indicators for United Technologies

	F-Stats	Prob.
COGS does not Granger Cause Sales	2.98*	0.06
Sales does not Granger Cause COGS	1.12	0.34
OExp does not Granger Cause Sales	0.37	0.70
Sales does not Granger Cause OExp	3.46**	0.04
RD does not Granger Cause Sales	1.17	0.32
Sales does not Granger Cause RD	2.58*	0.09
SGA does not Granger Cause Sales	3.47**	0.04
Sales does not Granger Cause SGA	2.69*	0.08
OInc does not Granger Cause Sales	5.54***	0.00
Sales does not Granger Cause OInc	10.14***	0.00

*** , **, * denotes significance levels of 1 percent, 5 percent, and 10 percent respectively.

Table 5: Pairwise Granger Causality Test between COGS and other Efficiency Indicators for United Technologies

	F-Stats	Prob.
OExp does not Granger Cause COGS	0.33	0.72
COGS does not Granger Cause OExp	4.53**	0.02
RD does not Granger Cause COGS	1.08	0.32
COGS does not Granger Cause RD	2.67*	0.08
SGA does not Granger Cause COGS	1.47	0.25
COGS does not Granger Cause SGA	3.87**	0.03
OInc does not Granger Cause COGS	2.87*	0.07
COGS does not Granger Cause OInc	10.77***	0.00

*** , **, * denotes significance levels of 1 percent, 5 percent, and 10 percent respectively.

Status of Women Empowerment in India: A Conceptual Perspective

*Varsha
**Gayathri Reddy K.
***Basanna Patagundi
****Uday Tate
*****Deepak Subedi

ABSTRACT

Empowerment of women is an important concept that helps the liberalization of women and provides an opportunity for them to embrace independence, to make their own selection/choices/decisions, thus contributing to society. In today's world, the rapid growth of globalization, industrialization, and changes in government policies and legislations have contributed to the development of the concept of Women Empowerment (WE). It is not just a localized social issue, but it has achieved a global importance from various perspectives, including but limited to social justice, economic and political progress, and delivery of education.

Based on a thorough literature review, the article highlights the conceptual framework for the development of empowerment for women in India, regarding five broad empowerment dimensions-economic, political, social, legal, and psychological empowerment. The article focuses on the importance of women's empowerment for the Indian society. The article also identifies some hurdles faced by individuals and institutions who practice and implement Women Empowerment., the article highlights some strategies to support and advance the empowerment of women in an effective, ethical, and efficient manner.

*P. S. Research Scholar, Cambridge Institute of Technology, Bengaluru, India
** Associate Professor, Visvesvaraya Technological University, Belgavi, India
***Professor and Director, Cambridge Institute of Technology, Bengaluru, India
*****Professor, Marshall University, USA
*****Professor, Marshall University, USA

CONCEPTUAL FOUNDATIONS OF WOMEN EMPOWERMENT

It is from time unknown that women have been the most deprived group in the world, regardless of their race, ethnicity, region, or religion. Women have been the victims of household and societal abuse and violence, molestation, physical abuse, rape, poverty, malnutrition, and murder, besides deep-rooted discrimination at work, in educational and legal systems, to name a few. Empowerment of women has become a global phenomenon which has proven to reduce poverty, increase in consumer and purchasing powers, decrease in domestic violence in households, increase in social and economic justice, more opportunities in education and work, in developing nations. Initiatives, activities, and commitments at local, regional, national, and global levels have encouraged more women (and men) to join the Women Empowerment movement, thus improving society's ability to manage cultural, social, legal and economic challenges. In addition, women's participation in societal activities, involvement in politics, and ownership and management of small and large organizations-business and non-business has given hope and vision for a future to women who have disadvantage and are in poverty (Cattaneo and Chapman 2010; Richardson 2018). A case in point is a study on Women Empowerment in India (Deshpande and Sethi 2001). While a lot more needs to be done regarding the implementation of Women Empowerment (WE), there are many success stories of women, from rural areas, enjoying such initiatives as those of the Ford Foundation, the United Nations Development Programs, Stree Shakti Scheme (Department of Women and Child Development at the State of Karnataka, Bengaluru, India), Micro Finance Institutes (MFIs in India), many more (Shettar 2015). However, the movement, Women Empowerment, has a long way to go to be successful in India and globally.

The term, Women Empowerment (WE), has been defined in many perspectives. According to Mandal (2013). These different perspectives include self-strength, self-control, self-power, self-reliance, choice, capability of fighting for one's rights, independence, own decision-making power, freedom, etc. Kaheer(1999) defines WE as the degree to which women can improve their ability to make important life decisions on their own. According to Malhotra and Schuler (2005), "WE" is beyond the concept of enablement of underprivileged women who face family problems and domestic violence in their household. Mosedale (2005) goes a step further in defining WE as the equality between men and women in each society. Thus, Women Empowerment is the path to improve the conditions of women in poverty, to boost their confidence leading to stand on their own, to start a small business and receive equality, respect and peace in their household, surrounding communities, and in society.

CORE COMPONENTS OF WOMEN EMPOWERMENT

According to Sushama Sahay (1998), "Empowerment is an active, multi-dimensional process which enables women to realize their full identity and powers in all spheres of life.", Women Empowerment's (WE) primary focus is on the balance between men and women in terms of household decision making, cultural equality, financial benefits, and so on (Alsop and Heinsohn 2005; Beteta 2006; OzaalandLosarwar1997), However, to recognize, assess, and apply the concept of WE in an effective manner, one must familiarize oneself with the multi-dimensionality of the concept, As shown in Figure 1,WE's five principal components are economic, social, psychological, political, and legal components (Drake and Rhyne 2002; Duflo 2012; Galaband Rao 2003; Hennicket al. 2012; Troutner and Smith, 2004).

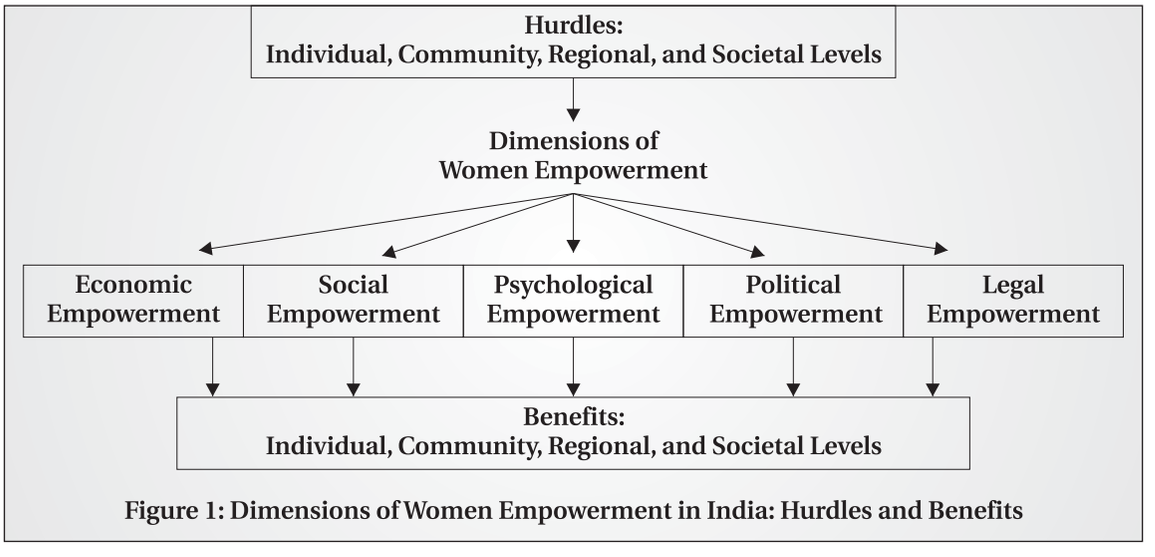

Figure 1: Dimensions of Women Empowerment in India: Hurdles and Benefits

ECONOMIC EMPOWERMENT

According to Biswas and Kabir (2004), "Economic Empowerment is a powerful tool against poverty.", Elliott (2008) points out, "Wage employment means economic power." Economic Empowerment is an imperative and a precondition for women's empowerment from a long-term sustainability and development perspective. One of the main hurdles to economic empowerment for women in India has been the

societal attitude and stereo-type belief that women's main role in the household is to carry out the job of cooking, laundry, tailoring, washing clothes, baby-sitting, taking care of elderly, to name a few. This hurdle is dominant in the rural parts of India. In addition, inequality, and the lack of women empowerment in educational opportunities have made the achievement of economic empowerment in India very challenging. Hence, it is imperative that efforts at local, state, and national levels must be devoted to creating the positive atmosphere to achieve economic empowerment for women (Golla, et al. 2016; Gupta 2014). These efforts must be coordinated with other dimensions of women's empowerment, such as legal, social, and political components.

OCIAL EMPOWERMENT

According to Mandal (2013), "social empowerment refers to the enabling force that strengthens women's social relations and their position in social structures." Social empowerment attempts to reduce, hopefully, eliminate, the social inequalities and discriminations that permeate in the society regarding caste, class, race, ethnicity, religion, region, gender, or disabilities. Social empowerment covers such aspects like household activities, decisions on children's education, marital arrangements, interactions with community, religious rites, and beliefs, etc. (Archer, 2006). The challenge of achieving social empowerment is a complicated task, particularly in rural parts of India. According to Griffin (1987), if social empowerment is achieved, it can advance women's status in a society at large and not just in their households. Social empowerment will also provide a platform based on which men, in India, will have learned to respect and appreciate the contribution made by women in their family, community, and society.

SYCHOLOGICAL EMPOWERMENT

Conger and Kanungo (1988) suggested that psychological empowerment focuses on the emotional experience among women as they interact with their family members, workplace, community, and society at large. Zimmerman (1995) postulates psychological empowerment is about individual capability and self-worth, embedded in three factors: (1) intrapersonal: an individual's self-perception, self-efficacy, perceived control, and competence, (2) interactional: an individual's understanding of the relationship between personal growth and environmental factors, such as family members, community groups, religious and political organizations, work-related individuals, and so on, and (3) behavioral: actions taken by individuals to cope with both intrapersonal and interpersonal factors. We can see a combination of three factors in an example: a woman who experiences violent treatment at home shares her problems and issues with her coworkers. Her coworkers then advise her to contact a local non-governmental organization that counsels women who have similar issues or family problems. If the woman then talks it out with her family members and reduces the impact of stressful family issues, we can consider this psychological empowerment for the woman.

OLITICAL EMPOWERMENT

Participation and involvement of women in the political arena and in decision-making processes of various business and non-business organization are critical foundations political empowerment for women (Alexander, et al.,2016). Political empowerment encompasses not only political participation but also includes such activities as social movements, labor strikes, protests, demonstrations, struggles,processions, religion-based disagreements, etc. According to Rajput (2001), "Empowerment of women in all spheres, in particular the political sphere is crucial for their advancement and the foundation of a gender equal society. It is central to the achievement of the goals of equality, development and peace." As suggested by Mandal (2013), without effective and continuous political participation of women will have a hard time in achieving the four other dimensions of women's empowerment social empowerment, economic empowerment, psychological empowerment, and legal empowerment. Narasihman (1999) support the concept of political empowerment by stating that"… bringing women into the main-stream of national activity as equal partners alongside men..."The challenges and hurdles of achieving political empowerment for women in India dominate rural, city, state, and national levels of politics, but more prevalent in the rural areas of the country.

EGAL EMPOWERMENT

All nations have a public legal education, also known as civics education, covers an array activity aimed at building public awareness and skills related to law and the justice system. However, having knowledge of legal structures, justice systems, state and private laws does not establish legal empowerment for women. As stated by Golub (2001), legal empowerment is based on enactment of laws and justice systems to improve poverty-stricken women's standard of living, providing facilities for education, opportunities for entrepreneurship and meaningful and sustainable career advancement, healthcare provisions, and protection from violence and discrimination.

As one can surmise, the five dimensions of women's empowerment like economic, social, psychological, political, and legal, are challenging, but achievable, given the commitment and resources provided by various components of a society or nation, including but not limited to, government agencies, non-governmental organizations, small or large corporations, religious entities, educational and social organizations, local communities, and individuals and their families. These five dimensions are interdependent, interactive, and ever-changing. They have become imperatives to the advancement of justice, standard of living, respect, and safety and security not only for women in a nation but also for that nation.

The Justification for Women Empowerment

To make Women Empowerment acceptable by all in India, it is imperative that we highlight the justification for WE in a transparent and thorough manner. A group, known as

Teamwork (2019), has articulated the importance of Women Empowerment as follows:

1. **Underemployed and Unemployed and Unused Women's Talents:** Women make up 50 percent of the world's population; given this, are we not damaging the world's economy by not using the skills, talents, and experience of women workers? By not hiring qualified women for various jobs, positions in corporations, government, social organizations, other societal entities, we are missing the opportunity to advance the wellness of any society or nation.

   As for India, if women took part in labor force at the same ratio as male, India would add 235 million workers in its workforce. However, India seems to be sliding backwards in this respect. In 2005, Indian women's labor participation was 35% (which is low). It slid down to 26 percent a decade later. This is the outcome of increased prosperity. Women from middle-class families in India prefer not to work outside of their homes (Economist, 2018).

2. **Inspiration for Others:** The world across, many women have performed well in various arenas, including politics, corporations, sports, social movements, etc.; in India, there are many success stories. A Web site, www.owlcation.com (2020) provides a list of 51 famous women from India, dating as far back as the 16th century. The list includes the famous names from all walks of life in India- warriors, freedom movement, social reformers, scientists, astronauts, military ranks, sportswomen, arts and medicine, corporate leaders, and many more. These and many more brave and talented women have served as role models for women and girls in India and across the globe. Take an example of a successful and well-known Bollywood movie, Dangal (Wikipedia 2020); the movie narrated the challenges, community-based and societal, faced by two youthful girls, the Phogat sisters, Geeta and Babeeta, who aspired to be wrestlers in the male-dominated sports in India. The movie highlighted the hurdles the youthful girls and their father, also a former wrestler, crossed and won national and international championships. According to Wikipedia (2020), the move has had a deep-seated political and social impact, so much as that the film was screened at the Indian Government's one of the Parliament session (Hindustan Times, March 22, 2017) to spread the message of women's empowerment across the nation. The movie inspired youthful girls to take part in various competitive tournaments, educational opportunities, job search, and so on.

3. **Overall Development of Society:** Women Empowerment helps self-confidence among women and youthful girls, gives them an opportunity to progress on many fronts. All of this has and will continue to help the nation in all interconnected areas- family, local, state, regional and national levels. It is a win-win situation for all. For example, Bangladesh, whose income per person in half of that of India has achieved a better standard of living, if measured in terms of numbers of years added to life, a reduction in premature infant deaths and similar other socio-economic indicators. They have achieved it through women's empowerment, emanating from added income to (rural) women through garment industry and micro-financing etc. (Economist, 2012)

4. **Economic Development:** Women Empowerment strives to achieve financial and economic independence for women across all the spectrums in India—caste, age, social class, educational level, religion, regional, and language differences. As suggested under Item#1, employment of women will lead to employment, which in turn, will lead to financial independence, plus, development of self-confidence, self-reliance, self-respect, social balance, and overall advancement of the Indian society (Gupta, 2014).

