The Sustainability Development Goals (SDGs) cover a broad range of social and economic development issues. At its core, science aims at understanding the world in a better way. Science also allows us to constantly expand and revise our knowledge, based on peer-reviewed evidence. The critical thinking that comes with science education is vital in training the mind, understanding the world, and making sustainable choices. Science, Engineering and Technology and management play a crucial role for sustainable development. Sustainable development can succeed only if all areas of the political sector, of society, and of science accept the concept and work together to implement it. Everyone needs to become sensitized to the impact of their practices on local and global sustainability. This book is written with all above aims to sensitize with social and economic development issues.

Prof. (Dr.) Manoj Mehrotra is Director at School of Management Sciences, Lucknow, and renowned Professor of Marketing, having more than 36 years of experience (13 years in the corporate and 20 years in academics). Prof. Mehrotra has done his MBA (Marketing) from MONIRBA of the University of Allahabad, in 1982 and obtained his Ph. D. in the area of Management from M.D. University, Rohtak; in 2005. Prof Mehrotra is an 'Accredited Management Teacher' (AMT) from AIMA, New Delhi, Member on the Board of Studies of a couple of reputed Universities, and is an expert or as a panel member for selection committees at various Institutes. He has more than 20 research papers and articles published in National and International Journals and presented at National Conferences. Prof. Mehrotra is the Editor-in-Chief of the National Journal - 'Adhyayan', and is also on the Advisory and Reviewer Board of a couple of other Journals. He is also the Editor-in-Chief of two books published as Proceedings of the National Conference on issues of immense importance in the area of Management. Prof. Mehrotra is the winner of several prestigious awards that include 'Best Education Performance Award 2007' by Health & Education Development Association, New Delhi; 'International Gold Star Award 2010' by EHRDA, New Delhi; and 'Shiksha Bharti Puraskar 2011' by All India Achievers Foundation, New Delhi.

Prof. (Dr.) Bharat Raj Singh, Director General, School of Management Sciences, Lucknow, was born in 1947 at Raibigo in Sultanpur district. He did his schooling from Sultanpur and Jaunpur and received his B.Sc. Degree in 1967 from Allahabad University. BE – Mechanical Engg, from Sardar Vallabhbhai Regional Engg, College, Surat, Gujarat in 1972; ME- from Motilal Nehru Regional Engg, College, Allahabad, and PhD in 2011 from Uttar Pradesh Technical University, Lucknow. He received many national / international awards in researches on environmental science including 3-Limca Book Records in 2014, 2015 & 2017. He published 153 papers, 16- books and 27- book chapters. He is promoting yoga within country & abroad and also inspiring people to stay healthy and live long life by adopting spirituality under the aegis of Vedic Science Center, SMS, Lucknow.

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Role of Science, Technology & Management in Sustainable Development

ROLE OF
SCIENCE, TECHNOLOGY & MANAGEMENT
IN SUSTAINABLE DEVELOPMENT

EDITORS
Prof. (Dr.)
MANOJ MEHROTRA
Prof. (Dr.)
BHARAT RAJ SINGH

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Editors

Prof. (Dr.) Manoj Mehrotra

Prof. (Dr.) Bharat Raj Singh

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PREFACE

We all know that sustainable development describes a process of change which promotes the principles of sustainability. It also recognizes that growth must be both inclusive and environmentally sound. The Sustainability Development Goals (SDGs) cover a broad range of social and economic development issues. At its core, science aims at understanding the world in a better way. Science also allows us to constantly expand and revise our knowledge, based on peer-reviewed evidence. The critical thinking that comes with science education is vital in training the mind, understanding the world, and making sustainable choices. Science, Engineering and Technology and management play a crucial role for sustainable development. Science, technology and management are essential for achieving sustainable development, for poverty eradication and influence the society as never before.

International Scientific Cooperation for Sustainable Development is an imperative for achievement of SDG goals. The specific role of science for sustainable development goes beyond issues like technology transfer and must not be limited to that of a tool only. There is no stand-alone goal on science among the Sustainability Development Goals. Sustainable development can succeed only if all areas of the political sector, of society, and of science accept the concept and work together to implement it. Everyone especially those working in the private sector and corporate entities need to become sensitized to the impact of their practices on local and global sustainability.

With the above aims, the book titled: ***Role of Science, Engineering, Technology and Management in Sustainable Development*** has been written in 10- chapters. The brief contributions of authors given in their chapters towards the sustainable development are listed below:

1. Leading Organizations To Sustainable Growth – Prof. Manoj Mehrotra elaborated about achieving sustainable growth. Says- it can be a challenge for even the most ambitious companies. Grow too quickly and financing may prove to be a serious challenge. But grow too slowly – or worse, not at all – and companies risk losing their competitive edge. This makes finding the right formula for sustainable growth critically important. Economists and business researchers contend that achieving sustainable growth is not possible without paying heed to *twin cornerstones*: *growth strategy* and *growth capability*. Flawless execution of such sustainable strategies demands a culture of enrichment, trust, shared values, professionalism,

learning, innovation and community enhancement perspectives. *Sustainability in organizations is created when all three components – leadership, corporate strategies and culture – reinforce each other for the long-term benefit of multiple stakeholders.*

2. Design and Analysis of 4-Wheeled Vehicles for Environmental Sustainability –Prof. Bharat Raj Singh, Manoj Kumar Singh and Pankaj Yadav explores the need of road network that will help for sustainable development. India has second largest road network over 5,897,671 kilometers than USA having 6,153,024 kilometers in the world, As such around 4,146,063 kilometers (70.3%) of total road network of 5,897,671 kilometers is of rural base and built by Panchayats and PMGSY with pavement or bituminous of required strength and remaining of kuchcha (mud) roads. This chapter evaluates need of 4-wheeled vehicle design for better comfort ride, it might be are revolutionary work.
3. Cyber Physical System and IoT: *the next generation computers*- Dr. Hemant Kumar Singh, Sunit Kumar Mishra and Sanjay Kumar Singh explain changes in next generation computing and challenges as well. The main issues, threats and attacks will also be described in the chapter. This chapter will also suggest the future research issues in CSS and IoT.
4. Exploring Consumers Participation towards Sustainable Growth: With Special reference to Green Marketing in City of Lucknow – Suchita Vishwakarma, Jyoti Kumari, tried to identify how well consumers have accepted the effort of market players, but at the same time it becomes important to understand their contribution and role as end user and stakeholder. The chapter focuses to understand whether the consumers of Lucknow are able to imbibe the green thought process in their daily usage and to what extent they are ready to change their style in accordance with green practices and sustainable development.
5. Sustainable Development Of Indian Retail Sector - Zain Mehdi , and Ashok Sen Gupta, explore as to what kind of FDI to seek and how to address the digital economy. This move would fetch about "supply chain improvement, investment in technology, manpower and skill development, tourism promotion, increased domestic sourcing, upgradation in agriculture, efficient and profitable small and medium scale industries, market development and monetary benefits to government through higher GDP, tax income and employment generation".
6. An Analysis on Constraints in Sustainable Higher Education Policy of Uttar Pradesh - Priyank Sharma and Manish Singh explain the various factors which involved

in the implementation of higher education in the system or the problem is at planning part or at implementation part Education is a very important economic factor for the economic development.

7. Electronics Stewardship -Gaurav Sharma mentioned that technology has been evolving daily; henceforth new technological gadgets have been increasing in number. New technology has made our lives easier and human being is completely dependent on them. Technology has been the major factor of our economy growth and it has become indispensable thing in our lives. But evolution of the technology possesses greater threat to the environment and for all the living beings if they are not properly handled and disposed after use.
8. Cavity Wall Construction And Its Purpose - Dr. Asha Kulshreshtha, Gaurav Ojha, Urooj Shameem, and Syed Shuja Askari worked on a material that has a sufficient, long-term sealing of the restorative margins. Every restorative material allows some degree of passage of fluids and micronutrients, termed as leakage. Micro leakage is "the clinically undetectable passage of bacteria, fluids, molecules or ions between a cavity wall and the restorative material".
9. Harmonics generated by Electric Arc Furnace in Power System and its Sustained Compensation - Ritu Singh and Dr. Amarjeet Singh covers in the chapter that electrical power system having distorted voltage and current waveform contains harmonics and it becomes a severe concern to the power system, especially Electric Arc Furnace (EAF). The compensation of the harmonics is greatly required for better performance and sustainable power system.
10. Online / Offline Signature Verification- An Overview – Dr. Sumit Narayan Jarholiya, and Prof. Bharat Raj Singh describe in their chapter about pre-processing of signature verification, signature verification architecture and its algorithm, definition of terms used for detecting forgeries in signature, and a brief introduction of Hidden Markov Model for signature verification. It helps in offline/ online biometric attendance and identification of Voter ID, Passport etc.

From the above 10-chapters, we find that the book may be useful for the developing countries like India pertaining to problem identification, designing, implementation of strategies, managing the progress in all aspects sustainable developments.

The editorial team is highly appreciative of the authors and other stack holders who have provided immense support and guidance throughout. Special Thanks confers on Mr. Sharad Singh, Secretary and CEO, School of Management Sciences,

Lucknow who has given us encouragement to take up such project in pursuance to academic enhancement. Finally we would like to thanks the almighty God without whom this assignment would not have reached to its final shape.

Prof. Manoj Mehrotra and
Prof. Bharat Raj Singh

Contents

Leading Organizations to Sustainable Growth

Manoj Mehrotra
School of Management Sciences, Lucknow, UP, India

INTRODUCTION

It is said that up to 50% of businesses fail within five years of inception. A brief review of some of the literature of the past ten years examining corporate sustainability reveals some figures:

- Chris Zook & James Allen found in the 2001 study, "Profit from the Core," (Harvard Business School Press) that only 13 percent of their sample of 1,854 companies were able to grow consistently over a ten-years period.
- Richard Foster & Sarah Kaplan in their book, 'Creative Destruction', concluded that only 160 of 1,008 companies they examined were able to survive from 1962 to 1998.
- Jim Collins in 'Good to Great', examined 1,435 companies over 30 years (1965-95) and found that only 126 (9 percent) had managed to outperform equity market averages for at least a ten-years period.

Most of the businesses start and end in obscurity. However, a few of them start up with the verve of a cannonball, only to crash with equal fanfare. Some of the companies like Enron, DeLorean Motors, Satyam, and Kingfisher Airlines, to name a few, exemplify this cataclysmic phenomenon. Some others like PanAm Airlines, Woolsworth, Polaroid, Scooters India and HMT just wane away.

Creating sustainable growth is a prime concern of small business owners and big corporate executives alike. However, achieving this goal is no easy task, given rapidly changing political, economic, competitive scenarios, highly volatile consumer trends, and fast-changing technology. These trends present unique challenges to business leaders searching for the elusive grail of sustainable growth. Customer expectations, for example, have changed considerably over the last few generations. For example a 5 year waiting for a 25 kmpl mileage for a Vespa or a Bajaj Scooter was acceptable in the 70's, but today even with immediate delivery, chosen colour and 100 kmpl of mileage is not enough. The customer is still looking for more.

So the question here is how to achieve sustainable growth for an organization? Before that, we need to understand the meaning of 'Sustainability' and 'Sustainable Growth'.

SUSTAINABILITY DEFINED

Sustainability means meeting our own needs without compromising the ability of future generations to meet their own needs. In addition to natural resources, we also need social and economic resources.

In 1976, it was understood that true success was reached when you could sustain business growth. So at that time, sustainable simply meant repeatable. Later Bentley opened its Center for Business Ethics and taught students that sustainability meant repeatable and ethical. More recently, customers and employees are speaking up, expecting companies to be more socially and environmentally aware, accountable and responsible for their impact, and can have, in society. Now in 2015, sustainable growth means growth that is repeatable, ethical and responsible to, and for, current and future communities. And it is the key to the long-term success of any business.

WHAT IS SUSTAINABLE ECONOMIC GROWTH?

People are often confused by the term *sustainable growth*. While most believe it is a worthy objective, its definition is less clear. Does it mean "green growth?" Is it part of the "triple bottom line"? Does it have to do with the corporate social responsibility (CSR) framework, which suggests that an entity has an obligation to act for the benefit of society at large? And what about the 17 Sustainable Development Goals set by the United Nations? What does sustainable growth really mean?

Sustainable growth has two main meanings in the world of business and finance – a traditional meaning and another more recent meaning.Traditionally, sustainable growth has meant the realistically achievable growth that a company or a national economy could maintain without running into problems. However, recently the term is frequently used by environmentalists, meaning economic growth that can continue over the long term without creating intolerable pollution or using up all the non-renewable resources.

When it comes to having a business, it could go one of three ways:

- You could grow very quickly, which sounds great, but then you could incur into the problem of how to fund this rapid growth and how to find the resources to support it.
- You could grow too slowly and stagnate.
- You could be losing sales and eventually go into bankruptcy.

There is a trade-off between rapid economic growth today, and growth in the future. Rapid economic growth today is great, but it often comes with a trade-off regarding future economic and financial health. If an economy grows too rapidly today, the process may exhaust resources and cause environmental problems for the next generation or the following one.

Sustainable economic growth is economic development that attempts to satisfy the needs of humans but in a manner that sustains natural resources and the environment for future generations. An economy functions in the ecosystem. We cannot separate the economy from it. In fact, an economy cannot exist without it. The ecosystem provides the production factors that fuel economic growth: land, natural resources, labor, and capital (which is created by labor and natural resources). Sustainable economic growth is managing these resources in a manner that they will not be depleted and will remain available for future generations

The sustainable growth rate is the maximum rate of growth that a company or social enterprise can sustain without having to finance growth with additional equity or debt. Finding the optimum growth rate is the goal of sustainably growing business organizations.

To achieve this worthy objective, it has been observed that diverse groups of leaders at all levels in companies need to regularly come together and hold themselves accountable to this higher bar. There are a few tips and tricks you could follow to achieve that with your company.

STRATEGIES FOR ACHIEVING SUSTAINABLE GROWTH

Achieving sustainable growth can be a challenge for even the most ambitious companies. Grow too quickly and financing may prove to be a serious challenge. But grow too slowly – or worse, not at all – and companies risk losing their competitive edge. This makes finding the right formula for sustainable growth critically important.

Whatever their organizational model or level of maturity, middle market companies are today's engines of global economic growth. The CEOs of these companies view accelerating and sustaining growth as their number one priority.

The growth challenge is articulated differently by different companies and within different industries. For some, developing and launching new products and services to meet the evolving needs of their customers is the issue. For others, capitalizing on global opportunities is the key. Some companies look to new business areas

representing the next major thrust for their business. And for a few companies, all of these strategic efforts are simultaneously used, along with ongoing efforts to rebuild organizational capabilities.

Economists and business researchers contend that achieving sustainable growth is impossible without paying attention to *twin cornerstones:* ***growth strategy*** and ***growth capability***. Companies that pay inadequate attention to one aspect or the other are doomed to fail to establish sustainable growth practices (though short-term gains may be realized). After all, long-term growth is impossible if a company has an excellent growth strategy in place but has not put the necessary infrastructure in place to execute that strategy. The reverse is true as well.

Most debates around organizational sustainability focus on an organization's impact on the environment due to its use or misuse of resources. This is indeed a very important discussion. However, considering only this one challenge is insufficient – it is but one dimension of the debate. We need to do the equivalent of a 360^0 performance evaluation to analyze our sustainability from all possible perspectives.

To carry out such a comprehensive analysis, four inter-related resources need to be examined to determine if each is sustainable. These resources are:

- the organization itself,
- its human resources (both inside and outside of the organization),
- its community/society/ethno-sphere, and
- the planet's biosphere (the environment).

The formula for determining 360^0-organizational sustainability is then simple: If anyone of these resources is not sustainable, i.e., not able to be maintained or is being depleted or permanently damaged over the long-term, problems for the other three will develop over the long-term. For an organization, the reality test is that if any of the other three resources are not truly sustainable, neither is the organization.

Sustainability in organizations is not just about addressing social responsibility or meeting triple bottom line criteria to maximize shareholders' short-term interests. Sustainability can only be created when business leaders transform the way they currently think, challenge economic myths, and adopt a systematic and holistic view. It will generate a philosophy of leadership that embraces a set of sustainable values and principles. Sustainable practices will become embedded in corporate strategies, balancing hard and soft goals for the long-term interests of multiple stakeholders. Flawless execution of such sustainable strategies demands a culture of enrichment, trust, shared values, professionalism, learning, innovation and community

enhancement perspectives. ***Sustainability in organizations is created when all three components – leadership, corporate strategies, and culture – reinforce each other for the long-term benefit of multiple stakeholders.***

A PEEK INTO THE SEVEN PILLARS OF SUSTAINABLE GROWTH

Growth is one of the hardest acts in business and Sustainable growth is incredibly hard. When you ask 90% of companies what barriers to growth were, the fascinating thing is that in only 15% of cases do they cite the market; i.e. only in 15% of cases do they say "We didn't grow because of something that happened externally." In most cases, what they describe are internal barriers to their growth, which leads us to step back and say "What kills the future of growth is not the market, but your own internal complexity."

In that context, understanding the ***seven key pillars of sustainable growth*** becomes the most important strategic perspective.

The first pillar is: You have to have ***a strong, well-defined core business*** that you drive to its full potential. Let's focus on those businesses we're leading and get better performance from them. And if you look at this way, of the 10% of companies that grew sustainably and profitably over a 10-years period, 95% of them were leaders in their core business. And if you often look at growth strategies, they're distracting management from the core business, trying to grow everywhere else but in the core. As per the words of David Finch, Managing Director of 'Purple Frog', "If you try and sell everything to everybody, you successfully sell nothing to anybody." And therefore *our first principle is, simplify, focus on your core and drive it to leadership.*

The second pillar is from leadership, ***capture leadership economics***. That is simplifying. You have to focus on a few things and need to drive it to leadership position. I refer to this as looking at the relationship between return on capital and your relative market share position, something that's called RMS. Leading positions, double down and focus on them and get superior economics. This also means an operations strategy committed to operational excellence and continuous improvement – and a resilient and sustainable supply chain.

The third pillar is about ***customer advocacy.*** If we could recommend one thing you do organically to lead in your industry, it would be to be maniacally focused on customer advocacy. But this is tough to say because every company believes they're already focused on the customer.

We are sometimes so engrossed with finding and nurturing relationships with new prospects and leads that we often forget about our customers. As Emmet and Mark Murphy write in their book 'Leading on the Edge of Chaos', acquiring new customers can cost an organization around five times more than retaining current ones. In fact, a 2% increase in customer retention can have the same effect as decreasing a company's costs by 10%. If you start considering customers as more than just a sale, you introduce the possibility of them coming back time and time again, which will increase their lifetime value to you.

In fact, when asked, 80% of the companies believe they deliver a superior proposition to their customers. The problem is if you ask the customers of those companies, in only 8% of cases do they agree. And we refer to this as a ***delivery gap***, the difference between what you think you're doing and the reality of how customers perceive you. But it's simplifying because it says if you could do one thing, it would be to deliver on the promises you've already made in the market. ***Close that delivery gap*** and it's no surprise that of ***those 10% of the companies*** that we ***refer to*** as ***sustained value creators; they have twice the level of customer advocacy as the follower in their industry.***

The Fourth pillar is with respect to ***sustainable consumption and production***, this means:

- Firstly, innovating to develop and market goods and services with a more sustainable life-cycle.
- Secondly, optimizing the economic and environmental efficiency and the social impact of current products and activities (e. g Green products, Green marketing, etc).
- And thirdly, recognizing that, by building trust with consumers, brands can facilitate consumer behaviour changes towards more sustainable and healthier choices and lifestyles.
- It is also essential to align your sales and marketing.Bringing your sales and marketing team together by making them focused on the same revenue goals is crucial for a company to grow. The marketing team will be able to generate more qualified leads that your sales team will then turn into customers. More customers = more sustainable revenue.

At the same time you need to implement repeatable models and processes that will save you planning time and assure you success. A great idea is to try and hook your clients and prospects into a retainer model, rather than getting them to pay on

an individual sale basis, so that you have some predictable, fixed incomeevery month.

The **Fifth pillar** of sustainability deals with ***getting the right organization's design***. The late Steve Jobs had said – "Design is not just what it looks like.Design is how it works." True sustainability is only possible in the presence of thoughtfully designed, adaptable, and intelligent systems. Companies are no exception. A complex, global, multicultural corporation's ability to become sustainable will be shaped by its governance and organizational design approach.

The sixth pillar brings out the importance of **technology and analytics.** Information is power. It can help leaders make better, quicker and smarter decisions that improve business performance. It is observed that successful growth strategies consider the digital enterprise, analytics, emerging technologies, data security and privacy and the technology function to get sustained growth.

The seventh and final pillar is People, Behaviors, Culture and Happiness.

Life at work represents only one role and an important one, which every person plays in life, which is to be HAPPY. In fact, it includes being happy, successful or satisfied in their lives, the need to have rich lives or success outside of work too.

"Success" = Happiness + Financial Security + Health + Family & Friends

Studies show that we now have more possessions than before but, not happier than before. Given our more sedentary lifestyles and our "Supersize Me" culture, we are obese, unfit or unhealthy. We do not have time or energy for our old friends and family, the result of spending more and more hours chasing success at work. Studies show that North Americans do not feel happier or more satisfied than 50 years ago.

Is such a feeling sustainable? The answer is clearly "No." Today, many employees outside of the work environment are feeling increasingly dissatisfied with the lives they are leading.

Organizations need to drive the people and build a culture so as to extract the maximum potential out of its employees. Having engaged employees often means having happier and more loyal customers, getting higher productivity and work quality from them, and spending less on recruitment costs. In order to keep your employees engaged and motivated, create a positive environment, reward high-performing teams and recruit the right staff that will fit in your company culture

Leading businesses attract and retain the right people who share the company's vision and fit its culture. These organizations pay close attention to capability, performance management, innovation, leadership, rewards and state of happines both for the individual as well the organization.

CONCLUSION

The ability to sustain our organizations and communities in the face of rapid global change and resource competition is a critical issue of our age. Citizens, employees and stakeholders must play a part. Managers, CEOs and leaders practicing transformational stewardship increasingly seek to find sustainable practices and strategies for their organizations. These principles of sustainable organizations are more holistic than business practices of the past. They recognize both the need for return on investment, and the wise use of resources and seek the well-being of their employees and stakeholders.

In summary, I will say that sustainability entails living mindfully of the future, embracing and respecting life in the present, and caring for the well-being of generations to follow. The concept is broadly defined as meeting the needs of the present generation without compromising the ability of future generations to meet their needs.

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Design and Analysis of 4-Wheeled Vehicles for Environmental Sustainability

Bharat Raj Singh[1], Manoj Kumar Singh[2], Pankaj Yadav[1]
[1]*School of Management Sciences, Technical Campus, Lucknow, UP, India*
[2]*Babu Sundar Singh Institute of Technology & Management, Lucknow, UP, India*

ABSTRACT

As per the records, India has second largest road network over 5,897,671 kilometers (3,686,044 mi) than USA having 6,153,024 kilometers in the world, out of which over 175161 kilometres (2.97%) of state highways, about 114,415 kilometres (1.94%) of national highways and expressways, plus another 586,228 kilometres (9.94%) of district highways, 546,714 kilometers (9.27%) urban roads and 329,090 kilometers (5.58%) is of Projects. As such around 4,146,063 kilometers (70.3%) of total road network of 5,897,671 kilometers is of rural base and built by Panchayats and PMGSY with pavement or bituminous of required strength and remaining of kuchcha (mud) roads. Thus there is need to evaluate 4-wheeled vehicle design for better comfort ride. It needs to cut down vibration drastically on poor road conditions for cost effective and environmental friendly design of vehicle. From this research work, it is found that the gap of work is to design an economical vehicle run at higher speed with comfort ride on such rural road geometrics. The detailed work has been done and a mathematical model is developed, considering different independent and dependent parameters such as suspension, tire stiffness coefficient and damping etc and dependent parameters like: Mass of the car or sprung mass, Front or rear mass of the wheels or unsprung mass, Pitch moment of inertia, Roll moment of inertia, Stiffness of vehicle for front / rear wheels, Front / rear damping coefficient and distance from centre of sprung mass to front / rear wheels. From the results of the study, it is found that the new rural vehicle can run under comfort zone even at 65 km/hr or above speed on very poor rural roads conditions without affecting life cycle. The cost of the vehicles can also drastically reduce and it can also reduce global warming due to its better performance.

Keywords: Environment, Four wheeler, Rural Roads, Sustainability, Vehicle design.

Corresponding Author: Bharat Raj Singh

E-mail: brsinghlko@yohoo.com

INTRODUCTION

As per data of 31 March 2017, India was having a network of over 5,897,671 kilometers of roads, which was second largest network than USA having 6,153,024 kilometres, out of which India had completed over 175161 kilometres (2.97%) of state highways, about 114,415 kilometres (1.94%) of national highways and expressways, plus another 586,228 kilometres (9.94%) of district highways,

546,714 kilometers (9.27%) urban roads and 329,090 kilometers (5.58%) is of Projects. As such around 4,146,063 kilometers (70.3%) of total road network of 5,897,671 kilometers is of rural base and built by Panchayats and Pradhan Mantri Gramin Sarak Yojana (PMGSY) with pavement or bituminous of required strength and remaining of kuchcha (mud) roads. This shows that rural road network's major portion with mud roads. We also know that still 70% population of India lives in rural base and its mode of transport is impacting economy as well global warming and climate change. Thus 70% population's vehicles that are running on these roads need to take care of discomfort like serious stress and fatigue especially passengers and drivers due to bumps and pot-holes on damaged roads. Such light vehicles running on rural roads need proper design of spring, damper, leaf suspension and proper tyres stiffness to sustain comfort above higher speed.

Chart-1: Progress of Indian Road Network 1950-2017

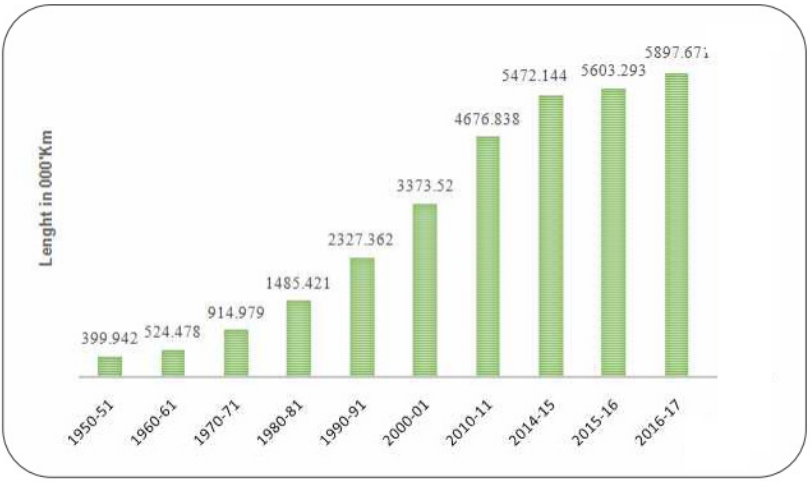

Table 1: Indian Roads Network as on 31st Mar 2017

S.No.	*Type of Roads*	*Roads in Kms.*	*Remarks*
1.	National Highways and Expressways	114,415	1.94% Connecting States
2.	State Highways	175,161	2.97% Roads within States
3.	Urban Roads	546,714	9.27% Roads within cities
4.	District Highways	586,228	9.94% Within Distt
4.	Roads under Projects	329,090	5.58% Roads within Projects
5.	Panchayat & PMGSY	4,146,063	70.30% Rural Roads
	Total:	5,897,671	

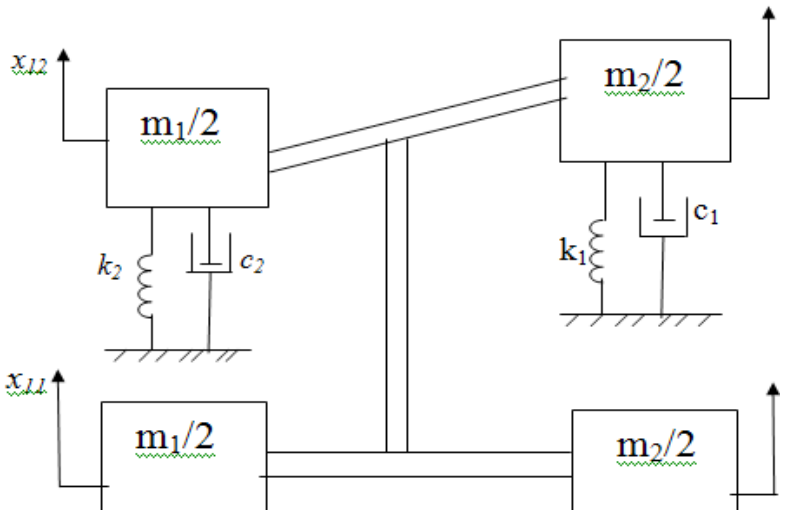

Figure 1.1: Status of Indian Road Net Work

In this area, studies were carried out on such work by various researchers and prepared proper mathematical model of light vehicle (car / jeep / dumper) with a non-linear equation, linear quadratic regulator method etc. They simulated their models either with algorithm, Matlab, 20Sim, Adams, Bond Graph, 20 Sim mechanisms or with Fuzzy Control etc.

LITERATURES REVIEW

A detailed literature studies are conducted and few studies are narrated as below:

An active suspension of full car model with seven degree of freedom was investigated by Adibi H., and Geoff R., (2006) for reduction in bounce, pitching and rolling effect on random road profile. Their hybrid bond graph simulation results of bounce acceleration, pitch acceleration, and roll acceleration. The bond graph concept was invented by H.M. Paynter (1961), of physical system modeling. This approach supports 0 and 1 junction element. It means that object as a system of interconnected element. A study on wheeled motors vehicle about comfort ride with eleven degree of freedom mathematical model was presented through MATLAB/Simulink vehicle was done by Jin, L. *et al.*, (2016). The mathematical model of quarter car evaluated in spring mass, displacement and acceleration was simulated through MATLAB for comfort ride of quarter car speed not exceeds 6.75 km/h by Hassaan, G.A., (2014), and simulation result was obtained using ADRC controller for comfort ride and Gao, J., et al.(2011) also developed a virtual model of comfort ride of vehicle.

