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E-waste Management : Corporate Sustainability through IT Sector

Parul Kashyap*

Yasha Porwal**

E-waste or electronic waste refers to the electronic items that are no longer in order or are dead and are needed to be disposed off. Poorly disposed e-waste harms the environment; internal components of discarded items usually contain heavy metals like zinc, lead and barium that leach through soil, get emitted into the air or worse, end up as toys with the kids. The aim of this paper is to discuss the various environmental techniques used by a few top IT companies of the world who have taken upon the challenge to reduce e-waste. Through this paper we find out how HP, Dell and TCS are doing their part to save the environment.

Keywords: E-wastes, electronics, IT Sector, corporate, recycle, HP, Dell, TCS,

INTRODUCTION

With more than 40 million PCs ready to reach end of their life-cycle, the disposal is the topic talked most about in current world scenario. Technological advancement and their growth are in rapid pace resulting in excess hardware that is potentially dangerous to world's ecosystem. If disposal of these hazardous materials keeps taking place in the regular fashion, the world's ecosystem would continue to degrade at a faster rate, resulting in release of toxin in land, water and atmosphere. To prevent this, Environmental protection agency (EPA) are setting the guidelines which are now followed by many companies worldwide.

So, why e-waste is a problem? This is the time of rapid technology changes, but the adaptations to these technological changes are not swift. We are placed in the blind side of the e-waste problems. Here, we would be discussing about various initiatives and projects taken up by different IT Sector giants. Corporate sustainability is much required right now, where the e-waste generated is the highest.

What are e-wastes? A list of E-waste typically generated in IT sector as per Annexure IB of the WEEE Directives is given below for reference:

1.	Centralized data processing	13.	User terminals and System
2.	Main Frames	14.	Lighting equipment
3.	Printer Units	15.	Audio/ Video conferencing System
4.	Mini Computers	16.	LCD Monitors, Projectors, Plasma Screens
5.	Personal Computing	17.	Photocopying machines, toners
6.	Personal Computers *(CPU, Mouse, Screen, Key Board included)*	18.	Refrigerators/Deep Freezers
7.	Laptop Computers* (CPU, Mouse, Screen, Key Board included)*	19.	Smoke Detectors/Heat Regulators
8.	Note Book Computers	20.	Automatic Dispensers for hot drinks.
9.	Note Pad Computers	21.	Air Conditioner appliances
10.	Printers	22.	Telephone, telex, facsimilie and other telecommunication system
11.	Copying Equipment	23.	Other products and equipment for the collection, storage, processing, presentation or communication of information by electronic means.
12.	Pocket and Desk Calculators		

Source: <http://www.tcs.com/>

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There are a lot of health issues also, faced by e-wastes around the globe!

Table 1: Effects of E-Waste constituent on health

Source of e-wastes	Constituent	Health effects
Solder in printed circuit boards, glass panels and gaskets in computer monitors	Lead (Pb)	<ul style="list-style-type: none"> • Damage to central and peripheral nervous systems, blood systems and kidney damage. • Affects brain development of children.
Chip resistors and semiconductors	Cadmium (Cd)	<ul style="list-style-type: none"> • Toxic irreversible effects on human health. • Accumulates in kidney and liver. • Causes neural damage. • Teratogenic.
Relays and switches, printed circuit boards	Mercury (Hg)	<ul style="list-style-type: none"> • Chronic damage to the brain. • Respiratory and skin disorders due to bioaccumulation in fishes.
Corrosion protection of untreated and galvanized steel plates, decorator or hardener for steel housings	Hexavalent chromium (Cr VI)	<ul style="list-style-type: none"> • Asthmatic bronchitis. • DNA damage.
Cabling and computer housing	Plastics including PVC	Burning produces dioxin. It causes <ul style="list-style-type: none"> • Reproductive and developmental problems; • Immune system damage; • Interfere with regulatory hormones • Disrupts endocrine system functions
Plastic housing of electronic equipments and circuit boards.	Brominated flame retardants (BFR)	<ul style="list-style-type: none"> • Disrupts endocrine system functions
Front panel of CRTs	Barium (Ba)	Short term exposure causes: <ul style="list-style-type: none"> • Muscle weakness; • Damage to heart, liver and spleen.
Motherboard	Beryllium (Be)	<ul style="list-style-type: none"> • Carcinogenic (lung cancer) • Inhalation of fumes and dust. Causes chronic beryllium disease or berylliosis. • Skin diseases such as warts.

Source: <http://wgbis.ces.iisc.ernet.in/energy/paper/ewaste/ewaste%20management.pdf>

Literature Review: This e-waste paper is a permutation of numerous research works. The methods of reconditioning the e-waste are being discussed in this paper.

RESEARCH METHODOLOGY

This paper is based on secondary data analysis and is constructed on the data collected and information congregated from the various websites of the IT companies. Different research papers and numerous documentaries have been comprehended for gathering information regarding the collection, disposal and recycling of the concerned e-wastes generated in US, India and all across the globe. The collected information was analysed to develop an understanding of existing initiatives and projects undertaken by several IT companies.