5. **Reduction in Domestic Violence and Corruption:** One of the tragic outcomes of caste system, male-dominated employment situations, outdated traditions and taboos, lack of awareness and ignorance of women's role in the society, has been the domestic violence against women and youthful girls. The laws, justice systems, education (Goswami 2013) and family bringing up have resulted in some reduction in the spread of this plague of domestic violence in India. However, it is imperative that the Indian society advances the cause of Women Empowerment movement; such an effort will cause creating much needed awareness across all the sectors of Indian society, leading to self-confidence self-respect among women and young girls so they can stand up for themselves in the face of any form of domestic violence.

   Another impact of Women Empowerment will have been on the reduction of corruption against women, when it relates to the employment and hiring opportunities. With the advancement of Women Empowerment, more women will get educated and develop appropriate hard and soft skills, resulting in the reduction in corruption against women, this benefiting the Indian society.

6. **Reduction in Poverty:** India has been burdened with poverty in many communities, regional and states (Satapathiand Jaiswal 2018). The plague of poverty is harsh and visible in the rural areas of India. It is hoped that the awareness and acceptance of Women Empowerment in India will give job opportunities for women across the rainbow of Indian Society. This will generate additional income for families, reducing poverty of individuals and families. According to one estimate if Indian women, who work for about 6 hours a day of unpaid work, took part in formal labor force, India's GDP would rise by 1.7 trillion dollars (Clinton, 2014).

7. **Psychological Benefits of Women Empowerment:** It will be short-sighted if we focus on the economic, financial, educational, political, and legal benefits of Women Empowerment movement in India. One of the important benefits, often not recognized or not so obvious, is the enhancement of self-esteem, self-confidence, development of soft skills, increased awareness on cleanliness and hygienic practices, and improved health, to name a few.

8. **Advancement of Nation:** As stated earlier, if incorporated in the heart and soul of Indian Society, Women Empowerment will give equal opportunities to women in terms of employment, education, health services, political representation, increased awareness of human rights, and gender equality. All these areas and issues will help in the national development process for India.

The above eight points justify the existence and advancement of Women Empowerment in India and across the globe. Both men and women together can keep families, organizations, communities, states, regions, and nations improve and move forward with moral dignity, social justice, equality (Sethuraman 2008), and integrity. It is in this framework and mindset that we all must support and internalize the movement of Women Empowerment, regardless of our gender, class, caste, ethnicity, religion, and nationality.

URDLES AGAINST WOMEN EMPOWERMENT IN INDIA

The Indian society is a complex melting pot of caste, ethnicity, religious factions, language differences, social class, rural versus urban outlooks, family and community traditions, age differences, to name a few. While the complex diversity has made India tolerant and sustainable over many centuries, it also has created many hurdles when it comes to the acceptance and spread of Women Empowerment across the nation (Raju and Venkateswarlu 2011). In a comprehensive study, Shettar and Rajeshwari (2015) have identified the following hindrances or hurdles in the path of Women Empowerment in India:

1. **Gender discrimination:** Gender discrimination or bias is a global scourge that has been in practice across nations in varying degrees. For example, as reported in Times of India on December 9, 2019 (timesofindia.indiatimes.com/india/undp-report,)Human Development Report (2019) by the United Nations ranked India at 130 out of 186 nations. According to Ravi and Jayaraman (2012), gender inequalities are entrenched in the Indian Society, particularly in the rural areas of the country. These inequalities cut across an array of sectors of Indian Society: politics, health services, education, birth preference, financial resources, employment opportunities, social status, caste and class recognition, to name a few (Kabeer, 2005; Kadam 2012; Kishor et al. 2009). The gender inequalities are profound in the rural regions of India.

2. **Lack of Education:** Since its independence in 1947, India has improved its educational system and its infrastructure; however, the gap between educated men (over 80 percent) versus educated women (just over 60 percent) is unacceptable as the main cause of low progress rate for women. This gender discrimination against women in the Indian educational system has led to fewer opportunities for women to get higher education, specialized professional training in such areas as medicine, information technology, and engineering (Goswami 2013). This has led to low rates of employment of women, particularly in managerial positions.

3. **Female Infanticide:** Many families still prefer and try to have a male child born in the family; should a woman not deliver a male child, the blame is placed on that woman (Bali 2019). This gender bias is prevalent in the rural areas in India. Amartya Sen introduced the concept of "missing women." In the 1990s, he estimated that 100 million women worldwide (of which 44 million from China and 37 million from India) died early because of a higher mortality rate amongst the females in many societies. Now, while that gap is being narrowed, wide availability of sexselective female abortion has led to imbalance in the male-female ratio. In Germany girl to boy ratio is 94.8 to 100. This is taken as the benchmark. But the same ratio in the four northern and western states in India (e.g., Punjab, Haryana, Delhi, and Gujrat) are between 79.3 and 87.8 girls per 100 boys, showing widespread practices of female infanticide (Sen, 2003).

4. **Family Responsibilities:** In the Indian society, a woman in the house, (in the role of mother, wife, sister, or daughter) is still responsible to carry out most of the household chores, such as cooking, washing closed, housecleaning, child care, elderly care, and so on. These multiple tasks are time consuming, leaving no time for women to pursue other aspects of like, such as education, employment, self-improvement. Fulfilling multi-family tasks also curtails the mobility of women to such that they have no choice but to stay home. According to one survey, while male spend 36 minutes per day on unpaid household works, female spend about 354 minutes per day (Wikipedia, 2020, Budlender 2008). This is more pervasive in the rural parts of India.

5. **Demands for Dowry:** The dowry system has been one of the major financial burden on the families while seeking marriage opportunities for their daughters and sisters. Frequently, once married into a family, a young woman faces unpleasant treatment, including verbal insults and domestic violence from her in-laws if the pre-marriage dowry is considered an insufficient and demands for more dowry are placed on such women (Chiplunkar and Weaver 2019 https://www. ideasforindia.in). Such violent treatments often result in youthful women being held as household prisoners, leaving them no time and effort for personal improvement and empowerment.

6. **Violence on Women (rapes, acid attacks, verbal insults and humiliations, murders):** Many governmental agencies, newspapers, and non-governmental organizations have reported violence against women, besides domestic violence, in both rural and urban areas (Rana and Choudhary 2014). The threats of such violence make many women to remain at home, instead of trying to prepare themselves for career opportunities. Also, any experience from domestic or street violence makes women and youthful girls lose their self-esteem self-confidence, increasing self-blame and feelings of guilt.

TRATEGIES TO SUPPORT THE MOVEMENT OF WOMEN EMPOWERMENT IN INDIA

Undoubtedly, the benefits of Women Empowerment are far-reaching, cutting across all the sectors of India. In other words, the Women Empowerment movement will not only help women and young girls in India to become self-reliant, self-confident, safe, and healthy, but it will also advance and progress the entire nation of India (Nagaraja, 2013). The question is: what strategies can various entities—individuals, communities, governmental agencies, non-governmental organizations, corporations, educational institutions, religious groups, to name a few—can plan and apply in order to implement Women Empowerment in India in an effective and efficient manner? (Raju and Venkateswarlu 2011). Team Work (www.importantindia.com 2019) has proposed several strategies to move WE forward.

1. **Role of Government and Non-Government Entities:** Having laws and legislation to advocate gender equality, to protect from domestic violence is one way of empowering women and girls, For example, the Government of India has several ministries or agencies, including Ministry of Women and Child Development, Ministry of Health and Family Development, Support to Training and Employment Program for Women (STEP), One-Stop Centre Scheme, "Save the Child" Movement, Mahila E-haat, to name a few (Shettar 2015). Similarly, there are many non-governmental organizations (NGOs) that support Women Empowerment, including but not limited to, Self-Employed Women's Association (SEWA), Snehalaya, North East Network. Azal Foundation, Mahila Kisan Adhikaar Manch (MAKAAM), Centre for Social Research (CSR), and Stree Shakti Scheme (Bengaluru, India). The Governmental agencies and NGOs must make sure to implement the laws and policies in a transparent, effective, efficient manner. It is equally important that both governmental entities and NGOs coordinate their processes, initiatives, and activities to achieve a positive, synergetic impact on Women Empowerment.

2. **Legal Platforms:** Women in India can be empowered through the creation and application of relevant legal platforms. Certainly, India has several legal tools to protect women from discrimination, child abuse, violence, etc. Examples of legal platforms are: The Dowry Prohibition Act of 1961, the Prohibition of Child Marriage Act of 2006, the Immoral Traffic (Prevention) Act of 1956, the Commission of Sati (Prevention) Act of 1987, and the list goes on. In addition, the Government of India launched a program called National Policy for Empowerment of Women in 2001 (www.edugeneral.org). This agency strives to achieve nine empowerment goals, such as "Changing societal attitudes and community practices by active participation and involvement of both genders: men and women," "Mainstreaming a gender perspective into all policies and programs for women development in the Indian system."

3. **Educational Opportunities:** One of the most important pathways of success for WE is the availability and opportunities for women and young girls to receive appropriate education at all levels--high schools, vocational institutes, colleges and universities (Goswami 2013; Stormquist2005; Suguna 2011). In these regards, it is critical that both state agencies and private and public entities make certain that their educational programs focus on developing both soft and hard skills in girls and women in order for them to prepare for the real world of business and non-business environments. In addition to providing education on an individual basis, efforts are necessary to educate the communities regarding the importance of educational opportunities for young girls and women, especially in the rural areas.

3. **Equality in Health Care and Medical Services:** There is a widely known common saying "Health is Wealth." This is true for both men and women, but particularly for women in the rural sectors in India, there is a significant shortage and biases when it comes to the provision of healthcare and medical services. Hospitals, health clinics, and other medical entities must provide timely and much needed health and medical services to women, particularly those with limited financial resources Bloom et al. 2001). In this regard, major cities are able to provide health and medical services on an equal term, but such case is not with the villages and small towns in India (Balarajan, et al. 2011).

4. **Development of Mentors and Leaders:** Communities, organizations (state or private), laws and legislation are important in empowering women in India. However, the commitment, dedication, and efforts by individuals are equally important. In this regard, having mentors and leaders at community, regional, state, and national levels will provide young girls and women much needed role models for their inspiration and improvement (www.importantindia.com 2019). The identification and training of mentors and leaders can be assisted by various governmental agencies, NGOs, and educational institutions. A series of workshops at local, community and state levels can be conducted to assist the development of mentors and leaders who will then contribute to the advancement of Women Empowerment.

5. **Commitment from Indian Men:** The primary beneficiaries of Women Empowerment are undoubtedly young girls and women. However, the advancement of Women Empowerment will also benefit households and communities across the regions, thus benefitting men as well. Therefore, it is imperative that men in India dedicate their time, effort, and commitment in making sure that 'WE' is successful. In this regard, educational institutions, mentors and leaders can help men understand the mission, scope, and benefits of Women Empowerment by providing appropriate information via written material, the Internet sources, and community dialogues.

6. **Creation of Equal Opportunities across the Spectrum:** Ultimately, the mission of Women Empowerment is to create equality for women in a fair and consistent manner, across all aspect of the Indian society

(www.importantindia.com 2019). It is not just about the equalities in employment, but also, in terms of social justice, political representation, education and training, healthcare and medical services, protection against domestic violence, financial and psychological support, and respect and appreciation. Every effort, individually or organizationally, must be made to achieve the mission of Women Empowerment.

7. **Role of Information and Communication Technology:** Information and communication technology (ICT) is all-pervasive development, across nations and continents,that has been the hallmark in the development of the world economy (Baruah 2013; Chandrashekhar et al. 2010; Sharma, D. 2016; Sharma, U. 2003). Also, ICT has been instrumental in spreading the importance of equality, education, healthcare services, etc. Particularly in India, the last two decades have seen an exponential growth of ICT, specifically, in the regions surrounding such major cities as Mumbai, Bengaluru, Pune, and Hyderabad, resulting in a much needed economic and social development of the nation. The impact of ICT has been widespread, including supply chain and transportation, agriculture, manufacturing, and service sectors (e.g., banking, education) The impact of ICT on women Empowerment can be seen in terms informing and educating women (and men) on the foundations and importance of empowerment of women.

   According to Ghosh (2015), the first publicly available internet service in India was introduced by state-owned Videsh Sanchar Nigam Limited (VSNL) on 15 August 1995. According to Telecom Regulatory Authority of India (2020), about 688 million (about 53 percent) Indians have the access to the Internet. Of these, only 36 percent of residents living in the rural areas have the Internet connections. Thus, the increase and improvement in the Internet infrastructure in both urban rural areas will speed up the acceptance and implementation of Women Empowerment in India (Chandrashekhar and Shivaprakash 2010).

8. **Role of Bollywood Celebrities:** Bollywood celebrities have played an influential role in the daily lives of Indians. These celebrities also serve as role models and mentors for many Indian citizens, regardless of their caste, income, class, religion, age, gender, educational levels, and regions. Certainly several Bollywood actors (Farhan Akhtar, Aamir Khan, Rahul Bose, Siddharth S. late Sridevi, to name a few), directors, musicians, and writers have participated in activities and movements supporting Women Empowerment in India (www.mensxp.com, June 18, 2018). They have contributed not only financially but also serving as messengers and spokespersons for Women Empowerment.

9. **Role of Media Outlets in India:** Undoubtedly, governmental agencies, non-governmental organizations, educational institutions, social and religious entities, political leaders at various levels play critical roles in advancing the mission of Women Empowerment. In the same context, mass media outlets (e.g., TV stations, newspapers, magazines, radio stations) have their responsibilities to report on the status of Women Empowerment in India, in a truthful, apolitical, and factual basis. According to Sonia Gupta (2018), "Media is the mirror of society and media reports are a reflection of happenings in the society. Communication is extremely important for women's development and mass media play a significant role in it."

ONCLUSION

In summary, Women Empowerment is not just a conceptual framework, but a real-life phenomenon that aims to support and advance the liberalization of women and provides an opportunity for them to become self-sufficient, self-confident, and productive, thus contributing to their community and society. In today's world, the rapid growth of globalization, industrialization and changes in government policies and legislations have made the concept of Women Empowerment (WE) not just a localized social issue, but it has achieved a global importance from various perspectives, including social justice, economic and political progress and delivery of education. Women Empowerment has and will continue to face the challenges and hurdles along its path to success. These obstructions have been overcome on the basis of help and commitment from various individuals, communities, organizations and nations. Both the individual and collective efforts need to keep defeating those hurdles. As they say, Women Empowerment is a win-win for all.