Karnopp, D. and Rosenberg, R., (1975) created parameter mathematical system formulated by Kirchoff Bond graph approach to electrical network and Yazan, M. A. R., et al. (2009) studied a chassis of the car and its centre of gravity position was assumed to be fixed with swarm optimization technique. The simulation mechanism was used to build full car active suspension using the laws of motion.

Radionova L.V et al., (2015), Mehmood, A., et al., (2014),and Hassaan, G.A., et. Al., (2015), presented for building mathematical model using Matlab/ Simulink. R.S. and Pilbeam, C., (2016), Ashtekar, J. B., and Thakur, A.G.,(2014), Dahil, L., (2017), Wu, S.J., et al. (2004) and Shirahatt, A., et al., (2008) introduced potential road performance of active suspension limited control bandwidth is obtained with theoretically analysis while using .primary function of a vehicle suspension by tire to the transmitted passenger. The results bounce back passenger acceleration and displacement reduced by 74.2%, 82.7% and 28.5% respectively.

Junoh, A.K et al. (2011), performed vehicle comfort vibration of passenger car cabin have a comfortable driving environment. Discomfort depends on the magnitude, frequency direction and duration of vibration. German Filippini et al. (2005), evaluated four wheel non linear vehicle dynamic Bond graph model. Modeling and simulation 20sim software use Bond Graph model of chassis, transmission, pneumatic tire and vehicle obtain through 20sim simulation, Sung K.G., et al. (2008) present robust vibration control using electro rheological (ER) suspension system passenger vehicle evaluated by fuzzy moving sliding more controller (FMSMC) was design and experimentally realized vibration level of sprung mass acceleration can be significantly reduce at body resonance using ER suspension. Wakeham K.J. Wakeham and Rideout, D.G., (2011), investigates vehicle active suspension controller using linear quadratic regulator (LQR) method. It was found that pitch acceleration 40% higher, decoupled model increased 90%. Chan, B.J. and Sandu, C., (2003) states the ride control system to evaluate their design simulation result obtain acceleration vs time and displacement vs time using Matlab. Compare result of modified MCVD system vs passive system of chassis acceleration, chassis displacement and axle displacement vs time.

Wu, G., et al. (2013), deal rigid and rigid flexible coupling vehicle multibody modes. Finite element method (FEM) builds flexible rear suspension. Banerjee, S., et al. (2016), deals with mathematical model of a full tracked with 17 degree of freedom trailing arm hydro-gas suspension. Mukherjee, A., and Samantray A.K., (2000), developed Symbols2000 software use modeling, simulation and design creation of model. It has incorporated a facility called encapsulation subsystem models are called capsules.

Budzik, R. and Dolecek, R., (2012), states that driving safety and comfort on road for information in vibration signal allows. Motor engine as the vibration consider vibration generators rotating machinery

Dridi S., et al., (2017) state that tubular permanent magnet linear synchronous actuator (TPMLSA) dynamic actuator modeled by bond graph formalism. Minimization of wheel vibration problem for comfort ride vehicle. A.Sezgin, A., and Yagiz, N., (2012) study the effect of vibration using simulation program of a full vehicle model. The road roughness is used as an input to the system. If a driver has journey at a rate of 72 km/h (20 m/s) from 5 hours to 6 hours on a smooth road he feel uncomfortable. Avesh, M., and Srivastava, R., (2012) propose active suspension system of automobile for improving ride comfort to passenger and stability of vehicle to reduce vibration effect on suspension system.

Hong, K.T., et al. (2003) deals with improving the ride comfort of passenger car using air cell. For different road disturbance using air cell make optimal pressure between human body and seat surface. Experimental method obtain spring constant and damping coefficient of an air cell with 3 degree of freedom of quarter car. Mahala, M.K., et al. (2007) stated lumped parameter mathematical model for study vehicle dynamics. In this paper different models are study at different road conditions. Louca, L.S., et al. (2001) presents integrated model of vehicle subsystem using bond graph. Energy based model methodology is applied for improvement performance of the vehicle system.

Patil, A.R. and Sanjay S.H., (2015), states that quarter car model s with non linear spring force property of Hyundai, Electra model suspension spring. Mitra, A., et al. (2013), states that full car model for various road profile analytically validated with MATLAB/Simulink.

The gap of research work has been found that designing of light vehicle for Indian rural road conditions are not available considering its performance, economics and comfort. In this paper, authors investigate the reduction in vibration of full car having seven degree of freedom using MATLAB/Simulink. The parameters for different road geometrics like: poor road, average road and good road condition for bumping and vibration were taken with an objective to design a control and active suspension system of full car with seven degree of freedom as compared to passive suspension system for comfort ride. The full car mathematical model is prepared and simulation results are tabulated, based on bouncing, pitching and rolling condition

DEVELOPMENT OF VEHICLE MODEL

Dynamic Model

The full car model develops linear equation of mass, spring and damper with seven degree of freedom suspension for comfort ride. To examine and optimize the vibration of a vehicle, full car vibrating model must be used. Full car model can be seen in **Fig. 3.1.**

Full car dynamic model

This model includes the body bounce the full car model may be different

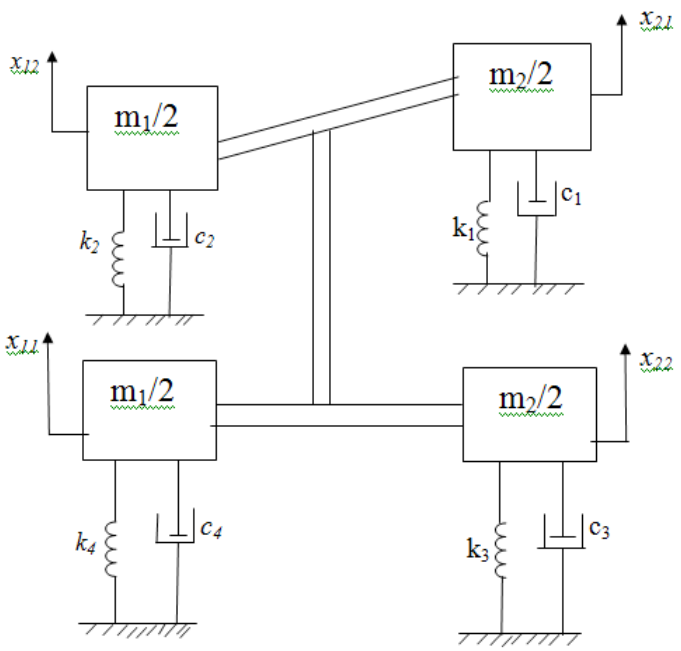

Figure 3.1: Dynamic model

for the front and rear suspension and mass distribution.,unsprung mass are $m_2/2$, $m_1/2$, $m_1/2$ and $m_2/2$ respectively,damping coefficient are c_1, c_2, c_3 and

$$\frac{m_2}{2}\ddot{x}_{21} + k_1(x_{21} - x_{12}) + c_1(\dot{x}_{21} - \dot{x}_{12}) = 0 \tag{3.1}$$

$$\frac{m_1}{2}\ddot{x}_{12} - k_1(x_{21} - x_{12}) - c_1(\dot{x}_{21} - \dot{x}_{12}) + k_2 x_{12} + c_2\dot{x}_{12} = 0 \tag{3.2}$$

$$\frac{m_2}{2}\ddot{x}_{22} + k_3 x_{22} + c_3\dot{x}_{22} = 0 \tag{3.3}$$

$$\frac{m_1}{2}\ddot{x}_{11} + k_4 x_{11} + c_4\dot{x}_{11} = 0 \tag{3.4}$$

When we consider stiffness and damping coefficient are equal k1=k3 and c1=c3

Applying in equation (3.3), we get

$$\frac{m_2}{2}\ddot{x}_{22} + k_1 x_{22} + c_1\dot{x}_{22} = 0$$

Applying Equation (3.5) into Equation (3.1) if both are equal

$$\frac{m_2}{2}\ddot{x}_{21} + k_1(x_{21} - x_{12}) + c_1(\dot{x}_{21} - \dot{x}_{12}) = \frac{m_2}{2}\ddot{x}_{22} + k_1 x_{22} + c_1\dot{x}_{22}$$

$$\frac{m_2}{2}(\ddot{x}_{21} - \ddot{x}_{22}) + k_1(x_{21} - x_{12} - x_{22}) + c_1(\dot{x}_{21} - \dot{x}_{12} - \dot{x}_{22}) = 0$$

Similarly we consider stiffness and damping coefficient are equal k2=k4 and c2=c4

Appling in equation (3.4), we get;

$$\frac{m_1}{2}\ddot{x}_{11} + k_2 x_{11} + c_2\dot{x}_{11} = 0 \tag{3.7}$$

Applying equation (3.7) into equation (3.2) if both are equal

$$\frac{m_1}{2}\ddot{x}_{12} - k_1(x_{21} - x_{12}) - c_1(\dot{x}_{21} - \dot{x}_{12}) + k_2 x_{12} + c_2\dot{x}_{12} = \frac{m_1}{2}\ddot{x}_{11} + c_2\dot{x}_{11} + k_2 x_{11}$$

$$\frac{m_1}{2}(\ddot{x}_{11} - \ddot{x}_{12}) + k_1(x_{21} - x_{12}) + c_1(\dot{x}_{21} - \dot{x}_{12}) + k_2(x_{11} - x_{12}) + c_2(\dot{x}_{11} - \dot{x}_{12}) = 0 \tag{3.8}$$

Consider displacement, stiffness, damping coefficient are equal

$$x_{21} = x_{22},\ k_1 = k_3,\ c_1 = c_3,\ c_2 = c_4,\ k_2 = k_4$$

Putting equation (3.6) and (3.8) we get;

From equation (3.6)

$$\frac{m_2}{2}(\ddot{x}_{21}-\ddot{x}_{22})+k_1(x_{21}-x_{12}-x_{22})+c_1(\dot{x}_{21}-\dot{x}_{12}-\dot{x}_{22})=0$$

$$\frac{m_2}{2}(\ddot{x}_{21}-\ddot{x}_{22})+k_1(x_{21}-x_{12}-x_{21})+c_1(\dot{x}_{21}-\dot{x}_{12}-\dot{x}_{22})=0$$

$$\frac{m_2}{2}(\ddot{x}_{21}-\ddot{x}_{22})-k_1x_{12}+c_1(\dot{x}_{21}-\dot{x}_{12}-\dot{x}_{22})=0$$

(3.9)

From equation (3.8)

$$\frac{m_1}{2}(\ddot{x}_{11}-\ddot{x}_{12})+k_1(x_{21}-x_{12})+c_1(\dot{x}_{21}-\dot{x}_{12})+k_2(x_{11}-x_{12})+c_2(\dot{x}_{11}-\dot{x}_{12})=0$$

$$\frac{m_1}{2}(\ddot{x}_{11}-\ddot{x}_{12})+k_3(x_{22}-x_{12})+c_3(\dot{x}_{21}-\dot{x}_{12})+k_4(x_{11}-x_{12})+c_4(\dot{x}_{11}-\dot{x}_{12})=0$$

(3.10)

We consider velocity, stiffness; damping coefficient and displacement are equal

$$x_{21}=x_{22}, \mathrm{k}_1=\mathrm{k}_3,\ \mathrm{c}_1=\mathrm{c}_3,\ \mathrm{c}_2=\mathrm{c}_4,\ x_{21}=x_{22}$$

Putting in equation (3.9) and (3.10) we get;

From equation (3.9) we get

$$\frac{m_2}{2}(\ddot{x}_{21}-\ddot{x}_{22})-k_1x_{12}+c_1(\dot{x}_{21}-\dot{x}_{12}-\dot{x}_{22})=0$$

$$\frac{m_2}{2}(\ddot{x}_{21}-\ddot{x}_{22})-k_1x_{12}+c_1(\dot{x}_{21}-\dot{x}_{12}-\dot{x}_{21})=0$$

$$\frac{m_2}{2}(\ddot{x}_{21}-\ddot{x}_{22})-k_1x_{12}-c_1\dot{x}_{12}=0$$

(3.11)

From equation (3.10)

$$\frac{m_1}{2}(\ddot{x}_{11}-\ddot{x}_{12})+k_3(x_{22}-x_{12})+c_3(\dot{x}_{21}-\dot{x}_{12})+k_4(x_{11}-x_{12})+c_4(\dot{x}_{11}-\dot{x}_{12})=0$$

$$\frac{m_1}{2}(\ddot{x}_{11}-\ddot{x}_{12})+k_1(x_{22}-x_{12})+c_1(\dot{x}_{21}-\dot{x}_{12})+k_2(x_{11}-x_{12})+c_2(\dot{x}_{11}-\dot{x}_{12})=0$$

(3.12)

c_4 respectively,stiffness are k_1, k_2, k_3 and k_4 are respectively,displacement are x_{21},x_{12},x_{11} x_{22}

Using differential and law of motion authors develop the following linear equation are given below:

Equations of motions of unsprung mass are given as

Dynamic Model with Pitching

To excellent examine and optimize the full car model with pitching vibration of a vehicle, Full car vibrating model must be used. This model includes the body bounce and body roll. The full car model may be different for the front and rear full car due to different suspension and mass distribution. Sprung mass is m,sprungmass displacement are z1, z2, z3 and z4 respectively, rolling in x direction pitching in y direction and bouncing in z direction respectively, unsprung mass are m2/2, m1/2, m1/2 and m2/2 respectively,damping coefficient are c1, c2, c3

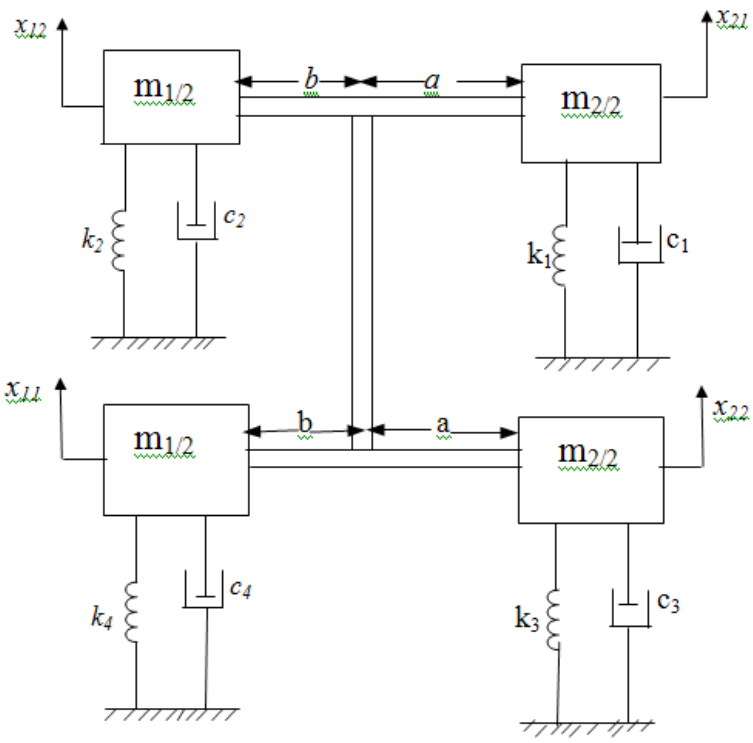

Figure 3.2: Dynamic model with pitching

Using newtons second law, the dynamic equation of bouncing are given as

$$m\ddot{z} - c_1(\dot{z}_1 - \dot{x}_{12}) - k_1(z_1 - x_{21}) - c_2(\dot{z}_2 - \dot{x}_{12}) - k_2(z_2 - \dot{x}_{12}) - c_3(\dot{z}_3 - \dot{x}_{22}) - k_3(z_3 - x_{22}) - c_4(\dot{z}_4 - x_{11}) - k_4(z_4 - x_{11}) = 0 \quad (3.13)$$

Using newtons second law , the dynamic equation of pitching are as

$$I\ddot{\theta} - bk_2(x_{12} - b\theta) - bc_2(\dot{x}_{12} - b\dot{\theta}) - bk_4(x_{11} - b\theta) - bc_4(\dot{x}_{11} - b\dot{\theta}) + ak_1(x_{21} - a\theta) + ac_1(\dot{x}_{21} - a\dot{\theta}) + ak_3(x_{22} - a\theta) + ac_3(\dot{x}_{22} - a\dot{\theta}) = 0 \quad (3.14)$$

$$I\ddot{\varphi} + bk_2(x_{12} - b\varphi) + bc_2(\dot{x}_{12} - b\dot{\varphi}) + bk_4(x_{11} - b\varphi) + bc_4(\dot{x}_{11} - b\dot{\varphi}) - ak_1(x_{21} - a\varphi) - ac_1(\dot{x}_{21} - a\dot{\varphi}) - ak_3(x_{22} - a\varphi) - ac_3(\dot{x}_{22} - a\dot{\varphi}) = 0 \quad (3.15)$$

and c4, respectively, stiffness are k1, k2, k3 and k4, respectively,displacement are x21, x12, x11 x22 However, vibration model of vehicle must be expanded for including pitch and other modes of vibrations a and b are distance from mass centre to front and rear axle full car model includes body bounce and body pitch Full car model with pitching can be seen in Fig. 3.2

Simulink Model

Table 2.1: Parameter of full Car Model

Symbol	*Parameter Description*	*Value*
ms	Mass of the car or sprung mass	1300 kg
muf	Front mass of the wheel or unsprung mass	65 kg
mur	Rear mass of the wheel or unsprung mass	60 kg
Ip	Pitch moment of inertia	2391.08 kg m2
Ir ()	Roll moment of inertia	391.08 kg m2
kf	Stiffness of vehicle for front	36300 N/m
kr	Stiffness of vehicle for rear	19600 N/m)
cf	Front damping coefficient	4000 kNs/m
cr	Rear damping coefficient	3000 kNs/m
a	Distance from centre of sprung mass to front wheel	1.6 m
b	Distance from centre of sprung mass to rear wheel	0.9 m

Using newtons second law, the dynamic equation of rolling are given as using newtons second law , the dynamic equation of pitching are as

Simulink model for the same road excitation, system needs to simulate the entire suspension system derive from equations (3.1) to (3.15), respectively for sprung mass, unsprung mass, unsprung wheel, pitching, rolling and bouncing. The mathematical model of 4-wheeled vehicle with driver seated on cushion seat is simulated with Simulink Software.

SIMULATION RESULTS AND DISCUSSION

Results are presented in summarized and graphical form in Table 2.1 after simulating the developed model. The different figures in the simulated results obtained at various speeds are 25 km/h to 125 km/h taken for simulation of parameter analyzed suspension displacement. The representation of simulation results can easily be reviewed and read with logical order. Different Bump heights

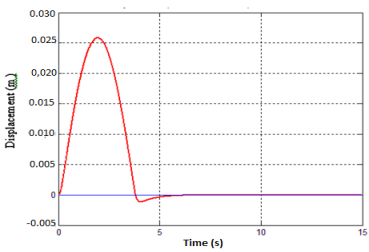

Fig 4.1: Sprung-Mass Displacement vs. Time at Bump height 0.025m and a speed of 25 km/h

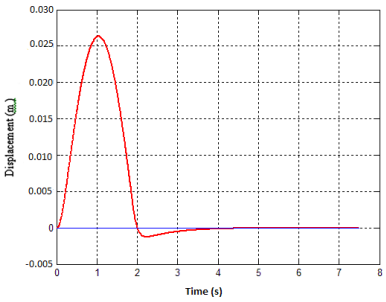

Fig 4.2: Sprung-Mass Displacement vs. Time at Bump height 0.025m and a speed of 50 km/h

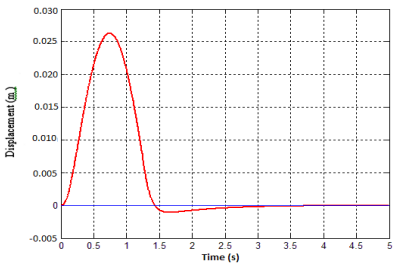

Fig 4.3: Sprung-Mass Displacement vs. Time at Bump height 0.025m and a speed of 75 km/h

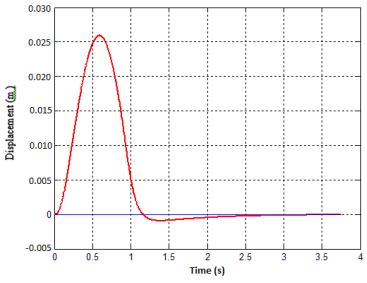

Fig 4.4: Sprung-Mass Displacement vs. Time at Bump height 0.025m and a speed of 100 km/h

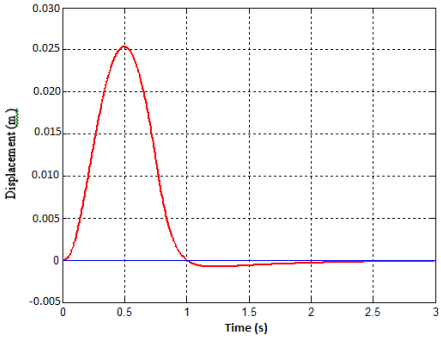

Fig 4.5: Sprung-Mass Displacement vs. Time at Bump height 0.025m and a speed of 125 km/h

- Simulation results at bump height 0.050m and at different speeds of 25 km/h, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr are shown below :

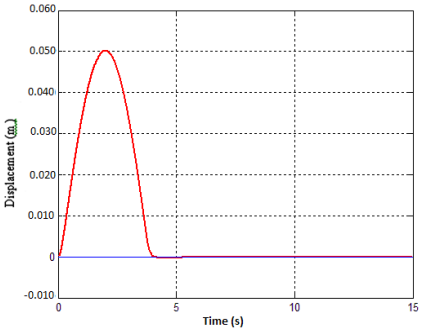

Fig 4.6: Sprung-Mass Displacement vs. Time at Bump height 0.050m and a speed of 25 km/h

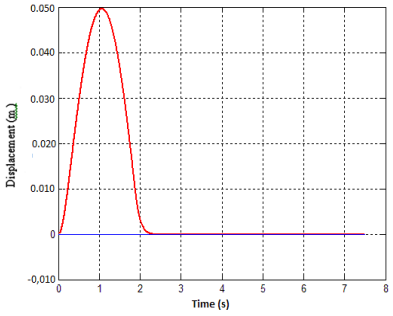

Fig 4.7: Sprung-Mass Displacement vs. Time at Bump height 0.050m and a speed of 50 km/h

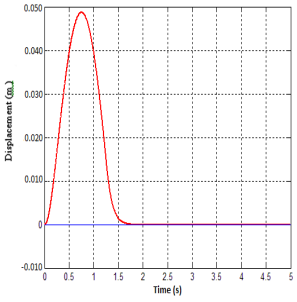

Fig 4.8: Sprung-Mass Displacement vs. Time at Bump height 0.050m and a speed of 75 km/h

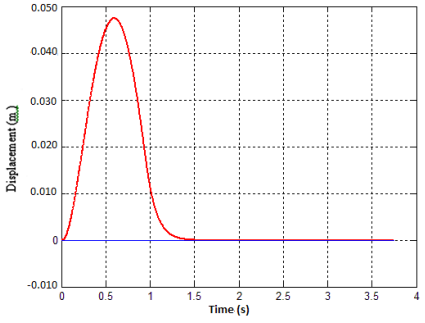

Fig 4.9: Sprung-Mass Displacements vs. Time at Bump height 0.050m and a speed of 100 km/h

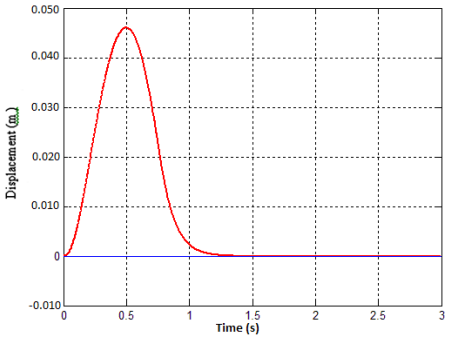

Fig 4.10: Sprung-Mass Displacement vs. Time at Bump height 0.050m and a speed of 125 km/h

- Simulation results at bump height 0.075m and at different speeds of 25 km/h, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr are shown below :

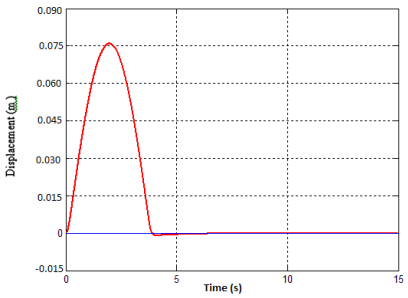

Fig 4.11: Sprung-Mass Displacements vs. Time at Bump height 0.075 m and a speed of 25 km/h

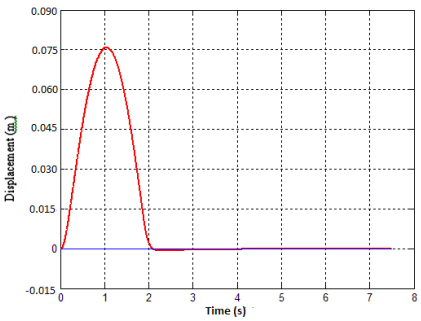

Fig 4.12: Sprung-Mass Displacements vs. Time at Bump height 0.075 m and a speed of 50 km/h

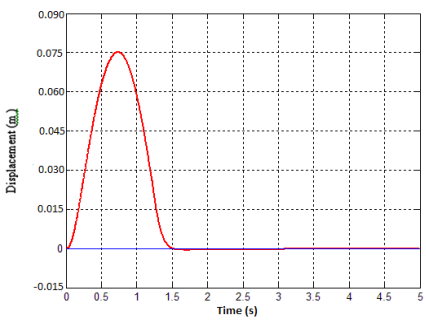

Fig 4.13: Sprung-mass displacement vs. Time at Bump height 0.075 m and a speed of 75 km/h

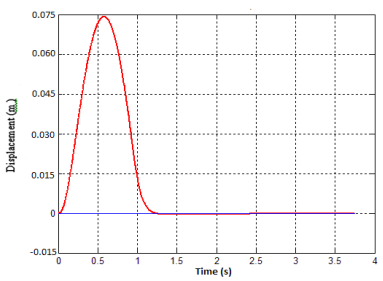

Fig 4.14: Sprung-Mass Displacements vs. Time at Bump height 0.075 m and a speed of 100 km/h

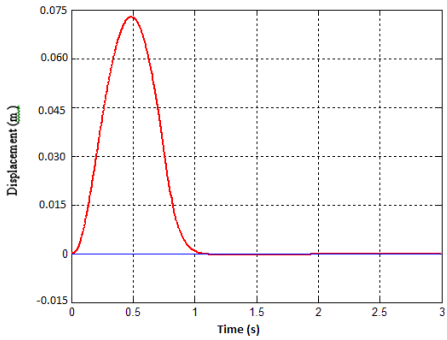

Fig 4.15: Sprung-Mass Displacements vs. Time at Bump height 0.075 m and a speed of 125 km/h

- Simulation results at bump height 0.100m and at different speeds of 25 km/h, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr are shown below :

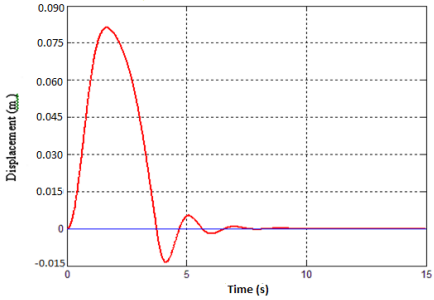

Fig 4.16: Sprung-Mass Displacement vs. Time at Bump height 0.1 m and a speed of 25 km/h

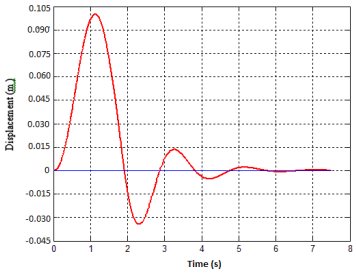

Fig 4.17: Sprung-Mass Displacement vs. Time at Bump height 0.1 m and vibration 0.098 m at a 1.9 second comfort zone at a speed of 50 km/h

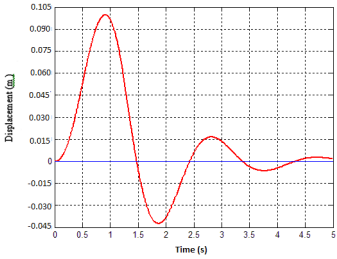

Fig 4.18: Sprung-Mass Displacement vs. Time at Bump height 0.1 m and a speed of 75 km/h

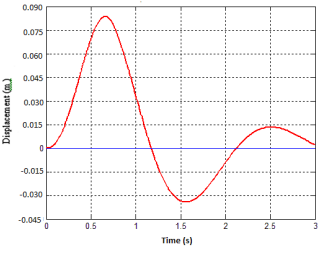

Fig 4.19: Sprung-mass displacement vs. Time at Bump height 0.1 m and a speed of 100 km/h

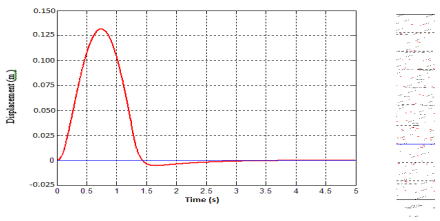

Fig 4.20: Sprung-Mass Displacement vs. Time at Bump height 0.1 m and a speed of 125 km/h

ranging: 0.025 m, 0.050 m, 0.075 m, 0.100 m, 0.125 m and 0.150 are taken to create vibrations with respect to time interval for comfort ride in real simulation.