OBJECTIVES

- 1) To identify the e-wastes generated by various IT companies around the globe.
- 2) To describe what are the steps taken by the IT Sector to recycle, refurbish and recondition the e-waste.

- 3) To compare the different strategies of different IT companies with common denominator of e-waste.
- 4) To collect various data on the companies' role in e-waste management.

FINDINGS

Little things can have a dramatic impact on the environment and it seems HP understands that. According to HP's website, "HP produces low-carbon solutions and energy-efficient products, using safer materials and greener packaging to lower our customers' environmental footprints and is also embracing the circular economy across its value chain."¹

Under the umbrella term of "Environment", HP is branching-out to various sectors for sustainable development. One of its operations covers product reuse and recycling. It is an industry leader in product take-back programs, which began in 1987. When its products have served its mechanical life's purpose, it takes proper responsibility to reuse and recycle them. HP has an innovative "closed loop" recycling program in which plastic from HP ink and

toner cartridges is combined with other plastics to create new HP ink or toner supplies as printing a document doesn't harm the environment directly however the waste of ink and cartridges does. The plastic is recovered via the HP Planet Partners program. HP Planet Partners program was developed in collaboration with recycling and materials supplier partners. They collect used products for resale and recycling in 74 countries and territories worldwide and provide their customers with comprehensive, responsible reuse and recycling programs globally. HP claim's on their website that in the last 11 years HP's solution has used over 177 million pounds of recycled plastic from over 682 million HP cartridges, 3.3 billion water bottles and, 50 million apparel hangers to manufacture over 3 billion closed-loop cartridges. More than 80% of our ink cartridges and 38% of HP LaserJet toner cartridges are now manufactured with closed-loop recycled plastic.(Ink cartridges that include recycled plastic contain 45 - 70% recycled plastic; HP LaserJet toner cartridges that include recycled plastic contain 10 - 33% recycled plastic)."They only recycle products that cannot be reused. Since 1987, HP Planet Partners have recovered 1,683,000 tons (3.71 billion pounds) of computer hardware (for reuse and recycling) and HP supplies (for recycling) and have recycled more than 3.3 billion pounds of products.

One of the major highlights of HP's environment awareness programs is their "Take-Back Programs." HP has taken the responsibility of recycling old and defunct IT assets. Improper disposal of such equipment's could harm various walks of life and poor handling can put people's information at risk. Therefore, HP offers secured and responsible services like:

- Complete destruction and recycling at state-of-the-art recycling facilities
- Onsite data annihilation (degaussing or shredding)
- Asset tracking, auditing, and certificates of destruction
- Complete transportation and logistics synchronisation

Their global network of vendors collect, process them for resale or recycles returned products. In the United States, they have partnered with major retailers to provide easy access for consumers in returning their items. And the entire process is tied by strict norms to ensure that returned products go

through a data-cleansing process to ensure customer privacy.

After a hardware product has been returned, determination of the best recovery solution is their first priority. They preferred an option with the lowest environment impact, like many other hardware companies, to refurbish and resell equipment when it has resale value.

HP mentions on their website about recycling returned hardware that is unsuitable for reuse. They cofounded European Recycling Platforms. It provides take-back and recycling services to HP and other companies in Europe. Consumers in United States can drop off hardware products for recycling at more than 3,700 Staples and FedEx Office locations. If they prefer, they can use HP's Consumer Buyback Program to return IT equipment of any brand in exchange for money or purchase credits if the product has some value. If the equipment had to be destructed, consumer can also request Certificates of Destruction "that verifies that products were destroyed through the recycling process, that the data on the products cannot be accessed by anyone else, and that the recycling methods used; met or exceeded applicable environmental regulations."HP Planet Partners have authorized collection sites, at more than 11,000 drop-off locations worldwide.

For smooth processing, HP has contract with Environmental Resources Management (ERM) to audit their recycling vendors against HP policies and vendor standards. In 2014, through ERM, it audited 72 vendor facilities (29 reused and 43 recycling) in 24 countries. This included repeat audits of 39 vendors to confirm their ongoing commitment towards improved performance.

According to Barbara Kyle, National Coordinator of 'Electronics TakeBack Coalition', Dell's policy on e-waste export is now strongest in the industry. Dell, in 2009, banned the export of non-working electronics and e-waste to developing countries such as India, China, and, Africa. In FY 2015, Closed-loop Recycling strategy was used by Dell. With the launch of 'Optiplex 3030' all-in-one, Dell became the first in the industry to offer a desktop made up of recycled plastics that are third party certified (by UL Environment) as closed loop. Also, in the year 2015, Dell signed 5-years agreement with United Nations Industrial Development Organization (UNIDO) to cooperate on identifying and implementing a sustainable e-waste management model for

developing countries in Africa, Asia and Latin America. Dell also, had setup an e-waste recycling hub and collection Network in Kenya in FY2014.