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Empirical Analysis of the Stock Markets of BRICS Economies

*Tanuja Puri

ABSTRACT

Developing an understanding of the relationship amongst the stock markets of the five emerging economies of the ever so growing financially integrated world has immense significance. BRICS the group of nations has the capacity to change the business environment of the world as they are highly financially integrated. The primary objective of this paper is to evaluate the integration among BRICS nations during the past 5 years (1st April 2014- 1st April 2019) by analyzing monthly price histories of BOVESPA Index, MOEX Russia Index, BSE Sensex, SSE Composite Index and JSE Index for Brazil, Russia, India, China and South Africa respectively. Descriptive statistics, correlation, ADF unit root test and Johansen Co-integration test have been applied on the data. Since BRICS appears to have a massive financial influence in this financially integrated world, the paper also establishes a good degree of relationship amongst the stock markets of these economies thereby implying the need for the foreign institutional investors to follow a diversified portfolio strategy and study the specific growth areas in these economies in order to take a good investment decision.

Keywords: *BRICS, Stock markets, Descriptive statistics, Correlation, ADF Test, Co-integration.*

**Assistant Professor, Delhi Institute of Advanced Studies, Delhi, India.*

INTRODUCTION

The liberalization, privatization and globalization processes of the emerging countries of the world picked up the pace after 1990s, contributing primarily to the economic development of the nations. Financial integration amongst the countries grew at a fast pace. According to Agénor (2003), financial integration refers to the extent to which the domestic financial markets are connected to each other at the domestic, regional, or international levels. So in this era of globalization, a magnificent increase has been seen in the transactions of the world financial markets, indicating a more integrated world market. A relationship amongst the nations is established when integration happens at such a rapid pace. Increased correlations amongst the stock markets of the economies can help investors in better designing of their portfolio and diversifying their risk. Also the policy makers study the integrated stock markets to analyze the economy and form policies for the citizens of the country. So, such hulking integration amongst the world markets calls for analyzing the co movements in the stock markets of the top emerging economies of the world. Out of all the developing economies, BRICS form the association of the strongest emerging countries of the world.

BRICS is the acronym for the major emerging economies of the world i.e. Brazil, Russia, India, China and South Africa. In the year 2006, the group was formed among Brazil, Russia, India and China and then South Africa joined in 2010. The main objective of BRICS is to promote dialogue and cooperation among the member countries in an incremental, proactive, pragmatic, open and transparent way. The purpose and association of BRICS is instrumental not only to fulfill the similar interests of the emerging economies, but also to ensure peace, prosperity and amicable relations amongst the government and private players of these nations. The association is considered to be the strongest among the developing economies of the world for the reason that the BRICS countries have a sizable contribution to the global growth, trade and investment.

BRICS plays an immensely crucial role in strengthening the world economy, influencing international monetary arrangements and in according with the Sustainable Development Goals. Persevered BRICS growth and its dialogue, cooperation and policy initiatives have greatly assisted other emerging and developed nations of the world. Approximately 40% of the world population is a part of BRICS. In 2015, the combined economic significance equaled almost one third of the Global Gross Domestic Product in PPP terms. Therefore, BRICS can be contemplated as the new hub of the profundity in the global economic structure. Over the last two decades, BRICS contribution to the world trade transactions has almost increased three times. The overseas inward and outward trades have observed an unceasing growth. Through extensive trade and investment amongst the BRICS, amicable relationships have been established that in turn has led to enhanced nexus, greater organizational formal communication, improved supply chain management, growth oriented deals and projects amongst the private players and governments of these nations. Inward and outward logistics, extensive network and communication between the BRICS and other countries of the world have also escalated through extended investment and trade. By the year 2030, it is expected from the BRICS economies to increase their contribution to the world economic growth, in case the interest rates and investment rates amongst these nations stay favorable to the economic conditions.

The investments in BRICS stock markets have seen tremendous growth, because investors resort to diversifying their portfolio by investing in different assets globally. As a result of which the financial markets have become more integrated. With such greater financial integration and linkages, it is of utmost importance to understand the relationship amongst the nations in order to maximize the returns from the investments made. It is implied that the more the markets are integrated, the greater the contagion effect can get as was observed in the US financial crisis 2008, and so investors should diversify their portfolio by investing in other countries apart from the ones that are highly co-integrated. Reckoning ever growing role of BRICS nations in the world hence makes it useful to assess the relationship and association amongst the Stock market indices of these nations. Table 1 contains the stock market indices selected for the analysis purpose in this study-

Table1: BRICS Nations and their Indices

Country	Major Stock Markets	Stock Market Indices
Brazil	BM & FBOVESPA	BOVESPA Index
Russia	Moscow Interbank Currency Exchange	MOEX Russia Index
India	Bombay Stock Exchange	BSE Sensex
China	Shanghai Exchange	SSE Composite Index
South Africa	Johannesburg Stock Exchange	JSE Index

The above stock market indices have been chosen for the purpose of data analysis as these indices are considered to be credible and are representatives of the economy. The composition of these indices captures the maximum capitalization of the stock exchanges for the respective nations. The indices together can be considered to provide a candid snapshot of the state of the stock markets of these nations.

ITERATURE REVIEW

Several empirical studies have been conducted to establish a relationship amongst the BRICS economies. Since the stock markets of the BRICS economies are being analyzed, relevant past studies in this regard have been discussed with a brief global background.

Mohanasundaram and Karthikeyan (2015) analyzed the nature of association and the possibility of existence of a short-run and long-run relationship amongst the stock-market indices of South Africa, India and the USA for the period from April 2004 to March 2014. It was observed that a strong correlation existed amongst the selected stock market indices. Also, according to the Johansen and Juselius multivariate co-integration approach applied, absence of a long-run

relationship was found among the three stock market indices. According to Tripti Nashier (2015), there is evidence of short term static and long term potent integration between the BRICS(Brazil, Russia, India, China and South Africa) economies and the stock markets of the USA and the UK. The tests applied were correlation and Johansen co integration test.

Abas (2009) examined the relationship between the stock markets of China and India and the markets of the US, the UK, Japan and Hong Kong. It has been observed that the markets of China and India are correlated with all four developed markets analyzed by him. According to Shachmurove (2006) a dynamic interrelationship was observed among the stock exchanges of the US and of the four Emerging nations, namely Brazil, China, India, and Russia. It has been observed that the Brazilian stock market returns are affected to a large extent by other stock markets. According to Bhar and Nikolova (2009) India has the highest level of integration amongst the BRIC countries. Bora et al. (2009) examined the stock market indices of developing economies of Brazil, Russia, India, China, and Argentina (BRICA) and analyzed the linkages among the stock markets of the BRICA countries and their relationship with the stock market of the USA. It was observed that the stock market of the USA had a noteworthy impact on all BRICA countries.

According to Chittedi (2009), there existed co-integration between BRIC countries and developed countries, namely, the USA, UK, and Japan. An and Brown (2010) examined the co-movements of the weekly and monthly index returns during October 13, 1995-October 13, 2009, of the US, Brazil, Russia, India, and China stock markets. It was discernible that there was some co integration between the US and China, but there was no co integration between the US and the other emerging markets. Sharma et al. (2013) using the conventional indices of the stock markets of Brazil, Russia, India, China, and South Africa (BRICS), attempted to study the relationship amongst the economies. The study revealed that the BRICS stock markets were influenced by each other, but not to a marked extent. Kishor & Singh (2017) attempted to establish relationship and linkages among BRICS economics and found the effect of one stock index of one country on the other countries stock indices. The cause and effect relationship among various indices was noted by the ADF, Unit root test and Granger Causality. For instance, a significant and positive correlation existed among Nifty and other BRICS indices. Albeit no long term relationship was discernible among Nifty and other stock indices. Anbarasu & Selvaraju (2015) studied the performance of the bourses movement on the secondary platform. Several indices were selected and historical data was taken to study share market prices from 2013 to 2014 .Tools like Descriptive Statistics, ADF Unit Root Examination and Corelogram Analysis were used to analyze the stock market prices. Gupta(2014) focused on the formation of dependence between the emerging stock markets of BRIC countries. The study aimed to provide a better theoretical approach to the BRICS countries' stock market and to find out which countries were more affiliated with the prices between India and other countries in BRICS. Various tools were used to evaluate data on stock indices - the Shapiro Wilx W test. These tools established the relationship among BRICS countries.

Ouattara (2017) analyzed the quarterly data from 2000 to 2015 and observed that no long term relationship existed among the stock market indices of BRICS economies. However, high positive linkages among the stock markets were noted and a bi directional causal relationship existed between Indian and Brazilian stock markets. Tripathy (2017) using GARCH, CHARMA, APARCH AND CGARCH models established the presence of asymmetric and leverage effects in all BRICS countries stock market returns. Time varying long-run volatility component was also reported to be more persistent in Chinese and Russian stock markets. The study further exhibited that volatility shocks were quite persistent in all BRIC countries stock markets revealing the changing pattern of volatility over time. Nasr, Cunado, Demirer& Gupta (2017) examined the linkages among the BRICS stock market returns, country risk ratings and international factors using NARDL models. It was established that quite a degree of heterogeneity existed in the interaction of the stock market returns with country-specific political, financial and economic risk ratings.

Panda &Thiripalraju (2018) using VAR Granger causality test and EGARCH model established the presence of bidirectional and unidirectional return spillover and it also established that negative news impacts more on volatility of BRICS stock markets. They also acknowledged that the transformation of information from one market to another market helps in developing hedging strategy, finding diversification opportunities and capturing the efficiency of the market. Dahiretal (2018) studied the dynamic links between the exchange rates and stock markets of BRICS economies. The results revealed a positive relationship between the stock prices and exchange rates in the medium and long-term and out of the five economies South Africa seemed to have a more bidirectional causality. Lima (2019) examined the sectoral dynamics of co-integration between the BRICS (Brazil, Russia, India China and South Africa) and developed stock markets, represented by Germany, Japan, the UK and the US. The results supported the existence of financial co-integration across sectors and among all the nine countries during the Global Financial Crisis and European Sovereign Debt Crisis. Only developed countries exhibited co-integration during the UK Brexit crisis.Allimuthu (2019) used the daily closing prices of the major stock indices of BRICS from 1 January 2000 to 31 December 2017 to examine the integration among the BRICS nations. After employing ADF test and PPP test for stationarity and value at risk techniques like Granger Causality test and Johansen &Juselius co-integration test, it was observed that short-run and long-run relationship did exist among these nations.

Mroua (2019) examined the causality and the dynamic links between exchange rates and stock market indices of Brazil, Russia, India, China, and South-Africa (BRICS). Generalized Method of Moments (GMM) model and the ARDL method were applied and it was observed that exchange rate changes had a significant effect on past and current volatility of the BRICS stock indices. Al-Mohamad etal (2020) applied the Augmented Dicker-Fuller (ADF) and Philips-Perron tests (PP) tests to analyze stationarity among the selected variables. The pre- and post-BRICS formation long-term linear relationship was investigated using Johansen and Juselius co-integration test while the Granger Causality was applied to assess the

direction of the causality between the stock market indices. It was noted that the degree of financial integration among the BRICS stock markets had moderately strengthened in the post-BRICS formation period compared to the pre-BRICS formation period. It was also observed that the Chinese stock market was mostly independent from other BRICS markets and a unidirectional causal relationship existed from the Russian stock market to its BRICS counterparts in both periods. There was an increased responsiveness of stock markets in BRICS countries to shocks in each other after the formation of the bloc as compared to pre- formation period.

Most of these studies found enhanced level of integration amongst the stock markets of BRICS. The aim of this paper is thus to further analyze the stock markets of these emerging economies using the latest monthly data of the past 5 years(1 April 2014-1April 2019). Anything more than 1 year, is considered to be long-term and in this ever so rapidly growing world economy where economies have become financially integrated and extremely dynamic to the external environment, 5 years time period is therefore more than enough to analyze the long-term association amongst the stock markets of the BRICS nations.

DATA ANALYSIS

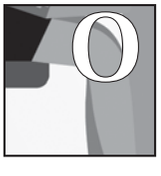
For the purpose of data analysis, 5 years monthly historical data have been taken of the stock market indices of the BRICS economies. Analysis has been conducted using EXCEL and E-views.

DESCRIPTIVE STATISTICS

The descriptive statistics has been used to summarize the general trend and pattern of the dataset. The results obtained from the Table 2 imply that out of the all stock exchanges only Russia's data set is negatively skewed indicating a long left tail of the distribution. All other distributions of the stock indices except for Russia are positively skewed i.e. they have a long right tail. Analyzing the kurtosis, we find that all the stock indices are having values that are less than 3. So, in comparison with a normal distribution, the height of the distribution selected for the study is short and tails of the distribution are thinner. Also, there exists a negative kurtosis among the Stock indices of Russia, India and South Africa. So, in comparison with a normal distribution, the peak of the distribution selected for the study is flatter and tails of the distribution are lighter.

Table2: Descriptive Statistics

BOVESPA		MOEX		SENSEX		SSE		JSE	
Mean	64264.82	Mean	1951.45	Mean	30062.21	Mean	3060.42	Mean	53303.45
Standard Error	2009.58	Standard Error	42.93	Standard Error	556.87	Standard Error	64.55	Standard	394.94
Median	61288.20	Median	1953.05	Median	28452.17	Median	3095.47	Median	52388.87
Mode	#N/A	Mode	#N/A	Mode	#N/A	Mode	#N/A	Mode	#N/A
Standard Deviation	15695.32	Standard Deviation	335.28	Standard Deviation	4349.27	Standard Deviation	504.14	Standard Deviation	3084.56
Sample	246342950.25	Sample	112412.68	Sample	18916162.15	Sample	254154.84	Sample	9514497.89
Kurtosis	-0.76	Kurtosis	-0.95	Kurtosis	-0.91	Kurtosis	1.75	Kurtosis	-0.70
Skewness	0.58	Skewness	-0.03	Skewness	0.49	Skewness	0.46	Skewness	0.63
Range	56987.70	Range	1253.31	Range	16613.75	Range	2585.39	Range	10902.73
Min	40406.00	Min	1306.01	Min	22417.80	Min	2026.36	Min	48870.10
Max	97393.70	Max	2559.32	Max	39031.55	Max	4611.74	Max	59772.83
Sum	3920154.20	Sum	119038.21	Sum	1833795.10	Sum	186685.78	Sum	3251510.41
Count	61.00	Count	61.00	Count	61.00	Count	61.00	Count	61.00



OBJECTIVE & RESEARCH METHODOLOGY

The objective of the study is to analyze the inter-relationship among the bourses of the BRICS economies by studying select stock market indices i.e. BOVESPA Index, MOEX Russia Index, BSE Sensex, SSE Composite Index and JSE Index. The study also analyzes the movement of BSE Sensex with other indices of BRICS nations. For selecting the samples, purposive sampling technique has been employed. The Sample size consists of the monthly prices of the stock market indices of BRICS nations. The sample period consists of last 5 years data from 1st April 2014 to 1st April 2019. Secondary sources were used for data collection. For the purpose of data analysis, descriptive statistics, correlation, Augmented Dickey Fuller test and Johansen Co-integration test have been used.