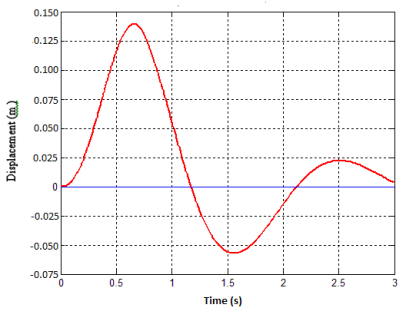

Fig 4.21: Sprung-Mass Displacement vs. Time at Bump height 0.125 m and a speed of 25 km/h

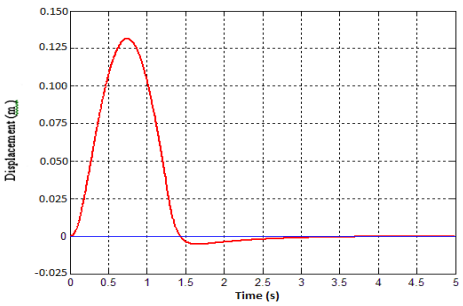

Fig 4.22: Sprung-Mass Displacement vs. Time at Bump height 0.125 m and a speed of 50 km/h

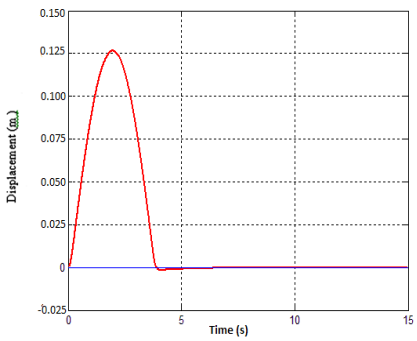

Fig 4.23: Sprung-Mass Displacement vs. Time at Bump height 0.125 m and a speed of 75 km/h

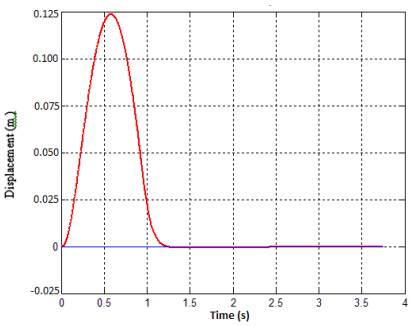

Fig 4.24: Sprung-Mass Displacement vs. Time at Bump height 0.125 m and a speed of 100 km/h

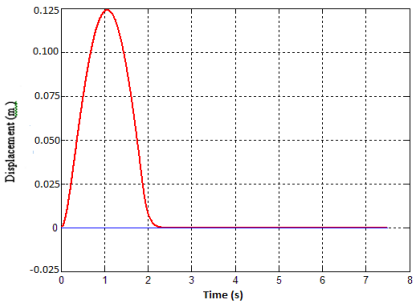

Fig 4.25: Sprung-Mass Displacements vs. Time at Bump height 0.125 m and a speed of 125 km/h

- Simulation results at Bump height 0.025m and at different speeds of 25 km/h, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr are shown below :

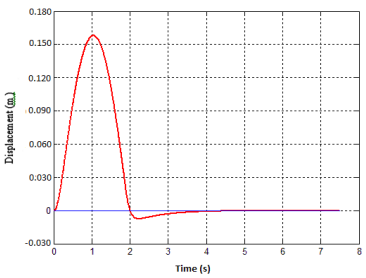

Fig 4.26: Sprung-mass displacement vs. Time at Bump height 0.150 m and a speed of 25 km/h

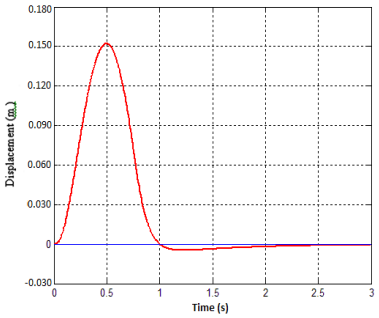

Fig 4.27: Sprung-mass displacement vs. Time at Bump height 0.150 m and a speed of 50 km/h

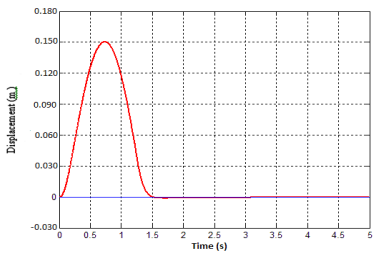

Fig 4.28: Sprung-mass displacement vs. Time at Bump height 0.150 m and a speed of 75 km/h

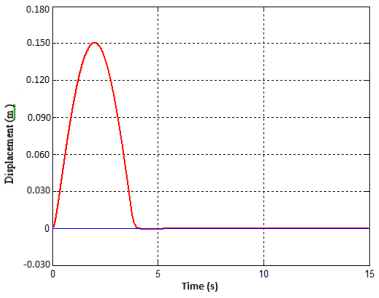

Fig 4.29: Sprung-mass displacement vs. Time at Bump height 0.150 m and a speed of 100 km/h

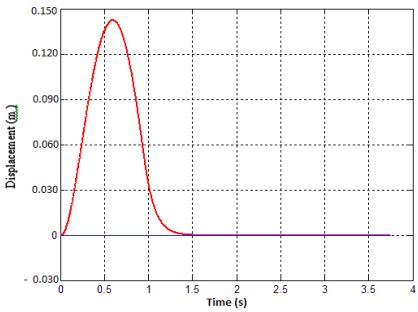

Fig 4.30: Sprung-mass displacement vs. Time at Bump height 0.150 m and a speed of 125 km/h

- Simulation results at bump height 0.125m and at different speeds of 25 km/h, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr are shown below :
- Simulation results at bump height 0.150m and at different speeds of 25 km/h, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr are shown below :

RESULTS AND DISCUSSION

From the simulated graphs shown in Figs. 4.1 to 4.5

At different speeds like: 25 km/hr, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr when bump height is kept 0.025 m, maximum amplitudes of vibration and its die out of time periods are listed below in the **Table 5.1.**

Table 5.1: Displacement vs. Time at 0.025m bump height at different Speeds of 25 km/hr, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/h

S.N	Bump height	Speed of Vehicle	Vibration amplitude	Time
1	0.025 m	25 km/hr	0.026 m	4 s
2	0.025 m	50 km/hr	0.027 m	2 s
3	0.025 m	75 km/hr	0.027 m	1.4 s
4	0.025 m	100 km/hr	0.026 m	1.1 s
5	0.025 m	125 km/hr	0.025 m	1 s

It is observed that at bump height 0.025 m vibration amplitudes are 0.026 m, 0.027, 0.027, 0.026 and 0.025 and its corresponding vibration die out time 4 sec, 2sec, 1.4 secs, 1.1 secs and 1.0 sec at vehicle speeds of 25 km/hr, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr respectively. This indicates that at low vehicle speed vibration

Table 5.2: Displacement vs. Time at 0.050m bump height at different Speeds of 25 km/hr, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr

S.N	Bump Height	Speed of Vehicle	Vibration Amplitude	Time (in seconds)
1	0.050 m	25 km/hr	0.050 m	4 s
2	0.050 m	50 km/hr	0.050 m	2.2 s
3	0.050 m	75 km/hr	0.048 m	1.7 s
4	0.050 m	100 km/hr	0.047 m	1.5 s
5	0.050 m	125 km/hr	0.046 m	1.3 s

It is observed that at bump height 0.050 m, vibration amplitudes are 0.050 m, 0.050., 0.048, 0.047 and 0.046 and its corresponding vibration die out time 4 sec, 2.2sec, 1.7 sec, 1.5 sec and 1.3 sec at vehicle speeds of 25 km/hr, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr respectively. This indicates that at low speed (i.e., 25 km /hr), vehicle vibration gets die out abruptly and time taken was found larger up to 4 seconds and at 125 km/hr vehicle vibration gets die out and time taken is found least up to 1.3 seconds for the vehicle under examination for its comfort ride. This situation creates comfort ride at low speed and at larger speeds discomfort for less time.

From the simulated graphs Fig. 4.11 to 4.15

At different speeds like: 25 km/hr, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr when bump height is kept 0.075m, maximum amplitudes of vibration and its die out of time periods are listed below in the **Table 5. 3.**

It is observed that at bump height 0.075 m, vibration amplitudes are 0.075m, 0.075, 0.075, 0.074 and 0.073 and its corresponding vibration die out time 4 sec, 2 sec, 1.5 sec, 1.2 sec and 1 sec at vehicle speeds of 25 km/hr, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr respectively. This indicates that at low speed (i.e., 25 km /hr), vehicle vibration gets die out abruptly and time taken was found larger up to 4 seconds and at 125 km/hr vehicle vibration gets die out and time taken is found least up to 1.0 seconds for the vehicle under examination for its comfort ride. This situation creates comfort ride at low speed and at larger speeds discomfort for less time.

Table 5.3: Displacement vs. Time at 0.075m bump height at different Speeds of 25 km/hr, 50 km/hr, **75 km/hr, 100 km/hr and 125 km/hr**

S.N	Bump height	Speed of Vehicle	Vibration	Time
1	0.075 m	25 km/hr	0.075 m	4 s
2	0.075 m	50 km/hr	0.075 m	2 s
3	0.075 m	75 km/hr	0.075 m	1.5 s
4	0.075 m	100 km/hr	0.074 m	1.2s
5	0.075 m	125 km/hr	0.073 m	1 s

gets die out abruptly and time taken was found larger up to 4 seconds whereas at 125 km/hr speeds time taken is 1 sec only for the vehicle under examination for its comfort ride. This situation creates comfort ride at low speed.

From the simulated graphs shown in Figs. 4.6 to 4.10

Table 5.4: Displacement vs. Time at 0.075m bump height at different Speeds of 25 km/hr, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr

S.N.	Bump height	Speed of Vehicle	Vibration amplitude	Time
1	0.1m	25 km/hr	0.080 m	3.9 s
			-0.001 m	4.1s
			0.003 m	5.0s
2	0.1m	50 km/hr	0.098 m	1.9 s
			-0.022m	2.3 s
			0.015m	3.2 s
			-0.002m	4.5 s
			0.000m	5.5s
3	0.1m	75 km/hr	0.097 m	1.4 s
4	0.1m	100 km/hr	0.082 m	1.2 s
5	0.1m	125 km/hr	0.092 m	1.3 s

It is observed that at bump height 0.100 m**,** vibration amplitudes are 0.080m, 0.098, 0.097, 0.082 and 0.097 and its corresponding vibration die out time periods are found 3.9 sec, 1.9sec, 1.4 sec, 1.2 sec and 1.3sec at vehicle speeds of 25 km/hr, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr respectively. This indicates that at low speed (i.e., 25 km /hr), vehicle vibration gets die out in harmonic motion and time taken was found larger up to 5.0 seconds, at 50km/hr vibration also die out in harmonic motion with 4.5 seconds, and at 125 km/hr vehicle vibration gets die out in pulse and time taken was found least up to 1.3 second for the vehicle under examination for its comfort ride. This situation creates comfort ride at low speed and at larger speeds discomfort for less time.

From the simulated graphs shown in Figs. 4.21 to 4.25

At different speeds of the 25 km/hr, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr at bump height 0.125m; maximum amplitudes of vibration and die out of times are listed below in the Table 5.5.

Table 5.5: Displacement vs. Time at 0.125m bump height at different Speeds of 25 km/hr, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr

S.N	Bump height	Speed of Vehicle	Vibration amplitude	Time
1	0.125 m	25 km/hr	0.137 m, -0.55 m, 0.025 m 0.000m	1.2 s, 1.5s, 2.5 sec 4.5sec
2	0.125 m	50 km/hr	0.131 m -0.016 m 0.00 m 0.001m	1.4 s 1.6 s 3.0s 5.0s
3	0.125 m	75 km/hr	0.126 m -0.040m 0.015m -0.001m 0.001m	4 s 1.7s 2.7s 3.7s 5.5s
4	0.125 m	100 km/hr	0.080 m -0.035m 0.015m 0.000m	0.6 s 1.6s 2.5s 3.6s
5	0.125 m	125 km/hr	0.095 m -0.040 m 0.015m -0.005m 0.000m	0.7 s 1.6 s 2.6s 3.5s 4.2s

it is observed that at bump height 0.125 m, vibration amplitudes are 0.137m, 0.131m, 0.126m, 0.080m and 0.095m and its corresponding vibration die out time periods are found 1.2 sec, 1.4sec, 4.0sec, 1.3sec and 2sec at vehicle speeds of 25 km/hr, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr respectively. This indicates that at low speed (i.e., 25 km /hr), vehicle vibration gets die out in harmonic motion and time taken was found larger from 1.2 to 4.5 seconds and at 125 km/hr vehicle vibration gets die out in non-harmonic motion and time taken was found least up to 4.2 second for the vehicle under examination for its comfort ride. This situation creates comfort ride at low speed of 25 km/h and at larger speeds discomfort in little less time.

From the simulated graphs shown in Figs. 4.26 to 4.30

At different speeds of the 25 km/hr, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr at bump height **0.150m;** maximum amplitudes of vibration and die out of times are listed below in the **Table 5.6.**

Table 5.6: Displacement vs. Time at 0.150 m bump height at different Speeds of 25 km/hr, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr

S.N	Bump height	Speed of Vehicle	Vibration amplitude	Time
1	0.150 m	25 km/hr	0.161 m	2 s
2	0.150 m	50 km/hr	0.151 m	1 s
3	0.150 m	75 km/hr	0.150 m	1.5 s
4	0.150 m	100 km/hr	0.150 m	4 s
5	0.150 m	125 km/hr	0.142 m	1.5 s

It is observed that at bump height 0.150m, vibration amplitudes are 0.161m, 0.151m, 0.150m, 0.150m and 0.42m and its corresponding vibration die out time periods are found 2 sec, 1sec, 1.5sec, 4sec and 1.5sec at vehicle speeds of 25 km/hr, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr respectively. This indicates that at low speed (i.e., 25 km /hr), vehicle vibration gets die out in 2 sec and time taken was found larger up to 4 seconds and at 125 km/hr vehicle vibration gets die out and time taken was found least up to 1.5 second for the vehicle under examination for its comfort ride. Under these situations vehicle passes through non-harmonic vibrations and creates discomfort ride between 25km/h to 125 km/h even higher speeds for less time.

At different speeds like: 25 km/hr, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr when bump height is kept 0.050m, maximum amplitudes of vibration and its die out of time periods are listed below in the **Table 5.2.**

From the simulated graphs shown in Figs. 4.16 to 4.20

At different speeds like: 25 km/hr, 50 km/hr, 75 km/hr, 100 km/hr and 125 km/hr when bump height is kept 0.100m, maximum amplitudes of vibration and die out of time periods are listed below in the **Table 5.4.**

CONCLUSION

The performance of 4-wheeled vehicle design model with seven degree of freedom was developed. The mathematical model of the vehicle for rural roads was prepared on the basis of road condition in India with bumps taken as: 0.025 m, 0.050m, 0.075 m, 0.1 m, 0.125 and 0.150 for the comfort ride on such vehicles moving at different speeds of: 25km/hr, 50km/hr, 75km/hr, 100km/hr and 100km/hr. The fixed and variable parameters such as: stiffness, damping coefficient, sprung mass and unstrung mass etc., is listed.

The simulation analysis of the model is carried out at various conditions taking vehicle speeds from 25 km/h to 125 km/h and sprung mass displacement 0.025 mm to 0.150 mm, from the Figures 3.1 to 3.30, it is found that:

- When vehicle speeds are kept 25 km/hr to 125 km/hr on rural roads with bumps 0.025m to 0.075m and tyre coefficient is considered constant; vibration of vehicle is shown in Fig. 4.1 to Fig. 4.15. This indicates that vibration of vehicle gets die out with first spike in 2 sec to 4 seconds at speed of 25 km/hr to 125 km/hr up to 0.075m bump. This situation creates discomfort to the rider at low speed and at larger speeds too.
- When vehicle speeds are kept 25 km/hr to 125 km/hr on rural roads with bumps 0.100m and tyre coefficient is considered constant; vibration of vehicle is shown in Fig.4.16 to Fig. 4.20. This indicates that vibration of vehicle gets die out in harmonic condition in 4 sec to 5 seconds at speed of 25 km/hr to 125 km/hr up to 0.075m bump. This situation creates comfort to the rider at 50 km/hr to 75 km/hr speed and at larger speeds gives little discomfort.
- When vehicle speeds are kept 25 km/hr to 125 km/hr on rural roads with bumps 0.150m and tyre coefficient is considered constant; vibration of vehicle is shown in Fig. 4.21 to Fig. 4.22. This indicates that vibration of vehicle gets die out in harmonic condition in 3 sec to 3.5 seconds at speeds of 25 km/hr and 50 km/hr and 0.150m bumps. This situation creates comfort to the rider at 25 km/hr to 50 km/hr speed and at larger speeds 75 km/hr to 125 km/hr no comfort situation is seen.

In Indian Rural Road conditions, it is therefore found from the simulations that 4-wheeled vehicles can be designed with a constant tyre coefficient at speeds of 25 km/hr to 125 km/hr with comfort ride and vehicles would also have considerably longer life. This will also impact on cost effectiveness of the vehicle as well as reduction in global warming impact.

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Cyber Physical System and IoT: The Next Generation Computers

Hemant Kumar Singh[1], Sunit Kumar Mishra[2], Sanjay Kumar Singh[2]

[1]*Azad Institute of Engineering & Technology, Lucknow, UP, India*
[2]*Department of CS & E, School of Management Sciences, Lucknow, UP, India*

ABSTRACT

With the development of digital industrial technology called as industry 4.0 that has given a big change to industry to transform their business to produce high quality products with minimal cost. It is possible through analyzing data across machines and facilitates better process to create high quality products at very low cost. This revolution in manufacturing sector will change the way of doing business and will also increase the industrial growth and economy exponentially. The development of cyber-physical systems (CSS) and Internet of things (IoT) creates new challenges to the society. The most important one is information security and privacy and preventing it from cyber-attacks particularly in defense sector.

The main aim of this chapter is to introduce about the cyber physical system and internet of things. How are they different? It will also explain changes in next generation computing and challenges as well.The main issues, threats and attacks will also be described in the chapter. This chapter will also suggest the future research issues in CSS and IoT.

Keywords: Cyber Attacks, Cyber Physical System, Internet of Things, Security threats.

Corresponding Author: Hemant Kumar Singh

E-mail: hemantbib@gmail.com

INTRODUCTION

The term CPS and IoT are tightly tangled in next generation computing solutions in which persons, devices and environment communicate among each other without human intervention to achieve definite goal. The concept of cyber physical system generated from combination of computer science and engineering fields such as embedded computing, mechatronics where smart devices, persons and computing infrastructure are tied together. Some examples of such systems are smart manufacturing units, smart grids, smart homes, smart transportation systems etc.

With the advent of networking and information technology the term information, networks, connectivity, data and communication has made the term IoT popular

in linking physical world to digital world. In connecting physical and digital world sensors, actuators and transducers plays vital role. Transducers changes energy from one form to another and sensors collects the information from the physical world and actuators works on it and moves/operate the objects.

CYBER PHYSICAL SYSTEM

The system whose mechanism is controlled and monitored by the computer based algorithms are known as cyber physical systems. They are very close to IoT but it may not be connected with internet. CPS are combination of computation and physical processes connected through networks. The examples of CPS can be factory robots to software controlled google class, driverless car, smart meters, Alexa controlled family, drone etc.

CPS are the next generation embedded smart systems which are co-dependent, interconnected, combined, self-directed that communicate, compute and control the various processes and components in different areas. CPS necessity is progressively growing in diverse applications like in energy, shipping, health and engineering sectors.

The expansion of CPS technology will improve the way we live but a fear is the security and vulnerabilities that may be caused via interactions and new security

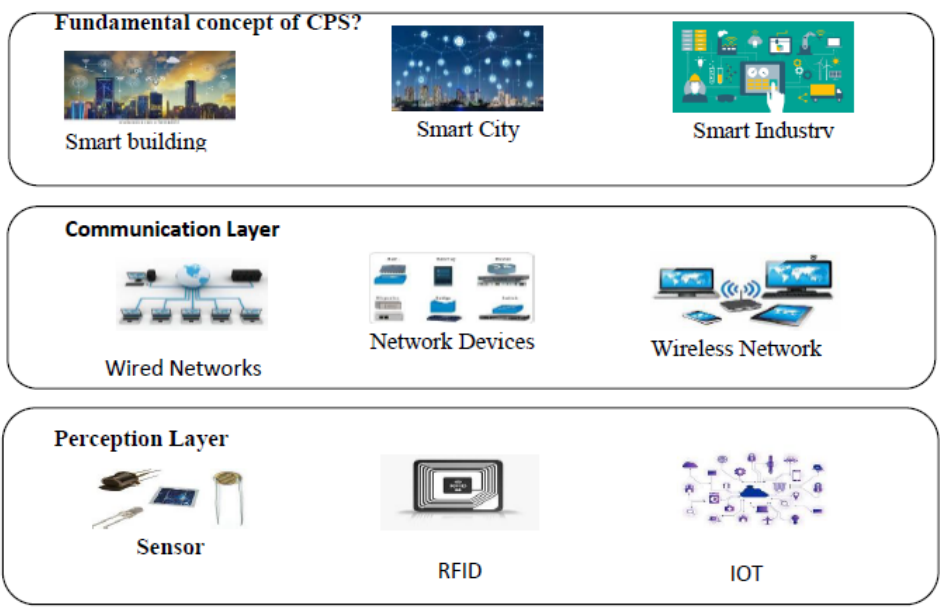

Figure 1

problems are evolving. Cyber-terrorists can outbreak actual control systems and information security in computers or Internet servers. So there is need to have better understanding on new security issues.

That are in communication. This communication takes place by wired as well as wireless network devices. The perception layer consists of IoT nodes, actuators, sensors etc. It recognizes and collects the data, leads it to transmission layer and unites the IoT nodes in the net.

CYBER PHYSICAL SYSTEM VS INTERNET OF THINGS:

Most of the time CPS and IoT are used interchangeably due to their overlapping features. IoT can be said the third wave of IT after internet and mobile communication. It can be defined as a communication network which connects the devices having naming, sensing as well as processing capabilities. The Interconnectivity among smart objects that includes devices, actuators, sensors, embedded systems and RFID tags which used standard communication protocols like Bluetooth, RFID, and ZigBee etc.

On the other hand, cyber physical system is mostly linked to real-time systems that includes computing and communication competences with monitoring and control of objects in the physical world. CPS are the next generation of embedded intelligent information and communications systems that are reliant and collaborative. This offers computation, communication and monitoring of physical parts, processes in many applications like transportation, healthcare, energy and manufacturing sectors. Furthermore, CPS are used in various fields that needs real-time data

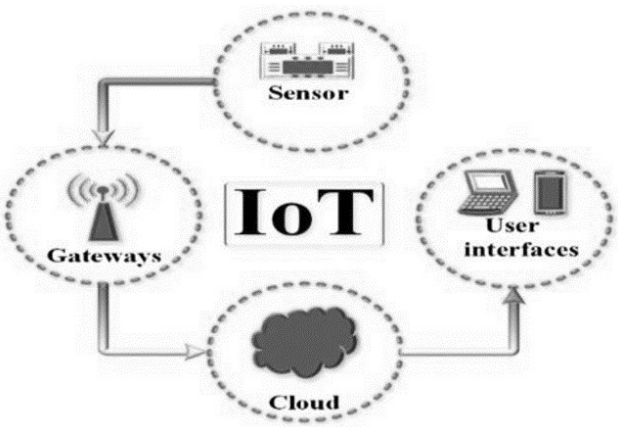

Figure 2

collection, feedback for decision making It includes robotic surgery, military war, air traffic control etc.

CPS CHALLENGES

Openness: Since it permits communication with probably new devices entering the system to attain common objectives. If there are spare resources in current devices, it may receive jobs from additional devices in the network.

Isolation: Permit a device to separate itself in order to attain its own goals within the given time. This is significant to guarantee a device cannot be hijacked by additional devices and their divested tasks.

Safety: CPS as well as IoT will be universal and our lives are going to depend on it. As a concern, we have to make sure that it will behave as anticipated. This is especially vital when we think of safety-critical uses and its consequences such as autonomous driving.

Security: A secure cyber physical system operating system(CPS-OS) is needed for data protection during data exchange from one device to another. The CPS-OS has to guarantee that sensible data never leave the device for unauthorized access.

Privacy: There should be allowed only authorized user to access the device.

Extensibility and Discovery: It should permit new devices to link network to accomplish common goals quicker. New devices should be discovered autonomously by the existing devices in the network. In addition, the network should have the capability to learn about the newly joined devices to utilize it as a new added resource as well as new added device should be aware about available knowledge in the network.

Robustness: In case of movement or removal of device from application should not have any effect on performance of the system.

Self-protecting and maintenance: It should be able to detect and project outside attaches. It should be functional in standard as well as uncertain situation.

Connectivity: Since the device is not in isolation, it is communicating with different devices in the network so it must have ability to connect to web and cloud services also.

Location: The individual device should be able to discover the other device in the network.

Data Storage: Data is required to be stored at different locations in distributed manner.

CYBER PHYSICAL SYSTEM APPLICATIONS

CPS have the potential to have noticeable challenges in information intensive technology segments like healthcare, manufacturing, transportation, Water Distribution Systems and smart buildings etc. Some of the major application areas of cyber physical system are as follows-

Manufacturing

The use of CPS and IoT in manufacturing industry is increasing fast. In manufacturing cyber physical systems are used for automate the production operations and control. CPS advances manufacturing processes by exchanging information among the machines, business systems and customers. Smart manufacturing offers high visibility controls on the supply chain which results in improving the traceability and security of goods. The impact of IoT and CPS in manufacturing industry is significantly growing. Sensors are used to predict equipment wear and diagnose faults. The analytics reduces the maintenance cost and increases operation performance.

Water Distribution Systems

Water Distribution systems is also moving towards automation. These systems contain reservoirs, wells, tanks, pumps and pipes that distribute water to taps. The devices also monitor activity like sensors to notice the overflow of water from a tank, pipe pressure.

Smart Greenhouse

Cyber physical system has vigorous role in agriculture sector. it advances yield and stops starvation. The system emphases on an adaptive technique with numerous parameters such as temperature, amount of light, humidity and irrigation.

Health Care

Most of medical systems use cyber physical systems for real time and remote

monitoring of physical conditions of the patients. This is useful to treat incapacitated and ageing patients and reduces patient hospitalization.

Transportation

Vehicles can interconnect & communicate with each other by exchanging real time information like traffic, locations and prevents accident and increases safety.

Buildings

CPS enabled building infrastructure are known as "smart buildings". It increases energy efficacy and drops energy consumption and greenhouse gas releases. A network senses the temperature, humidity and activate actuators that are embedded into the building to sense fluctuations in the environment.

Claytronics

It is a technology to build virtual reality with which human can interac. IT joins nano gauge robots and computer theory to build nanometer-scale systems known as claytronic atoms or catoms. These catoms can interact with other to create 3D structures. The purpose of claytroics is to build a vibrant motion in 3-D objects.

CONCLUSION

Cyber physical systems and IoT are intelligent system which join hardware and software aa well as they are linked over a network as the real world combines with the virtual world into cyberspace/internet. The improvement of CPS's relies on the input from various fields and needs a skilled staff to support and preserve its growth. It has the ability to transform and advance lives and to resolve many serious challenges

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Exploring Consumers Participation Towards Sustainable Growth: With Special Reference to Green Marketing in City of Lucknow

Suchita Vishwakarma[1], Jyoti Kumari[1]
[1]*School of Management Sciences, Lucknow, UP, India*

ABSTRACT

Organizations world-wide are adopting new strategies to become sustainable. Hence the marketing activities today cannot remain untouched with the aspects of sustainability. One name that can be given to sustainable marketing effort is eco friendly practices. Most of the leading companies across sectors are trying to imbibe different strategies to gain competitiveness based on the green practices. The customer do appreciate such efforts by market players, but at the same time it becomes important to understand their contribution and role as end user and stakeholder in helping the organizations successfully implement and bring adequate actionable in this sphere. The author through this paper has tried to identify how well consumers have accepted this effort. The author has tried to understand whether the consumers of Lucknow are able to imbibe the green thought process in their daily usage and to what extent they are ready to change their style in accordance with green practices and sustainable development.

Keywords: Green Marketing, Sustainability, Ecofriendly

Corresponding Author: Suchita Vishwakarma

E-mail: suchitavishwakarma@smslucknow.com

INTRODUCTION

Green marketing refers to holistic marketing concept wherein the production, marketing, consumption and disposal of products and services happen in a manner that is less detrimental to the environment. According to American Marketing Association Green Marketing is the development and marketing of products designed to minimize negative effects on the physical environment or to improve its quality. It incorporates the efforts by organizations to produce, promote, package, and reclaim products in a manner that is sensitive or responsive to ecological concerns.[1] Green Marketing came into prominence in the late 1980s and early 1990s. In 1987, World Commission on Environment and Development in their report defined sustainable development as meeting "*the needs of the present without compromising the ability of future generations to meet their own*

need", this became known as the Brundtland Report and was another step towards widespread thinking on sustainability in everyday activity and this formed a base for the development of the concept of Green Marketing.[2] In the last few decades there was increased competition and race among companies to gain competitive edge and thus the concept of green marketing got its strong place positioning in the marketing framework.

However, the concept of green marketing has till date not been able to create a strong hold in the mind set of consumers. The consumers though willing to go green are very often ready to tradeoff between the benefits of the product, price of the product and the convenience, perceived benefits and other related aspects of ecofriendly products. Thus, the ownership of green practices keeps shifting from one shoulder to another.