While Dell is undertaking their share, TCS is also leading the e-waste management with complete promptness.

Under waste management and corporate sustainability, TCS is unfailingly following the matrix of Profit, People and Planet. As the charity begins at home, TCS makes a conscious effort in their offices. It is the responsibility of every associate to separate their wastes into recyclable materials and place them in the proper recycling bins. All offices across TCS must purchase and sell the goods made up of recyclable materials. The implementation of the office of Waste Reduction and Recycling will work towards making the office and surroundings free from e-waste.

'Green Desktop Infrastructure' adopted by TCS is an approach to reduce desktop carbon footprint.

CONCLUSION

With our research about various IT companies, we gained knowledge regarding how much HP, Dell and TCS are vigilant towards environment and things that can harm it. Each company has taken varied measure to reduce their carbon footprint thus minimising the effects of e-waste to a certain level. We conclude this paper in hope that these companies will continue to do so and many more IT firms will try to follow their footsteps.

RECOMMENDATIONS

- 1) Spreading awareness at a right young age, so as to catch up with our "free-from-e waste" future slightly early.

- 2) A standardized process must be mentioned by government authority for collection and disposal of the hazardous e-wastes.
- 3) The designers and manufacturers must design the product for disassembling and maintenance. The products must be designed for remanufacturing.

GAPS

Although, we tried not to miss on any aspect however due to limited sources, we couldn't thoroughly contact the above discussed firms personally for better understanding of their mentioned programs. Also this paper doesn't include various other small-scale industries who are doing their part in saving the threatened environment.

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Space Debris- An increasing Junk Yard

Disha Saxena*

The subject of Space Debris, not the 2015 US TV Series but the real junk left in outer space which is headed into our future is a matter of grave concern and requires immediate attention of the National and International Authorities. Since 1957, more than 4,900 space launches have led to an on-orbit population today of more than 18,000 tracked objects. Only 1,100 are functional spacecraft. The remaining 94% are space debris, i.e. objects which no longer serve any useful purpose. This paper focuses on the risks associated with space debris and how it can be controlled.

Keywords: Space debris, atmosphere, man-made objects, space based methods

INTRODUCTION

Why is space junk such a growing problem?

Taking a tangent from the topic of environmental pollution (If you know people in NCR - Delhi you know what happened after Diwali'16, Air pollution levels left us unsettled) - let's give some thought to Space pollution. According to NASA, America's space agency, the skies high above the Earth are cluttered up with around 23,000 pieces of man-made space junk measuring 10cm or more across, zipping along at great speed and posing a threat to working satellites. The European Space Agency reckons that collision alerts arising from worn-out satellites, defunct rockets and other clutter (such as launch adapters, lens covers, copper wires and the odd glove) have doubled in the past decade. Every such collision spawns more junk - a phenomenon known as the Kessler syndrome, named after Donald Kessler, an American physicist who postulated it in the 1970s. Low-Earth orbit, the region between 160 and 2,000km above the Earth, is crucial to space exploration. It is home to about half

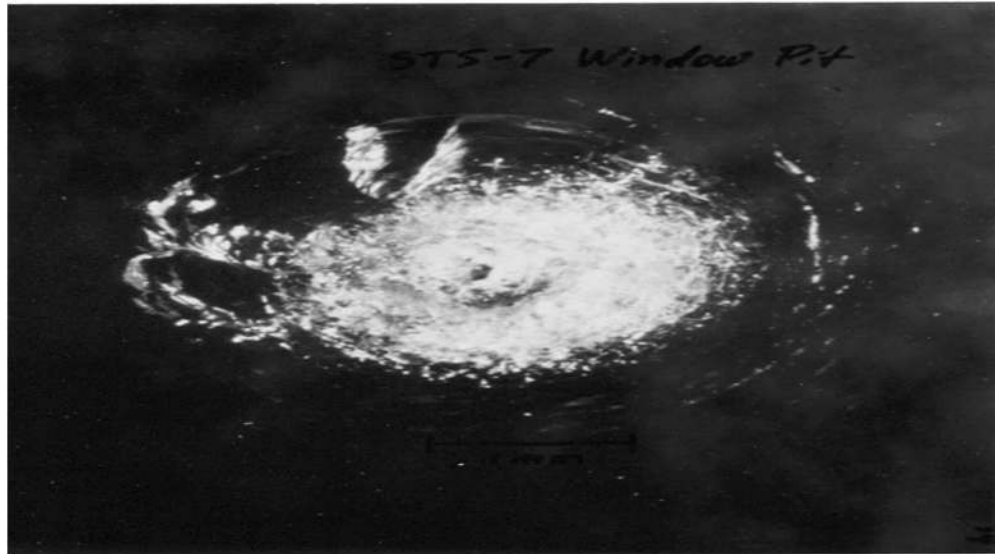
of the roughly 1,300 satellites which scan the Earth in great detail for both military and civilian purposes. It is also littered with "around 5,000 objects that are either rocket bodies or dead payloads," says Kessler. This is dangerous. A fleck of paint travelling at an orbital velocity of 17,500kph can dent a spacecraft, kill an astronaut or do enough damage to throw a satellite off course. Inoperative rockets are prone to random explosions of the unused fuel they carry.