To compare the variability of the distributions, coefficient of variation is calculated as per equation no. 1:

Coefficient of variation- (standard deviation / Mean) *100…….....(1)

Table 3: Coefficient of variation of Stock Market Indices

	BOVESPA	MOEX	SENSEX	SSE	JEE
C.V.=(STD/ MEAN)*100	24%	17%	14%	16%	6%

From Table 3 it is apparent that the stock market of Brazil is the most volatile in comparison with the stock markets of other 4 countries, its variability being the highest i.e. 24%. The most uniform out of all the markets is that of South Africa, its variability being the lowest. India's stock market is less uniform and consistent as compared to South Africa, but is more consistent and uniform as compared to the stock markets of Brazil, Russia and China.

Various reasons can be attributed to the high volatility in the stock markets of Brazil. One prime reason can be the political instability that was observed in 2016 with the impeachment of the president Dilma Rousseff for breaking Brazil's budget laws. The mentality of the investors where they tend to follow each other while buying securities as soon as a change in the government is announced, can also be a reason for high volatility in Brazil in comparison to the stock markets of Russia, China, India and South Africa. It can also be implied that the stock markets of India and China are less volatile for the reason that they are the prime developing countries of the world. Their consumer and industrial markets have been expanding rapidly and domestic as well as international investors have generally viewed them as a profitable investment option. But their volatility is more than that of South Africa. So, from the point of volatility, markets of South Africa can be preferred as a stable investment option as the coefficient of variation is the least out of all the BRICS economies.

ORRELATION

Correlation analysis is used to find whether there exists a relationship between any two or more than two data sets. Strength and direction of the relationship can be calculated and an association among the select data sets can be established. For the analysis purpose, correlation for the 5 stock indices has been calculated using Excel Analysis Tool Pak.

Table4: Correlation among the Stock Market Indices

	BOVESPA	MOEX	SENSEX	SSE	JEE
BOVESPA	1				
MOEX	0.839982	1			
SENSEX	0.903708	0.821333	1		
SSE	-0.09219	0.066151	0.039323	1	
JSE	0.674672	0.659956	0.774087	0.25906	1

From Table 4, correlation among the BRICS economies is computed. Highest correlation of 90% is there between SENSEX and BOVESPA which indicates a strong relationship between the stock markets of Brazil and India. A strong correlation of 83% and 82% is there between MOEX and BOVESPA and SENSEX and MOEX respectively, indicating a strong positive relationship between the stock markets of Russia and Brazil as well as of India and Russia respectively. Stock market of India is highly correlated with Brazil followed by Russia and South Africa. A negative correlation of 9.2% is there between SSE and BOVESPA, indicating an opposite direction movement between the stock markets of China and Brazil. A very low degree of correlation i.e. of 3% is there between SENSEX and SSE, indicating a poor relationship between the stock markets of India and China. Also between the markets of South Africa and China, relatively lower degree of correlation i.e. 25% is visible.

From the data, it can be concluded that Indian stock markets have a strong relationship with the stock markets of Brazil, Russia and South Africa. The stock markets of Russia, Brazil and India share a greater degree of relationship amongst each other as compared to the other nations. It can be implied that the possible reasons for such a good degree of correlation can be the increased dialogue, cooperation and policy initiatives of the BRICS economies. In 2015, BRICS economic significance expanded one third of GDP in PPP terms, thereby showing the increased trade and investment linkages amongst these nations. Amicable political relations amongst Russia, Brazil and India can also be one of the possible reasons for good degree of correlation amongst these nations. Thus, the global investors can gain an idea of how to diversify their portfolio of securities if they decide to invest in India then investment in countries apart from Russia, Brazil and South Africa would be a preferable option in order to minimize their risks and increase their possibility of returns, thereby reducing their risk of contagion effect.

UGMENTED DICKEY FULLER TEST

Stationarity test is a preliminary test used before applying major statistical tools. It is the test that leads to the next set of statistical tools such as Unit root, Johansen Co-integration and Granger causality test. The time series data should have absence of unit root thereby making the data stationary and fit for applying further econometric tests. The movement of time series data should revolve around a mean value. It should not reflect any fluctuations during the period. For the data to be stable, there must be absence of unit root. If data set with unit root elements are applied in the analysis, it would lead to spurious or nonsensical regression.

So, existence of stationarity is tested through Augmented Dickey–Fuller (ADF) Unit Root test. Eviews software is used to apply the test to the 5 stock market indices.

The hypothesis is set to test the existence or non- existence of unit root in the stock market indices of the BRICS economies. The indices are tested for the presence of unit root using ADF test. The lag truncation parameter is based on Akaike Info Criterion with a lag length of 4. The test has been conducted on the level and on the first difference and respective 'intercept' and 'trend and intercept' values have been recorded as shown in table 4. When calculated, it was found that the values of

Table 5: ADF Unit Root Test

Indices	Level				1st Difference			
	Intercept		Trend & Intercept		Intercept		Trend & Intercept	
	t-statistic	Prob	t-statistic	Prob	t-statistic	Prob	t-statistic	Prob
BOVESPA	-0.009942	0.9536	-2.040325	0.5676	-4.257722	0.0013	-4.722107	0.0019
MOEX	-1.005064	0.7462	-3.732436	0.0276	-8.890801	0.0000	-8.804934	0.0000
SENSEX	-0.022059	0.9523	-2.043812	0.5657	-6.994089	0.0000	-6.986442	0.0000
SSE	-3.20933	0.0243	-3.189273	0.0965	-5.237677	0.0000	-5.313315	0.0003
JSE	-2.099878	0.2455	-3.075146	0.1216	-8.126243	0.0000	-8.051853	0.0000

Null Hypothesis: Unit root exists in the selected indices.
Alternate hypothesis: Unit root does not exist in selected indices.

'intercept' and 'trend & intercept' at the first difference, are significant to reject the null hypothesis. ADF statistics for the indices are -BOVESPA (-4.722107), MOEX (-8.804934), SENSEX (-6.986442), SSE (-5.313315) and JSE (-8.051853). Hence, the null hypothesis is rejected. It can be concluded that the indices are stationary at first difference i.e. unit root does not exist. This makes the indices ideal for further econometric testing.

OHANSEN CO-INTEGRATION TEST

Johansen Co integration test is used to ascertain the long-term association among the variables. If the two variables are co-integrated with each other, then they are presumed to have long-term relationship. In this study, Johansen Co-integration Test has been used using E Views , to analyze the co-integrating relationship between variables.

Null Hypothesis: No long-term association exists among the selected indices.

Alternate Hypothesis: Long-term association exists among the selected indices.

Johansen test is conducted on the 5 stock market indices of the BRICS economies. Trace test and maximum Eigen value tests can be conducted under it. In both trace and Max-Eigen Statistics, the p value should be more than 0.05 to accept the null hypothesis. In table 6 since the p value for trace test and

Table 6 : Johansen Co-integration Test among the Five Stock Market Indices

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical value	Prob.**
None *	0.558319	86.67901	69.81889	0.0013
At most 1	0.279417	40.10046	47.85613	0.2189
At most 2	0.178741	21.42184	29.79707	0.3319
At most 3	0.159439	10.19762	15.49471	0.2658
At most 4	0.005206	0.297523	3.841466	0.5854
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical value	Prob.**
None *	0.558319	46.57855	33.87687	0.0009
At most 1	0.279417	18.67862	27.58434	0.4398
At most 2	0.178741	11.22422	21.13162	0.6249
At most 3	0.159439	9.900093	14.26460	0.2186
At most 4	0.005206	0.297523	3.841466	0.5854
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

the maximum eigen value test in 'none' hypothesis is less than 0.05, therefore the null hypothesis is rejected and the alternate hypothesis is accepted, which means that there exists a long-term association among the stock markets of BRICS economies. The results indicate that all the variables are co-integrated.

The possible reasons for such co-integration can be increased bilateral trade relations, amicable political relations, common foreign international investments and increased foreign direct investments since the formation of BRICS that has all added up to the economic proximity amongst these nations. The presence of the co-integrating relationship amongst the BRICS nations, suggests that the markets move together and there is some common risk factor that makes them co-integrated in the long run. Such co-integration thus implies that the international investors have limited investment opportunities for minimizing their risk in these nations. To protect the investments from the contagion effect, they should resort to diversifying their portfolio by investing in other countries in tandem with the BRICS nations. However, certain benefits can be derived from the co-integration of stock markets like increased liquidity and reduced transaction costs. Hence the global portfolio managers can still add value from investments in these countries. But increased level of co-integration of these nations necessitates the need for global investors to follow diversified portfolio strategy and ascertain specific growth areas within these economics before making investment decision.

ONCLUDING OBSERVATIONS

The importance of BRICS countries can be assessed from the fact that it accounts for 40% of the global population and the combined economic weight in 2015 equaled almost a third of the global Gross Domestic Product in PPP terms. BRICS is contemplated to be the novel economic strength in the global financial arrangement. The BRICS share of world trade has nearly tripled over the last twenty years. Outward and inward investment and overseas trade has experienced a sustained growth. Inward and outward logistics, inter connected network and communication between the BRICS and other countries of the world have also escalated through extended investment and trade. Due to the fact that BRICS has become such a powerful association in the past few years, an attempt has been made in this paper to examine the relationship amongst the stock markets of BRICS economies by analyzing the monthly data of the past 5 years(1 April 2014-1 April 2019). The paper is useful for policy makers, global investors and researchers who want to examine the financial interconnectedness amongst these nations. The analysis started with descriptive statistics, wherein skewness, kurtosis and coefficient of variation were studied. It was observed that the stock market of Brazil was the most volatile and the distribution sets of all the indices were having tails thinner than the normal distribution. It was implied that from the point of volatility, markets of South Africa could be preferred as a stable investment option as the coefficient of variation was the least out of all the BRICS economies. Correlation analysis helped in establishing the highest degree of positive relationship between the markets of India and Brazil. Also the markets of Russia, Brazil and India shared a greater degree of relationship between each other as compared to the other nations. Global investors should diversify their portfolio of securities, for if they decide to invest in India then investment in countries apart from Russia, Brazil and South Africa would be a preferable option in order to minimize their risks and increase their possibility of returns, thereby reducing their risk of contagion effect. After this the variables were tested for stationarity using Augmented Dickey Fuller Test, wherein it was found that the indices were stationary at first difference i.e. unit root was absent. The indices were then considered for Johansen Co-integration test. According to Johansen Co-integration test, it was observed that a long term association existed among the bourses of BRICS nations, the possible reasons of which could be increased bilateral trade relations, amicable political relations, common foreign international investments and increased foreign direct investments since the formation of BRICS that has all added up to the economic proximity amongst these nations. The presence of the co-integrating relationship amongst the BRICS nations, suggested that the markets move together and there is some common risk factor that makes them co-integrated in the long run. Such co-integration, thus, implied that the international investors have limited investment opportunities for minimizing their risk in these nations. To protect the investments from the contagion effect, they should resort to diversifying their portfolio by investing in other countries in tandem with the BRICS nations. From the study, it can be concluded that the variables are co-integrated and the BRICS economies are financially integrated and have an immense potential to remain powerful and influence the globalized economy.

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Development of Students' Academic and Employability Model through Data Mining

**Dr. Tripti Mishra*

The Abstract is of the Thesis "Development of Students' Academic and Employability Model through Data Mining" submitted by Dr.Tripti Mishra for the award of Ph.D. degree from Mewar University, Chittorgarh. The Supervisors were: Dr. C.D. Kumawat, Professor, Department of Computer Science, Mewar University, Chittorgarh and Dr. Sangeeta Gupta, Professor, Management Education and Research Institute, New Delhi. The University awarded the Doctorate to the research scholar in 2019.

**The Research Scholar Dr. Mishra is presently Professor, Delhi Institute of Advanced Studies, Delhi.*

INTRODUCTION

Background

With more than one billion population, in which half of the population is under the age of 25 years, India is all set to become the youngest nation by 2020. This pool of young people can be converted to highly productive human capital, by providing them higher education. Today higher education (HE) is an industry in itself which provides a strong work force to other industries.

Limited opportunities in government-run organizations for higher education has forced the Indian government to encourage private players to set up new institutions and deemed universities. Further, this unprecedented growth of Institutions has created a highly competitive education sector. The major challenges and issues of this sector are

(i) Increasing students' dropout rate;

(ii) Migration of students from one Institution to other Institutions;

(iii) Finding the learning ability of the student by the institutions;

(iv) Recommending a suitable course to the students in which s/he will excel;

(v) Developing a curriculum based on students need and capability;

(vi) Continuous improvement of quality of education;

(vii) Increasing economic viability of the course by increasing the employability of the students;

(viii) Curriculum update as per industry requirement

The sudden surge of private Institutions has increased the accessibility of HE to the masses. However, the quality of education being provided has always been questioned, as the unemployment of students having higher education degree, has been rising.

Keeping in view the problems faced by the Institutions and the above challenges, the Institutions are adopting technologies that can help them take timely and informed decision. Today every educational Institution generates a huge amount of data which can be a storehouse of information. Bearing in mind this ever growing data and the prominence of students' assessment, the solution of the problem will turn out to be data mining (DM). Concerning education, a novel application of DM technique known as educational data mining (EDM) can be used for knowledge discovery in educational databases for learning, cognition, and assessment. The research work presented in this thesis makes use of EDM concepts to develop a predictive model for predicting student's performance and their employability.

TATEMENT OF THE PROBLEM

The Institutions providing higher education are thriving in a highly competitive world. Students seek admission in an Institution based on the academic performance of the students graduating from that Institution in a particular course and the employability of these students. According to (Susila M. et.al, 2013) career prospects and reputation of the Institution plays an important role in selection of Institution by students. A student dissatisfied on these parameters may migrate to another institution resulting in loss of reputation and revenue of the Institution. Thus the primary goal of any higher educational institution is to improve the academic decisions, endow with quality education, enhanced student's performance and elevated employability of students. With the increasing complexity of educational system, the decision making process is becoming all the more difficult. One of the significant facts in higher learning institution is the explosive growth of educational data. The technology like data mining can help in setting new strategies and better the existing process to improve quality of education. Data mining techniques can be used to build models that can help predict the academic performance of student as well as its employability. The performance prediction models can be used by Institute authorities to take timely action and give special attention, training and counseling to students at high risk of poor academic performance and at the risk of unemployment so as to bring much needed improvement in results. Additionally, the prediction can provide excellent guidelines for making better strategy in future.

BJECTIVES OF THE STUDY

In context to the statement of the problem the objectives of the study are:

1. To identify factors that affect students' academic performance;

2. To design a predictive model for the performance of students using factors identified;

3. To suggest guidelines for timely intervention to improve performance thus increasing success rate;

4. To identify factors that affect students employability;

5. To design a predictive model for employability using factors identified;

6. To suggest a guideline for enhancing the employability and construct a decision support system for prediction of academic performance and employability.

HEORETICAL BASIS: EDUCATIONAL DATA MINING

International Educational Data Mining Society defines Educational Data Mining as "an emerging discipline, concerned with developing methods for exploring the unique types of data that come from educational settings, and using those methods to better understand students, and the settings which they learn in."

EDM is poised to leverage a massive amount of research from the data mining community. It is an interesting research area which extracts useful, previously unknown patterns from educational databases for better understanding, improved

educational performance and assessment of student learning process and provide a system that can help different stakeholders of education system. EDM has been applied in different educational setups like traditional education, E-learning and student centric Intelligent Tutoring System. The stake holders of EDM are students, educators, course developers, and administration. Figure 1.1 depicts a typical data mining set up in educational systems.