LITERATURE REVIEW

Green marketing term appeared at the end of the 1980's. This concept has been defined by Stanton and Futrell (1987) followed by Mintu and Lozanda (1993) and Polonsky (1994) in their studies (Ghosh, 2010, p.83). In a broad sense it can be understood as the marketing activities which facilitate exchanges to satisfy consumer needs and wants by minimizing the impact of these activities on the physical environment.

According to Polonsky *et al.* (1994) green or environmental marketing consists of all activities designed to generate and facilitate any exchange intended to satisfy human needs or wants, such that the satisfaction of these needs and wants occurs, with minimal detrimental impact on the natural environment.

Ottman 2006) points out that, if played by its rules, "*green marketing can lead to product improvements that can enhance marketability, improve overall performance and become a potent new source of innovation*". A new series of concepts have also evolved to explain this concept which includes product improvements, performance and innovation. Thus, through green marketing, purpose of marketing is enlarged in general terms. However, it is important to clarify that for adhering to green concepts, marketing is intended, to abide to process of marketing products and services that have environmentally friendly characteristics

Cost of the products associated with the waste disposal or According to Chen and Chai, Green marketing is defined as the activities taken by firms concerned about environmental problems or green problems, by delivering

the environmental sound goods or services to create customers' and society's satisfaction.

Welford defined green marketing as "the management process responsible for identifying, anticipating and satisfying the requirements of customers and society in a profitable and sustainable way".

Green marketing has been developing considering that the individual's wants are unlimited, but the natural and artificial resources are limited.

Green marketing-mix elements and eco-friendly products are designed and developed as having less harmful for the environment.

Elkington defines green consumer as the person who avoids the products that are likely to endanger the health of the consumer or others, significant damage to the manufacturing products, consume a disproportionate amount of energy, unnecessary wastage, use materials derived from threatened species or environments, involve unnecessary use of or cruelty to animals and adversely affect the other countries.

GREEN OFFERING BY COMPANIES

THE GOOD GREEN PRACTICES

GREEN PRODUCT - Products aimed to be made from recycled materials or used goods. They not only save water, energy and money, but also reduce harmful effects on the environment. Green chemistry forms the growing focus of product development. These products are developed and designed in a manner that it will use and also produce less of chemicals, toxics and other hazardous substances.

GREEN PRICE - is a pricing strategy aimed at encouraging the use of green products and charging the products that are against the planet and people.

GREEN PLACE – is managing logistics to cut down transportation emissions, thereby aiming at reducing the carbon footprint.

GREEN PROMOTION – is a process of using the tools of promotion, such as advertising, marketing materials, signage, white papers, web sites, videos and presentations by keeping people, planet and profits in mind.

THE NOT SO GOOD GREEN PRACTICES

GREEN WASHING OR "*GREEN SHEEN*," is a form of spin in which green PR or green marketing is deceptively used to promote a perception that the organization's

products or policies are environmentally friendly. Organizations today are using this concept very often by pointing out differences in their advertising strategy. They spend significantly large amount of money and time creating a “green" image (that is, operating with consideration for the environment) for the product, than what they actually spend on environmentally sound practices. Green washing efforts can range from changing the name or label of a product to evoke the natural environment on a product that contains harmful chemicals to multimillion dollar advertising campaigns portraying highly polluting energy companies as eco-friendly.

GREEN SPINNING occurs when a company, usually one who receives criticism for its environmental impact, implements a strong public relations (PR) campaign to demonstrate that they are environmentally friendly. Though this approach, they projects the company in a better light, in the eyes of public, but at the same time it fails to change the business' production, policies and processes. They divert all their resource and energy into such PR campaign making, and thereby makes the resources unavailable for institutional policies that can change the operations of the organization in a positive manner. This approach is often used in an adversarial manner.

GREEN SELLING is similar to green spinning in that no organizational changes are made. Instead, the company adjusts its promotional campaigns to include the environmental features of current products. However, no processes or standards are in place to authenticate or support the green claims of businesses. They position their products using false or misleading information. This approach often led to consumers mistrusting green products due to false advertising or promotions.

GREEN HARVESTING is an outcome of businesses decreasing the amount of packaging used in their products besides cutting energy usage at the same time. These practices provide many benefits to the organization, but these benefits are never able to make their way to the consumers.

ECO-LABELING schemes offer environmentally less harmless label program on the packaging of product. It was initiated by Germany in 1978. It is awarded to a manufacturer by a competent authority. The government of India too had launched an Eco mark scheme in 1991 to increase consumer awareness in respect

of environment friendly product which aimed to encourage the customers to purchase products which have less harmful environmental impact.

OBJECTIVE OF STUDY

To identify the awareness level about green marketing and green practices among the consumers of Lucknow.

To understand the consumers perception about green marketing practices in relation to demographic profile.

RESEARCH METHODOLOGY

Research Design - Descriptive
Sample Area - City of Lucknow
Sample Size - 150
Sampling Technique- Non Probability Convenience Sampling Method
Data Collection - Primary Data
Data Collection Method- For collecting the data a closed ended questionnaire was prepared based on Five Point Likert Scale. The Questionnaire was distributed to the consumers to know their opinion, only after their consent.

Table 1: Demographic profile of respondents

Variables		*No. of respondents*	*Percentage*
Gender	Male	89	59.33
	Female	61	40.67
Age	15-25	28	18.67
	26-45	72	48.00
	46 and above	50	33.33
Occupation	Employed	57	38.00
	Self Employed	28	18.67
	Home maker/ Retired	37	24.67
	Student	28	18.67
Family Income (monthly)	Less than 20000	18	12.00
	20000 -50000	56	37.33
	More than 50000	76	50.67
Education Level	Matriculation	9	6.00
	Intermediate	12	8.00
	Graduation and above	129	86.00

Table 2: Consumer's perception about green marketing practices

Demographic Variables		Green marketing practices are able to conserve the environment	Do you regularly purchase green products	Willing to pay an extra price for a green product	Companies today are using green methods of promotion	Companies today are trying to reduce their fuel consumption	How green are you as a consumer
Age	15-25	4.393	2.714	3.036	2.071	1.821	3.071
	26-45	4.278	3.042	2.597	2.028	1.889	3.139
	45<	3.380	2.960	2.720	2.120	1.780	2.900
	p value	0.003	0.584	0.437	0.895	0.766	0.363
Gender	Female	4.049	2.770	2.918	2.082	1.787	3.098
	Male	3.966	3.079	2.584	2.056	1.876	3.011
	p value	0.316	0.988	0.588	0.554	0.358	0.797
Education	Matriculation	4.111	2.444	3.778	1.667	1.889	3.111
	Intermediate	4.333	2.917	3.000	2.000	1.750	3.417
	Graduate and above	3.961	2.992	2.620	2.101	1.845	3.008
	p value	0.521	0.531	0.070	0.484	0.914	0.328
Occupation	Employed	4.000	3.105	2.667	1.860	1.912	3.000
	Self employed	4.107	2.964	2.643	1.964	1.857	3.143
	Housewife/ retired	3.865	2.703	2.811	2.351	1.784	3.027
	Student	4.071	2.964	2.786	2.214	1.750	3.071
	p value	0.825	0.612	0.956	0.129	0.812	0.921
Family Income	<20 K	4.222	2.944	2.944	1.889	2.000	3.111
	20-50 K	3.911	2.696	2.964	2.054	1.893	3.179
	50 k <	4.013	3.145	2.487	2.118	1.763	2.934
	p value	0.585	0.197	0.165	0.708	0.455	0.302

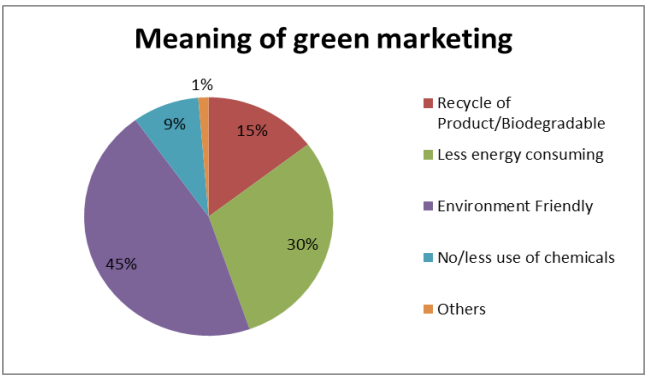

Figure 1: Understanding of green marketing

FINDING & CONCLUSION

The responses collected had fair spread on representation from all demographic segments of society. The researcher wanted to know the awareness level about green marketing in all these segments of society. The responses collected clearly shows that all the people had fairly well knowledge about green marketing, though their analogy did vary to some extent. Through the study it was observed that majority of the respondents considered green marketing as offering of environment friendly and less energy consuming products.

To understand the consumer's perception about green marketing practices researcher conducted MANOVA and ANOVA test. The result shows, that there was a significant difference in the perception of respondents on whether green marketing practices can conserve the environment or not. For this question the mean value of responses of age group 15-25 years and 26-45 years was 4.39 and 4.27, which clearly shows that according to them green marketing was an effective tool. Though, the opinion of respondents above the age of 45 years was found not to be very positive towards this concept. They were not very sure of the outcome of green marketing practices in conserving the environment.

Apart from this, in all other cases the perception of respondents was observed to be insignificantly different from each other. This means that no matter the respondents were of which gender, educational background, occupation or income category, their overall perception remained same on questions that whether they regularly purchase green products or are willing to pay an extra price for a green product. The mean value of the responses also showed that the respondents had little interest in purchasing the green products regularly and were not very keen on

paying an extra price for purchase of green products. The reason of such a response was more clearly evident through the detailed study of responses for the questions that whether companies today are using green methods of promotion or are trying to reduce their fuel consumption or not. The perception of all set of respondents for these two questions was towards negative side. The mean value of their responses varied from a min value of 1.75 to maximum of 2.35, which clearly explained that the respondents felt that companies are themselves not using the resources in a green manner and hence the respondents do not had much trust on the green offerings by the companies. These responses were similar for all demographic segments on which the study was conducted.

Moreover, upon asking the respondents about their perception regarding themselves as green consumers, they seemed to be confused. The responses for this question rotated near the mid value of mean of 3.00. This explains that despite the knowledge and acceptance of the green concept of marketing the respondents felt that even their own participation as green consumers were not encouraging.

Thus, the researcher after this study was in position to understand and interpret that only creating awareness towards green marketing practices cannot be considered sufficient, and the participation of consumers towards purchase and acceptance of green products will be a reflection of the green practices adopted by companies. The consumers today are able to sense out the shady behavior and practices of companies as a result the customers are not able to develop the desired amount of trust towards green products and practices.

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Sustainable Development of Indian Retail Sector

Zain Mehdi[1], Ashok Sen Gupta[1]

[1]*Department of Management, School of Management Sciences, Lucknow*

ABSTRACT

Retail growth in India is going to be happened. "A.T. Kearney" an international management consultant said "India as the second most lucrative destination of the world for retail business". In recent years, this sector bystander has changed from small, unorganized, family-owned retail formats to prearranged retailing. "A vivid change is underneath way in patterns of FDI in retail sector: proceeds in equipment are restructure its very location, nature, and scale as part of a new digital economy". The fallout are forcing corporation and nations – particularly developing economies – to reconsider what kind of FDI to seek and how to address the digital economy. Going slowly and by means of due concern India has over a decade in conclusion it was opened itself to 100% FDI in Single Brand Retail and 51% FDI in Multi-Brand Retail. This move would fetch about "supply chain improvement, investment in technology, manpower and skill development, tourism promotion, increased domestic sourcing, upgradation in agriculture, efficient and profitable small and medium scale industries, market development and monetary benefits to government through higher GDP, tax income and employment generation". In this expression, there appears no issue in the pursuance of the concept considering the underlying benefit to many stakeholders concerned in the procedure. However, going into the details, there appear to be fissures that need to be covered up to make it a win-win affair fetching bounties to one and all. The major problem that needs deliberation on displacement of many small retailers like the kirana stores who cannot protect themselves against the multinational retail giants with digital technology at large. Once a monopoly is created, this might turn into buying low and selling high.

Detailed analysis of the circumstances, considering the viewpoints of various stakeholders and available experience of the similar experimentations elsewhere, this study has attempted to come to some conclusion as to course of action that would be beneficial to the nation in the long run. Considering the stakes involved the significance of the study is necessary.

Keywords: Foreign Direct Investment (FDI), Indian Retail, Kirana Stores, MNC Retailers, Multi brand retail, Single brand retail.

Corresponding Author: Ashok Sengupta

E-mail: ashokgupta@smslucknow.com

The Foreign Direct Investment (FDI) means "cross border investment made by a resident in one economy in an enterprise in another economy, to establish a lasting interest in the investee economy. The Indian retail sector has moving as one of the majority quick growing and changes industries owing to the entry of more than a few new companies. As a conclusion, the retail market is predicted to grow to $1.5 trillion by 2030, increasing $700 billion from the current estimated market size of $793 billion in 2016.

FDI is also defined as "investment into the production of a country by a company in another country". Typically, the investment is in production by either buying a company in the target country or through expanding operations of an existing business in that country. Such investments can take place for various reasons like, to take advantage of cheaper wages, special investment privileges (e.g. tax exemptions) offered by the country, etc.

Interests of Nations in Soliciting for FDI POST Digitalisation

- When the domestic capital is meagre or insufficient for the requirement of economic growth.
- The foreign capital is usually imperative, at least during the period when the capital market is amidst development process.
- A foreign resource generally brings it with other limited prolific factors like technological prowess, business acumen and knowledge.

The Multifarious Advantages of the FDI

- It improves the foreign exchange position of the nation;
- It helps in generate employment and growth in production;
- Fresh capital supplements the domestic capital.
- It helps in technological up gradation, improvement of management skills, and adding the intellectual property.
- It makes the economy more efficient by increasing the domestic competitiveness.
- Exports are increased considerably.
- The income from taxes is augmented considerably.

There is a definite history of initial domestic protests against FDI.

- The domestic companies have an apprehension of losing ownership to foreign company.
- The small ventures fear being outcompeted by the foreign MNCs.
- The big MNCs usually covers the market and earn profit.
- The foreign companies have their own priorities that leads to more investment in machinery and intangible assets.
- Control of government is very minimum and it work under the foreign companies as subsidiary.

Investment in India by foreign country is basically through FDI and FII. The "Foreign Direct Investment (FDI)" in any foreign country is the net inflow of investment (capital or other), in order to acquire working control and profit sharing (10% or more voting stock) or the whole ownership of an accredited company operating in the country receiving investment. The foreign direct investment generally comprises of the transfer of technology and expertise, and participation in the management. Highly productive advantages of foreign direct investment have been constantly utilized by both governmental and private organizations of all over the world.

In India any Foreign Company who wants to conduct its business can set up its corporation either by-:

- Incorporating a company under the Companies Act, 1956, as a Joint Venture or a Wholly Owned Subsidiary.
- Set up a Liaison Office / Representative Office or a Project Office or a Branch Office of the foreign company which can undertake activities permitted under the Foreign Exchange Management (Establishment in India of Branch Office or Other Place of Business) Regulations, 2000.

The Foreign Direct investment in India can be done either by Automatic route or by taking prior approval from the government.

Automatic Route – "The Foreign Direct Investment through the automatic route can be done without prior permission from the government or the RBI in all the sectors which the government has allowed intermittently".

Government Route – "Foreign Direct Investment in the sectors prohibited by the automatic route need the prior permission from the government either by Foreign Investment Promotion Board (FIPB), Department of Economic Affairs, and Ministry of Finance".

FDI in Indian Retail Sector Post Digitalisation

"In 2004, The High Court of Delhi defined the term 'retail' as sale for final consumption in contrast to sale for further sale or processing (i.e. wholesale)". Hence it can be portrayed as "A sale to the ultimate consumer."

India ranks among the best countries to invest in the Retail space.

Factors that make India so attractive include:

- The second-largest population globally
- A middle class of 600 million people
- Increasing urbanization
- Rising household incomes
- Connected rural consumers
- Rising consumer spending

"It is estimated that till 2016, India was positioned second in the Global Retail Development Index (GRDI). In FY20, the retail sector contributed $800 billion to India's GDP and employed 8% of the country's workforce (35 million people). By 2030, it is anticipated to have created 25 million new employments".

"Recent policy changes allow 100% FDI in e-commerce under the automatic route for single-brand retail trading".

"Thus, retailing can be said to be an interface between the producer and the individual consumer buying for personal consumption. This excludes direct interface between the manufacturer and institutional buyers such as the government and other bulk customers. Retailing is the last link that connects the individual consumer with the manufacturing through the distribution channel. A retailer is involved in the act of selling goods to the individual consumer at some profit".

The retail industry is mainly divided into: - 1) Organized and 2) Unorganized Retailing

"Organized retailing refers to trading activities done by licensed retailers, that is, those who are registered for sales tax, income tax, etc. These include the corporate-backed hypermarkets and retail chains, and also the individual businesses".

"Unorganized retailing, on the other hand, refers to the traditional low-cost retailing, e.g. the kirana shops, owner manned general stores, paan/beedi shops, convenience stores, hand cart and pavement vendors, etc".

"The Indian retail sector is highly fragmented with 95 per cent of its business being run by the unorganized retailers. The organized retail however is at an embryonic stage. The sector is the largest source of employment after agriculture, and has deep penetration into rural India contributing around 10 per cent of India's GDP".

"The retailing sector in India had grown with terrific success, being rated as one of the sunrise sectors of the economy. A.T. Kearney, the well known international management consultancy, considered India as the second most lucrative destination of the world for retail business. India is in the midst of a retail boom. The sector witnessed significant transformation in the past decade from small, unorganized family owned retailing to organized formats. Indian business houses and manufacturers are setting up retail formats while real estate players are investing in retail infrastructure. Many international brands have entered the market in a big way. The unorganized retailers are increasingly feeling the heat and are undergoing quick modifications in their business setup".

"As part of the economic liberalization process kick started by the Industrial Policy of 1991, the Indian government slowly opened up the retail sector to FDI through a series of steps. In 1995 World Trade Organization's (WTO) General Agreement on Trade in Services, including both wholesale and retailing services, came into effect. In 1997 FDI in cash and carry (wholesale) with 100% rights was allowed under the government approval route. In 2016 FDI in cash and carry (wholesale) was brought under automatic approval route. Until 2011, foreign direct investment (FDI) was not allowed in multi-brand retail, forbidding foreign companies from any ownership in supermarkets, convenience stores or any retail outlets. Even single-brand retail was limited to 51 per cent ownership. In January 2012, India allowed 100 per cent FDI investment in single-brand retail, under condition that the single brand retailer would have to source 30 percent of its goods from India. On 7 December 2012, India allowed 51 per cent FDI in multi-brand retail. With this decision, international companies, especially the supermarkets, are planning to increase their presence in the multi-brand retail sector of India. However, they were not allowed to own more than 51 per cent stakes in these establishments. The government has put a condition before foreign multi brand retailers to utilize at least 50% of their total investment in the back-end infrastructure, thus giving a push to logistics and warehousing. Nevertheless, it is also a stark truth that investment through FDI route will prosper the country but on the other hand it will poorly affect the livelihood of millions of people who are having some grocery shops, those who are intermediaries in the process and many other associated people".

FDI IN SINGLE BRAND RETAILING

"Foreign Direct Investment in Single Brand means trading in a Single Brand i.e. a retail store with foreign investment can sell only one brand. Examples are Reebok, Adidas, etc. It means that the retail store of Adidas can sell the products of Adidas only and if the one wants to simultaneously sell the product of Reebok then separate approval of the government is required. In India the Government has allowed FDI up to 100% in Single Brand retail after the government's approval". FDI in Single Brand product retail trading would be subject to the following conditions:

- Products to be sold should be of a 'Single Brand' only.
- Products should be sold under the same brand internationally i.e. products should be sold under the same brand in one or more countries other than India.
- 'Single Brand' product-retail trading would cover only products which are branded during manufacturing.
- The foreign investor should be the owner of the brand.
- In respect of proposals involving FDI beyond 51%, mandatory sourcing of at least 30% of the value of products sold would have to be done from Indian 'small industries/ village and cottage industries, artisans and craftsmen'. 'Small industries' would be defined as industries which have a total investment in plant & machinery not exceeding US $ 1.00 million.

FDI IN MULTI BRAND RETAILING

Multi brand retailing means selling of two or more similar and competing products by the same retail store under different and unrelated brands. While these brands eat into each others' sales multi-brand strategy does have some advantages as a means of obtaining greater shelf space and leaving little for competitors' products, Saturating a market by filling all price and quality gaps, Catering to brand-switchers users who like to experiment with different brands, and keeping the firm's managers on their toes by generating internal competition.

In India the government has declared 51% in FDI in multi brand retail sector with the prior approval of the government subject to following restrictions:

- Minimum amount to be brought in, as FDI, by the foreign investor, would be US $ 100 million.

- "At least 50% of total FDI brought in shall be invested in 'backend infrastructure' within three years of the first lot of FDI, where 'back-end infrastructure' will include capital expenditure on all activities, excluding that on front-end units; for instance, back-end infrastructure will include investment made towards processing, manufacturing, distribution, design improvement, quality control, packaging, logistics, storage, ware-house, agriculture market produce infrastructure etc. Expenditure on land cost and rentals, if any, will not be counted for purposes of back end infrastructure".
- At least 30% of the value of procurement of manufactured processed products purchased shall be sourced from Indian 'small industries' which have a total investment in plant & machinery not exceeding US $ 1.00 million.
- "Retail sales outlets may be set up only in cities with a population of more than 10 lakh as per 2011 Census and may also cover an area of 10 kms around the municipal/urban agglomeration limits of such cities; retail locations will be restricted to conforming areas as per the Master/Zonal Plans of the concerned cities and provision will be made for requisite facilities such as transport connectivity and parking".
- Government will have the first right to procurement of agricultural products.
- "The above policy is an enabling policy only and the State Governments Union Territories would be free to take their own decisions in regard to implementation of the policy. Retail trading, in any form, by means of e-commerce, would not be permissible, for companies with FDI engaged in multi-brand retail trading".
- Applications would be processed in the Department of Industrial Policy & Promotion, to determine whether the proposed investment satisfies the notified guidelines, before being considered by the FIPB for Government approval.

RESEARCH PROBLEM

The retail sector in our country is one of the largest in the world. The Indian retail market is the fifth largest retail destination globally and "has been ranked as the most attractive emerging market for investment in" retail after Vietnam. However, complex corporate structures and the fact that intermediaries obtain a disproportionate share of value in the supply chain have always deterred foreign investments in the retail arena". After digitalization, the last few years witnessed the hectic growth by this sector, the key drivers being changing consumer profile and demographics, increase in the number of international brands available, economic implications of the Government increasing urbanization, easy

availability of credit, improvement in the infrastructure, increasing investments in technology and real estate building a world class shopping environment for the consumers". "Now the consumer wants to shop at a place where he can get food, entertainment, and shopping all less than one roof. This has given Indian organized retail market a major boost".

It is undeniable that every developing country like India is today FDI starved to enhance its economic growth satisfactorily. According to experts, FDI in multi-brand retail is a domain which will constitute next set of reforms to boost economic growth. The size of Indian Retail Sector is $ 590 Billion (Rs 26 Lakh Crore). FDI in multi brand offers multifarious benefits.

With the help of FDI, an economy will develop and the society at large. The employment will rise with the introduction of MNC's and big firms, competition will increase which will enable the Indian industrialist to think new mechanism to carry out their work with the innovation. This will even lead to increase in technology, by which the supply and consumption will both increase. The people will then focus on quality education as the firms will need the educated people. Many sectors in India which have decelerated like real estate and other will increase as the demand of land will increase. So there is expected an overall development in the economy.

Nevertheless, FDI in retail might not be good news for people employed in the Kirana or small stores as they might not be able to fend for themselves against the mighty MNC giants which will consequently set shop in the country.

Should the Government go ahead with the FDI in retail which seems to benefit the majority of the stakeholders? Or should it keep it in abeyance until a foolproof solution emerges that is acceptable to all? Should the government add some more caveats in order to safeguard the vulnerable or they are satisfactory and will serve the purpose? These and many more questions stand before the government and citizens as everybody braces for the golden future.

PROBLEM STATEMENT

Will FDI in retail lead to better conditions for the various stakeholders like farmers, consumers, suppliers, domestic retail establishments, etc. or it would fill the coffers of the MNCs only post digitalization?

OBJECTIVES OF THE RESEARCH

- To study the positives to be gained post digitalization as a result of liberalization of FDI.

- To analysis the negatives associated with the above mentioned process.
- To conclude with some measure of confidence the feasible and advisable path to be undertaken in the interest of all the stakeholders involved.

SIGNIFICANCE OF THE RESEARCH

Indian economy post digitalisation is presently standing at a crossroad and the coming years are going to decide the future course that this Asian giant would be taking. Whether it will go the FDI way in the retail sector or it will go the other way? Foreign Direct Investment (FDI) has become an essential part of an open and effective international economic system. The economies which are in the nascent stages of development look to FDI as an essential aspect for economic development, for invoking modernization, and add on the per capita income and employment.

Despite several advantages that this arrangement would lead the economy to, there are some encumbrances also as some groups are finding themselves at the wrong side and at the receiving end if this policy takes off. This has led to demands from some quarters to keep this in suspended state until some foolproof solution emerges. However, considering the overall gains imminent from this arrangement, this demand might lead the country to a missed opportunity. It would be like missing a bus when our economy needed it the most. This concept can act as a growth engine that can usher the country to new horizons unchartered in the past. To make the dreams come true a huge amount of funds are required which FDI in Retail could very well provide by kick-starting a chain of actions which would create the synergy needed to make things happen. Hence any knee jerk action would be the last thing warranted and this concept needs a detailed analysis and deliberation in the interest of the nation. This study intends to throw some light on this important policy matter by analyzing the ground realities in some detail and considering the stakes involved the significance of this study can hardly be exaggerated.

In all likelihood there would be a greater choice for the consumers with better options. They could be assured of better quality, greater transparency, and easier monitoring of adulteration and counterfeit products. For low income family organized competitive retail will lower the cost of the monthly consumption basket as much as by 5-10%. Indians spend a lot of money shopping abroad. This policy would enable them to spend the same money on the same goods in India which would further boost up the economy.

FDI will bring contract farming in vogue and farmers will get access to new varieties of seeds and other technologies with an assured buyer for the farm products with good price without any need to negotiate with the mediators for the price. It is expected that there will be an increase in price realization for the farmer by 10-20%, through sourcing directly to the farm. There would be upgradation of the framer's capabilities by availability of know-how and capital. From a study it is found that about 30-40% of the farmer's produces gets destroyed because of lack cold storage and warehouse facility. Development on this front would improve farmer output and yield through better extension services and user friendly processes.

According to the policy, at least 30% of the value of products purchased shall be sourced from Indian 'small industries' which have a total investment in plant & machinery not exceeding US $ 1.00 million. This would boost up the small scale industry and will also increase the employment in manufacture side. These industries also stand to get added advantages of technology up gradation, which would give them an upper hand in yield and local value addition, thereby raising the profitability and earnings of small manufacturers.

Investments in the organized retail sector will see gainful employment opportunities in agro-processing, sorting, marketing, logistic management, small manufacturing sector like textiles and apparel, construction, IT, and other infrastructure and government can be expected to received an additional income of $25-30 billion by the way of a variety of taxes. With the coming of the foreign companies, new and elaborate infrastructure will be build, helping the real estate sector grow phenomenally and consequently pushing the banking sector as well.

Economy on the whole will gain momentum as foreign investment comes with required skills, consumers are benefitted, supply chain system improves, better logistics and warehousing facilities develop, food quality improves, gainful jobs are available for the middle class and farmers get good price with contract farming concept blooming in India. It is widely acknowledge that FDI can have a positive result on the economy triggering a series of reaction that in the long run can lead to greater efficiency and improvement of living standard apart from greater integration into the global economy.

THE WAY AHEAD- A DETAILED ANALYSIS

Indian Council of Research in International Economic Relations (ICRIER), a premier economic think tank of the country, which was appointed to look into the impact

Of FDI in the retail sector, has come to conclusion that FDI in the retail sector would in the long run not harm interests of small, traditional, retailers.

Industrial organizations such as CII, FICCI, US-India Business Council (USIBC), the American Chamber of Commerce in India, The Retail Association of India (RAI) and Shopping Centers Association of India favor a phased approach toward liberalizing FDI in multi-brand retailing, and most of them agree with considering a cap of 49-51 per cent at the outset.

We have the examples of successful experiments in countries like Thailand and China; where too the issue of allowing FDI in the retail sector was first met with incessant protests, but later turned out to be one of the most promising political and economical decisions and led not only to the commendable rise in the level of employment but also to the enormous development of their country's GDP.

The various riders attached by the government to the opening of multi brand retail in India are likely to take care of probable fissures. According to these conditions the establishing retail store must invest at least 50% of its total investment in developing back end infrastructure and facilities like modern product sourcing management, logistics, supply-chain management, cold storage, packing, transportation, sorting and processing, refrigeration etc. which will prevent post-harvest losses and will also lead to infrastructure development and employment generation in diverse sectors as around 10 million jobs will be created in three years and farmers will be able to get better prices for their products. Also the mandatory sourcing of at least 30% of their products from small and medium scale enterprises will also boost small scale industries as these chains will procure the same for their foreign outlets.

In India these stores will be allowed only in the cities having a population of million plus thus only about 53 cities will be covered in initial phase. Moreover the final decision to implement the policy will be left with the state governments only allowing them to either accept it or reject it.

However, some experts say that while analyzing the positives and drawbacks of FDI in retail, both the government and the opposition did not refer to the Parliament Committee report where its effects had been studied exhaustively. The committee had taken into cognizance many witnesses, NGOs, individuals, and trade associations in making the report.