"Space debris are all man-made objects, including their fragments and parts, whether their owners can be identified or not, in Earth orbit or re-entering the dense layers of the atmosphere that are non-functional with no reasonable expectation of their being able to assume or resume their intended functions or any other functions for which they are or can be authorized."

Wikipedia says "collection of defunct man-made objects in space - old satellites, spent rocket stages, and fragments from disintegration, erosion, and collisions - including those caused by debris itself".

As of December 2016 there were 5 satellite collisions with space waste. About 64% of the routinely tracked objects are fragments from some 250 breakups, explosions and collisions of satellites or rocket bodies. In addition, there is evidence of a much larger population of debris that cannot be tracked operationally. An estimated number of 700,000 objects larger than 1 cm and 170 million objects larger than 1mm are expected to reside in earth orbits.

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How do we measure space debris?

Space debris mitigation measures, if properly implemented by spacecraft designers and missions operators, can curtail the growth rate of the space debris population. Active removal, however, has been shown to be necessary to reverse the debris increase. So how do we measure these objects? Ground based (Radar and Optical) methods along with Space based methods are put in place to collect data. Objects are divided into LEO, and HEO; Lower Earth Orbit and Higher Earth Orbit. We have been able to measure objects as small as 10cms in LEO. Small debris objects (smaller than a few millimeters in diameter) have already caused some damage to operational space systems. These impacts have had no known effect on mission success. This damage can be divided into two categories. The first category is damage to surfaces or subsystems. The second category is the effect on operations. Wide field Imaging for observations get degraded due to debris, this pollutes the measurements and hence operations.

Space Debris Mitigation Measures

It is a big problem and an issue as to how to clean up the space debris. Schudder (2016) made the observation that, "I can tell you the worst way to clean up a dead satellite, which unfortunately happened in 2007; the Chinese military decided to test their anti-satellite technology on one of their dead weather satellites. This test successfully exploded the dead satellite, and created over two thousand new pieces of space debris, which, at the time, increased our space junk tally by 25%. (We had another spike in the space debris population after a dead, but intact, Russian spacecraft managed to collide with a not-dead privately owned satellite - that produced another 2000+ large pieces of debris.)"

Japan Aerospace Exploration Agency (JAXA) recently launched into orbit a space junk collector to clean up space debris. Kounotori, which means stork in Japanese, blasted off from the southern Japanese island of Tanegashima on Dec. 9 onboard an H-IIB rocket, Phys.org reports.



NASA envisions autonomous rendezvous in the future, making refuelling and servicing satellites possible even without human participation. (Photo : Paolo Nespoli - ESA/NASA via Getty Images)

Collected data comes in handy while applying Risk Mitigation methods for short term and long term models. Space debris models provide a mathematical description of the distribution of objects in space, the movement and flux of objects and the physical characteristics of objects (e.g. size, mass, density, reflection properties and intrinsic motion).

The scope of the long-term modelling of the space debris environment is the long-term (up to 100-year) prediction of the number of objects as a function of time, of altitude, of inclination and of object size. These projections are important for assessing the necessity and the effectiveness of debris mitigation techniques and the impact of new space activity. Risk assessments in LEO are routinely utilized to enhance the safety of space operation. In cases involving human space flight, risk assessments have proved invaluable in ensuring the safety of shuttle operations. Shuttle missions are operationally reconfigured whenever a pre-flight risk assessment indicates that the risks of space debris are at an unacceptable level.

Risk assessments were utilized to design the location and type of space debris shielding that would protect the crew as well as the crucial subsystems on the International Space Station. Space agencies and private companies from various countries have proposed a variety of methods to clean up the mess. Scientists in Japan have recommended installing lasers on the International

Space Station to nudge debris into the Earth's atmosphere, where it would burn up harmlessly. NASA scientists have proposed doing the same thing using ground-based lasers. In March 2015, the European Space Agency experimented with nets designed to capture moving debris. Japan Aerospace Exploration Agency has devised an electrodynamic tether which, when tied to a piece of space junk, would cause it to slow down and fall into a lower orbit. Space agencies across the globe are considering other options too. Dead satellites located in geosynchronous orbit (about 36,000km above the surface of the Earth) are sometimes pushed into a "graveyard orbit" about 300km further out. New technologies allow rockets that have delivered their payloads to reignite their engines, lower their orbits and then burn up in the Earth's atmosphere. Many countries have agreed that satellites should be designed to burn up harmlessly in the atmosphere within 25 years of their operational lifespan coming to an end.

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Dress code in the Mauritian Working Environment: Defeminising Executive Women

Aansa D. Bedacee*

Today's emancipated women are educated and are occupying senior positions in the professional world. However, it does not necessarily mean that there is gender equality at the work place. The meaning of gender equality does not stop at providing equal rights legislation, but it goes further. A deeper look provides us with a more accurate status of the executive women.