However, effects of emotional skill have not been considered by researchers in EDM. In the present work we have considered, emotional skills, academic parameters and socio economic parameters to develop performance and employability prediction model.

Next section discusses the contribution of the thesis.

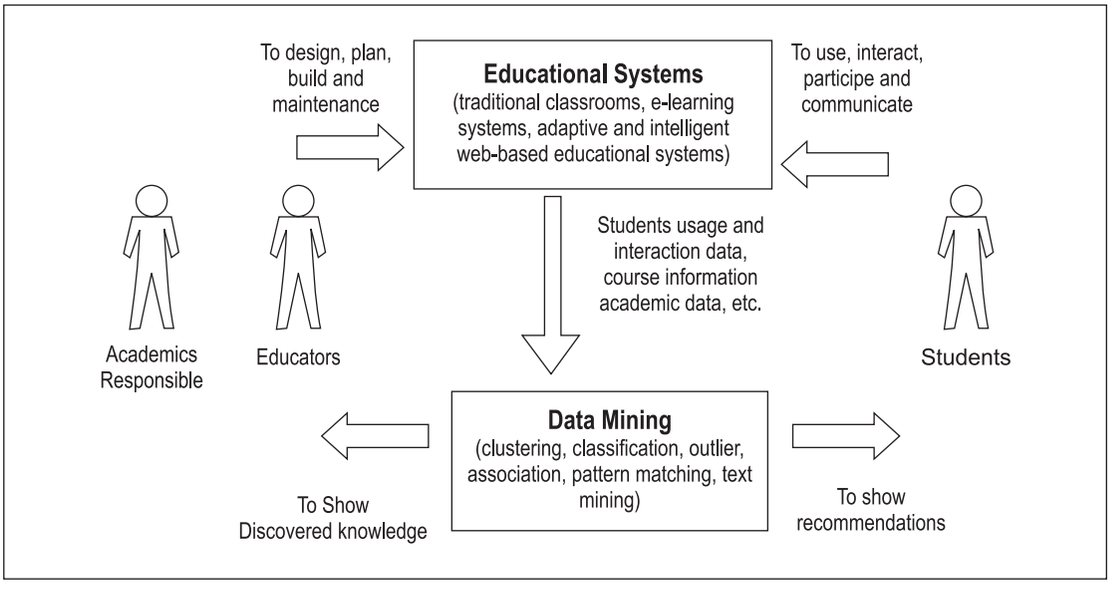

Figure 1: Data Mining in Educational Setup [Source: Romero and Ventura, 2007]

APPLICATIONS OF EDM

Different groups of users or stakeholders view the system provided by EDM from different perspectives, each group having its own goal, vision and objectives. Based on the perspective of various stakeholders, Educational data mining has forayed into various research areas such as

- Students' Modeling
- Recommender Systems
- Studying Pedagogical Support
- Course Management Systems
- Student Retention and Attrition
- Students' Performance Prediction
- Students' Employability Prediction

With the above methods, it has been observed that there is a need of further research that can help improve the quality of education and improve its economic viability.

Academic performance and employability of students build the reputation of an Institute. Performance prediction is a mature field. Researchers have used academic and socioeconomic parameters to predict the performance of students. Emotional skills are very important factors that have been proved to affect the performance and employability by (Potgieter , 2013),(Marc A. Brackett,et.al, 2012) in psychology.

CONTRIBUTION OF THE THESIS

The present research work is an attempt to combine the issues of quality education.

(i) Students' academic performance prediction has been one of the favorite topics of the research but, not much work is done in the area of employability prediction. Predictive model for both academic performance and employability is developed in this study.

(ii) The existing research has considered mostly academic and socioeconomic parameters for prediction purposes. The present study uses a standard tool (Emotional skill Assessment Process) to calculate emotional skills like leadership quality, self-esteem, drive strength, empathy, time management, stress management, decision making and assertion and uses them as predictive parameters apart from considering academic and socioeconomic parameters.

(iii) A comprehensive Decision Support System is developed to predict the academic performance and employability of students to help the management (teachers/ trainers) of the institute.

LITERTURE REVIEW

The review of the past research efforts related to theoretical framework in Educational Data Mining method is organized chronologically

and categorically offer an insight on how past research efforts laid the groundwork for subsequent studies, including the present research efforts. The detailed review has been carried out, so that the present research can be tailored to add the present body of literature, as well as the scope and direction of the present research effort

DUCATIONAL DATA MINING

Educational data mining develops methods and applies techniques from statistics, machine learning and data mining to analyze data collected from educational settings. From these it should be possible to test learning theories, develop algorithms and models to help education sector.

According to the literature study, it has been observed that EDM research pertains to mainly three heads, according to the way data is collected-

Traditional face to face or the offline education system based on data generated in the classroom. E-learning in which the learning is provided through online content based on online activity logs. Intelligent tutoring system (ITS) and Adaptive Educational Hypermedia System (AEHS)involve online teaching based on students need, his or her progress rather than providing same structured lesson to all the students. For the analysis purpose the data picked up by these systems are log files, user models, etc.

As the present work relates to traditional educational environment a comprehensive view of traditional educational environment is mentioned here.

RADITIONAL EDUCATIONAL SETUP

Traditional educational set up refers to class room teaching which is still the most popular form of teaching by the Institutions across the globe and needs to be explored. Next two subsections discuss the researcher's inclination towards prediction of both students' performance and their employability. The important factors for performance and employability prediction are the attributes considered and method adopted for prediction. Both academic performance and employability take into consideration students past record, as well as performance in current learning environment and other attributes that can help or affect negatively student's learning.

REDICTION OF STUDENTS' PERFORMANCE

Students' academic performance is a mature field now with many researchers contributing to it. Moving in chronological increasing order from 2007 onwards the researchers have considered various parameters for prediction and using different algorithm tried to predict the result of specific course of a particular university.

Nghe, Janecek and Haddawy (2007) have considered two diverse population,international, large Can Thao University of Vietnam and Asian Institute of Technology a small international postgraduate institute and achieved similar levels of accuracy of prediction performance. In this analysis, the decision tree was consistently 3-12% more accurate than the Bayesian network.

Ogor (2007) has developed a simple student performance assessment and monitoring system based on various data mining techniques. The predictor attributes included students demographic details, course average score in Ist to 5th semester overall gain performance, etc. For classification of students in three categories Excellent, Good, Satisfactory. C5 showed highest accuracy (97.3%) followed by CART (92.5%), ANN (91.42%) CHAID (57.77%).Ogor further used clustering to understand groups, non-performance attributes that latently affect performance.

Obdokumet. Al (2008) used records of 112 students, each recording 10 attributes like University matriculation exam, GCE (General Certificate of Education) Score, Senior Secondary Certified Examination score SSCE), grades in O level subject, location of University from, gender and age, Cumulative Grade point was to be classified as Good, Average and Poor. Oladokum has used only Neural networks with 56% data for training 30% for Testing and 14% for cross validation. ANN was able to give 74% accuracy of prediction.

Instead of Higher education, Cortez and Silva (2008) have focused on prediction of school students performances taken from two secondary school students .A total of 33 parameters including socio -demographic details like (parental marital status, father's job, mother's job, quality of family relationship, attitude towards study (No. of hour, past failure)Internet facility, family support, free time after school, health , alcohol consumption etc. were considered and four Data mining algorithms Decision tree, Neural network, Support Vector machine Random forest were used to predict the academic performance. Attendance, parents job, previous year performance affect the current performance.

Feature Selection is the process of choosing a subset of input variables by removing the feature irrelevant to prediction. Ramaswami and Bhaskaran (2009) experimented with 1969 higher secondary student from different schools of Tamilnadu taking 32 variables initially for prediction of secondary exam (pass/fail). Student's gender, Eyesight, Community, Physical handicap, food habit, family details, mode of transport , medium of instruction, sports activity etc. were considered. Using WEKA a set of methods were applied and four reduced subsets obtained with maximum 17 and minimum 12 attributes.It was also observed that classification methods like Naïve Bayes, one R voted perception performed much better with feature selected subset than where all variables were considered.

Paris , Affendy and Musthpha (2010)have compared C4.5,NB Tree, Bayes Net, Hidden Naïve Bayes , and voting techniques of classification based on three weak classifiers (Naïve Bayes, One R and Decision Stump) for improving the accuracy of performance prediction. The combination of HNB method and one weak classifier Decision Stump is used for voting technique. This particular combination has been taken, as HNB works well with most of the classes except for a high distribution class where Decision Stump gives good result.

The students dropping out of an open polytechnic of New Zealand due to failure has been explored by Kovaic. Z (2010). Enrollment data consisting of socio-demographic variables (age, gender, ethnicity, education, work status, and disability) and study environment (course programme and course block) .CART algorithm was found to be best suited with highest accuracy.

Expanding their earlier work, Kovacic and Green(2010) applied classification on data of students enrolled in Open Polytechnic programme. Ethnicity, Course level, Secondary school, age, Course block , Course offer type and Work status have been found most important attributes after feature selection. The logistic regression and discriminant analysis models were found to be a superior prediction model with higher accuracy than the classification tree models (between 1% to 4%) however at the cost of using more variables. The authors therefore recommend the use of the CART classification tree model in the early identification of at risk students.

Ramaswami and Bhaskaran (2010) used Chi-squared Automatic Interaction Detector (CHAID) and HSC result prediction model was derived based on 34 independent variables. Apart from demographic details student health, tuition, care of study at home etc. have been studied. Prediction Accuracy obtained was 44.69, and Potential influences variables were found to be Xth grade marks, location of school and Mother's private tuition .

Guruler,Istanbuller, Karahasan (2010) used SQL server and Analysis services to construct Mugla University student knowledge discovery unit program. The study aims to discover individual characteristics that decide their success using Microsoft Decision Tree. The type of registration and family income were found to be the greatest factors affecting the target.

Affendey, Paris and Mustafa (2010) emphasized attribute importance by ranking them , using correlation based feature subset selection and consistency subset selection (COE) and using them further find accuracy of various classifiers. Unlike other researchers, authors do not consider demographical details of the students, but concentrate only on grades of various courses as attributes to predict categories of students as first class, the other consisting second class upper lower and third class. Using a 10 fold cross validation, it is observed that Naïve Bayes, AODE and RBF Network performed best on the date set (2427 records) followed by RBF Network SMO and Logistic and decision tree.

Oyelade et al (2010) applied cluster analysis on the data set of students of one semester of one of the Nigerian University. The performance index based on GPA was decided into Excellent (>70), Very good (60-69), Good (50-59), Very Fair (45-49), Fair (40-45) and Poor (below 45). By considering k=3,4,5 different cluster sets of students are obtained which help monitor the progression students' performance in higher education.

Semibiring et al (2011) applied smooth support vector machine (SSVM) classification and Kernal K means clustering techniques to develop a model of student academic predictors by employing psychometric factors such as Interest, Study behavior Engage Time, and Family Support. Successful partioning was obtained with 5 clusters J48 decision tree was used to generate predictive rules which was implemented into SSVM algorithm to predict the student final grade.

Bharadwaj and Pal (2011) base their experiment only on Previous Semester marks, class test grade, seminar performance, Assignment, attendance , Lab work to predict end semester marks.

Huang S (2011) uniquely considers 6 combinations of predictor variables, three pre requisite courses, scores of three dynamics midterm, to predict academic performance in Engineering Drawing course. The analysis reveals that type of MLR, multiplayer perception MLP network, radial basis function RBF, network and support vector machine) has only slight effect on average prediction accuracy or percentage of predictions. Huang recommends use of SVM when individual academic performance of the student is to be predicted while multiple regression technique is best suited when average performance of whole class is to be predicted.

Cheewaprakobkit (2012) applied decision tree and neural network to predict academic performance. Decision tree proves to be a better classifier than the neural network with 1.31% more accuracy. Number of hours worked per semester, additional English course ,no of credits enrolled per semester and marital status of the students are major factors affecting the performance.

Sen, Uçar, and Delen (2012)have ranked importance of 24 predictor variables including demography, scores in Maths, Turkish, religion and ethics, science and technology and level determination exams etc for predicting Turkish secondary education placement result. Application of Artificial Neural Network, Support Vector Machine, Multiple Regression and Decision Tree were considered and decision Tree C5 gives the best result.

Osmanbegovic and Suljic (2012)collected 12 attributes of Ist year students of Economics a course consisting of demographic variable, score of high school entrance exam and attributes related to their attitude towards studying ,Importance of input variables on prediction was obtained using Chi – square test, One-R test, Information Gain test and Gain – ratio test. It is that GPA, score of entrance exam, study material and average weekly hours devoted to studying are having maximum impact while number of household members distance of residence and gender have least impact.

Shah N. S. (2012) applied various algorithms decisions tree (C45 Random Forest, BF Tree, Rep Tree)Functions (logistic RBF Network) Rule (3 Rip) and Bayes Net, Naive Bayes to categorize (predict) students in 5 categories (Very good, Good, Satisfactory, Below Satisfactory and Fail)Random Forest proven to most accurate classifier .

Kabakchieva (2013) used 14 attributes including personal profile, secondary educational score, entrance exam score, admission year and used l the classifier J48, Bayesian, K-nearest neighbor one R and J Rip. Kabakchieva concludes that J48 performs best with highest overall accuracy, followed by

rule barn (J Rip) and the K-NN classifier with Naïve Bayes being least accurate classifier.

REDICTION OF STUDENTS' EMPLOYABILITY

Today, the reputation of an Institution is judged by its academic success, it's ability to retain students and to provide employment for its' students. The term "Employability" still has no precise definition. Lee Harvey (2001) has made an attempt to describe it in many ways like the ability to secure a job, getting a job within a specified time period after graduating, the ability to skill map oneself according to the job need, or the willingness of the student to extend the graduate learning at work. According to V.K. Gokuladas (2010) "employability is determined according to students' success in campus recruitment drives by information technology companies, that is, whether they received an offer of employment". The same definition has been followed in the present study.

Research in employability prediction is in nascent stage. It mostly involves identification of skills or attributes required from the perspective of employers and is obtained from employer through questionnaire and interviews. Mostly statiscal methods have been applied and research is more of descriptive than predictive.

Rees (2006) in his report by Higher Education Academy with the Council for Industry and Higher Education (CIHE) in United Kingdom concluded that cognitive, personal, technical, practical, generic abilities along with organizational awareness are most important competencies employers look for. Kayha (2007) has considered the effect of working environment on performance of the employee.

Researchers Chein and Chen (2008) have taken attributes from the curriculum vitae, application and interview of the candidate and applied data mining techniques to predict the performance of a new applicant. The model helps the management in deciding the hiring of the employee.

Mukhtar et al (2009) have concluded that as the paradigm is shifting from product based to service based industry specially in Information Technology, hence the curriculum and method of delivering lecture must evolve. The new challenges are faced by considering a combination of approaches.