The Committee visited various corners of India and also went through other reports and gathered knowledge about the experience of similar decisions in other countries. It also enquired from several government departments

regarding the matter. The Committee had surmised in its report that the number of people getting jobs will be lesser than the amount of people losing the same as a substantial amount of marginal and small farmers will be wiped out. As per the Committee's report almost 8 percent of India's workforce is employed in the unorganized retail sector. This comes up to roughly 40 million people. It has been stated that FDI in retail will generate 2 million jobs. Some other major problems expected out of this were aggressive pricing and prevalence of monopoly. The Parliamentary Committee report on FDI was never discussed in Parliament itself, and as per experts, it is not a good sign as far as the democratic system in India is concerned.

Leading economic experts from outside India have pointed at the labor practices of the MNCs such as Wal-Mart. Most of these are not exactly healthy for workers. This has also led them to ask if such processes were really needed in India. It is being said that the lobby favoring FDI in retail in India has invested at least Rs 52 crore and experts feel this could have had a major say in the way things turned out.

Some critics also opine that the policy does not include any restrictions on farm and allied produce procurement to protect the primary producers' interest. In fact, there are no incentives to encourage small farmer inclusion. Even the decision regarding the formal registered contract for farming is not mandatory and even not discussed anywhere. In the supermarkets operating in India, large part of procurement is from whole sale market not from farmers. FDI will have adverse effect on farmers. The instances of the same can be seen from various countries where entering of MNC's in the country has been harmful for farmers specially the smaller one and in India major farmers are small one.

So there are mixed reactions on the issue which stems from the fact that we still do not have any concrete experience as the concept is still in the embryonic stage. What is conspicuous, however, is that majority of the thinkers and experts on the subjects are in favor of gradual adoption of the concept.

CONCLUSION

Taking cognizance of majority of the experts views, the report prepared by Indian Council of Research in International Economic Relations, the experience of other Asian economies like China, Thailand, etc., some of the well thought caveats introduced by the government to stem out the hiccups emerging due to FDI in retail. It can be said without an iota of doubt that the FDI in Retail would

boost the economy like nothing else. Allowing FDI in multi-brand retail will bring about supply chain improvement, investment in technology, manpower and skill development, tourism development, greater domestic sourcing, up-gradation in agriculture, efficient small and medium scale industries, market development, and benefits to government through greater GDP, tax income and employment generation.

The MNCs in retail have better experience, efficient management system, and will adopt new and better technology to increase productivity and efficiency. Those companies will set up supply chains and logistical capabilities, spurring significant improvements in the infrastructure needed to source, ship, store and deliver products (covering all aspects of value chain and supply chain activities, including storage, warehousing, and information-intensive operations). Even existing Retailers like Shoppers Stop and Reliance Retail feel that with the induction of FDI they can grow at a much faster rate than now and can cover most of Tier 2 and Tier 3 towns of India and share the expertise of Wal-Mart and other Multinational retailers.

We are too familiar with the performance enhancement of many Indian sectors like banks, automobiles, electronics, etc. under pressure from the entry of multinational ventures. Similarly, foreign direct investment in the retail sector would also incentivize the existing traders and retail outlets to upgrade and become more efficient. This would usher in better services to the consumers and good remunerations to the producers from whom they source the products. We also have global precedents like the cases of consumer electronics in Brazil and India, food retail in Mexico, and auto in China, India, and Brazil.

It has been advocated by many, including Mr.Kishore Biyani of Future Group that the current situation in Indian Retail is at a very nascent stage; hence the decision should be kept in abeyance for now. However, it should not be missed that the Industrial policy 1991 had crafted a trajectory of change whereby every sector of Indian economy, at one point of time or the other, would be embraced by liberalization, privatization and globalization. FDI in retail is, in that sense a steady progression of that trajectory. The implementation of the process would also be a gradual process. There has been enough time for the domestic players to prepare for the challenge and perform according to international standards.

Much has been said about the MNCs' big buying, monopolistic power, which would be a death knell for the existing domestic retailers. However, large retail chains, even in advanced countries, have not wiped out the small shopkeepers

or what are called 'Mom and Pop' stores. They retain a personal touch that is absent in large retail outlets. Also, their proximity to where people live is a great advantage". Banking on this characteristic our kirana stores can very take on the challenge head on.

Moreover, post digitalization Indian market has high complexities in terms of a wide geographic spread and distinct consumer preferences varying by each region, necessitating a need for localization even within the geographic zones. Hence things would not be that rosy for the international players as well and the domestic retailers could use this fact to put forth a formidable challenge to the foreign players.

Having said that, it is a given fact that FDI in retail would lead to the displacement of many small retailers who would not be able to compete with big international players. It is the government's moral duty to think of ways to support these small traders like the kirana stores and help them fend for themselves against foreign retailers. A possible policy may be to provide these small retailers with cheap credits, subsidies, and technical facilities to increase their efficiency and make them competitive. Appropriate legal frameworks can be implemented to prevent multinational retailers from resorting to predatory pricing and monopolistic tendencies.

Moreover, the government can also bring some prerequisites and restraints regarding sourcing the material from the small farmers, which would ensure that the resourceful and powerful MNCs do not exploit this vulnerable section. Some incentives could be introduced to ensure compliance. It would be advisable to work out these in details to help safeguard the small farmers.

As per the previous sections discussions, the government has already put some caveats in place as a condition to the entry of the foreign players considering the ground realities to make it a level playing field for all the stakeholders involved. It is free to put in place any further requirements in case it deems it fit in the interests of the multitude associated with the affairs. The story has just begun, and still a lot has to enfold in the days to come. Nobody can presume everything with complete accuracy, and many things will have to be left for the future, and we ought to wait patiently and hopefully for the results. At the present juncture, it could be said with some confidence that the concept of FDI in retail appears to be feasible and in the interest of the Indian economy. If applied tactfully, it will provide rich dividends in the future, incorporating some provisions necessary to check the hiccups cropping up in the initial stages of the process. It is to be seen if we can wisely utilize the prowess and experience of the MNCs and advance in a mutually symbiotic relationship whereby

in return for the relevant skills and experience, we also provide them with splendid opportunities to work and excel.

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An Analysis on Constraints in Sustainable Higher Education Policy of Uttar Pradesh

Priyank Sharma, Manish Singh
School of Management Sciences, Lucknow, UP, India

ABSTRACT

The idea to take this topic for study came to my mind due to the problem of educated jobless youth in the economy, The higher education is not able to develop the skills required for students to perform jobs, simply the students are only acquiring degree and the universities are compromising with their standards day by day for their existence. They are degrading their syllabus content and not even changing their syllabus with the dynamic changing environment. The resultant is the jobless educated youth. In This study, we are trying to know the various factors which involved in the implementation of higher education in the system or the problem is at planning part or at implementation part Education is a very important economic factor for the economic development. With the help of this research, the researchers try to find out the key elements education, basic resources and result of higher education in economic development. The data is secondary and is collected from various sources. The aim of this is to identify the effect of education on employment generation. The researcher applied correlation and regression as a statistical tool. Data is collected from state /central/deemed/private universities and colleges

Keywords: Higher education policy, Universities, Job markets, Syllabus

Corresponding Author: Priyank Sharma

E-mail: psharma@smslucknow.com

INTRODUCTION

India is at 3rd rank in term of students after USA and China if we talk about at international level. We have 2nd in population after China. Our GDP growth rate is about 7.2% p.a (sep 2016). But if we look towards the literacy we are 74.04% (census 2011) i.e is 138th rank in world. Education, being the most fundamental need of any developing country, should be the number one priority for India. In this sector, our country has ranked 92, which is way behind the ranks of other developing countries such as Philippines (76), Malaysia (51), Sri Lanka (59), we are behind not even China but Iran (86%), Iraq (79%), Indonesia (93.9%)[1]

India is nowhere near the top 10 countries when it comes to economic development, entrepreneurship and opportunity, governance, education, health,

safety and security, personal freedom and social capital. As per the Legatum Prosperity Index 2015, India is at ranks 99 amongst 142 countries that have been assessed in these sectors.

In India education system is governed by Ministry of Human Resource Development, under which University Grant Commission

History: The present system of higher education stated back to Mountstuart Elphinstone's minutes of 1823, which stressed out on the need for establishing schools for teaching English and the European sciences. It sought to encourage original education and planned the formulation of a rational policy of education after; the universities of Calcutta, Mumbai, and Madras were set up in 1857, followed by the University of Allahabad in 1887. The first attempt to prepare a national system of education in India was thought in 1944, with the Report of the Central Advisory Board of Education on Post-War Educational Development in India, which also known as the Sargeant Report. It recommended the formation of a University Grants Committee, which was shaped in 1945 to oversee the work of the three Central Universities of Aligarh, Banaras and Delhi. The University Education Commission was established in 1948 under the leadership of Dr. S. Radhakrishnan as Chairman "*to report on Indian university education and put forward improvement and extensions that might be desirable to go with the present and future needs and aspirations of the country*". It suggested that the University Grants Committee be reframed on the general model of the University Grants Commission of the United Kingdom with a Chainman as head of this body. His working is full-time in nature and other members to be appointed from along with educationists of repute. The UGC, was formally established in 1956 in the month of November, as a statutory body of the Government of India through an Act of Parliament for the management, determination, and maintenance of standards of university education overall in India. In order to ensure effective coverage in region-wise in the

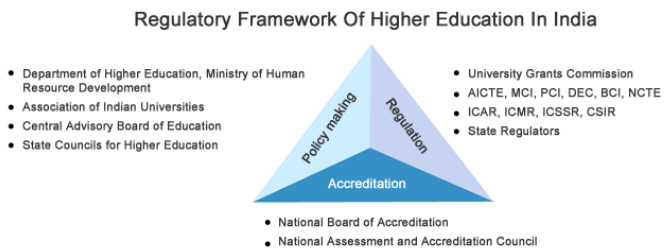


Fig 1 Source: ibef.org

country. The UGC has decentralized its operations by setting up 6 regional centres, which are at Pune, Bhopal, Hyderabad, Kolkata, Bangalore, and Guwahati. UGC's head office is located at Bahadur Shah Zafar Marg in New Delhi.

Present Scenario

At the time of Independence of India, there were only 20 Universities and 500 Colleges in the country with 2.1lakhs students in higher education. The numbers now have increased 40 times in the case of the Universities, 82 times in the case of colleges and the students enrolment has gone up to over 127 times in the formal system of higher education in comparison to the figures at the time of independence.

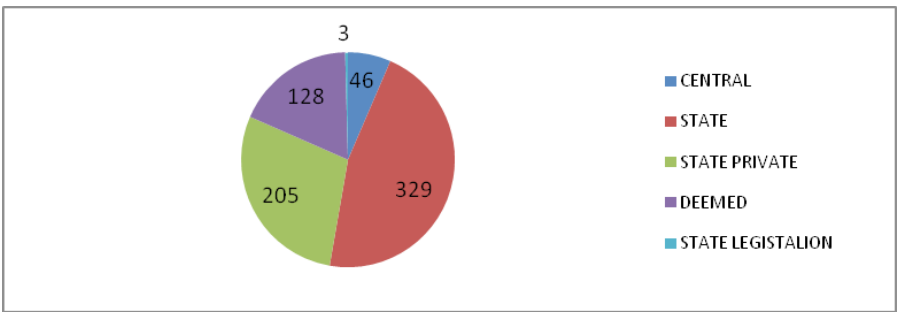


Fig 2 : Source from UGC

- As on 31.03.2015, the number of universities had gone up to 711 – (46 central, 329 state, 205 state private,128 deemed to be universities, three institutions established under state legislation) and 40760 colleges in the higher education sector
- So far as the number of universities in states is concerned, Rajasthan tops the list with 68 universities, followed by Uttar Pradesh (64), Tamil Nadu (52), etc. It is observed from the list that there is uneven establishment of universities in the states
- During the reporting year 2014-2015, 18 State Public and 30 State Private Universities were included in the UGC list of universities and 6 universities were declared fit to receive central assistance under 12B of the UGC Act.
- As many as 1147 new colleges were established in various states during 2014-2015, thus taking the total number of colleges from 39613 in 2013-14 to 40760 in 2014-2015. At the end of the financial year 2014-2015, the total

number of colleges recognized under Section 2(f) of the UGC Act, 1956, was 9940. The maximum number of colleges recognized so far under Section 2(f) is in the State of Uttar Pradesh (2000), followed by Maharashtra (1266), Karnataka (848), Gujarat (521), etc.

- During the academic session 2014-2015, the total enrolment in all courses and levels in regular stream was 265.85 lakhs including 124.76 lakhs women students, constituting 46.93%. The maximum number of students had been enrolled in the state of Uttar Pradesh (43.97 lakhs), followed by Maharashtra (28.60 lakhs), Tamil Nadu (24.01 lakhs), Rajasthan (16.24 lakhs), etc.
- The student enrolment in terms of percentages at various levels had been observed as UG (88.26%), PG(11.09%), Research (0.67%), Diploma/Certificate (1.57%) and Integrated (0.41%).
- About 88.37% of all the under-graduate students and 71.09% of all post-graduate students were in the affiliated colleges while the remaining were in university departments and their constituent colleges.
- Out of the total enrolment of students (265.85 lakhs), 37.41% students were in the Faculty of Arts, followed by Science 17.59% and Commerce/Management 16.39%, thus constituting 71% enrolment in just three faculties, while the remaining 29.00% enrolment were in professional faculties. This uneven distribution is an indicator demanding a policy change.
- The strength of the teaching faculty in universities and colleges has gone up to 12.61 lakhs as compared to10.49 lakhs teachers in the previous year. Out of 12.61 lakh teachers, 84.66% teachers were in colleges and the remaining 15.34% in universities.

The number of research degree Ph.D. awarded during 2013-14 was:

Faculty	*Enrollment*	*Percentage*
Faculty of Arts	7480	32.74
Faculty of Science	7018	30.71
Other	8351	36.55
Total	22849	100

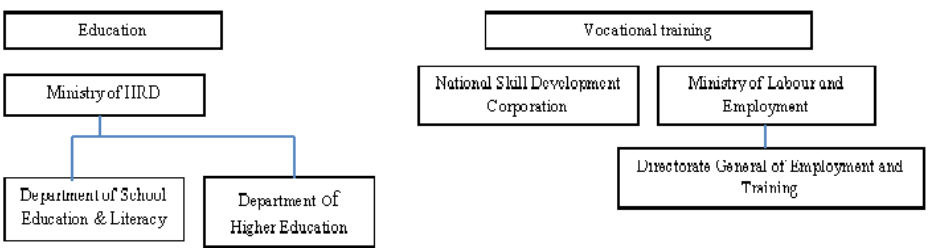
Fig 3: Source from UGC

States and UT	*Enrollment*
Lakshadweep	71.17%,
Goa	60.06%
UP	21.73 lakhs
Maharashtra	13.01 lakhs
Tamil Nadu	12.32 lakhs

Fig 4: Source from UGC

- The number of women students enrolled per hundred men students enrolled at all levels was 88 in the reporting year 2014-2015.
- The women enrolment had been the highest in the Faculty of Arts (41.70%), followed by Science (18.60%) and Commerce (15.73%), constituting 76.03% in the three faculties, while the remaining 23.97% in all the professional faculties. The maximum percentage of women enrolment in professional faculties had been in the Faculty of Engineering/Technology (9.88%).
- The growth of higher education since 1950-51 in terms of degree awarding universities/institutions registered 24.7 fold increase, a number of colleges had 58 fold increases, student enrolment had 67 fold increase and teacher strength had 52 fold increase as observed in 2014-15.
- On average, higher education accounts for 15.3% of the total household expenditure in rural and 18.4% in urban areas. In the southern part of the country, the corresponding figures are 43% and 38%.

Structure of Education in India



Q.1

Source: FICCI (2015) Report on the Skill Development Landscape in India

Condensed Statistics on Growth of Higher Education

The growth of higher education since 1950-51 in terms of degree awarding Universities/Institutions registered 24.7 fold increase, a number of colleges had 58 fold increase, Student Enrolment had 67 fold increase and Teacher's strength had 52 fold increase as observed during 2014-15.

Literature Review

Department Of Higher Education New Delhi 2013 The top 6 States in terms of highest number of colleges in India are Uttar Pradesh, Andhra Pradesh, Maharashtra, Karnataka, Rajasthan and Tamil Nadu. Uttar Pradesh comes at

number one with the highest student enrolment followed by Maharashtra and Andhra Pradesh.[1]

(Dr. Singh JD) in his paper, he stated that quantity of universities has increased since independence but the quality is continuously degrading which is an area of concern for the education sector for ensuring quality a proper check should be on the syllabus content, faculty recruitment norms and exposure to students.

Chakravarty Alok 2007, In this report, the researcher attempted to provide a brief overview of the educational system in India. He focuses on the modern education system in India which is based on the AngloAmerican Tradition, there is a great variety of institutional systems in higher education. The government also plays a dominant role not only in providing funds for education but also in the administration and control of these institutions.

Gupta Navneet, Gupta Deepti 2012 in their research the author studies about the various institutions like IITs, IIMs, NITs and also about the 11th five-year plan. In this plan government 'education for all' slogan and education is right for every child in the country.

Ambrsih Dr, Kumar Anuj Dr 2015: The researcher put their effort to find out the higher education system in India with gross enrollment ratio. According to them, UGC must initiate to develop the skills in youth from 18 to 22 years of age. They also focus on mal-practicing of institution providing higher education.

Research Objective

- To study the education system of India.
- To analyze the Higher education policies in Uttar Pradesh
- To study the factors which affect higher education in Uttar Pradesh.
- To study impact corporate governance in the education system.

Research Design

In this study, we used descriptive research design and taken secondary data for the study from different sources.

Descriptive Research

This study describes the phenomena under the study. The data collected here may relate to the demographic or the behavioral variable of the respondent

under study. In this type of research, objectives are very specific and clear cut data required.

Higher Education System in Uttar Pradesh

About State: Uttar Pradesh is India's important state in term of geography, culture, education, politics and demographic reasons. It has highest in term of population and growth rate 26%, with population 199,581,477 (census 2011), it contributes approx 16.6% of India's total population. Sex ratio in Uttar Pradesh is 908 females out of 1000 (census 2011).

Uttar Pradesh is third largest after Maharashtra and Tamil Nadu in terms of Net State Domestic products. Maximum population is engaged in agriculture. Sugarcane and Potato are maximum produced crops. If talk about Art and craft versatility is found over all state. Each district is famous own culture and language like Aligarh for locks, Muradabad for the brass item, Firozabad for glass ornaments, Lucknow for its famous Chicken handicraft, Bhadoi for the carpet industry.

Education and Literacy

Literacy rate of Uttar Pradesh is 67.7% (census 2011). The calculation of literacy rate is

(Total no. of literat)*100/ Total population

But the above method is used to calculate the Crude Literacy Rate, which includes child below 7 years of age.

Effective Literacy Rate = Total no. of population is above 7 years *100

Total Population

If we talk about ELR, as per census 2011, Uttar Pradesh is at last in bottom 5 state in India in Female category 59.3% and not in even male list.Effective Literacy Trend 2001-2011

The above table states that Uttar Pradesh is at 3rd rank after Bihar and Jharkhand in literacy growth rate. Uttar Pradesh is at 29 ranks all India as per Census 2011.

Educational Institute In Uttar Pradesh

Uttar Pradesh has approx 67 universities including central/state/private/deemed

Rank	*India /State/UT*	*No. of Litrerate 2011*	*No. of Litrerate 2001*	*Absolute Inc. In No. of Literates*	*Percentage Change*
	India	778454120	560753179	217700941	38.82
1	Bihar	54390254	31109577	23280677	74.83
2	Jharkhand	18753660	11777201	6976459	59.24
3	Uttar Pradesh	118423805	75719284	42704521	56.40
4	Rajasthan	38970500	27702010	11268490	40.68
5	Chhattisgarh	15598314	11173149	4425165	39.61
6	Madhya Pradesh	43827193	31592563	12234630	38.73
7	Uttarakhand	6997433	5105782	1891651	37.05
8	Orrisa	27112376	19837055	7275321	36.68

Fig 5: Sources: State of literacy chapter 6

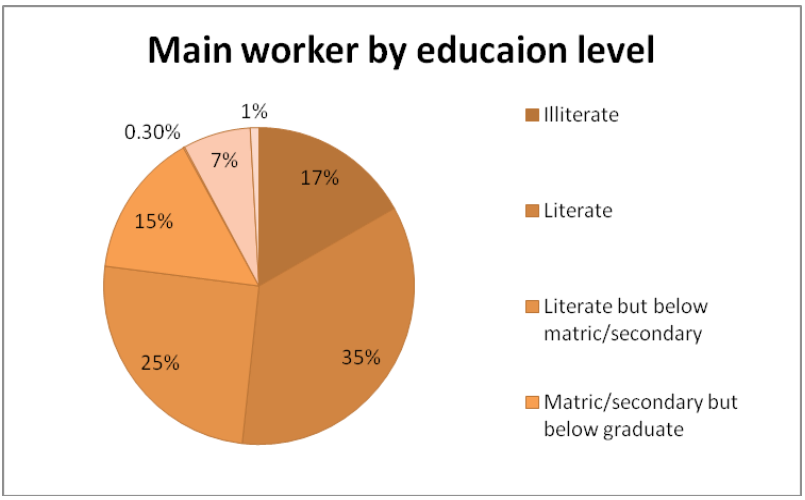
universities. 1 The technical University covers approx 700 private colleges 13 research institutes and 9 Autonomous institutes including IIMs.

As per a report by CII –Deloitte total enrolment of 342.1 lakh in 2016 ((54% male and 46% female enrolments) in higher education institutes in India, Uttar Pradesh. Accounting to the report "The Higher Education sector in India currently finds itself at a very critical juncture. Efforts of the policy makers can be seen through the operationalization of the vision and the mission of the New Education Policy which will affect the higher education space for a progressive realization. Given the government's intent to increase accessibility of educational programs, aligning higher education with skill development objectives, integrating Information and Communication Technologies (ICT).

In 2016 approx 90% of seats in engineering colleges in Uttar Pradesh are vacant (TOI, 4 Jan 2016,) which force the owners to close the colleges. Candidate Applying for UPSEE 2016 Decline, Lowest in Last Five Year. In UPSEE Uttar Pradesh State Entrance Exam 2016 popularity is decreasing year by year, as according to university number of candidate apply online for Dr. APJ AKTU 2016 admission process is lowest in last five year. A number of applicants apply has come down from 2.4 lakh last year to 1.5 lakh this year, the lowest in five years. Available Seats in UPTU or Dr. APJ AKTU 2016: 1.44 lakh B.Tech in 300 colleges, MBA (42,100), 7,415 in MCA and 6,770 in B.Pharma.401 MBA and 292 B.Tech UPTU colleges in the state, while in 2008-09, UP had only 196 MBA and 208 B.Tech colleges. The main reason for decreasing in no. of candidate application for entrance exam is increase in the quantity of the colleges for MBA and B.Tech but placement, quality of faculty, infrastructure is degrading continuously

Job Status of Uttar Pradesh

From above figure, the people having technical knowledge with a certificate and having post graduate degree having less percentage of the main worker. The data is taken from census 2011.



Illiterate	32.59
Literate	67.41
Literate but below matric/secondary	48.83
Matric/secondary but below graduate	28.74
Technical diploma or certificate not equal to degree	0.30
Graduate and above other than technical degree	13.65
Technical degree or diploma equal to degree or post-graduate degree	1.76

Fig 6 : Source: Prepared by researcher

The figure 7 shows that India is young country population between the age group of 25-29 is largest as per census 2011. This is important factor of the society.

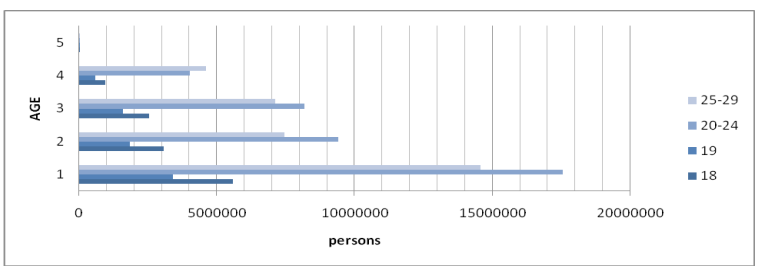


Fig 7: Source: prepared by researcher

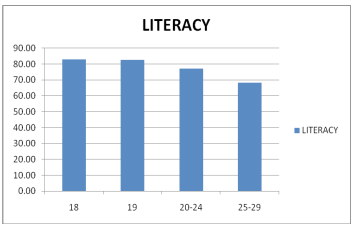


Fig 7.1: Relationship b/w Literacy and Age

Country can develop only when county have sufficient work to keep these youth productive for the nation.

This figure reveals that as the people are falling in higher age group the literacy level is reducing as per the analysis of the census 2011 the literacy rate is higher in the age group of 18-19 and as the age is growing the level of literacy is decreasing that means lot of people tries to engage themselves for livelihood after graduation and don't prefer higher education.

GAP ANALYSIS IN HIGHER EDUCATION

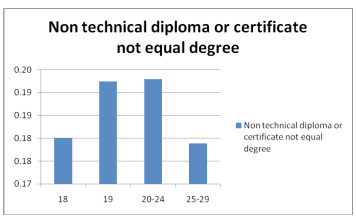


Fig. 8: (Developed by Author)

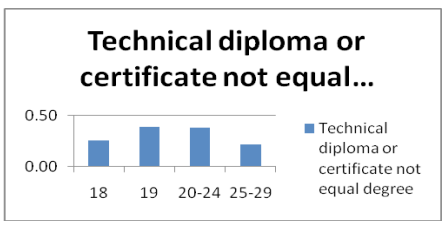


Fig. 8.1: (Developed by Author)

Figs. 8 & 8.1 : We had also tried to compare the type of education preferred by the students as per the different age group it is clear from these figures that the people having non-technical diploma or certificate that is not equivalent to a graduate or post graduate degree is highest at the age of 19 and the age group of 20-24 and a drastic decrease in the age of 25-29 and same trend continues with the persons having technical diploma not equal to degree. which means people are not interested in spending their savings on higher studies due to its less productivity.

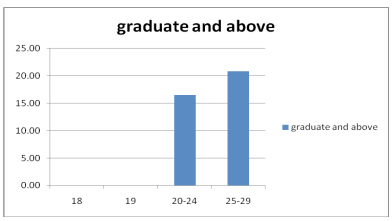


Fig. 9: 9Developed by Author)

Fig 9: This figure reveals that the percentage of population ofUP that is graduate and post graduate as per the census 2011 only 18 % of the population between the age group of 20-24 is graduate and post graduate and moving towards the age group of 25-29 this percentage is slightly improved and reached to 21% which means the only 20% of the population of up is pursuing the higher education.

S.NO	*ISSUES*	*WHAT ARE?*	*WHAT TO BE?*
1	Traditional Course	Most of the colleges either private or public offering traditional courses like BA, B.com, MBA, Engineering with (IT,CS,ME). The institutes are mushrooming over the years especially private professional colleges affiliated with various state universities. The courses are not updated with current industrial scenario. Most part of the course curriculum covered theoretical approach.	UGC, AICTE or other bodies of higher education system, should make chances in course curriculum, according to the industrialization and globalization.
2	Poor Infrastructure of Government Colleges	Most of the government colleges offering higher level courses having low classes of infrastructure. Poor building, lack of architecture, also cause poor admission in colleges.	Government should start PPP schemes for the infrastructure development of government colleges and proper monitoring of implementation of fund allocated for this purpose.
3	High Fees of Private Institutions	One of the major problems in admission is fees of courses, even colleges affiliated by Lucknow or any other university. Institute is offering bank loan services, but students are harassed by bank to fulfill their norms.	Fees fixation committee must recommended maximum and minimum range of fee for an individual courses. Institute must justify the fee charge from them.
4	Lack of Placement from institutions	Every students want good placement from campus, but due to lack of corporate relation with institute, students is not able to place. Second reason of in proper placement is personality development of students which is lacking	Statement government must coordinate with industries and institute for better placement. District wise or zonal wise cell from state government must established, which look after the problem of institutes regarding placement and coordinate at least one pool campus.
5	Class Attendance	In current scenario student are not interest in class room lecture, there are some reasons which are : Distance learning courses. Multiple courses join by students. Fear of ragging. Learning habits from guides	Workshops, activates, apart from course curriculum may attract students in classes. An anti-ragging cell which is mandatory as per the guidelines of Hon'ble Supreme Course must look after the ragging issues. Faculty can provide their notes in precise form to the students which in some way reduce the habit of learning from market available guides.
6	Personality/soft skill development	Most of the government institution are not conduction personality development programs, private institution tries to do some but not able to implement it because of lack of self-motivation factors among the students.	Personality development from must be in every institute and colleges either government or private. Colleges must prepare strategies, so most of the students attend the session.
7	Student Priority in jobs	Students are now days more interest to do job private and government. They are practice to beat the competition, or this they join coaching centre etc. This will affect the education system at higher level	Motivates the students to join a regular course which is more useful for their future career.
8	Migration of Students to Metros/ abroad	Perception of students to study abroad or in metro big cities is major issues these days. Students are expected to get a good education with placement from the Institute in abroad or metro. 9 out of 10 students want to migrate from his native place for higher education. Approx 200 IIT graduates went abroad last year. (source: TOI: 16-1-17)	State government must review the institute yearly. There must be a proper cell which reviews the institute both government and private, discuss their problem. To establishes a high-class education system in Uttar Pradesh

There are several points which is very important in respect of downfall in admission in graduate and post graduate courses in Uttar Pradesh

Governance in Higher Education

The UGC has initiated the implementation of the e-governance project through a centralized initiative to realize the objective of inter-operability of various e-governance applications for a decentralized implementation model.

Impact of GST on Higher Education

In our country nearly half of the population is below 25 years of age, the generation is having huge expectation towards their career. Companies also want new energetic face faces with decision making and analytical skilled. The Government exempts the taxes to higher education to encourage the institutes to provide better quality education at affordable prices.