Even though, women in the 21st century have proved their capacity as executives in the working environment, we think of an "executive" as a man because in the collective mind, feminine characteristics are still perceived as inferior for the workplace. "Female is by virtue a certain lack of quality" (Beauvoir, 1949) linked with weakness, passivity, fragility, emotion and beauty. This has resulted into an implicit defeminisation of the executive women.

The purpose of this paper is to sensitise people on implicit gender inequalities prevailing in today's working environment and to change sexist perceptions. This paper probes into the realities of the corporate world to understand the process of perpetuating the masculinisation of the executive image through the defeminisation of women.

INTRODUCTION

Thousands of years ago, when people started covering their body to protect themselves, they demarcated themselves from animals. Human beings are the only living creatures to use clothes and today, clothing has become so indispensable that the contemporary society cannot function without clothes. At present, clothing is not merely worn for protection, but it has many other meanings attached to it. Apart from differentiating males from females, clothing reveals the status of the wearer and its association with a particular culture/society or group.

With time, as people evolved, the function and interpretation of clothing became more and more complex. A survey was conducted among 85 participants and the subjects were asked to determine the importance of clothing. It was found that for 47% of the subjects, clothing represented a way to express their inner self, compared to 32% who associated clothing to comfort. The remaining

21% of participants said that clothing is linked to their looks or the way they want to be perceived. Therefore, it can be said that clothing has a far deeper meaning than simply covering and protecting the body.

The subject of women's clothing can be considered as unimportant, but it is an undeniable fact that women's clothing has always reflected their role and status in society. For example, in the 17th and 18th centuries, when the life of women was mainly restricted to the household and their participation in the corporate world was almost inexistent, their dress style was more complex than functional. They were wearing several layers of clothing. The opening of the drapery-parted skirt which they wore revealed an underskirt or a petticoat. Their dressing style laid emphasis on dilated hips and the corseted waist. Such clothing inevitably brought along an extreme restriction of mobility. However, with the advent of feminist movements and with the emancipation of women, fashion designs evolved and allowed more freedom of actions for women.

When women were fighting for their rights in the 1960's, a symbolic 'bra-burning' incident was reported by the 'New York Times' on 8 September 1968. It was a way for women to say that they do not accept oppression and that they are equal to men. As such, clothing was once again associated to the emancipation of women.

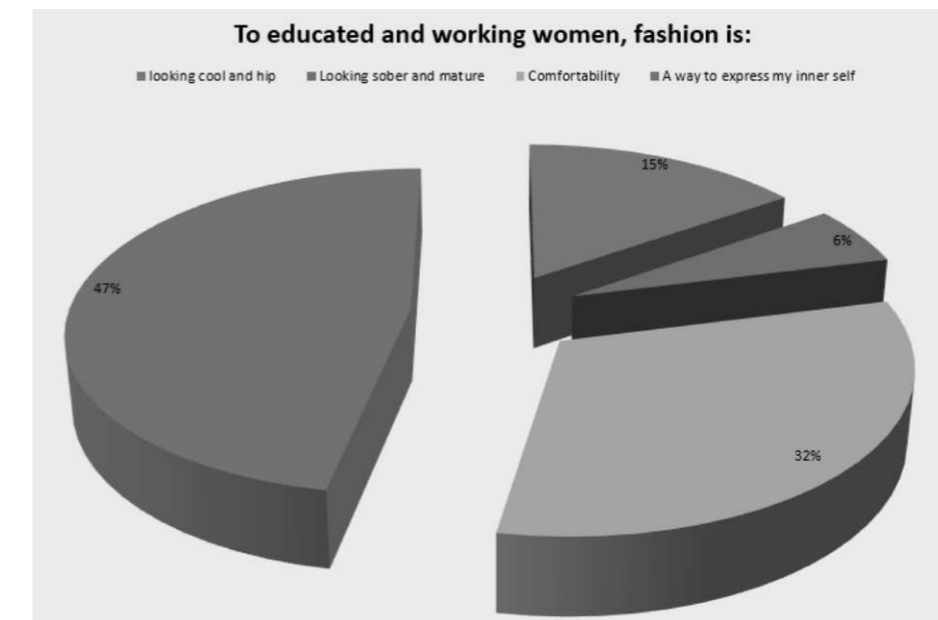


Figure 1: The importance of clothing

Eventually, the 'garçonne' look was created for women with the intention to give authority and power to women. As a result, contrary to past centuries, nowadays, nobody is shocked to see women wearing pants and suits, carrying a suit case and going to the office. Yet, in her research entitled "The working wardrobe: Perceptions of Women's clothing at work", Sue Gerrard (2005) wrote: "Research on clothing at work is significant by its absence in the organizational psychology literature (Rafaelli & Pratt, 1993). However, everyone wears clothes to work and most organizations have some kind of dress code (Easterling, Leslie and Jones, 1992)". The website theagtrader.com conducted a study among 3,000 workers and found out that for a majority of women, the way they dress affects their day of work and their performance. The way women feel and look do affect their career path and the study further reveals that two-thirds of the participants agree that dressing smartly is correlated to the respect gained at the workplace.