General studies for identifying factors that affect the job prospects of a student, have been conducted by Shafie and Nayan (2010). A descriptive study in the research indicates that employers look forward to employees with Personal attributes that include loyalty, commitment, honesty, integrity, enthusiasm, reliability, personal presentation, common sense, positive self-esteem, a sense of humor, motivation, adaptability, a balanced attitude to work and home life and ability to deal with pressure.

Gokuladas (2010) has used correlation and ordinal regression to conclude that a students' non-technical education consisting of reasoning, logical ability and soft skills were stronger predictor of their employability than their technical education consisting of their academic performance. Othman et.al.(2010) identified the reasons for the low employability rate amongst university graduates . Poor English language competency is found to be a major reason for the low employability. This has been supported by Gokuladas in 2011, that knowledge of GPA and English Language competency are required for the students in software industry to continue with their employment and also the female candidates were better performers than male candidates in campus placement drives.

The quest for finding the skills that make a student employable has been explored in the field of psychology. An attempt to relate the participant's personality to employability has been made by authors, Potgieter & Coetzee, in SA Journal of Industrial Psychology, 2013 using methods of psychology. Career competence, Career resilience, Self efficacy, Procativity etc. were few personality traits considered.

Yusoff et al. (2012) have used statistical methods to calculate the performance score of entry level engineers based on normalized skill weight. Employers' perspective regarding communication skill, team work, lifelong learning, problem solving skill, competency of employees were found to be important parameters .It has been confirmed that soft skills are significant as compared to technical skills. It also provides an equation based on which an engineer can be selected at entry level.

This work was extended by BangsukJantawan, (2013) who has used real data of graduate students of Maejo University in Thailand for three academic years. The parameters considered are socio economic, academics, and job satisfaction, reason for not working, etc were considered for prediction. Algorithms of Bayesian Network, and Decision Tree, both with five variations, have been used to build the classification model for graduate employability.

Pool, L, Dacre, Qualter, P. (2013) found that emotional self efficacy strongly decides the employability of a student. Further, it also affects the person satisfaction from his/her job.

One of the researchers recently (2014) stated that emotional intelligence, self management and life experiences are important factors for Employability development profile. Another researcher describes employbility in strong correlation with competences and depositions.

The attributes identified are categorized under three heads. Some of the factors are pertaining to social integration, some others are based on academic integration and rest are on emotional skills that have been obtained in this study using Emotional skill Assessment Process (ESAP) .These attributes can be used for different purposes with respect to a candidate like predicting employability alone, performance alone or combining both of thern.

In traditional education, performance prediction is in matured state with contribution from many researchers. However, there is paucity of research in the field of employability prediction. As both performance and employability of students graduating from an institution decide the market value of the institution, research is required to develop comprehensive models for performance and employability tool and develop a system that will be able to predict both performance and employability.

As both performance and employability are associated with each other all the factors that are used for performance prediction are used for employability. From the literature review, it is clear that most commonly used predictors are socio economic /demographic profile and past academic record of the students. Apart from this, number of hours dedicated to studies, distance of the institution from home, loan, internet facility etc has been considered by the individual researchers in their studies. Thus in general researchers in the field of EDM have focused on academic and social integration of students for performance and employability prediction.

Researchers in psychology have shown that the emotional skills of students are also important factors for performance prediction. However, not much work has been done in the field of EDM to validate the existing knowledge or construct new knowledge about emotional skill being predictor of performance. One reason for not considering emotional skill is lack of authentic data. The present work is an attempt to bridge this gap. The present study constructs authentic primary data that has factors of academic integration and social integration and emotional skills.

ETHODOLOGY

Research Design

The research design adopted is exploratory and experimental due to the nature of the study. An exploratory design was needed to conduct literature survey and identify factors used by researchers in past. Further, in order to develop predictive model, the data set has to go through an experimental set up under which different algorithms are applied on the data set (sample). Then the algorithm that gives the best result is selected for model building. Thus, experimental design follows the exploratory design in this study.

Sampling Technique and Data Collection

A structured questionnaire is constructed using Google Doc which has been administered to the MCA students from all the institutions affiliated to Guru Gobind Singh University over Internet. The sampling technique used fall under the category of convenience sampling. A data of 1545 students was collected.

Performance prediction includes attributes pertaining to academic integration (AI) (Table 1), social integration (SI) (Table 2), and emotional skills (ES) (Table 3). Whereas, employability prediction includes, all the attributes used for performance prediction along with project work, on-campus placement. The attributes regarding academic integration and social integration were obtained by direct responses to questions through check boxes or radio buttons. Based on the exploratory study done in , factors have been identified categorized under three heads. Some of the factors are pertaining to social integration (SI), some others are based on academic integration (AI) and rest are on emotional skills(ES). These attributes can be used for different purposes with respect to a candidate like predicting employability alone, performance alone or combining both. The emotional skills attributes were calculated based on the responses to a set of questions. For this standard tool of Emotional skill assessment Process (ESAP) has been used .

Table 1 Attributes Pertaining to Social Integration

Attribute	Values
Attribute	Values
Gender	Male, Female
Father's Education (FE)	Secondary, Senior secondary, Grad, Postgrad
Mother's Education (ME)	Secondary, Senior secondary, Grad, Postgrad
Father's Occupation (FO)	Government job, Private job, Business, Others
Mother's Occupation (MO)	Government job, Private job, Business, Housewife
Family Income (FI)	Low income Group (LIG)(<2 lakh per annum)
	Middle income group (MIG) (2 to 4 lakh per annum)Other
Loan	Yes, No
Early Life (Where a student has spent first 15 years of his life	Metro, City, Village

Table 2 Attributes Pertaining to Academic Integration

Attribute	Values
Medium of Instruction at school level	English, others
Percentage of Marks in Secondary, Senior secondary, Graduation, Firstsem, SecondSem, Third Sem, Fourthsem	Below average BLAVG (<60) Average AVG (60 to less than 70) Above Average ABVG (70 to less than 80) Excellent EXCL(>=80)

Type of Graduation degree (GRADDEGTYPE)	Regular, Distance
Graduation Stream (GRADDEGSTREAM)	Computer Science(CS) Non Computer Science(NCS)
Gap year after Graduation (GAPYEAR)	Yes, No
Hours spent on academic activities ACADEMICHRS)	Insufficient(UNSUF) <2Hrs Sufficient(SUF) 2-4Hrs Optimal > 4 Hrs.
On campus placement (ONCAMPUSPLACE)	Yes, No
Relevant work experience (RELWORKEXP)	Yes. No
Project	Yes, No

Emotional Skill attributes are assessed through Emotional Skill Assessment Process (ESAP) tool developed by (Nelson and Low, 2003), consisting of psychometric questions to judge various parameters.

Following attributes were considered

Table 3 Emotional Skill Attributes

Attribute	Values
1. Assertion (Ability to communicate effectively, honestly, clearly)	D: Needs to develop the skill(Absent)
2. Empathy (Ability to care for others)	S: Skill is present but need to strengthen(Moderate)
3. Decision making (Ability to take informed decisions)	E: Skill is present and Enhanced(Enhanced)
4. Leadership (Ability to influence others)	
5. Drive Strength (Ability to set a goal and strive for it)	
6. Time Management (Ability to manage time for best productive use)	
7. Self Esteem (Ability to regard himself or herself)	
8. Stress management(Ability to work under stress)	

After the collection of data, it needs to be cleaned and formatted so as to make it suitable for modeling.

ESULT AND ANALYSIS

Prediction of academic performance and employability helps the faculty and administrator take proactive measures like special instructional strategies and specialized training for the students who are at risk of poor performance and unemployment.

Prediction of a variable requires exploring the predicting variables or parameters that might play a role in influencing the prediction of target variable. Thus, the foremost objectives were to explore the factors that affect the academic performance and employability of students individually. The factors were identified based on the exploratory study of recent works done. Emotional skill parameters that were not emphasized in previous studies were also included in our study.

Next objective was to construct a prediction model for academic performance and employability individually and provide guidelines to management for improving academic performance and employability .Further, the research aimed at developing a decision support system tool for the prediction of both the academic performance and the employability. We explain all result and analysis pertaining to academic performance and that for employability prediction objectives.

CADEMIC PERFORMANCE PREDICTION

It takes almost a year for a student to get integrated in the environment of the institution hence for academic performance prediction, MCA third semester results are considered for prediction in category below average (BAVG), average (AVG), above average (ABVG) and excellent(EXCL) . Prediction of categorical variable is a classification problem and there is no specific algorithm that will prove to be best in any given situation. Thus it was required to apply various algorithms on the research work at hand and select the best suited after comparison of results obtained. Multilayer Perceptron (MLP), Sequential Minimal Optimization (SMO), Naïve Bayes, Random forest, Random Tree and J48 were selected for the experimentation based on the exploratory study. Results obtained were compared on accuracy, F-measure, Area under ROC curve and time taken by classifier to develop the model.

NALYSIS OF ACADEMIC RESULTS

This section presents the glimpse of the comparative results obtained in the above section. The classifiers' performances for prediction of academic results are compared using parameters F Measure, ROC area, Accuracy and Time taken to build the model. The comparative results are presented in Table 4 Figure 1 and Figure 2 shows the graphical view of the obtained results.

Analyzing the classifiers, we find that Naive Bayes and Random tree, inspite of their instant model building cannot be selected due to their low performance on other parameters. Naive Bayes has high AUC but lower accuracy . Similarly, Multilayer Perceptron, though having higher accuracy than Naive Bayes and Random tree has less accuracy than J48 and Random Forest. Further model classification time is very high. Accuracy and F measure of Random Forest, SMO, and J48 are comparable but Random forest, and SMO take substantial time to build the model.

Table 4 Comparative Analysis of Classifiers for Academic performance prediction

Algorithm	F Measure	Accuracy (%)	ROC Area	Model Building time(Seconds)
SMO	0.944	94.41	0.973	1.2
Naïve Bayes	0.909	90.75	98.2	0.02
Multilayer Perceptron	0.955	95.47	97.6	50.7
Random Forest	0.946	94.90	0.97	0.12
Random Tree	0.926	92.30	0.962	0.01
J 48	0.945	94.48	0.973	0.01

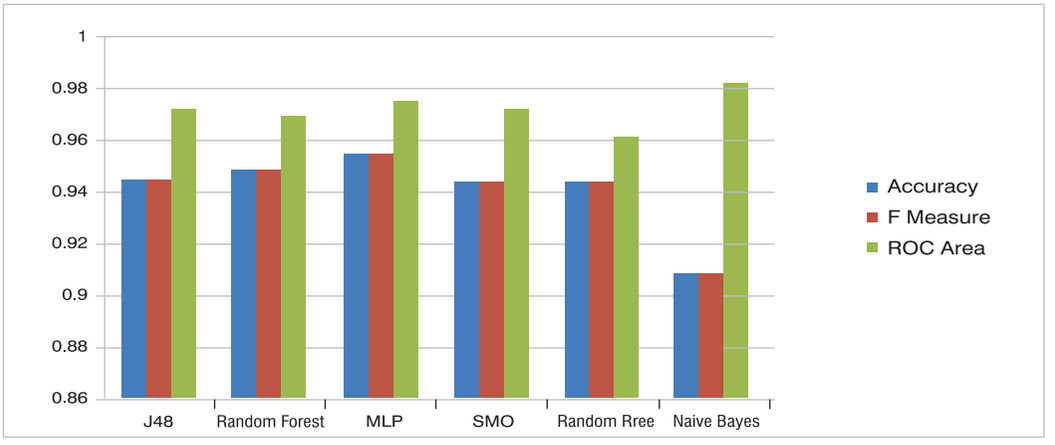

Figure 1: Classifiers comparison for academic performance prediction

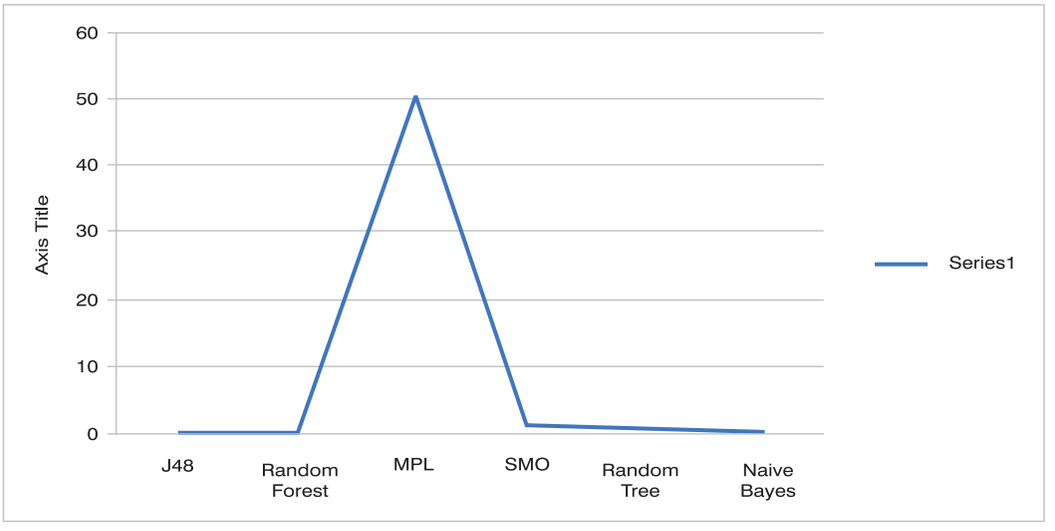

Figure 2: Comparison of time taken for model building for academic performance

Apart from this, the tree generated by J48 can be converted to rules which are easily interpret able. Thus J48 is selected for building the predictive model for academic performance due to its high accuracy, F-Measure, ROC area, low model building time, and easy interpretation.

CADEMIC PERFORMANCE PREDICTION MODEL

The analysis performed in the above section motivated us to use J48 algorithm to obtain the further analysis. Thus, we have used this algorithm to generate the tree, as shown in Figure 3.

```
SECSEM = AVG
|  FIRSTSEM = AVG
|  |EARLYLIFE = Metro: AVG
|  |  EARLYLIFE = City
|  |  |  MI = Other
|  |  |  |  STRESSMGMT = D: BAVG
|  |  |  |  |  STRESSMGMT = S: AVG
|  |  |  |  |  STRESSMGMT = E: ABAVG
|  |  |  |  MI = English: ABVG
|  |  EARLYLIFE = Village
|  |  |DRIVE=D: BAVG
|  |  |DRIVE=S: AVG
|  |  |DRIVE= E: AVG
|  FIRSTSEM = EXCL: EXCL
|  FIRSTSEM = ABAVG: ABVG
|  FIRSTSEM = BAVG: BAVG
SECSEM = EXCL
|  GRADDEGTYPE = Regular: EXCL
|  GRADDEGTYPE = Distance: AVG
SECSEM = ABAVG
|  |  GAPYEAR = Yes
|  |  |  DRIVE=D: BAVG
|  |  |  DRIVE=S: AVG
|  |  |  DRIVE= E: AVG
|  |  GAPYEAR = No: ABVG
SECSEM = BAVG
|  ACADEMICHRS=INSUF: BAVG
|  ACADEMICHRS=SUF: AVG
|  ACADEMICHRS=OPTIMAL: AVG
```

Figure 3: Tree generated by J48 for academic prediction

These set of rules then works as model for predicting the Academic performance. Figure 4 presented the model obtained, which consist of rules to classify the data and predict the students' performance.