FINDINGS AND CONCLUSIONS

After the analysis from the various resources, we as researcher found most of the students are not will to do the higher course from Uttar Pradesh because of above issues. We concluded the research with the following suggestion.

- State government must take initiative to fill the gap between Institute and corporate for more job creation.
- Focus on skill development program. As so many skill development programs are launched like NSDC, PMSDY etc, but these programs does not well control and monitoring by the government. Some common course is running in these centres like a basic computer, beauticians. The government needs to focus on another course.
- Change the course curriculum on the more practical basis for the Institute and agencies should be recruiting to check the implementation of these courses.
- Job fair must organize by district wise by collaboration with institutes, universities, and government.
- Feasibility in education loan from the bank.
- Institutes are unfair practices of different government schemes to sustain in the sector.

- Education sector provides jobs and livelihood to many families. The closer of institutes is not a proper solution. Many industrialists open institute as part of their business and when its not work, they put an application for a closer, at the end, people are working in Institute are suffered. The government must think and listen the problem of teaching and non-teaching persons.

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Electronics Stewardship

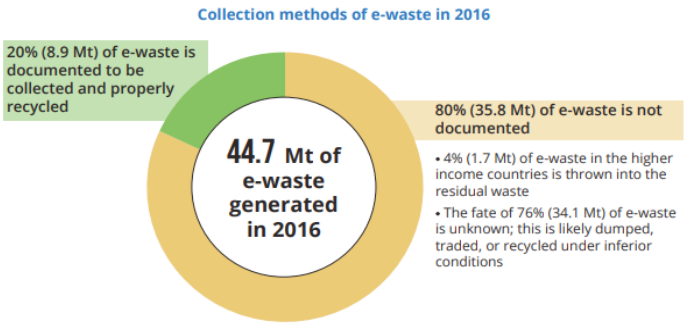
Gaurav Sharma*, Vikarm Singh
School of Management Sciences, Lucknow, UP, India

Corresponding Author: Gaurav Sharma
E-mail: gaurav@smslucknow.com

INTRODUCTION

According to 2016 report by Consumer Electronic Association, United States tech industry retail sales are expected to climb to $88 billion- a 1.3% increase year over year according to CTA US Consumer Technology one year forecast. According to EPA's Facts and Figures about Materials, Waste and Recycling, it is estimated that if the demand of electronic gadgets keeps increasing at such pace, then US will alone generate millions of trash.

Note: In 2016, 44.7 million metric tonnes of e-waste were generated. This is an equivalent of almost 4500 Eiffel Towers



According to this diagram, globally 20% of E-waste is really documented and recycled by using sophisticated technology of waste reduction, the rest 80% was unaccountable and was dumped in underdeveloped or developing countries. Asia is at the pinnacle in producing e-waste among the world in 2016 and Africa comes at last in producing e-waste.

What is Electronic Waste?

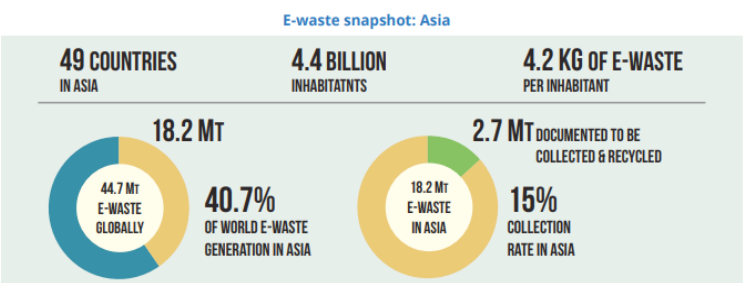
E-wastes are the electronic goods that are unwanted, not working, and are at the end of their useful life. Notebooks/ Laptops, C.D/DVD Players, monitors, mouse, and projectors are the products we use daily.

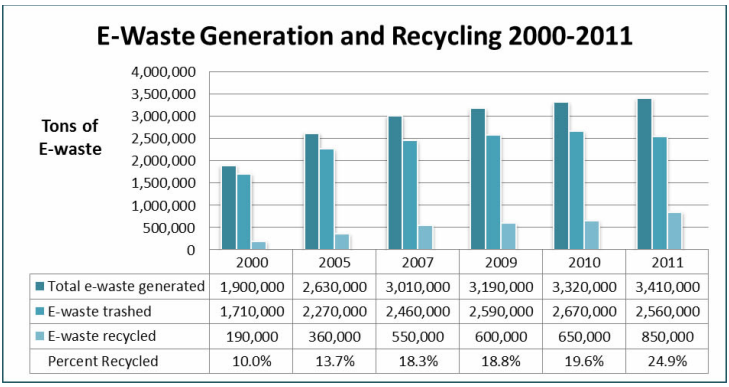
These products are made of various components, and assemblies amongst which some are valuable, some are toxic.

Toxic Components

Few toxic substances which are commonly found in e-waste are:

- Lead





	2000	2005	2007	2009	2010	2011
Total e-waste generated	1,900,000	2,630,000	3,010,000	3,190,000	3,320,000	3,410,000
E-waste trashed	1,710,000	2,270,000	2,460,000	2,590,000	2,670,000	2,560,000
E-waste recycled	190,000	360,000	550,000	600,000	650,000	850,000
Percent Recycled	10.0%	13.7%	18.3%	18.8%	19.6%	24.9%

Source: http://www.electronicstakeback.com/2013/06/24/new-epa-report-shows-we-are-generating-more-e-waste-but-also-recycling-more/

- Mercury
- Cadmium
- Beryllium
- Gold
- Silicon
- Aluminum
- Copper
- Platinum
- Palladium
- Flame retardants
- Bisphenol-A

An average computer, a popular electronic gadget, consists of many toxic substances as depicted in the following figure. Several studies have been conducted to find out total number of toxicity in a device. We can categorize them into five categories

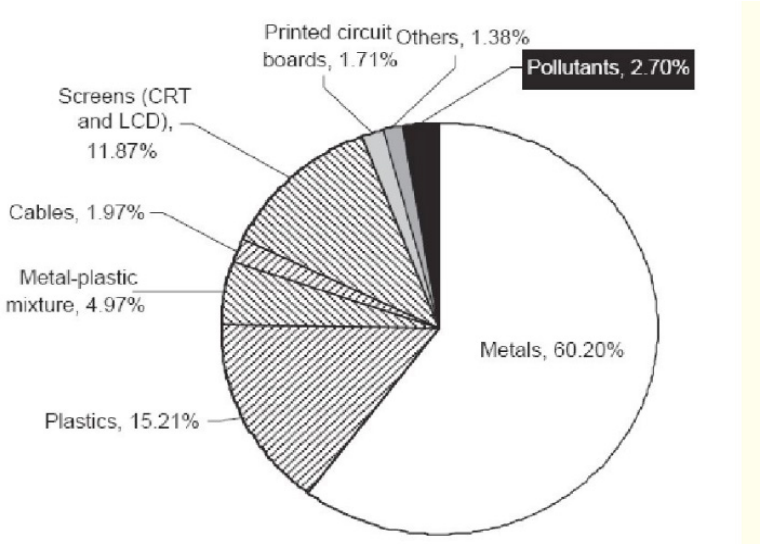
- Ferrous Metal
- Non-Ferrous metal
- Glass

- Plastics
- Others

60% composition of metals is the primary substance found in e-waste. Plastics are the second-highest substance ranging up to 15%

E-Waste Resources and their Health Effects

In today's era, e-waste is a rising predicament in whole world, and it is growing at

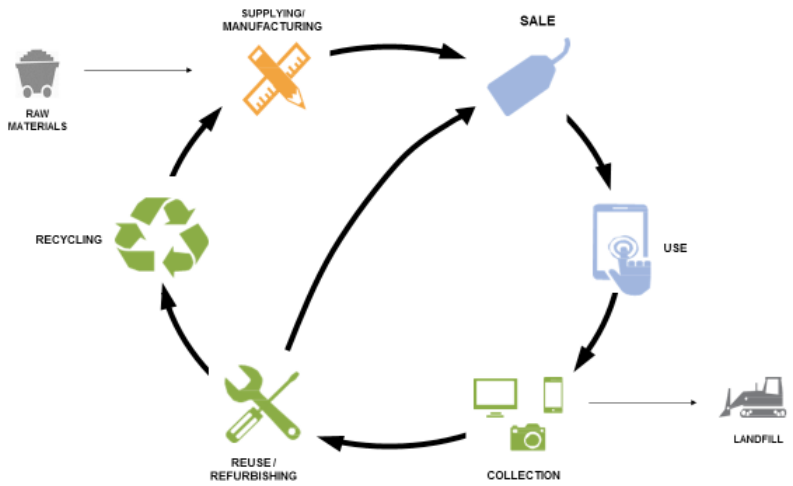


Source: https://www.intechopen.com/chapters/49287

an alarming rate. It has been overwhelmed with the increasing population and rising demand for e gadgets, making it more dangerous. Due to this unquenchable demand for electronic gadgets, it has become the world's fastest-growing waste stream. It is increasing exponentially due to the increasing per capita income of the population and with a growing economy, strong future of a digitally connected world, green energy schemes and rapidly changing technology causing technology obsolescence. This waste can harm the environment drastically and make it vulnerable for future generations. It has been noted that only 20% of e-waste is treated properly, leaving 80% untreated.

Table: 1

E-waste sources	*Constitutents*	*Health effects*
Solder in PCBs, glass panels, and gaskets in computer monitors	Lead	Causes damage to the nervous system, circulatory system, and kidney. Also affects brain developments in children.
Chip resistors and semiconductors	Cadmium	Causes neural damage.
Relays and switches, PCBs	Mercury	Cause chronic damage to the brain and respiratory and skin disorders.
Corrosion protection of untreated galvanized steel plates, decorator, or hardener for steel housing	Hexavalent chromiun	Causes bronchitis and DNA damage.
Cabling and computer housing	Plastics including PVC	Affects the reproductive system and immune system and lead to hormonal disorder.
Plastic housing of electronic equipments and circuit boards	Brominated flame retardants	Disrupts endocrine system functions.
Front panel of CRTs	Barium, phosphor, and heavy metals	Causes muscle weakness and damage to heart, liver, and spleen.
Motherboard	Beryllium	Carcinogenic in nature causing skin diseases



Sources: https://www.epa.gov/smm-electronics/basic-information-about-electronics-stewardship

Life Cycle of Electronic Gadgets

However life cycle of electronic gadgets can be improved by increasing reuse, refurbishing, increasing the life of products, and recycling of gadgets can minimize the total quantity of electronic waste produced domestically and globally. The Life Cycle Approach is synchronized with EPA's Waste Management Hierarchy. The Hierarchy arranges various management strategies from most environment friendly to the least and emphasizes reducing, reusing and recycling as a primary element in sustainable management policy.

The life cycle of electronic gadgets involves the following stages:

Materials Used in Production

Raw material plays a vital role in electronic gadgets affecting our daily lives. Materials such as gold, lead, silicon, aluminum, copper, platinum, and palladium are found in high tech electronic gadgets. These raw materials increase respiratory health issues among workers such as tuberculosis, bronchitis and lung cancer. Extracting these raw materials from earth utilizes lots of energy, promotes greenhouse gas emissions, and depletes our natural resources. Gold mines are the topmost source of mercury air pollution in the US. Source reducing raw materials can save natural resources, preserve energy and diminish pollution.

Transformation of Raw Material

Through the life cycle analysis we can visualize which kind of raw materials are required to manufacture electronic gadgets with the perspective of the environment in mind. Use of less raw material i.e., source reduction and raw materials which are a lesser threat to the environment and are recycled, should be given priority. Through this process, we can reduce the impact of raw material on health of humans and the environment.

Sale

The first and foremost step in using sustainable gadgets involves buying those gadgets that has been designed by the manufacturer considering those design issues which causes least threat to environment.

Usage

It is the company's responsibility to develop such products that have longer life, can be recycled easily, can be reused easily, and are reliable. It is the responsibility of the user to use the product efficiently and effectively. Life of a gadget can be increased significantly if he/she follows following guidelines:

- A gadget should be shut down or it should be kept in standby mode when not actively use
- Maximum use of energy efficient devices
- Brightness should be reduced
- Documents should be printed on double side

Procurement

Used gadgets are procured at a common place by following some procedure either by manufacturer or by some electronic shop owners. It is advisable that more authentic measures be adopted and more and more participation of government electronic recyclers should be used. After the waste or unused gadgets are procured at one place, these gadgets which can be reused are refurbished and resold in shops, the materials which can be recycled from waste are sent to revitalization centers for restoration purposes.

Landfill

Contemporary landfills are engineering services intended to take delivery of explicit kinds of waste gadgets, together with municipal solid waste (MSW), construction and demolition debris (C&D) and hazardous waste, which are deposited for final disposal and covered. Such units and facilities are to be manufactured in a way that there are minimal chances of release of contaminated and hazardous waste into the surroundings. The disadvantage of this method is that the valuable material can't be recovered once the waste gadget goes into it.

Reuse/Restore

Restored gadgets are refurbished gadgets that have been transformed from an

unused state to a working state and are ready for sale at the shops. Restoration of used gadgets increases their life span and moreover, used it adds to the source reduction of materials used in the production.

Reprocessing

Indigenous reprocessing or recycling consists of categorizing, taking apart, perfunctory severance, and recuperating precious resources. Reprocessing of used electronic materials can restore valuable resources (e.g., gold, copper, glass, aluminum) that can be saved and used again and again in the supply chain, ultimately saving raw material and the cost of discarding. With the advancement of technology more sophisticated restoration technologies are evolving.

EPA encourages electronics recyclers to become certified. Certified electronics recyclers have demonstrated to accredited, independent third-party auditors that they continually meet specific high environmental standards and safely manage used electronics. Once certified, continual oversight by the independent accredited certifying body holds the recycler to a particular standard.

Technology has been evolving daily; henceforth, new technological gadgets have increased. New technology has made our lives easier, and human beings are completely dependent on them. Technology has been the major factor of our economic growth and it has become an indispensable thing in our lives. But the evolution of technology poses a greater threat to the environment and all living beings if they are not correctly handled and disposed of after use.

Sustainable electronics management involves the following practices:

Reusing and Donating Electronic Gadgets

The items which are to be discarded from the house or business organization can be donated to any individual who is in dire need of such item, but cannot afford it to buy. If the item is in working condition, it can fulfill that person's need and by this, we can extend the life of that valuable product.

Recycling electronics Gadgets

The gadgets commonly used in home/offices can be donated for reuse and if the option is not feasible, the household/ business items can be recycled.

Buying Green Electronic Gadgets

Environmentally responsible electronics use involves proper end-of-life disposition of obsolete equipment and purchasing new equipment that has been designed with environmentally preferable attributes.

Advantages of Electronics Stewardship

Ever-increasing efforts of sustainable electronics management can also create green jobs, and valuable materials can be reused more productively, lead to an increase in American exports, and sustain a pulsating recycling and refurbishing industry. If done appropriately, U.S. can accelerate its domestic recycling efforts, minimize harm from the export of electronics waste to developing and under-developed countries, reinforce local and international markets for feasible and practical used electronic products. It can prevent physical and environmental threats at home and overseas.

Recycling electronic gadgets helps decrease pollution generated in producing a new product and in extracting valuable and scarce resources. Recycling also minimizes the energy used in new product manufacturing.

Green electronics contains minimum harmful constituents. The use of recycled gadgets in new products possesses the following benefits:

- More energy efficient
- More easily upgraded or disassembled
- Use minimum packaging
- Meets performance criteria and
- More environment friendly

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Cavity Wall Construction and its Purpose

Asha Kulshreshtha[1],Gaurav Ojha[2],Uroj Shameem[3]

[1]Departmemt of Civil Engineering, Babu Banarasi Das Northern India Institute of Technology, Lucknow, UP, India

[2]Department of Machnical Engineering, School of Management Sciences Lucknow, UP, India

[3]R R Institute of Technology, Lucknow, UP, India

ABSTRACT

The most important feature that a material must have is sufficient, long-term sealing of the restorative margins. No restorative material developed to date is completely adhesive to the tooth structure. Every restorative material allows some degree of passage of fluids and micronutrients. It is termed as leakage. Micro leakage is "the clinically undetectable passage of bacteria, fluids, molecules or ions between a cavity wall and the restorative material". It is the flow of a substance into a defect at the restoration and tooth margin interface. Marginal leakage around restorative margins has been a concern with various clinical conditions. It includes quickening of the breakdown and dissolution of restorative materials. Marginal staining leads to the collapse of margins, compromise in aesthetics and, with time, the need to substitute the restoration.

Keywords: Fluids, Cavity, Micro Leakage, Micronutrients.

Corresponding Author: Dr. Asha Kulshreshtha

E-mail: ashabbd@gmail.com

INTRODUCTION

A cavity wall is composed of two masonry walls separated by an air space. The outer wall is made of brick and faces the outside of the building structure. These two walls are fastened together with metal ties or bonding blocks. The ties strengthen the cavity wall.

A typical cavity wall will be around 250 mm (10 inches) , whereas a solid brick wall will be around 220 mm (8½ inches). It's not a big difference, so you need to measure carefully. If you have a stone wall, then this rule doesn't apply. Stone fronted walls are generally thicker, whether they have a cavity or not. Essentially, the residual/clear cavity between the insulation and outer leaf should be at least 50mm, except in areas of very severe exposure, where it must be 75mm if the outer leaf is fair-faced masonry.

A cavity wall is a wall formed by an inner skin and an outer skin of masonry (sometimes referred to as 'leaves' or 'wythes' if they are a single unit wide), connected by

ties but separated by a cavity. The masonry is formed by brick, stone, or block units. Cavity wall is also called as Hollow wall. For non-load bearing cavity wall, two leaves are of equal thickness or sometimes an internal leaf with more thickness is provided. The cavity size should be between 4 to 10 cm. The internal and external leaves should have at least 10 mm thickness. By installing third-party accredited insulation slabs. Ensure you leave a minimum residual 50mm clear cavity between partial fill insulation and the external leaf

A cavity wall is a type of wall that has a hollow center. They can be described as consisting of two "*skins*" separated by a hollow space (cavity). The skins typically are masonries, such as brick or cinder block. Masonry is an absorbent material that can slowly draw rainwater or even humidity into the wall. One function of the cavity is to drain water through weep holes at the base of the wall system or above windows. The weep holes allow wind to create an air stream through the cavity that exports evaporated water from the cavity to the outside. Usually, weep holes are created by separating several vertical joints approximately two meters apart at the base of each story. Weep holes are also placed above windows to prevent dry rot of wooden window frames. A cavity wall with masonry as both inner and outer skins is more commonly referred to as a double by the masonry wall.

A tie in a cavity wall is used to secure the internal and external walls (or leaves)—constructed of bricks or cement blocks. They can be made from:

- Stone
- Brick
- Iron - prone to rusting & expanding
- Stainless steel
- Plastic
- Elastic

A cavity wall is comprised of two masonry walls separated by an air space. The outer wall is made of brick and faces the outside of the building structure. The inner wall may be constructed of masonry units such as concrete block, structural clay, brick or reinforced concrete. These two walls are fastened together with metal ties or bonding blocks The ties strengthen the cavity wall. The water barrier is a thin membrane that keeps moisture away from the cavity side of the interior wall.

The flashing component is important. Its main purpose is to direct water out of the cavity. Metal flashing usually extends from the interior wall through the outer wall

and a weep hole with a downward curve allows the water to drain. Flashing systems in cavity walls are typically located close to the base of the wall, so that it will collect the water that goes down the wall. Weep are drainage holes left in the exterior wall of the cavity wall, to provide an exit way for water in the cavity.

Expansion and control joints do not have to be aligned in cavity walls. In modern cavity wall construction, cavity insulation is typically added. This construction makes it possible to add a continuous insulation layer between the two withes and, vertically, through the slabs, which minimizes thermal bridges

Cavity designs for composites should be as conservative as possible to overcome the disadvantages of polymerization shrinkage. Modified cavity designs, placement of bevels, reduced depth and rounded internal line angles are very effective in providing good marginal adaptation and reducing micro leakage. The role of bevels on cavosurface margins in reducing micro leakage remains controversial. Beveling provides exposed enamel rod ends to be obtainable for bonding. Bowen et al. found that the bevel compensates for polymerization shrinkage. This might be because bevel increases the surface area of cut enamel, making it more tough for fluids to permeate in the restoration-tooth interface. When beveled, the enamel margins produce oblique sections of prisms, and the strength of the bond between enamel and resin increases. Also, the bevel area is more tightly bonded to resin, which reinforces the enamel margins, decreasing polymerization shrinkage in this area. On the contrary Retief *etal*. found no advantages of beveling to reduce micro leakage in anterior teeth, while various other have reported less leakage with the tooth having a bevel.

Use of Cavity Liner or Base

To minimize the stress factors in resin composite restoration, the layer of flexible material is placed in between the restoration and cavity walls to amplify the compliance of the bonding substrate. Along with this low elastic modulus layer, the stress distribution is more even and uniform. This technique of using an intermediate layer of low viscosity flowable material is called elastic cavity wall and it helps to reduce micro leakage. The commonly used materials as intermediate layers are glass ionomer, self-cure composite resins, and flowable composites. Simi and Suprabha stated that the marginal integrity of a composite is enhanced when used along with a flow able composite. Chuang et al. stated that microleakage is significantly reduced when a thin 0.5–1.0 mm layer of flowable composite liner is used under packable or condensable composite. A composite of low viscosity

can be used as a liner. The injectable composite recently entered into the field of aesthetic dentistry claims to have a low modulus of elasticity and prepolymerised filler, i.e., organic fillers and inorganic fillers. The pre polymerized fillers decrease the volumetric shrinkage by increasing the accessible sites for composite flow with no effect on mechanical properties. The glass ionomer-composite resin interface bond is stronger than the glass ionomer-dentin bond. Hence, cement liner detaches from the dentin wall during the polymerization shrinkage process. Consequently, few researchers advise against practicing glass ionomer as an intermediate liner.

Technique for Reduce Cavity

It was seen that additional film of hydrophobic resin significantly reduces the leakage of the universal bonding type with the self-etch mode at the dentin's margins and has no consequence with the etch rinse mode. The etch rinse mode is more useful in the margins of enamel than the margins of dentin, and the Self etch mode provides improved results in the margins of dentin compared to the enamel margin. The 8th generation bonding agent shows less gingival microleakage in deep class II cavities when compared with 7^{th} generation bonding agent. To minimize polymerization shrinkage and increase the degree of conversion, multilayer technique is recommended for the ultimate success of composite.

Conditioning the Dentin Surface

Conditioning the dentin surface after acid etching with ethanol or chlorhexidine can effectively decrease the leakage, especially over time.

Re-Bonding of Composites

Re-bonding technique can substantially minimize marginal leakage of composite restorations when a flowable sealant is applied over cavosurface margins of finished restorations (Dickinson & Leinfelder). These materials enter into the structural micro-defects and marginal gap by capillary action that seal them, thus improving marginal sealing. In addition, they would fill or repair the pores and structural defects formed during the finishing and polishing processes. These materials are commercially available in a range of monomer combinations, including BisGMa, TEGDMA and UDMA.

Immediate Dentinal Sealing

Marginal sealing is crucial for long-standing success of the direct or indirect restoration. In disparity, adhesive breakdown at the restoration margins can affect the durability of a restoration. Studies have shown that although immediate dentin sealing improved bond strengths for adhesive, it did not decrease the marginal micro- leakage for restorations.

Insulation

Cavity wall insulation reduces heat loss through a cavity wall by filling the air space with material that inhibits heat transfer. This immobilizes the air within the cavity (air is still the actual insulator), preventing convection, and can substantially reduce space heating costs.

During construction of new buildings, cavities are often filled with glass fiber wool or mineral wool panels placed between the two leaves (sides) of the wall, but many other building insulation materials offer various advantages and many others are also widely used.

For existing buildings that were not built with insulated cavities, a fibrous material, polystyrene beads, or sometimes polyurethane foam can be installed in the cavity to reduce heat loss. The fibrous material often is cellulose insulation or glass wool blown into the cavity through suitably drilled holes until it fills the entire wall space. Although some foams used in the past, such as urea-formaldehyde, are no longer used (some people are allergic to this material, that is very difficult to remove once inside the wall), others, such as polyurethane, have taken their place.

Cavity wall insulation also helps prevent convection and can keep a house warm by ensuring that less heat is lost through walls; this can also thus be a more cost-efficient way of heating a house. About a third of the heat lost in an uninsulated home escapes through its walls.

Breathing performance; early cavity wall buildings exchange moisture readily with the indoor and outdoor environment. Materials used for repairs must be selected with care not to affect the materials' breathing performance

Cavity wall insulation installed in older buildings can create problems with moisture retention.

Thermal mass cavity walls are thick walls that help stabilize the interior environment better than thinner modern walls.

Environmental Influences: The orientation or design of a building may affect the performance of different façades on a building. Some walls may receive more rainwater and wind than others depending in their orientation or protection to some of the faces. Moisture is one of the main problems in materials weathering.

Purpose of Cavity Wall

Damp Prevention

Cavity walls reduce the chance of moisture intrusion from outer leaf to the inner leaf and thus help in keeping the inside of the building free from dampness.

Thermal Insulation

The air in the cavity wall acts as a non-conductor of heat and minimizes heat transmission from the outer leaf to the internal face of the interior leaf. Thus, cavity walls help in maintaining the thermal insulation of a premise.

Thermal insulators are those materials that prevent or reduce various forms of heat transfer (conduction, convection and radiation). Insulator resists the heat transfer from out to in or in opposite direction whether the environment temperature is high or low. There are many advantages of thermal insulation that isolates the building from the heat and reduces the energy consumption and the costs of air-conditioning operation. Also, it makes the indoor temperature of the building stable and non-volatile. To reduce heat transmission, buildings must be isolated to protect it from heat loss in winter and heat gain in the summer. It is found that about 60% of heat losses directly through the ceilings and building walls, about 15% through the glass, and about 25% infiltrates cracks, openings, and doors. To make the thermal insulation of the building an economical process, the following factors should be chosen carefully:

- The amount of insulation material and thickness
- The cost of insulation material and labor costs for installation.
- The amount of energy saving and the reduction in greenhouse emissions.

Location of Thermal Insulation

It is used to choose a quality of insulation material that satisfies the balance between economic and energy saving. Buildings are divided in terms of thermal

insulation location into two types, buildings in warm climates and buildings in cold climates. Most of the heat gained in hot climates come through the outer shell of the building due to high solar intensity and the temperature differences between indoor and outdoor environment. The heat gained from external sources is higher than from the internal heat generated by the various activities. The increase in thermal insulation in the outer shell of the building will lead necessarily to reduce the amount of heat gained and this consequently leads to reduce the energy needed for cooling. The U-value is a dominant factor in finding the insulator's optimal thickness in building. The amount of the total cost is equal to the total cost of insulating material plus the cost of energy saved in the building for a certain period. In cold climates, heat is transferred from inside to out, so the insulating layer should be located in the internal face of the surfaces in order to reduce the heat losses.

Types of thermal insulators

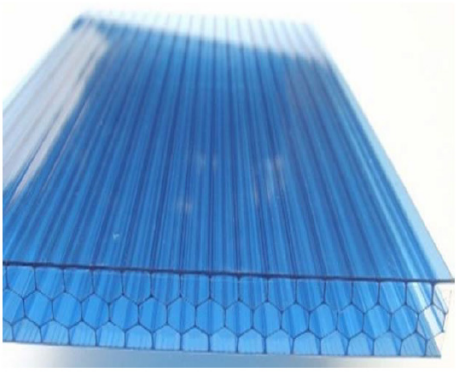
Thermal insulation refers to all isolators systems that reduce the heat transfer. Thermal insulation in buildings prevents heat loss in winter and resists the heat from out in summer. It is looked to use best thermal insulation materials that reduce all types of heat transfer modes like conduction, convection, and radiation. Glass wool is one of the most common thermal insulators, polyurethane, cork, polymers and many other materials.

Advantages of Thermal Insulation

- Reduce the amount of heat transmitted through the parts of the house.
- Reduce the energy required for heating or cooling the house.
- Make the internal temperature of the building stable, non-volatile.
- Keep the temperature of the building elements stable thus long time life.
- Reduce energy bills.
- Reduce the burning of fuel in power plants.
- Reduce the emission of greenhouse gases.

Glass Wool

EPS



polycarbonate sheet

Polyurethane panel

Ceramic roll

Calcium silicate

Fig: Thermal Insulator

Sound Insulation

The air in the cavity acts as a cushion for absorbing sound. By building cavity walls, a premise may work as a sound proof zone as a large quantity of external noise gets absorbed within the cavity.

Sound is a very multidimensional phenomenon. Some of its properties are purely physical and can be measured in the form of speed, air pressure amplitude, velocity, or acceleration, the same as concepts like loudness, intensity, energy, pitch, timbre.[14] Nonetheless, human perception of sound and the influence of sound on people is a much more complex problem.15 Unfortunately, it is still not possible to put a metering device directly on listeners and get a specific number out of it. However, the popularity of research of measuring EEG. EKG, and other physiological signals responses on audio stimuli have been on the rise in the last couple of decades. The alternative way of assessing how listeners perceive audio is to ask them directly to quantify their experience. This is the most common form of perceptual evaluation that often takes the form of a formal listening test. Although testing of audio quality and other properties of sound reproduction systems exist in some form of listening tests ever since the first" Mr. Watson, come here. I want to see you." That was said at Graham Bell's Lab, many improvements in the listening test methodology have been made over time. Since all listening tests have to take into consideration the uncertainty of the measurement linked with the human factor, it is a field of science that is still being explored extensively.

Sound fields in rooms are of primary importance in the study of sound insulation. This section starts with the basic principles needed to discuss the more detailed aspects of sound fields relevant to measurement and prediction. In the laboratory, there is some degree of control over the sound field in rooms due to the validation procedures used to commission them. Hence for at least part of the building acoustics frequency range, the sound field in laboratories can often be considered a diffuse sound field, a very useful idealized model. Outside of the laboratory, there are various rooms with different sound fields. These can usually be interpreted with reference to two idealized models: the modal sound field and the diffuse sound field.