With regard to the above, we have decided to concentrate our research on the hidden implications directly linked to the executive dress code of women professionals and gender discrimination. When our work on women's clothing began, many people felt that it was insignificant. But, in fact, women's executive wear seems to be a black spot in women's emancipation. Women have surely come a long way and they are proud of their achievement. But professional achievement never meant the denial of one's identity. To be more precise, women

executives voluntarily or reluctantly reject their feminine characteristics and adopt a masculine image to better fit the male-dominated professional world. In 1980, the author of "Women: Dress for Success", Molloy concluded that if women wanted to be successful in the business environment, they had to dress in ways which would give the tight messages to men with power. It appears that women who wish to be taken seriously at work need to mimic the male business uniform (Harragan, 1977; Douglas, 1983; Saunders & Stead, 1986). Mc Craken (1985) suggests that by doing so, women are reinforcing all the masculine stereotype symbolizes, including their subordinate status. There is actually no law or practice in Mauritius compelling women to choose masculine garments and to minimize their femininity. But sometimes, unwritten codes can exercise powerful control (Kaiser, 1983-4).

Background and statement of the problem

The net gives the following comprehensive background on Mauritius: Mauritian society is a multicultural society and its population has its origin from three continents: Europe, Asia and Africa. Three or four decades ago, the mentally vis-à-vis women in Mauritius was very traditional. Very few women enjoyed freedom to seek education or any kind of training. A majority of them were viewed as second-class citizens and this was justified as being the natural result of the biological differences between the two sexes. As men were the sole breadwinners, the role of women was relegated. All decision taking was in the hands of

*

the husband. Moreover, the freedom of women was restricted as most families were extended.

After independence, much emphasis was laid on industrialization. Industrial zones were being set up and incentives were given for foreign investment. As a result of the extensive use of machines particularly in the field of textile and clothing, manpower was greatly needed to work in factories. Thus, female labour was absorbed by this industry. In the early seventies, many women began to leave their homes and start working, thus adding to the monthly income of the family. Today more than 75% of women work in textile factories. As a result women began to enjoy economic independence, their status in society rose and they enjoyed more dignity. The whole approach towards women changed. Women today are no longer regarded as the inferior sex and enjoy more equality.

As a result of economic independence, there was a change in the structure of the family unit. We began to have more nuclear families. In such a step, the traditional role of women began to lose importance. Both husband and wife have a role to play and start living on equal terms. At the same time trade unions began to fight for equal wages and such demands were backed up by feminist movements fighting for equal rights. Those organizations consisted mainly of intellectuals, both men and women. As there were mainly sexist laws that are to the detriment of emancipation of women, the authorities concerned were pressurized to change those obsolete laws and replace them with more equal ones.

Another factor, which has played a major role in boosting up the status of the Mauritian women, is education. Free education was granted in 1976. Since then, many more women and girls began to have access to education. Today, many boys and girls reach tertiary education. Moreover, legislation has been passed to make education compulsory till the age of sixteen. Girls completing tertiary education are thus able to occupy posts of responsibility. In almost all sectors, women are present, performing jobs once considered as male-oriented like, police force, driving vehicles and management posts."

In 2015, the population comprised 637,836 women compared to 624,769 men. Women outnumbered men by 13,067. The data for the year 2015 of the

Mauritian Government reveals that:

- Unemployed women were generally more qualified than their male counterparts;
- The average income tends to be lower for women than for men across all occupations;
- Women are largely under-represented in decision making at higher sphere of society;
- In the public sector, only around 40% of senior staff positions are held by women;
- The number of female parliamentarians is 8 out of a total of 70; and
- Women represented only 7% of the boards of directors of the Top 50 Companies in 2015 (ranked by profits).

In an attempt to find out more about the Mauritian society and the emancipation of women, a survey was conducted. Twenty-five participants of both sexes were asked to give the name of a powerful executive person. 92% of the subjects gave the name of a male person. This result indirectly indicates that in the collective mind, Mauritians still think of an executive person as man because feminine characteristics are still perceived as inferior for the workplace. "Female is by virtue a certain lack of quality" (Beauvoir, 1949) linked with weakness, passivity, fragility, emotion and beauty. This has resulted into an implicit desexualisation of the female executive. The desexualisation process of executive women include the masculinization of the clothing style and the masculinization of behavior and attitude.

Such forces prevent the corporate women from having their full potential in comparison to their male colleagues. Regrettably, very little research has been carried out to understand the process of the masculinisation of the clothing style of executive women and its impact on them.