1. IF(SECSEM = AVG) AND (FIRSTSEM = AVG) AND (EARLYLIFE = Metro) :AVG
2. IF(SECSEM = AVG) AND (FIRSTSEM = AVG) AND (EARLYLIFE = City) AND (MI = Other)
   AND(STRESSMGMT = D): BAVG
3. IF(SECSEM = AVG) AND (FIRSTSEM = AVG) AND (EARLYLIFE = City) AND (MI = Other)
   AND (STRESSMGMT = S): AVG
4. IF(SECSEM = AVG) AND (FIRSTSEM = AVG) AND (EARLYLIFE = City) AND (MI = Other)
   AND(STRESSMGMT = E): ABAVG
5. IF(SECSEM = AVG) AND (FIRSTSEM = AVG) AND (EARLYLIFE = City) AND (MI = English): ABVG
6. IF(SECSEM = AVG) AND (FIRSTSEM = AVG) AND(EARLYLIFE = Village)AND (DRIVE=D): BAVG
7. IF(SECSEM = AVG) AND (FIRSTSEM = AVG) AND(EARLYLIFE = village)AND(DRIVE=S): AVG
8. IF(SECSEM = AVG) AND (FIRSTSEM = AVG) AND(EARLYLIFE = Village)AND (DRIVE= E): AVG)
9. IF (SECSEM=AVG) AND (FIRSTSEM= EXCL): EXCL
10. IF (SECSEM=AVG) AND (FIRSTSEM= ABVG): ABVG
11. IF (SECSEM=AVG) AND (FIRSTSEM= BAVG): BAVG
12. IF (SECSEM = EXCL)AND (GRADDEGTYPE = Regular): EXCL
13. IF (SECSEM = EXCL)AND (GRADDEGTYPE = Distance):AVG
14. IF (SECSEM = ABVG) AND (GAPYEAR =No):ABVG
15. IF (SECSEM = ABAVG) AND (GAPYEAR = Yes) AND(DRIVE=D): BAVG
16. IF (SECSEM = ABAVG) AND (GAPYEAR = Yes)AND(DRIVE=S): AND (DRIVE= E)) : AVG
17. IF (SECSEM=BAVG) AND(ACADEMICHRS=INSUF):BAVG
18. IF (SECSEM=BAVG) AND((ACADEMICHRS=SUF) AND (ACADEMICHRS= OPTIMAL)) :AVG

Figure 4: Model developed for academic prediction

ISCUSSION OF RESULTS FOR ACADEMIC PERFORMANCE

For easy interpretation the tree was converted into a set of rules as shown in Figure 4. The research aimed at developing a predictive model for the academic performance of MCA students after they have spent one year in college (i.e. prediction of Third Semester). The rule set obtained from the tree clearly illustrates the attributes which are actually important for deciding the academic performance of the students. They are,

(i) Second Semester Result (ii) First Semester result (iii)Early life (iv) Medium of Instruction (v) Emotional skills stress management and drive (vi) Graduate degree type (vii)Gap year (viii) Academic hours

The following conclusions can be derived from above rule set

- A student with average performance in first and second semester gives average performance in third semester inspite of his initial upbringing of metro.[Rule 1].
- Stress management skill is imperative for all the students, however, it becomes pertinent especially for a student with upbringing of a city, with vernacular medium of instruction in school and average performance in first and second semester. It is observed that academic perfomance of third semester is above average for a student with enhanced stress management skill(E), average if Stress managemnt skill is strengthened (S) and below average if it he has poor stress management skill(D). Also under the similar circumstances an English medium student performance will be above average [From Rule 2,3,4,5].
- A student with average performance in first and second semester with the early upbringing of a village and poor drive(D) results in below average academic performance in third semester where as if Drive is strengthened(S) or is enhanced (E) the result can improve to average [Rules 6,7,8].
- It is observed that graduation degree from a regular course is important.A student who has completed his graduation in a regular course and gives excellent performance in second semester also gives excellent performance in third semester but above average performance if the graduate degree is from distance learning [Rule 12,13]. A regular education gives a better edge to the students in comparison to the one from distance learning course
- It is observerd that if a students first semester performannce is other than average then with second semester performance as average , the third semester performance depends on first semester result. The third semester result is above average, below average and excelllent if first semester performance is above average, below average and excellent respectively.[Rule 9,10,11].
- A student with above average performance in second semester with no gap year also gives above average performance [Rule 14].
- A student with above average performance in second semester having gap year after graduation degree is predicted to perform below average if his drive is poor or absent and average performance if his drive as present but needs to be strengthened (S) or enhanced (E) [Rule 15,16,17].
- A student with below average performance in second semester can improve the result to average by putting in sufficient or optimal number of hours in studies otherwise for insufficient academic hours yield below average result [Rules 18,19,20].

UIDELINES TO THE MANAGEMENT FOR IMPROVING ACADEMIC PERFORMANCE

From the academic prediction model it was observed that first and second semester results, early life, medium of instruction, academic hours, gap year and graduate degree type and emotional skills like stress management and drive are attributes that affect the third semester result. From the above observations it is suggested that the management of any Institution offering MCA needs to comprehend the student's Socio-economic condition, past academic records as well as emotional skill to predict academic result.

First Semester result plays an important role in students' performance after one year hence care should be taken in building the foundation and basic concepts in the first year itself. Further, below average performer in second semester must be given tutorial classes so as to increase their academic hours and improve the results. Students from non-English medium back ground should be given extra support for enhancing their proficiency thus enabling them to cope up with the stress arising due to education in English ,where they face difficulty in expressing themselves either in written exam or viva. Students from rural background need to be counseled to improve the drive for the higher education and competing with others. Similarly, students with distance learning course in graduation or those who have a gap year after graduation need special attention in the form of extra classes, extra assignment and motivation to improve their performance. Apart from faculty who help the students with academics appointing a counselor can bring improvement to students' emotional skill and thus help give a thrust to academic performance.

MPLOYABILITY PREDICTION

Further, next objective is to design the predictive model for the student's employability and thereby suggest the guidelines for enhancing the employability. The employability is defined as the capability to get on-campus placement in terms of YES and NO.

Analysis of Employability Results

The classifiers are compared using parameters F-Measure, ROC area, Accuracy and Time taken to build the model. The results obtained are presented in Table 5 for comparison. The graphical views of obtained results are shown in Figure 5 and Figure 6.

Table 5: Comparative Analysis of Classifiers for Employability prediction

Algorithm	F Measure	Accuracy (%)	ROC Area	Model Building time(Seconds)
SMO	0.839	83.9	0.831	1.88
Naïve Bayes	0.74	73.85	0.818	0.02
Multilayer Perceptron	0.932	92.08	0.971	47.59
Random Tree	0.876	87.63	0.887	0.0
Random Forest	0.886	88.6	0.887	0.17
J 48	0.883	88.3	0.884	0.01

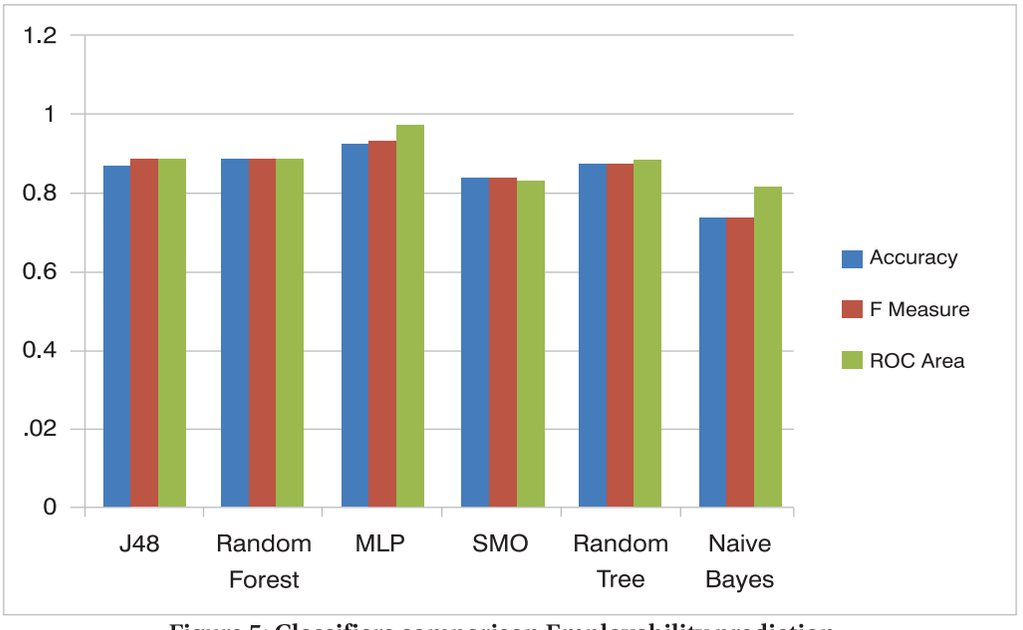

Figure 5: Classifiers comparison Employability prediction

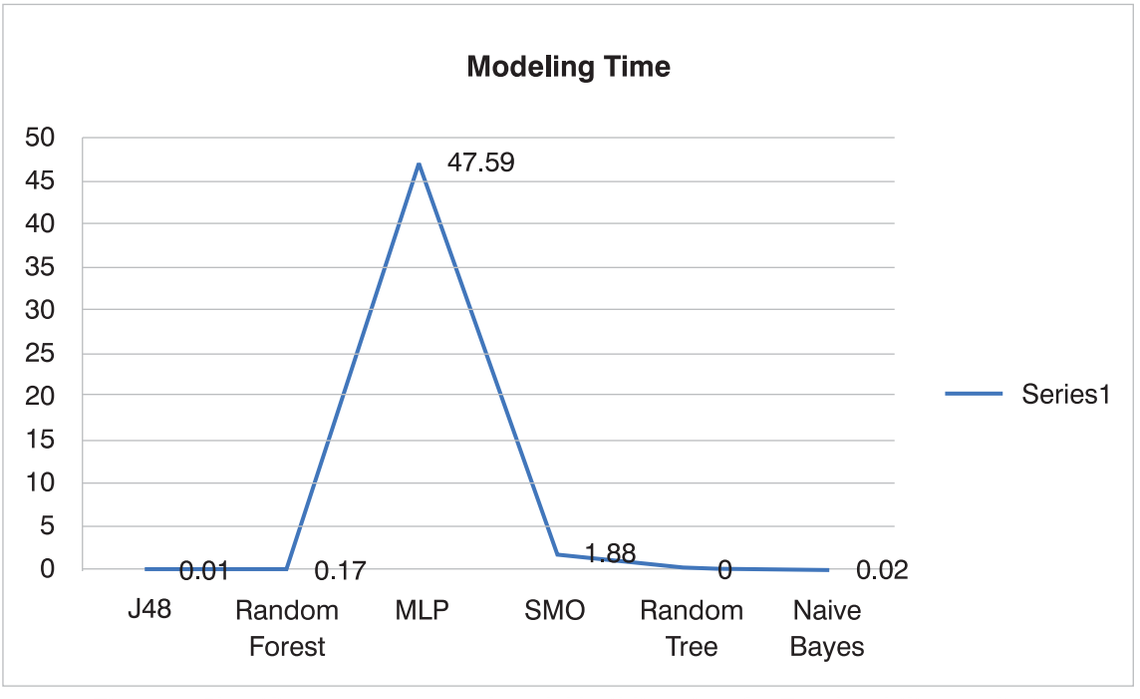

Figure 6: Classifiers comparison of model building time for Employability prediction

Analyzing the classifiers, and by the similar arguments as in academic performance we find that J48 is most suited for the problem of employability prediction.

MPLOYABILITY PREDICTION MODEL

This section discusses the tree obtained by applying J48 algorithm for predicting employability of the students as shown in Figure 7.

```
PROJECT = Yes
|  THIRDSEM= EXCL
|  |  RELWORKEXP = No
|  |  |  STRESSMGMT=D: No
|  |  |  STRESSMGMT=S: Yes
|  |  |  STRESSMGMT=E: Yes
|  |  RELWORKEXP = Yes
|  |  |  ACADEMICHRS = SUF: Yes
|  |  |  ACADEMICHRS = INSUF: No
|  |  |  ACADEMICHRS = OPTIMAL: No
|  THIRDSEM= ABVG
|  |  EMPATHY = D: No
|  |  EMPTHAY = S: No
|  |  EMPTHAY = E: Yes
|  THIRDSEM= AVG
|  |  MI = Other
|  |  |  GRAD = BAVG: No
|  |  |  GRAD = AVG
|  |  |  |  DRIVE = D: No
|  |  |  |  DRIVE =S: N0
|  |  |  |  DRIVE =E: Yes
|  |  |  GRAD = ABAVG
|  |  |  |  DRIVE = D: No
|  |  |  |  DRIVE = E: Yes
|  |  |  |  DRIVE = S: Yes
|  |  |  GRAD = EXCL: Yes
|  |  MI =English
|  |  |  GRAD = BAVG: No
|  |  |  GRAD = AVG: No
|  |  |  GRAD = ABAVG: Yes
|  |  |  GRAD = EXCL: Yes
|  THIRDSEM= BAVG
|  |  EARLYLIFE = Metro: Yes
|  |  EARLYLIFE = City: Yes
|  |  EARLYLIFE = Village: No
PROJECT = No
|  LOAN = No: No
|  LOAN = Yes
|  |  DRIVE = D: No
|  |  DRIVE =S: No
|  |  DRIVE =E: Yes
```

Figure 7: J48 Tree for Employability Prediction

Rules derived from the above tree are used as model to predict the employability of the students are presented in Figure 4.8.