Efflorescence Prevention

As dampness is not allowed to penetrate the cavity, the inner leaf of the cavity, which is always a load bearing wall, is kept free from efflorescence effects.

Brickwork provides aesthetically pleasing structures. Occasionally, a white crystalline deposit will appear on its surface. These deposits are likely water-soluble salts referred to as efflorescence. Although undesirable, efflorescence is usually not harmful to brick masonry. This Technical Note describes the mechanisms of efflorescence, including possible sources of salts and water, providing a basic understanding of the phenomenon of efflorescence that is essential to minimize its occurrence and prevent its reoccurrence. Although similar, salts' sources and efflorescence's development on paving surfaces are discussed in the Technical Notes Series on brick pavements. A thorough efflorescence prevention or control program may include identifying the type of efflorescence and investigating its causes before options for correction are considered.

Causes of Efflorescence

There are many mechanisms of efflorescence, often complicated. Simply stated, efflorescence occurs when water containing dissolved salts is brought to the surface of masonry, the water evaporates and the salts are left on the surface. The salt solutions may migrate across surfaces of masonry units, between the mortar and brick units, or through the pores of the mortar or brick units. There are certain simultaneous conditions that must exist in order for efflorescence to occur:

- Soluble salts must be present within or in contact with the brickwork. These salts may be present in mortar ingredients, backing materials, trim, adjacent soil, brick, etc.
- A source of water must be in contact with the salts for a period of time sufficient to dissolve them.
- A pore structure must be present in the masonry that allows the migration of salt solutions to the surface or other locations where evaporation of water can occur. A driving force, such as a temperature or humidity gradient, directs moisture through the pore structure.

Individuals who have not previously observed efflorescence generally assume that it is caused by the material on which it appears—usually the brick. Soluble compounds that contribute to efflorescence on the surface of brick are most commonly found to have originated from the materials in contact with the brick, such as mortar, grout, concrete masonry, concrete, soil or other materials. However, soluble compounds can also originate within brick units. Since efflorescence is usually white, it is more visible against darker colors. As noted by John Sanders and Denis Brosnan:

The typically incorrect assumption that brick causes efflorescence is because the soluble compounds are usually visible on the brick due to its darker color and the tendency of the brick to transport water due to its capillary porous nature [which is necessary] for the development of the bond between brick and mortar.[6]

Efflorescence that appears on newly constructed brickwork, less than a year old, is referred to as "new building bloom." New building bloom generally appears in a fairly uniform pattern across the wall surface and can be attributed to normal evaporation of water after construction is complete. In most cases, new building bloom will dissipate over time if the brickwork is allowed to dry after completion and if environmental factors such as wind and rain are given sufficient time to naturally clean the brickwork. When efflorescence occurs more than a year after construction is complete, it can generally be attributed to excessive water penetration or poor drainage and is often most severe in winter or periods of cold weather.

Under certain specific circumstances and conditions, it is possible for the crystals of efflorescence to form within the bodies of brick units. When this occurs, the growth of crystals and the resulting pressure may cause cracking and distress to masonry.

It is not practical to exclude all soluble salts from masonry materials, nor is it possible to prevent moisture from coming into contact with masonry exposed to the weather. However, reducing each factor that contributes to efflorescence is a realistic approach that will usually prevent efflorescence from occurring or reduce its severity. The most effective means of preventing efflorescence is to minimize the amount of water that penetrates brickwork. This, as well as separating brickwork from sources of salts, is primarily accomplished through careful design and construction. To the extent possible, material selection should be used to minimize the salts present in the brickwork.

Economy

According to 'W. B. McKay' (Author of Building Construction), building a 275 mm cavity wall costs less than constructing a 328 mm solid wall (which is of the minimum thickness if dampness has to be mostly avoided). This measuring data may vary from one place to another and on the specific climate of the construction site. One has to calculate the customized details before deciding the measurement of a cavity wall

Mineral Wool or Rockwool is the cavity wall insulation material used commonly for insulation in residential buildings. It is made from an igneous rock heated and

spun to create fiber material. This is blown into the cavity wall, which then occupies the space between the exterior and interior walls of the building. The material is water-resistant and can prevent moisture intrusion caused by rain, which usually gets through the outer leaf of the wall to reach the inside leaf of the building

CONCLUSION

This work reflects the first part of ongoing research. Therefore, the conclusions have been achieved basically based on a literature review. Following the necessity of selecting the most suitable thermal insulation method for dwelling under tropical climatic conditions for cavity wall, a detailed literature review was done to study existing methods. It can be concluded that the most suitable method for dwelling under tropical climatic conditions for cavity walls is wall panels constructed using natural insulation materials mixed with wall construction materials.

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Harmonics Generated by Electric Arc Furnace in Power System and its Sustained Compensation

Ritu Singh[1], Amarjeet Singh[2*]

[1]Department of Electronics & Communication Engineering, School of Management Sciences, Lucknow, Uttar Pradesh, India

[2]Department in Electrical Engineering, School of Management Sciences Lucknow, Uttar Pradesh, India

ABSTRACT

Electrical power system having distorted voltage and current waveform contains harmonics. Harmonics become a severe concern for the power system, especially Electric Arc Furnace (EAF). The compensation of the harmonics is greatly required for better performance of the power system. Since the nature of the arc is highly non-linear and time-varying, harmonic analysis becomes important. This book chapter presents an introduction to EAF along with a comprehensive analysis of harmonics generated by the steel plant containing EAF and its auxiliary units such as Ladle Melt Furnace, Continuous Casting Plants, Rolling Mills and Forging Press during different stages of melting of iron scrap and its compensation by various techniques and also amount of the sustained harmonics in the power system during the different modes operation of Electric Arc Furnace.

Keywords: Distortion factor, Electric Arc Furnace, Flickers, Interharmonics, Melting & Refining, Sustained Harmonics.

Corresponding Author: Amarjeet Singh

E-mail: amarjeetsingh@smslucknow.com

Introduction of Electric Arc Furnace

The electric arc furnace is either AC or DC operated. It transfers the electric energy to thermal energy to melt the scrap material held by the furnace. The arc produced between the electrodes low voltage and high current supplied by the furnace transformer. The operation of electric arc furnace can be divided into intervals, namely smelting and refining periods. The electrode is lowered through a hydraulic actuator system during the melting stage to maintain the stable arc. The furnace draws active power in this condition. More and more buckets of scrap material is added to the furnace during the melting stages. During the refining stage, a long arc is established. The factors involved during the furnace operation are electrode position, electrode arm control scheme, supply voltage, operating reactance

and the materials used for smelting and refining. With its high thermal efficiency, the electric arc furnace is suitable for melting down scrap.

The electric arc furnace uses about 30% less energy for the same process that the blast furnace and the basic oxygen steelmaking plant. Moreover, in the electric arc furnace scrap can be replaced up to 100% by unreduced iron ore (sponge iron). Electric arc furnace accounts for 51% of the total span of the three basic raw materials (scrap, pig iron, and sponge iron), while open-hearth furnace takes about 17% and basic oxygen converters take about 9%. The growing availability of sponge iron increases the economic significance of the electric arc furnace. Electric arc furnaces are extremely flexible and can be used in changing circumstances and production levels. It can be used as a smelting and refining mode. The electric power can be used in a controlled way as per the demand. The electric arc furnace also can be combined with an oxygen fuel burner when making special steels.

Electric Arc Furnace Characterizations

The purpose of the electric arc furnace is to utilize the electric energy into heat energy in the form of heat to melt the scrap materials held by the furnace. The electrical arc is generated between the electrodes and the raw material held in the melting bath under the electrode is characterized by low voltage and high current. The electric arc furnace can be operated either by AC or DC supply. During all the above stages of melting, the electrodes are lowered with the help of an actuator system to produce a stable arc between the electrode tip and the scrap material, enabling the arc furnace to draw active power from the supply system. During the melting cycle, raw materials are loaded into the furnace and during the refining stage, a long arc is generally created. The random movement of the melting material has no two cycles of the arc voltage and arc current waveforms are identical and therefore, due to such highly varying loads, the power quality problems arise in the interconnected power system. Since the electric arc furnace can be operated by using either AC or DC and hence there are harmonics, inter-harmonics, voltage, current unbalance and flickers in the frequency range of 0–30Hz.

Harmonics in Power System

The harmonics are the analytical way to describe the distortion of voltage and current waveform. It refers the components of the waveform, which are the integers multiple of fundamental frequency.[1] The extensive use of power

electronics and non-linear system in power system has great importance in harmonics study. The harmonics study is used to know the distortion in voltage and current waveform in the power supply network. It gives the physical insight into the interactions between the several circuit elements in the power network. Harmonics are the non-sinusoidal waveform generated by the non-linear load such as arc furnace, inverters, DC converters, switch mode power supply, DC and AC motor drives etc. Due to the presence of such non-linear load, the voltage and current waveform get distorted. Therefore, it becomes necessary to analyze the distorted phenomena of the waveform by a method called harmonics analysis. In such analysis, the distorted voltage waveform and current waveform are expressed as the sum of DC components, a fundamental sinusoidal wave of the distorted waveform and pure sine wave. These sinusoidal waves have different amplitudes and corresponding frequencies, the integer multiple of the fundamentally distorted waveform.

General Definition of Harmonics

The waveform is said to be distorted when the pure sine wave of the fundamental frequency deviates from its steady state. There are five types of waveform distortions, namely DC Offsets, harmonics, interharmonics, notching, and electric noise. The different types of harmonics are triplen harmonics, sub-harmonics and inter harmonics. Triplen harmonics are odd multiples of third harmonics. Sub harmonics have frequencies below the fundamental frequency, whereas Inter-harmonics are not the integer multiples of the fundamental frequency. These are found in the form of band spectrum.

Measurement of Sustained Harmonics Distortion

Harmonic Factor or Distortion Factor

The ratio of root mean square value of harmonic content to the root mean square value of the fundamental quantity is called the Harmonic Factor or Distortion Factor and it is expressed as the percent of the fundamental.

$$Distortion\ Factor = \sqrt{\frac{Sum\ of\ the\ square\ of\ amplitude\ of\ all\ harmonic}{square\ of\ amplitude\ of\ fundamental}} \quad (1.1)$$

Total Harmonic Distortion (THD)

It can be calculated for either voltage or current as

$$\mathrm{THD_M} = \frac{\sqrt{\sum_{h=2}^{\infty}(M_h^2)}}{M_1} \tag{1.2}$$

Where M_h is the rms value of harmonic component of h of the quantity M which is either voltage or current.

Total Demand Distortion (TDD)

It is only defined for the current as

$$\mathrm{TDD_I} = \frac{\sqrt{\sum_{h=2}^{\infty}(I_h^2)}}{I_1, rated} \tag{1.3}$$

It serves as the guideline to avoid the risk of being misled by high current THD.

Sustained Harmonic Standard in Power System

The harmonic standard is set to limit the harmonic distortion level at point of common coupling (PCC). The harmonic standards differ from country to country with respect to the total voltage distortion and total current distortion. The harmonic standards are different for EHV, HV, and MV and LV profiles. The harmonic standard is further divided into system and equipment levels based on application area. The system standard deals with customers connecting the large non linear loads and the equipment standard deals with the limits for the individual harmonic current emission. The recognized standard is IEC Standard, IEEE Standard. In this thesis, IEEE 519-1992 standard has been discussed. It was prepared by the joint task force sponsored by several IEEE organizations. It seems ideal if the harmonics are fully controlled caused by harmonics generating loads connected in the power system, but the harmonics effect is fully unavoidable. The recommendations provided by IEEE 519-1992 reduce the effects of harmonics at any point in the power system at the point of common coupling (PCC). From time to time, the harmonics measurement must be done to know the equipment's behavior and performance.

The IEEE 519-1992 is the most important guideline and the document for the users to obey also, the utilities must provide the clean voltage sine wave at PCC.

Voltage Distortion limits

The individual harmonics limit and the THD at the point of common coupling (PCC) regarding line to line voltage. IEEE Standard 519-1992 harmonic voltage limit has been shown in Table 1.1.

Current Distortion Limits

The current harmonic limits are concerned with the following limits presented in tables 1.2 and 1.3, respectively for different voltage profiles of power system. To define the current distortion limit, the IEEE 519-1992 uses the short circuit ratio to know the customer size and the influence on the voltage distortion of

Table 1.1: IEEE 519-1992 Standard harmonic voltages limit

SN	*Bus voltage*	*Individual Harmonics Limit*	*Total Harmonic Distortion THD-V*
1	Below 69kV	3.0	5.0
2	69kV to 161 kV	1.5	2.5
3	169kV and above	1.0	1.5

Table 1.2: IEEE 519-1992 Standard harmonic current limits for General Distribution systems (120V - through 69kV).

Maximum harmonic current distortion in percent of load current						
Individual harmonic order (odd harmonics)						
ISC/ IL	< 11	11≤h<17	17≤h< 23	23≤h< 35	35≤h	T DD
20*	4.0	2.0	1.5	0.6	0.3	5.0
20< 50	7.0	3.5	2. 5	1.0	0.5	8.0
50< 100	10.0	4.5	4. 0	1.5	0.7	12.0
100<1000	12.0	5.5	5. 0	2.0	1.0	15.0
> 1000	15.0	7.0	6.0	2.5	1.4	20.0

Table 1.3: IEEE 519-1992 Standard harmonic current limits for distribution systems (>161kV)

Maximum harmonic current distortion of load current (%)						
Individual harmonic order (odd harmonics)						
ISC/ IL	< 11	11≤h<17	17≤h< 23	23≤h< 35	35≤h	TDD
<50	2.0	1.0	0.75	0.3	0.15	2.5
>=50	3.0	1.5	1.15	0.45	0.22	3.75
Even harmonics are limited to25%of the odd harmonic limits above.						
Current distortions that result in a dc offset, e.g. half-wave converters, are not allowed.						
All power generation equipment is limited to these values of current distortion, regardless of actual Isc/IL						

the system. The short circuit ratio (I_{SC}/I_L) is defined as the ratio of the short circuit current (I_{SC}) at PCC with the utility to the demand current of the customer which is also called the maximum load current (I_L).

In above tables, Isc is the maximum short circuit current at point of common coupling (PCC) and I_L is the maximum load current at fundamental frequency.

Harmonic Compensation in Distribution Power System

It presents harmonic compensation in low voltage and medium voltage power distribution systems. It starts with passive filtering, active filtering to hybrid filtering. Multi-level inverter (MLI) has also been reviewed for harmonic compensation in power distribution system. Harmonic compensation in a low voltage power distribution system can be implemented by three approaches, namely:

a. Passive filtering
b. Active power filtering and
c. Hybrid active power filtering

Harmonic Compensation by Using Passive Filter

Gonzalez, D. A.[4] proposed shunt passive filters for harmonic compensation in power system. Shunt passive filters are implemented with inductance, capacitance and resistance and tuned to control the harmonics. The configurations of common types of passive filters are shown in Figure 1.1.

Shunt passive filters are better than series compensators since they compensate harmonics as well as reactive power and in addition, they do not carry large currents followed by associated losses. High pass filter for notch reduction was proposed by

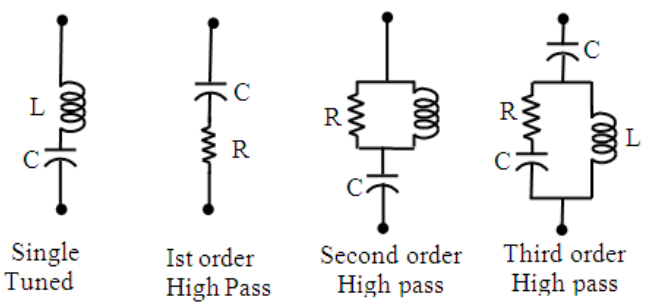


Figure 1.1: Configurations of common types of passive filters

Ludbrook[5] in a power distribution system containing large electronic loads. Single tuned filters are more effective in suppressing harmonics of the selected frequency. The first-order filter characterized by large power losses at fundamental frequency is simple to be implemented. The second-order high power filter provides better filtering with reduced losses at the fundamental frequency. The filtering performance of the third-order high power filter is again better than that of the second-order filter. The passive filter, being simple and least expensive, has several drawbacks too. According to Das, the filter components are bulky because the harmonics that require to be compensated are normally of a low order. J. C.[6] The passive filter is also prone to resonance which affects the stability of the power system.

Harmonic Compensation by Using Active Power Filter

The basic principle of APF is to produce specific harmonic current components that cancel the harmonic current components caused by the non-linear load. Figure 1.2 shows the components of an APF system and their connections.

APFs have several advantages over the passive filters, such as they can suppress not only the supply current harmonics.

Akagi, H.[7] proposed the classification of active filters based on their system configuration, electrical circuits and control strategy. APF can be implemented by shunt APF, series APF, and hybrid APF. The configuration of Shunt Active Power Filter (shunt APF) is frequently used in active filtering for current harmonic reduction. The configuration of a VSI based shunt APF has been shown in Figure 1.3.

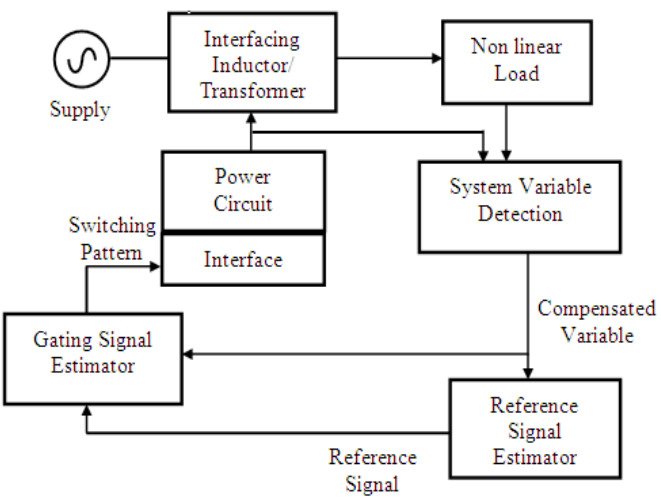


Figure 1.2: Components of an APF system and their connections.

Bhavaraju V. B. proposed series active filter connected through a coupling transformer for compensating line voltage sag. Rigby B.S. proposed inverter based series compensator which compensates for dynamic changes. The configuration of series Active Power Filter is shown in Figure 1.4.

The operations of Active Power Filter with a non linear load in three different conditions have been shown in Figure 1.5. Series APFs are less common than the shunt APF because they have to handle high load currents, increasing their current rating considerably compared with shunt APF, especially on the secondary side of the interfacing transformer. It increases the I^2R losses. However, the main advantage

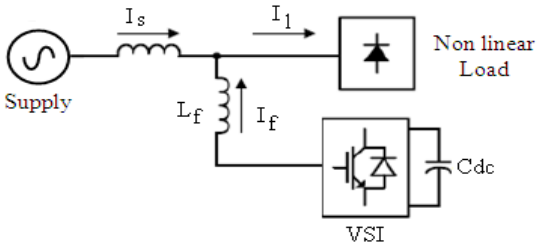


Figure 1.3: Configuration of a VSI based shunt APF

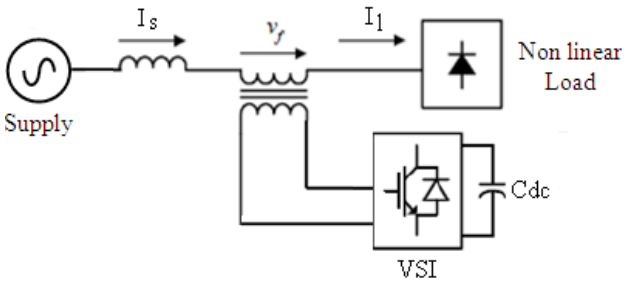
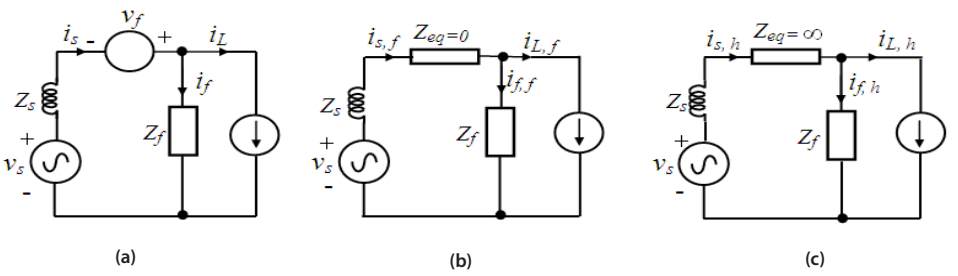


Figure 1.4: Connection of Active Power Filter with a non linear load



(a) Single-phase equivalent of series of APF (b) Fundamental equivalent circuit (c) Harmonic equivalent circuit

Figure 1.5: Diagrams of operations of Active Power Filter with a non linear load

of series APF over shunt APF is that they are ideal for voltage harmonics elimination. It provides the load with a pure sinusoidal waveform for voltage sensitive devices such as power system protection devices. Series APFs are, therefore, quite suitable for improving the power quality of the distribution system. There are a number of new ideas proposed in literature for active harmonic filtering in power distribution systems. Principle of magnetic flux compensation was proposed earlier. This is achieved by using the current to produce a flux to interact with the flux produced by the harmonics. The drawback of this idea is its inability to suppress the lower order harmonics (2^{nd}, 3^{rd} and 4^{th}). Bird proposed that the harmonic currents produced by pulse converters could be eliminated by injecting a third harmonic component current into the rectangular waveform produced by the converter to compensate for the harmonics of choice. The results proved that the method effectively eliminates one harmonic of choice. But Bird's work was inefficient and its drawback was that it was impossible to eliminate more than one harmonic fully. Later on, Bird's work was improved in other reeraches to eliminate multiple harmonics. In1976, Gyugyi and Strycula gave the concept of compensating for harmonics by applying semiconductor switches for PWM inverters. Both proposed a switching system consisting of a simple bridge circuit of transistors switched in pairs to generate a two-level current waveform by implementing the PWM technique. Two topologies based on CSC and VSC were proposed to counteract the flow of harmonic currents from the non-linear load to the utility system. Active power conditioning system developedduringthe1970s were earlier stage because the circuit technology was not technically sound enough to implement.

There was remarkable progress in power electronic in 1980s that encouraged the study of active power line conditioners for reactive power and harmonic compensations. p-q theory was developed a PWM-voltage type converter topology for instantaneous reactive power compensation was implemented. The authors decomposed the instantaneous voltages and currents into orthogonal components. The active filter is controlled to eliminate the instantaneous reactive power resulting in reactive power compensation in the time domain proved more effective in compensating harmonics.

Hayashi and others developed current source active filters for harmonic compensation. The current compensation in this scheme was done in the frequency domain. A research group in Korea presented an active power filter that reduced the magnitude of harmonics by means of the injection of PWM currents made up of sine and cosine terms of a compensating current. Enjeti proposed evaluating

different PWM techniques to eliminate harmonics for single-phase and three-phase inverters. The main problem with the schemes is high switching losses due to the fast switching rates.

Harmonic compensation by using Hybrid Filters

To reduce the ratings of active power filters, active filters and passive filters were combined together by many researchers. Peng proposed using a series of active filter to operate in parallel with passive filters. This technique was different for harmonic current compensation and it got improved the filtering performance of the passive filters. The determination of the harmonic currents to be injected by the active filter is based on p-q theory developed by Akagi. The drawback of this circuit is the series transformer that would require a high basic insulation level to withstand the large switching transients and lightning surges. Another point is that the current calculated by the active filter will also include the fundamental component of the load current and the fundamental leading power factor current of the shunt passive filter. To avoid the problems with the active filter in parallel with passive filters topology of another system of active filters and passive filters was proposed by Fujita and Akagi and Tokuda. In these schemes, the active filters are connected in series with either a shunt passive filter or an LC tuned filter. The difference between these topologies.

And the one presented in reference is that the single-phase PWM inverters are replaced by one three-phase inverter, and the DC-side voltage source is regulated by a feedback loop. In another work, Van Zyle proposed a converter with a passive filter that is permanent.

Installed on the line and termed the Power Quality Manager (PQM). The passive filter consists of tuned filters for fifth and seventh-order harmonics. The PQM improves voltage regulation and can work as a harmonic isolator. The weakness of these schemes is that the active filter always carries the fundamental capacitive component of the current through the shunt passive filter or the LC tuned filter. Figure 1.6 shows the combination of series APF and shunt passive filter and the combination of shunt APF and shunt passive filter

Control Methodology for APF in Compensating Harmonics

For the successful compensation of harmonics, it is required to implement two steps:

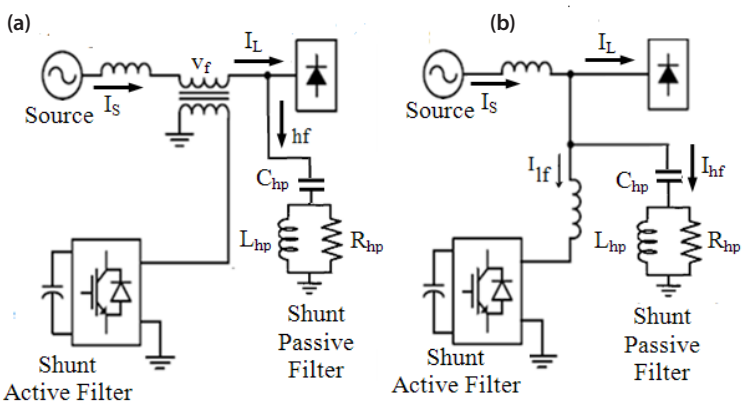


Figure 1.6: Hybrid APFs (a) Combination of series APF and shunt passive filter and (b) Combination of shunt APF and shunt passive filter.

Table 1.4: Frequency domain approach

Technique	The Fourier Transform is applied to find the voltage and current signal. The harmonic of the voltage and current signal is separated by eliminating the fundamental component. Again Inverse Fourier Transform is applied to generate the compensating reference signal in time domain.
Drawback/ modification	Time delay in system variable sampling. El-Habrouk, M.; the fundamental component current is calculated to separate the total harmonic signal.
Application	For slow varying load conditions

- Generating the reference compensating signal
- Generation of firing signal to operate VSI

Generating the Reference Compensating Signal

The generation of reference signal generation is performed by detecting voltage and current signals. The voltage variables are AC source voltage and DC bus voltage and the current variables are normally load current, source current, and compensation current. The reference voltage and current compensating signals are either estimated in terms of frequency domain approach or time domain approach.

- ***Frequency Domain approach***

Grady, W. M. and Norman, M. proposed reference signal generation in frequency domain and presented in tabular form as shown in Table 1.4.

- *Time Domain Approach*

In time domain approach, the estimation of the reference signal is obtained by instantaneous value of voltage or current signal from harmonic voltage and current. This approach is applicable for both single-phase and three-phase systems. Four different approaches are adopted in these techniques presented in tables 1.5 to 1.8, respectively, which are mentioned below:

- Instantaneous Reactive Power theorem
- Synchronous Detection theorem

Table 1.5: Instantaneous Reactive Power theorem

Technique	Three phase voltage and current in a-b-c reference frame are transformed to α-β-0 stationary reference frame. The instantaneous active and reactive power of the non-linear load is calculated from the transformed quantity which consists of a DC component and an AC component. The AC component is extracted by implementing high pass filter. After using inverse transformation the compensation reference signals are obtained in terms of either currents or voltages.
Drawback/ modification	Instantaneous Reactive Power theorem is poor. It was modified by Komatsu and Kawabata to make it applicable in three phase distorted system.
Application	For only three-phase load.
advantage	The advantage of this technique is that it is easier to find three-phase instantaneous reactive power than the conventional p-q theorem.

Table 1.6: Synchronous Detection theorem approach

Technique	The reference signal is synchronized relative to the source voltage for each phase. The three phase source current is assumed to be balanced and equal even after compensation.
Drawback/ modification	Jou, H.L. proposed a modified synchronous-detection theorem based on the fact that APF maintains the source current sinusoidal and in phase with the source voltage despite the variations in the load.
Application	For three phase non linear load.
advantage	This technique is easy to implement and it suffers from the fact that it depends to a great extent of harmonics in the source voltage.

Table 1.7: Sine Multiplication theorem

Technique	The non-linear load current signal is multiplied by a sine wave of fundamental frequency and integrated the result to obtain the fundamental component of the non-linear load current
Drawback	Its performance is slow due to integration and sampling.
Application	For both single and three phase systems.
advantage	This technique eliminates the time delay in low/high-pass filtering

- Sine Multiplication theorem
- Synchronous Reference Frame theorem

Generation of firing Signals for switching Voltage Source Inverter

The objectives of APF control are to generate appropriate gating signals for the switching devices based on the estimated compensation reference signal. The performance of an APF is affected greatly by control techniques. This method of generation of firing signals has been presented in Tables 1.9 and 1.10.

Table 1.8: Synchronous Reference Frame theorem

Technique	This theorem is based on Park's Transformations to transform the three phase system voltage and current variables into a stationary reference frame. The active and reactive components of the three-phase system are represented by the direct and quadrature components, respectively. The fundamental components are transformed into DC quantities which are separated by filtering. To implement this theorem synchronizing system phase locked loop (PLL) is required.
Drawback	Exhibits significant time delay in filtering the DC quantities.
Application	For three phase systems
advantage	This technique is very stable since the controller deals mainly with DC quantities and the computation is instantaneous

Table 1.9: Linear Control Technique

Technique	The compensation current signal is compared with its estimated reference signal by a compensated error amplifier to generate control signal. The control signal thus obtained is compared with a sawtooth signal through a pulse width modulation (PWM) controller to generate appropriate switching signals for the switching devices
Drawback	Due to the problem of analogue circuitry, the linear control technique shows unsatisfactory harmonic compensation performance.
Application	For single and three phase systems.
Advantage	Sawtooth signals through a pulse width modulation (PWM) controller generate appropriate switching signals for the switching devices.