The purpose

Therefore the purpose of this research is as follows:

- To understand the concept of gender in the Mauritian working environment and the prevailing perceptions regarding dress code
- The expectations/unwritten laws or subtle requirements pressurizing women to undergo an implicit process of defeminisation either voluntarily or against their will;
- To better understand the executive women's

personality trait in comparison to the executive image and the consequences of the desexualisation process.

Method

Two different surveys were conducted. Subjects were asked to fill a survey form about the executive women's dress style. The first survey was conducted among educated (higher education level) executive women to determine the following:

Is dress style is important to them?

Is their clothing style linked to their self-esteem?

The significance of fashion to them

Their personal style

Their personality trait

Their 'wish' image

Their reaction to a change in their dressing style

Their level of comfort in wearing masculine clothing style at work everyday

The second survey targeted male employers and they were requested to answer the following questions:

The importance of applying dress code in an organisation

What type of dress code should be set by the employer?

What type of dress should women wear to best project the image of the organization?

What clothing style would be promoted at work?

Is dress style connected to the wearer's self-concept?

Which clothing style can lead to a promotion at work?

Does the application of dress code at work have an impact on the female employee's self-concept and self-esteem?

What kind of impact would it be?

It is worth mentioning that this research focuses on the Mauritian society and all participants are Mauritians.

For all the questions, participants were provided multiple answers to choose, but they were also given the opportunity to give their own answers so questionnaire designed was both open ended and closed ended. The questionnaires were distributed in both public and private organizations. Out of 110

survey forms distributed to women, 85 answered, whilst only 11 men filled in the form out of 25.

Subjects

For the first survey, subjects consisted of 85 educated (tertiary education level) and professional women aged between 30 to 50 years, occupying executive positions in either the government or private sector. Occupations of the participants were as follows: Chief Executive Officers, lawyers, second line officers, Assistant secretary in Ministries, Officer-in-Charge, academics, etc.

There were 11 male employers who participated the second survey. They were mostly from the education, ICT, banking and manufacturing, plus services sectors.

Findings

For centuries, the place and role of women were limited as mothers, wives and daughters in the household. But the fight of feminists over decades has changed the fate of oppressed women in many parts of the world and numerous countries have taken initiatives to guarantee equal rights, equal opportunities and equal treatments for men and women. Along the same line, relevant laws and policies were enacted in Mauritius to ensure that women are treated fairly, with dignity and respect. The constitution of Mauritius guarantees the equality of all citizens and the respect of fundamental rights and freedom. In 1995, the constitution was amended to make sex discrimination illegal and in 2011, the government adopted the Equal Opportunities Act (2011) which emphasizes equality of opportunities. Moreover, in order to provide support to working women, the following laws were also enacted as per the "Sex Discrimination Act":

- Eliminate, discrimination against persons on the ground of sex, marital status, pregnancy;
- Eliminate discrimination involving dismissal of employees on the ground of family responsibilities;
- Eliminate discrimination involving sexual harassment in the workplace, in education institutions and in other areas of public activity; and
- Promote recognition and acceptance within the community of the principle of the equality of men and women.

There is also the “Labour & Industrial Relations Act” which guarantees the equality of men and women with respect to the individual's constitutional right to work and protection from unlawful dismissal. However, the wide-ranging initiatives taken to eliminate gender inequality in Mauritius have not been completely successful. In an interview to Business Magazine, Catherine McIlraith (March 2016) stated that “the glass ceiling does exist in Mauritius. Mauritius earned a ranking of 120 out of 142 places [...] due to a poor performance with regards to the economic participation, opportunity and political empowerment.” Although the Mauritian law guarantees gender equality, in reality, the deep rooted social construction of gender roles is a major barrier for women to get equal treatment at the workplace. Through the process of correspondent inference (Jones, 1976), the division of labour led to gender roles. Boymel Kampen (1996) defines gender as “the social and cultural construction of femininity, masculinity, and anything in between as opposed to the biological sex”. People are generally socialized to be ‘feminine’ or ‘masculine’ based on cultural norms and assumptions of gender difference are often so embedded into our cultural systems, beliefs, and behaviours that they appear ‘natural’, and thus we tend to take them for granted” (Morris, 2000).

Gender roles are collections of factors like appearance, sexual orientation, social conduct, the

type of jobs, economic roles, chores, hobbies, etc. In brief, gender roles determine the specific positions and actions of a given gender as defined by a culture. Eventually, gender roles have created a gender stereotype. This stereotype has resulted into specific ways of living in society, whereby both men and women need to stick to their respective attributed positions and responsibilities in order to be socially accepted. Ultimately, in the collective mind, the image of “perfect woman” and “perfect man” took shape according to the assigned gender roles and gender stereotypes. The characteristics for the “perfect woman” include femininity, beauty, fragility, physical weakness, peacefulness, respectfulness, passivity, compassion, caring and loving nature, sensitivity, dependency and generosity. For men to match the “perfect masculine image”, they need to be powerful, well-built and muscular, a provider, authoritative, strong-minded and independent. For those who have decided to maintain their individuality or who are far from the prescribed image of the ‘perfect’ man or woman, very often they have a low self-esteem and feel socially rejected. Therefore, in an attempt to fit the image of the ‘perfect’ female, the majority of women in the patriarchal Mauritian society ‘naturally’ adopt feminine characteristics. This statement is proved by our survey which was conducted among 85 executive women. 33% of executive women chose to have a feminine dress style, compared to 27% who prefer a creative/artistic clothing style, and 23% who opt for a classic/elegant style.