1 IF (PROJECT = YES) AND (THIRDSEM = EXCL) AND (RELWORKEX = NO) AND (STRESSMGMT=D): NO

2 IF (PROJECT = YES) AND (THIRDSEM = EXCL) AND (RELWORKEX = NO) AND (STRESSMGMT=E or STRESSMGMT=S): YES

3 IF (PROJECT = YES) AND (THIRDSEM = EXCL) AND (RELWORKEX = YES) AND (ACADEMICHRS=SUFF): YES

4 IF (PROJECT = YES) AND (THIRDSEM = EXCL) AND (RELWORKEX = YES) AND (ACADEMICHRS=INSUFF): NO

5 IF (PROJECT = YES) AND (THIRDSEM = EXCL) AND (RELWORKEX = YES) AND (ACADEMICHRS=OPTIMAL): NO

6 IF (PROJECT = YES) AND (THIRDSEM =ABVG) AND (EMPATHY = D) OR (EMPATHY = S): NO

7 IF (PROJECT = YES) AND (THIRDSEM =ABVG) AND (EMPATHY = E): YES

8. IF (PROJECT = YES) AND (THIRDSEM= AVG) AND (MI = OTHER) AND (GRAD = BAVG): NO

9. IF (PROJECT = YES) AND (THIRDSEM= AVG) AND (MI =OTHER) AND (GRAD = AVG) AND (DRIVE = D) OR(DRIVE=S): NO

10. IF (PROJECT = YES) AND (THIRDSEM= AVG) AND (MI = OTHER) AND (GRAD = AVG) AND (DRIVE = E): YES

11. IF (PROJECT = YES) AND (THIRDSEM= AVG) AND (MI = OTHER) AND (GARD =ABVG) AND (DRIVE = D): NO

12. IF (PROJECT = YES) AND (THIRDSEM= AVG) AND (MI =OTHER) AND (GARD =ABVG) AND (DRIVE = E) OR (DRIVE = S): YES

13. IF (PROJECT = YES) AND (THIRDSEM= AVG) AND (MI = OTHER) AND (GRAD =EXCL): YES

14. IF (PROJECT = YES) AND (THIRDSEM= AVG) AND (MI = ENGLISH) AND (GRAD = BAVG) OR (GRAD = AVG): NO

15. IF (PROJECT = YES) AND (THIRDSEM= AVG) AND (MI = ENGLISH) AND (GRAD =ABVG) OR (GRAD = EXCL): YES

16. IF (PROJECT = YES) AND (THIRDSEM =BAVG) AND (EARLYLIFE = METRO OR EARLYLIFE = CITY): YES

17. IF (PROJECT = YES) AND (THIRDSEM =BAVG) AND (EARLYLIFE = VILLAGE): NO

18. IF (PROJECT = NO) AND (LOAN = NO):NO

19. IF (PROJECT = NO) AND (LOAN = YES) AND (DRIVE = S OR DRIVE = D): NO

20. IF (PROJECT = NO) AND (LOAN = YES) AND (DRIVE = E): YES

Figure 8: Model developed for Employability Prediction

DISCUSSION OF RESULTS FOR EMPLOYABILITY

The rule set obtained from the tree it is obvious that out of all the attributes considered, following attributes are important for deciding the employability of the student semester(i) Project (ii) Third semester result (iii) Graduation result (iv) Relevant work experience (v) Emotional skills like stress management .

Following conclusions can be drawn

- A student who has undertaken project ,with excellent third semester result ,with no relevant work experience is not employable if he lacks in stress management skill i.e. Stress management skill is D. However, under the same circumstances, if he possesses strengthened (S) or enhanced stress management skill (E), his employability is assured [Rule 1,2]
- A student with excellent third semester result and project having relevant work experience is employable if he puts in sufficient academic hours in studies whereas he is not employable if his academic hours are insufficient or optimal. [Rule 3,4,5]
- A student who has undertaken project and above average performance in third semester result is employable only if he posses empathy that is enhanced (E) otherwise not. [Rule 6,7]
- For a student who has undertaken project , has average result in thrid semester, with vernacular medium of instruction Graduate result and drive becomes important. A below average performance in graduation makes him unemployable. Further, with an average performance in graduation he is employable only if his/her drive is fully enhanced (E) otherwise not. Under the similar circumstances but having above average performance the students is employable if Drive is enhanced (E) or strengthen (S) otherwise not. [Rule 8,9,10,11,12,13]
- A student who has undertaken project, with average performance in third semester, is unemployable in spite of having medium of instruction as English if his performance in graduation degree is below average or average. However, an above average or excellent result in graduation under these circumstances makes him employable. [Rule 14,15]
- A student who has undertaken project and has below average third semester performance can get employment if he/ she has upbringing of a city or metro but an initial upbringing of village makes him unemployable. [Rule 16,17]
- If the student who has not undertaken a project has and has not taken educational loan is not employable. A student who has taken loan and has enhanced drive(E) is employable otherwise not. [Rule 18,19,20]

GUIDELINES TO THE MANAGEMENT FOR IMPROVING EMPLOYABILITY

Investigation of employability models divulges that project, third semester result, performance in graduate degree, loan taken by the students along with a new emotional skill empathy, stress management and drive plays a pivotal role in employability.

In order to improve the employability the faculty members must ensure that students do live projects and help them learn the subject through practical implementation. Students with average and below average performance in graduation needs to be monitored and trained to improve their academic performance as well as drive to excel in this competitive world. Personality development and Communication classes for the students of non-English medium back ground students or those students with upbringing of a village must be held regularly to groom them and enhance their confidence. Students should be encouraged to form groups and solve each other problems thus enhancing the empathy in them and making them team player. A counselor can be appointed to develop and make student work upon their emotional skills like stress management, drive and empathy.

A decision support system EMPPT (Employability and Performance Prediction Tool), based on the model discussed above, is developed and validated. The description of this system is described in the next section.

MODEL VALIDATION THROUGH DECISION SUPPORT SYSTEM EMPPT

As stated in Chapter 1, after model building for academic performance and employability prediction, the next objective is to validate them through Decision support system (DSS). DSS will help the senior level management in taking well informed decision. It is a computerized system that aids in decision making by highlighting certain facts which may not be visible otherwise.

In this section we present a decision support system prototype Employability and Performance Prediction Tool (EMPTT). EMPTT uses model derived from classification algorithm J48 for prediction of Academic performance and employability performance.

ARCHITECTURE OF EMPPT

Figure 9 shows the architecture of EMPTT, and its interaction with the model building process.

The software captures students attribute (I) after the declaration of second semester result to predict third semester result (ii) in fifth semester to predict the employability of the students

The DSS consists of following components:

- Login Component
- Add student Component

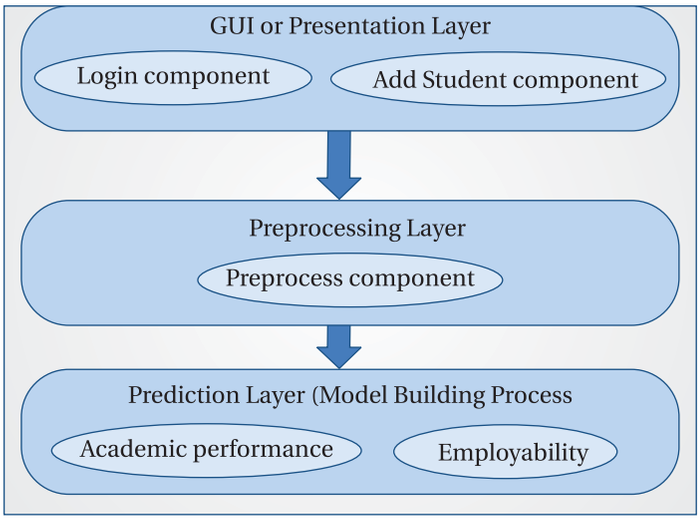

Figure 9: Architecture of EMPPT

- Preprocess Component
- Start Prediction Component
- Academic Performance Prediction
- Employability Prediction

Login Component

This component gives login facility to two users (I) Student (ii) Administrator. Student can only fill in his/her data while admin will be responsible for loading the complete class data, do the preprocessing and then predict the academic performance and employability of whole class. The login component provides facility to register first and then login.

Add Student Component

This component allows addition of records of students. It adds data through a form and hence data entered is in raw form.

File Upload

Once the data is entered in excel file it is uploaded and preprocessed. During preprocessing all numeric ranges are converted to categorical value and emotional traits are calculated based on the questionnaire filled by the students. Once the file is processed the message alerts that file has been processed and we one can proceed for prediction.

Academic Prediction

This component predicts the third semester result based on the parameters uploaded.

Once academic prediction is selected and Start prediction button is pressed the software gives the predicted value of third semester result in terms of average, above average, good, and Excellent. The results are verified on a new set of data where the third semester values results are known to verify whether the software is working properly or not The result in figure shows a comparison of actual value and predicted value.

Employability Prediction

This component predicts that whether students will get on campus placement or not which starts in Vth semester. For verification a new data set (different from which the model was trained and tested) was applied to the software and result of actual value and predicted value can be seen to be same.

CONCLUSION

The key research objective was to first identify the factors that affect the academic performance and employability. In present work, MCA (Masters in Computer Applications) which is a professional post graduate degree course has been chosen. Exhaustive literature survey conducted revealed that many prediction models with various approaches have been developed that predict the academic performance of the students based on primary attributes related to their academic qualification, social background etc. Not much emphasis has been given to attributes pertaining to emotional skills which could also be factors concerning the performance and employability of a student majorly due to lack of authentic data. Thus, as first step the sample set was collected. A sample of 1504 students of MCA students of various colleges affiliated to Guru Gobind Singh Indra Prastha University was collected through a structured questionnaire, which included attributes that have been categorized into academic integration(all declared past academic results, medium of instruction, no. of hours devoted to study, project work done ,type of graduation degree, graduation stream, gap year, relevant work experience), social integration (parent's education, parent's occupation, family income , loan taken by the student, environment where student has spent his early life) and emotional skills (assertion, emapthy, decision making, leadership, drive strength, time management, self esteem, and stress management each measured as D i.e need to develop, S i.e needs to strength and E i.e enhanced). Data is collected thorough google forms. Emotional Skill parameters are assessed through Emotional Skill Assessment Process (ESAP) tool consisting of psychometric questions to judge various parameters. The collected dataset was preprocessed to make it appropriate for the data mining tasks.

The next objectives were to develop prediction model individually for academic performance and employability. Third semester result was selected for prediction based on the logic that a student will take approximately a year(first two semester) to adjust to institution environment. The prediction model was created by applying various classification algorithms available in WEKA data mining tool. The algorithms were compared on various parameters of accuracy, model building time, interpretability, F-measure and ROC Area. It was found that J48 algorithm which is implementation of pruned C4.5 Decision Tree algorithm of WEKA is most suitable for the both academic performance and employability prediction. From the predictions though decision tree, rules were derived that best predicts the academic performance and the employability. The findings were validated though a Decision Support System (DSS) tool called Employability and Performance Prediction Tool (EMPPT) which has been developed based on the predicted model in the last step.

Out of all past academic results first and second semester is key influencer of third semester result. It is expected also, as the programming subjects of second semester form the foundation of programming subjects of third semester. Thus consistently good academic performance is clearly a good indication of good performance in third semester too. Stress management becomes important for an average performer with upbringing of city but vernacular medium of instruction at school, where as a student with early life spent at village and average performance in first and second semester of MCA his Drive strength plays an important role in deciding his third semester result. A student with graduation from regular degree course has a better performance than distance learning graduation degree. Gap year after graduation results in poor performance if the Drive is absent. Sufficient and optimal no. of hours put in study can improve the result.

Some interesting findings related to employability are observed. Third semester of MCA is highly computer programming oriented semester and after that students are supposed to apply it in their projects. The finding reveals that student with an excellent third semester result, relevant work experience and project is more employable if he devotes sufficient number of hours to studies (4 to 8 hrs a day) than the student who devotes optimal number of hours (more than 8 hrs) .This indicates that long hours of studies could bring in saturation adversely affect the performance.

Empathy seems to play a substantial role in employability of the students as student with project and above average third semester result are found successful if they have enhanced empathy. The reason could be that such students do take care of other class mates by solving their difficulty, explaining them concepts that improve their own communication skill, expression power and ability to work in a team etc. much sought after qualities by the recruiters.

Further graduation result, medium of instruction in school (that may decide English language fluency) and drive strength of the student play a major role in on campus placement. A below average graduation degree along with vernacular medium schooling puts a student at risk of poor performance in on campus placement even if s/he is having average third semester result and project however , if his graduation result is above average and drive is strengthened or enhanced the students will be employed. If the student has taken loan and has enhanced drive then in spite of not having a project the student has chances of getting selected in on campus placement.

In case of employability stress management becomes very important. A student with project but below average third Semester result is more employable if his early life is spent in City or Metro than in village as students from Metro and city have better opportunities of grooming their personality.

This research has identified factors affecting academic performance and employability and the effect of some of the emotional skill parameters on academic performance and employability has been established where others have not shown much effect as per expectation.

The Decision support system developed is capable of predicting academic performance and employability with acceptable accuracy.

The general guidelines for the institutions to enhance performance and employability are to make the foundation very strong in first and second semester and give it practical orientation so that students are capable of doing projects. Monitoring of students with vernacular medium and village back ground is essential. They need more grooming than students brought up in city or metro and those who have studied in English medium schools. Thus special communication classes can be arranged separately for those students. A counselor can be appointed for developing emotional quotient and helping student learn stress management, develop empathy and use their drive strength in positive direction.

UTUREWORK

Future work will include the students of B. Sc. and B. E as well and will try to find out if there is a preference being given in the companies to B.Sc. / B. E. over MCA. Further employability has been defined as the students' ability to get employment during on Campus drives conducted in Vth Semester and does not take into account the pay package offered and the rating of the company in which he or she is placed. These aspects will be considered in our future work. Although academic performance is one of the criteria of student's consistent efforts and perseverance, most of the companies are now concentrating upon employee's logical reasoning, quantitative aptitude, communication skill, etc.. Average students are also capable of getting good employment based on other skills and virtues. These parameters will be included in further research so as to infer these academically.

The research reveals great potential of data mining in education sector. More work is needed to establish it as a customized guiding tool for students. In conclusion, this study can motivate and help institutions to perform data mining tasks for students' data regularly to find out interesting results and patterns which can help both the university as well as the students in many ways.

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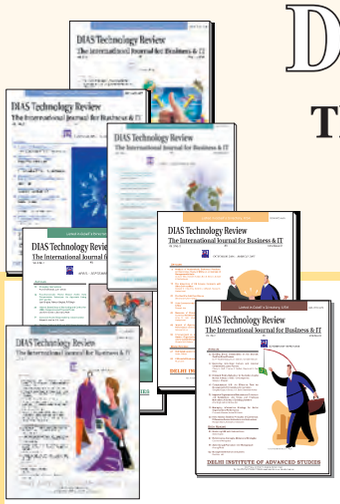

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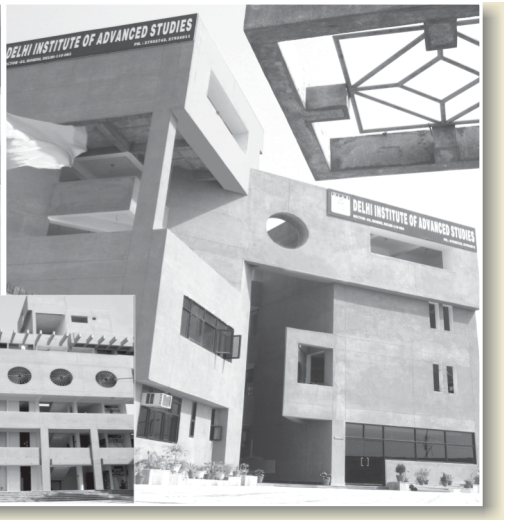

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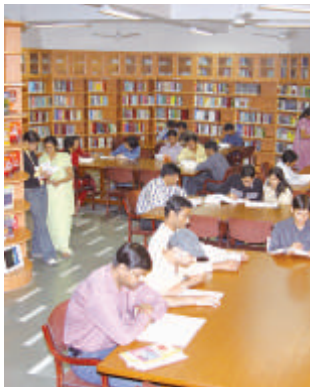

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