Table 1.10: Hysteresis Control Technique

Technique	This technique presents instantaneous control that allows the APF compensation current or voltage signal to follow its estimated reference signal within a certain tolerance band. Switching occurs whenever the error hits the hysteresis band.
Drawback	It produces uneven switching frequency, which affects APF efficiency and reliability.
Application	For single and three phase systems.
advantage	The advantages of using the hysteresis current controller are its excellent dynamic performance and controllability

A diagram of Linear Control Techniques is shown in figure 1.7

The control scheme of Hysteresis Control Technique is shown in a figure 1.8.

Harmonic Compensation by FACTS Devices

Harmonic generation in the power system is an issue that is getting important to the electricity users at all levels of the usage. The FACTS devices are the solutions to shield the sensitive loads against the harmonics and other power quality problems in the system. The DVR is a popular and cost-effective solution for the protection of varying load from voltage sag and voltage swell and its control has been mentioned in other research. Other author have proposed a method in which an electrical arc furnace (EAF) is a major flicker source that causes major power quality problems. CMC-based STATCOM was presented and verified in the proposed method through a transient network analyser (TNA). The STATCOM capacity was first realized through a generalized steady-state analysis. Second, the STATCOM control strategy for flicker mitigation was introduced, and simulation results were produced. Finally, a TNA system of the STATCOM and an EAF system were implemented. The author has the simulation for the unified series-shunt compensator (USSC) for investigating power quality in power distribution system. The USSC simulation consists of two 12-pulse inverters connected in series and in shunt with the system. A generalized sinusoidal pulse width modulation

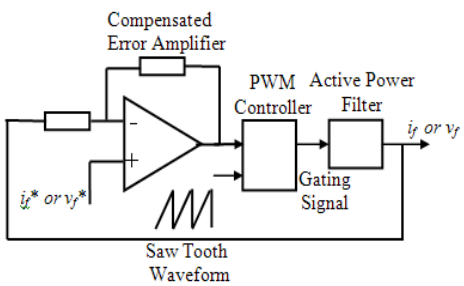


Figure 1.7: Diagram of Linear Control Techniques

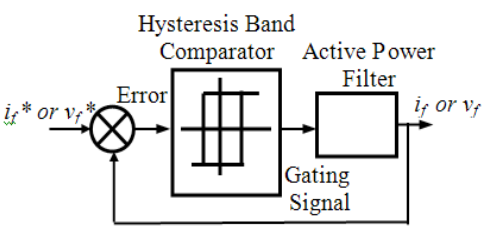


Figure 1.8: Block diagram of Hysteresis Control Technique

(SPWM) switching technique was developed in the proposed controller for fast control action of the USSC. Simulation from the proposed model demonstrated the performance of USSC and its effectiveness for voltage sag compensation, flicker reduction, voltage unbalance compensation, power flow control, and harmonics elimination.

Some authors introduced a new FACT device called UPQC (Unified Power Quality Conditioner), which does not require energy storage. It is designed to compensate for any sag above a certain magnitude, independent of duration. This can compete with the uninterruptible power supply (UPS) typically used to protect low power and low voltage equipment. The D-STATCOM is less flexible than UPQC. The connection of UPQC with the power system is shown in Figure 1.9.

One author proposed a Distribution Static Compensator (D-STATCOM) for balancing supply currents, power factor correction and harmonic compensation in three-phase system supplying delta-connected load. The control strategy implemented to the D-STATCOM has a major role in its performance. A novel approach based on an improved instantaneous active and reactive current component (IARCC) theory is proposed to generate three-phase reference currents for D-STATCOM. A three phase voltage source converter with a DC bus capacitor tracks the reference currents in a hysteresis band scheme. The performance of D-STATCOM is evaluated under sinusoidal, unbalanced sinusoidal, and unbalanced distorted source conditions. The performance of the D-STATCOM using the proposed control strategy is demonstrated using simulation results in Matlab/Simulink software.

Harmonic Compensation by Multi-level Converters

For low-power applications, the active power filter is realized by one PWM converter. The required voltage and current carrying capacity can be obtained by series and parallel connections of switches. Bit in a high power application, the

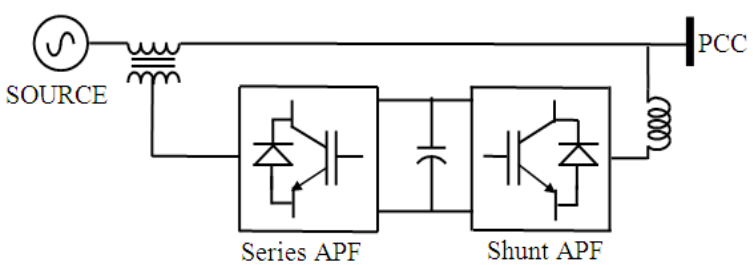


Figure 1.9: Connection of UPQC with the power system

filtering cannot be performed by one converter alone due to the power rating and switching frequency limitations and the problems associated with connecting many switches in series or parallel. To overcome the restrictions mentioned above, the concept of multi-level topologies was introduced. The general structure of the multi-level converters is to synthesize a staircase voltage waveform from different voltages, typically obtained from capacitor voltage sources. Menard and Foch proposed a multi-level converter in which a simulation was presented of 20 kV power systems. The compensation of the current harmonies was carried out up to 19th order. The drawbacks of the multi-level converter are the switching frequency and neutral voltage fluctuation. Cascade multi-converter active power filters based on VSC topology have been proposed by. They have neither the switching frequency nor neutral voltage fluctuation limitations of multi-level configuration. The drawbacks of cascade multi-converter active power filters are low reliability and control circuit complexity. Another multi-converter active filtering approach is proposed by Huang and WU.

The above approach is an extension of the fundamental filtering concepts introduced by the author using three phase voltage source converters. One phase leg of n-level inverter has been shown in Figure 1.10.

Acceptable Harmonics Limits and Compliance with IEEE 519-1992 Standards

A useful recommended practice for the control of harmonic in electrical network is provided by IEEE 519-1992. Many industries and consultants widely use this

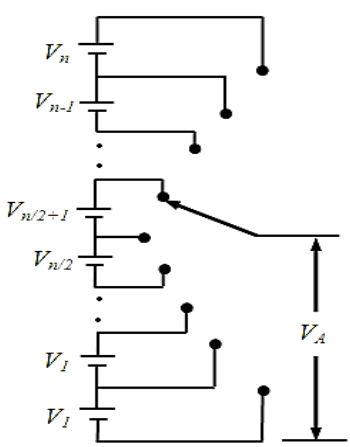


Figure 1.10: One phase leg of n-level inverter

practice. Some other specifications also exist such as IEC 61000-3-2, which specifies limits for the current harmonics for the low voltage equipment with an input current less than 16 Ampere. The industries do not use these specifications since they focus on individual harmonic sources such as VFDs. Again, in 2008, another specification was IEC 61000-3-6. It performs regarding assessing the limits of harmonics emission for the distorting load in medium voltage and high voltage power system. Untill now, this standard is not used widely because it is newly created. The IEEE 519-1992 engineering recommendations are one of the most well-known and widely used documents in power quality. But the objective of the recommendation is misunderstood and consequently wrongly interpreted and applied. This panel reviews and discusses common misinterpretations and distortions in applying harmonic distortion recommendations with particular reference to IEEE 519-1992. The panelist has to attempt to clarify many different issues and misconceptions related to parameters, point of application, and nature of the recommendations. Suggestions are made for improving the implementation of these engineering recommendations.

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Online / Offline Signature Verification- An Overview

Sumit N. Jarholiya[1*], Bharat Raj Singh[2]
[1]*Jaypee Polytechnic & Training Centre, Rewa, MP, India*
[2]*School of Management Sciences, Lucknow, UP, India*

ABSTRACT

Signature verification is widely accepted in our daily life, including commercial applications, banking transactions, automatic fund transfers, etc. Two categories of verification systems are usually distinguished: offline and online systems for handwritten signature authentication and verification.

Offline signature verification is a type of biometrics whereby a person's identity is verified based on his / her signature images signed on paper document. This method suffers from three different types of forgeries, i.e., random, unskilled and skilled forgeries. Several offline signature verification modeling techniques have been used to model signature, such as Dynamic Plane Warping (DPW), Support Vector Machine (SVM), Neural Networks, Hidden Markov Model (HMM) and Dynamic Time Warping (DTW) etc.

Online signature verification method use dynamic information. A special pen is used on an electronic surface such as a digitizer combined with a liquid crystal display in the online case. In this pen the pen pressure and the angle and direction of the pen are captured dynamically and then stored as a function of time. Online signature verification approaches are feature-based approach, function-based methods, hybrid approach and trajectory construction methods etc.

This chapter also describes pre-processing of signature verification, signature verification architecture and its algorithm, definition of terms used for detecting forgeries in signature, and a brief introduction of Hidden Markov Model for signature verification

Keywords: Online, Offline, Signature, Simple Forgery, Unskilled Forgery ,Skilled Forgery and Hidden Markov Model (HMM)

Corresponding Author: Sumit Narayan Jarholiya

E-mail: sum_it_1976@yahoo.com

INTRODUCTION OF SIGNATURE VERIFICATION

Hand-written signature is widely accepted all around the world by socially and legally. It is not dependent on age and it is well exposed to forensic environments. The design of an accurate algorithm for verification is still a challenge.

Signature verification is widely accepted in our daily life, including commerce applications, banking transactions, automatic fund transfers, etc. Two categories of

verification systems are usually distinguished: Offline and online systems for hand written signature authentication and verification.

Signature verification (or authentication) is the process of verifying one input of a person against one input in the database. i.e.: the system verifies if the person is who he/she claims to be another widely used term is signature identification, which is the process of finding the person among other persons in the database, based on one input signature. As can be seen, the two terms relate to each other, but their definition is different. Signature verification is studied and realized, since the purpose is to verify signatures based on the input of different persons.

Offline signature verification is a type of biometrics whereby a person's identity is verified based on his / her signature images signed on paper document. This necessitates the use of a scanner to convert the image into its equivalent electronic format, and low level image processing for feature extraction. The main advantage of Offline signature verification is that unlike other types of biometrics such as fingerprint, retina or face recognition system, Offline signature verification system is widely accepted by the general public and does not suffer from the privacy intrusion issues. For decades, human are used to sign on paper documents as means of identification especially in many important applications such as clearing of bank checks, binding of legal documents, and authorization of financial transactions etc. However, signatures are also susceptible to forgery, thus the need for an accurate signature verification system that is able to differentiate between genuine and forged signatures is undeniable. In addition to this, many signature biometrics applications demands for huge volume of processing, which in turns give rise to the need of developing system with fast processing time. A number of researches have been done in developing automatic signature verification systems and many of these systems involve different methods to extract key features of the signature samples, whereby the features are then used as a basis to build the reference model that describes the unique characteristics of an individual's signatures. Features can either be global or local in nature. A global feature is often one value that describes one particular characteristic of the signature image, such as the signature area, signature height-to-width ratio, maximum horizontal histogram and maximum vertical histograms. Global features can be extracted easily and are robust to noise but at the same time they only deliver limited information of the signature. Whereas, a local feature is often consist of a series values that describe a particular geometrical and topological characteristic of local segments. Example of local features includes strokes, sub-stroke, pixel density segment curvature, gravity center distance, direction and

contour. Local features provide rich descriptions of writing shapes and are powerful for discriminating users. Several signature modeling techniques have been used to model signature such as Dynamic Plane Warping (DPW), Support Vector Machine (SVM), Neural Networks , Hidden Markov Model (HMM) and Dynamic Time Warping (DTW) . Signature modeling techniques for offline handwritten signature verification can be described using Hidden Markov Model. It contains of stochastic processes. Deploying the HMM first requires for setting of its parameters, such as the number of states required, the number of observation symbols, the state transition topology, the maximum and minimum number of iterations allowed etc.

Once the signature verification techniques are implemented and the results are gathered, an evaluation will be given. This evaluation will contain information about the used parameters and reveals which combination of parameters yields the desired results.

Offline Signature Verification approaches

Offline signature verification method does not use dynamic information. This method suffering from three different types of forgeries: i.e. random forgeries / simple forgeries, unskilled and skilled forgeries.

In offline method, the signatures are treated as grey level images. The image can be scanned from a copy of document or can be a saved file.

In Offline systems for which the signature is captured once the writing processing is over and thus only a static image is available. This method is called static image data of a Signature.

Offline systems are of interest in scenarios where only hard copies of signatures are available, for example where a large number of documents need to be authenticated.

In Offline systems for which the signature is captured once the writing processing is over, and thus only a static image is available. As for offline signature verification processing, most of the earlier work involves the extraction of features from the signatures image by various schemes. Following are the Offline signature verification approaches:

- Template Matching– Warping Based
- Hidden Markov Models
- Structural Techniques
- Feature-Based Techniques

- Fuzzy Logic Based
- Neural Network Based
- Contour Based
- Self Organizing Map Based

Image acquisition and feature extraction of Offline Signature Verification

In Offline Signature Verification features are to be invariant to rotation, translation and scaling of the object sample. The static features are vertical midpoints , number of vertical midpoint crossings in signature, total pen travel writing distance/signature area, maximum pixel change, rotation angle, centre of signature gravity, horizontal and vertical histograms (number of signature's pixels in each row and in each column can be counted),curvature measurements, ratio of long to short stroke. Slant measure and variability measure will lead for predicting the performance of Offline signature verification.

Online Signature Verification approaches

This signature verification method use dynamic information. In the online case, a special pen is used on an electronic surface such as a digitizer combined with a liquid crystal display. In this pen the pen pressure as well as the angle and direction of the pen are captured dynamically and then stored as a function of time. The stored data is referred to as a dynamic signature and also contains information on pen velocity and acceleration. In digitizing table-based systems both global and local features that summarize aspects of signature shape and dynamics of signature production are used for signature verification. In Pen-based systems a smart pen is used to collect data such as pen-tip positions, speeds, accelerations, or forces while a person is signing. The invisible pen-up parts of the signature are used to construct a signature verification system. Trajectories left in pen-up situation, called "virtual strokes," are used to extract the optimal features, which represent the personal characteristics of the authentic signature and affect the error rate greatly.

Online Signature Verification refers to make use of the time functions of the signing process. The work done by Luan provides the listing of 42 feature set and 49 normalized feature set. Some of the primary features are x-coordinate value(less oscillations

with respect to time, grow linearly with time), y-co-ordinate value(more oscillatory variations with respect to time),pressure, azimuth, altitude, sliding computation window, torque, moments of inertia in a moving co-ordinate frame, weighted cross-correlation and warping with consistency-characteristic functions ,inter segment distance, number of sign changes in x and y velocities, accelerations(The fine structure of the muscle forces that are exerted during the writing of a signature is constant and well defined for most people) Pertinent representation space can also be achieved by fractal dimension calculus. Inter feature dependencies can be exploited. In the process of acquisition, types of forgeries are to be analyzed for proper training and testing of the verification system.

Following are the Online signature verification approaches:-

- Feature based approach
- Function based methods
- Hybrid approach
- Trajectory construction methods

Stages of verification

- **Data pre-processing:** To select, filter, clean, and transform data.
- **Prediction:** To predict the value for a specific attribute.
- **Model Visualization:** To make the discovered knowledge representable.
- **Classification:** To determine which of the classes a specific data item belongs to.
- **Clustering:** To partition the set of data items into a set of classes such that items with similar characteristics are grouped together.

Pre-processing

Thinning

It is the process which reduces the thickness of the signature without changing the shape of the signature. Hence it is making the Skeleton of the signature. Therefore it is also called **Skeletonization** or **thinning** of the image. One major advantage of thinning is the reduction of memory space required for storing the

essential structural information presented in a pattern.

Serial and Parallel Thinning

The processing can be either serial or parallel. In serial (or sequential) processing, one point at a time is processed. Sequential processing can be more efficient than parallel processing when it is implemented on a general purpose computer.

In parallel processing all the points of the figure can be processed simultaneously. Parallel processing is advantageous when speed is an important criterion. Advantage of parallel processing can also be taken when using general purpose computers, since all bits of each memory word can be processed simultaneously.

Slant Correction

It is making the image straight. However, their accuracy is significantly degraded

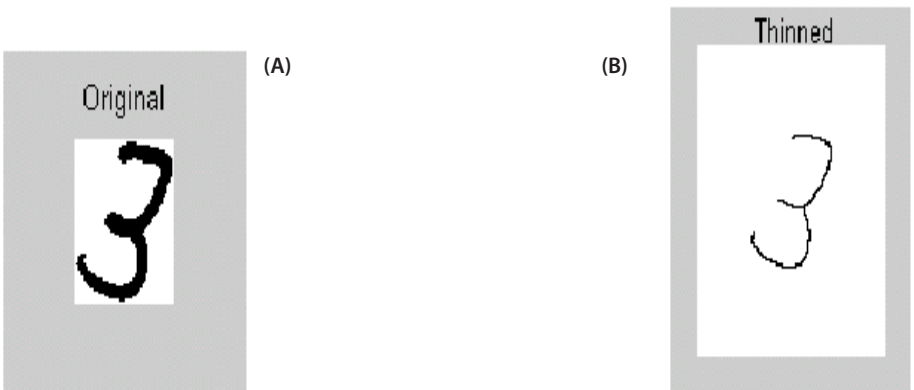


Fig 1.1(A): Image before thinning.**(B):** Image after thinning.

Fig1.2 (A): Image before application of slant correction algorithm. **(B):** Image after application of slant correction algorithm.

with the presence of slants. In general, numerals are rarely slanted beyond 45 degrees. **The algorithm for slant correction is as follows**

Step 1: Initialize θ to 45 degrees and active bitmap to input bitmap.

Step 2: While θ >1, do steps 3 and 4.

Step 3: Let active bitmap be B1. Transform it through – θ and + θ using the transformation function described above to get two new bitmaps5 B2 and B3.

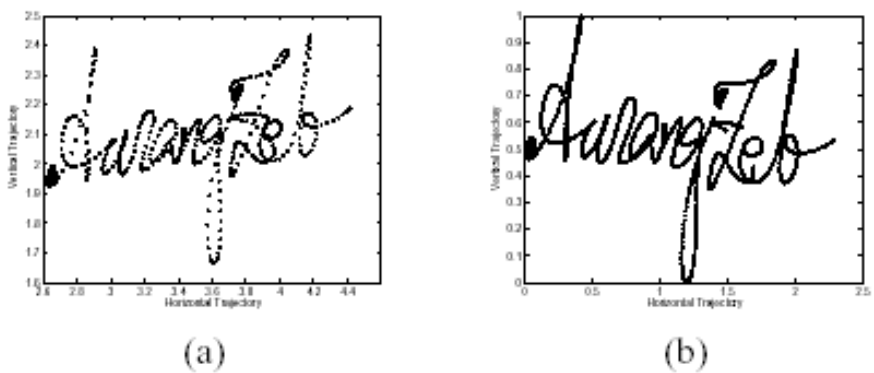
Step 4: Let the minimum width bitmap amongst B1, B2 and B3 be new active bitmap. Let θ be θ /2. Go to step2.

Translation, Rotation and Scaling

Now the next step is to make all the signatures scale-invariant, as after making them translation-invariant, all the signatures are at origin. It means that they lie on all four quadrants with different scale. So we make all the signatures lie in the first quadrant only.10 After making all the signatures scale-invariant, the vertical trajectories of each signature will be scaled from 0 to 1, and the horizontal trajectories will be scaled from zero to the ratio between the un-scaled vertical and horizontal trajectories, as shown in *Fig.1.3*

Size Normalization

The normalization of the signatures is essential because of the different writing styles for different individuals, which result in several variations in shapes and



(a) (b)

Fig 1.3: (A) Signature before pre-processing (B) Signature after pre-processing

sizes. Therefore to bring about uniformity in the input signatures all of them should be made of the same size. For this reason, signatures are fit into a standard size window. Every measure has to be taken to preserve the exact aspect ratio of the input signatures. Preprocessing of an input image forms a crucial step in any image processing application. This section discusses in detail the various pre-processing steps required and the algorithms used for their realization.

Signature Verification Architecture and Algorithm

The architecture of the system is shown in Fig 1.5. The input to the system is a scanned signature image which is pre-processed to remove noise and the skeletonization. Skeletonizing the image is important to derive a key feature because it reduces the computational time for the system and makes the implementation simple. This is because; we extract the pixel information by tracing along the boundary of the skeletonized image. A key feature of the pre-processed image is then extracted and used as an observation sequence in building the user's HMM signature model. Finally, based on the probability score given by the signature model, the verification of each signature image is done.

The algorithm for signature verification is as follows

Step 1: Capture the Scanned signature image and treat it as input image.

Step 2: Pre-processed that input image.

Step 3: Extract Feature of pre-processed image

Step 4: Apply Hidden Markov Model on Step 3

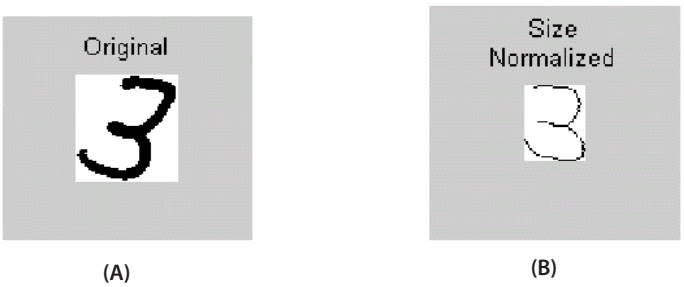


Fig 1.4 : Results after slant correction, thinning and size normalization.

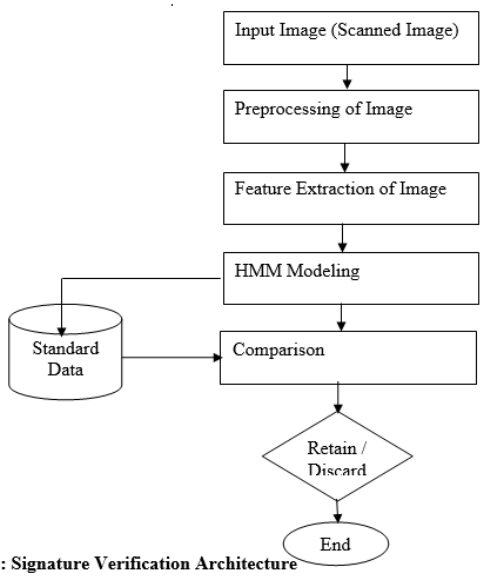


Fig 1.5: Signature Verification Architecture

Step 5: Compare step 4 image with original signature image.

Step 6: If it matches with original signature image then accept it otherwise, reject it.

Step 7: End of Algorithm

Types of Signature Forgery

Figure 1.6 shows the classification of forgeries.

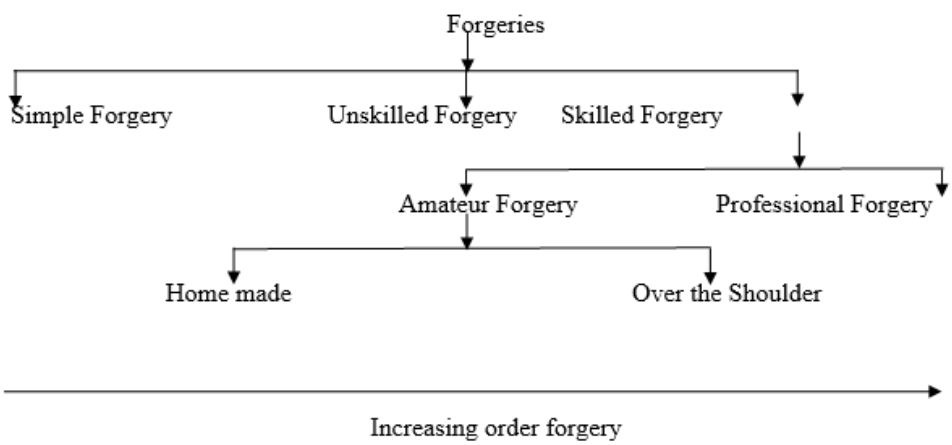


Fig 1.6: Forgery classification

Random / Simple Forgery: The signer uses the victim's name in his style to create a forgery known as the simple forgery or random forgery. This forgery accounts for the majority of the forgery cases, although they are very easy to detect even by the naked eye.

Unskilled /Casual forgery: The signer imitates the signature in his own style without knowing the spelling and does not have any prior experience. The imitation is preceded by observing the signature closely for a while.

Skilled forgery: Undoubtedly, the most difficult of all forgeries is created by professional impostors or persons who have experience in copying the signature. To achieve this, one could either trace or imitate the signature in a hard way. Some examples of signatures and their forgeries are shown in Table 1.1.

Definition of Terms

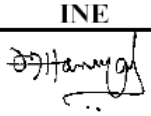
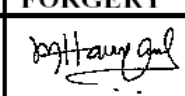
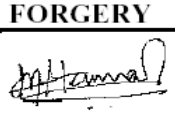
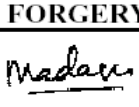
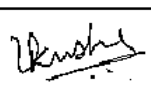
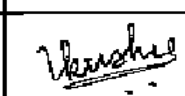
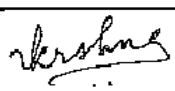
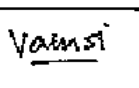
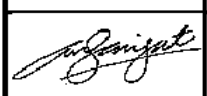
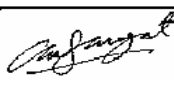
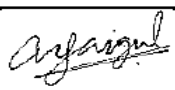
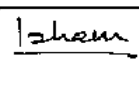
The following definition of terms are used for detecting forgeries in signature:

Definition 1: Pattern Matching is the science that concerns the description or classification of measurements based on the underlying model.

Definition 2: False Rejection (FR) is when a genuine signature is rejected as a forged signature.

Definition 3: False Acceptance (FA) is when a forged signature is accepted as a genuine signature.

Table 1.1: Examples of signature forgeries.[9]

GENU-INE	SKILLED FORGERY	UNSKILLED FORGERY	RANDOM FORGERY
			
			
			

Definition 4: False Rejection Rate (FRR) is ratio of the number of genuine signatures rejected to the total number of genuine signatures submitted.

$$FRR = \frac{\text{Total Number of genuine signature rejected X 100}}{\text{Total Number of tested signature}}$$

Definition 5: False Acceptance Rate (FAR) is ratio of the number of forged signatures accepted to the total number of forged signatures submitted.

$$FAR = \frac{\text{Total Number of forged signature accepted X 100}}{\text{Total Number of tested signature}}$$

Definition 6: Average Error Rate (AER) is the average of FAR and FRR.

Definition 7: Equal Error Rate (EER) is a point where FAR and FRR are equal.

Types of Biometrics

Biometrics can be classified into two types; physiological and behavioral. Physiological biometrics measure some physical features of the subject like fingerprints, iris, hand, and finger geometry which are stable over time. Behavioral biometrics measures user actions like speaking, writing, and walking, which are affected by health, age and physiological factors. A signature is a behavioral biometric characterized by a behavioral trait that a writer learns and acquires over a while and becomes his unique identity. We make a distinction between signature recognition and signature verification. Verification decides whether a claim that a particular signature belongs to a specific class (writer) is true or

Table 1.2: Qualities of different biometric.

S. No.	*Biometric*	*Reliability*	*Acceptability*	*Cost*
1.	Fingerprint	4	3	2
2.	Hand Geomtry	3	4	3
3.	Iris	5	2	2
4.	Face	3	4	3
5.	Eye Retina	5	2	1
6.	Handwriting	2	4	2
7.	Keystroke	1	4	5
8.	Voice	3	5	3
9.	Signature	3	5	4

false whereas recognition decides which of a certain number of classes (writers) a particular signature belongs.

Table 1.2 shows the qualities of different biometrics. This table presents an attempt to relate a number of biometric properties on a five point scale. The best score for reliability and acceptability is five. Cost indicates the manufacturing cost based on the components where five indicates low cost. Although storage of biometric is another design criterion, it is not included in table 1.2 because the used techniques and algorithms heavily affect the storage requirements.

Hidden Markov Models (HMM)

A Hidden Markov Model (HMM) is, like a GMM, a statistical approach. An HMM assumes that the system to be modeled consists of Markov processes with unknown parameters. An HMM is seen as the most simple form of a Dynamic Bayesian Network (DBN). The Hidden Markov Model (HMM) consists of the following elements:

- The number of states, N
- The number of observation symbols in the alphabet, M
- A set of state transition probabilities

The first element is the amount of samples taken from a signature. The second element represents the symbols that are used as states. With signature verification, these symbols can be the x and y coordinates. The third element is the probability of transition from one state to another. The term "hidden" in hidden Markov models means that only the outcome (not the state) is visible to an external observer. A simple HMM is shown in figure 1.7. In this figure, there are three states and five transition probabilities. The state transition probabilities can be calculated by using the

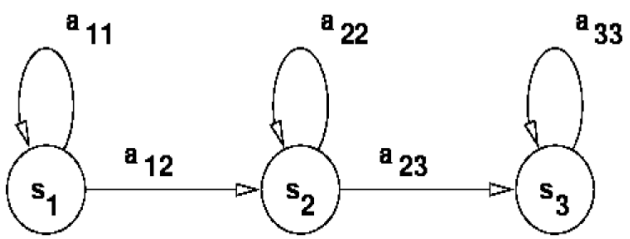


Figure 6-1: HMM graph

Fig 1.7: Hidden Markov Models

following formula

The state transition probabilities can be calculated using equation 1.1

$$a_{ij}=p\{S_{t+1} = j \mid S_t = i\},\ 1 \le i, j \le N \qquad \{1.1\}$$

Where S_t = Current state

aij = Transition Probability between state i and j

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