The response of female participants to this survey is

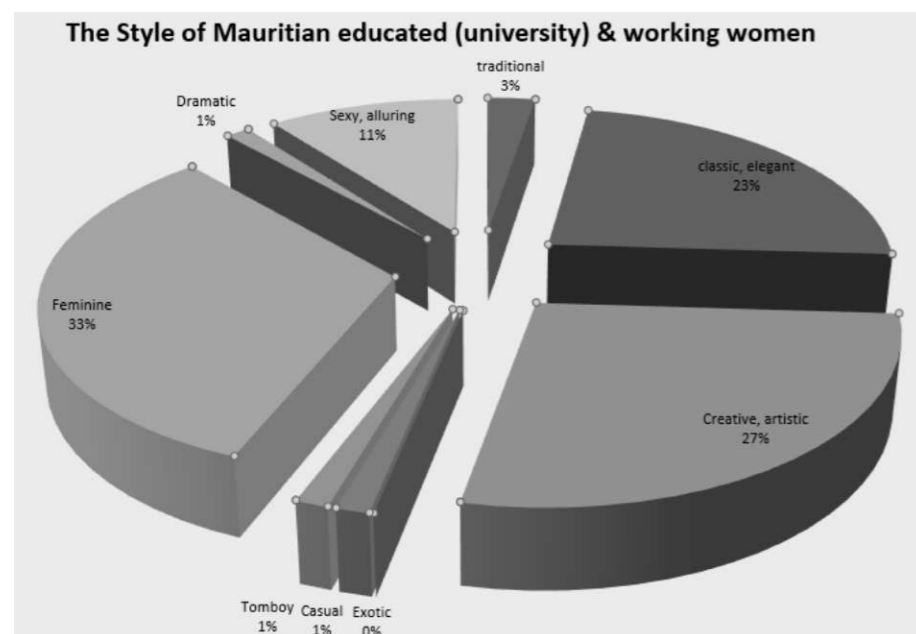


Figure 2: The dress style chosen Mauritian executive women

not at all surprising. From the time of the birth of a baby girl to the age of adulthood, feminine characteristics are inculcated in women. Maltz and Broker's (1982) research showed that the games children play contribute to socializing children into masculine and feminine cultures. Besides, Simone de Beauvoir (1949) rightly said that “One is not born, but rather, becomes a woman”. Throughout their childhood, little girls are told fairy tales like “Cinderella”, “Snow White”, “The Sleeping Beauty” and so on. These children stories reinforce the gender stereotypes whereby the female protagonists of these stories are all very beautiful, loving, compassionate, defenseless, submissive and dependent. In short, they represent the 'ideal woman' of the patriarchal society who need a man (the prince charming) to save them, to marry them, to give them children and to provide for them. The upbringing of little girls in male dominated societies is undeniably based on gender stereotypes. By the time little girls reach adulthood, they take on distinctive attitudes about their role and position in society. The psychologist, Dr. Sandra Lipsitz (1981) developed the gender schema theory whereby throughout their life people act and react based on the combination of aspects of the social learning theory and the cognitive development theory of sex role acquisition. The theories about social learning and cognitive development help us to understand why 53% of Mauritian women are engaged in “traditional female occupations”. Based on specific gender assignment, people expect men to occupy authoritative and powerful positions and women to hold subordinate positions. This partly explains

why, in Mauritius, the majority of the female working population holds traditional female or elementary jobs. The female jobs include the following: Air hostess, esthetician, typist, secretary, nurse, nanny, maid servant, receptionist, personal assistant, model, nail artist, teacher, and so forth. It does not take long to notice that such employments not only give a subordinate status to women, but they are all requiring the female employee to enhance their feminine traits. To be feminine means having qualities and or appearances traditionally associated with women. The male dominated corporate world even applies specific dressing style for women occupying subordinate positions in the corporate world. These female employees need to look attractive, nice and welcoming. These women usually wear makeup and feminine clothing or uniforms such as skirts, blouses and dresses. “Culturally, women learn that they should care about how they look more than men do.” It therefore appears natural that in order to fulfill their gender role and to be socially accepted, women chose to be feminine and to occupy gender-linked jobs. Thus, even though women in Mauritius are doing well in terms of educational attainment, this is not translated into equality in terms of the position they occupy in the corporate world. Only a small percentage occupies high positions. The reason being that “the elements of convention or tradition seem to play a dominant role in deciding which occupations fit in with which gender roles. The majority of patriarchal societies is not often tolerant of one gender fulfilling another role. The traditions of such societies often direct that certain career

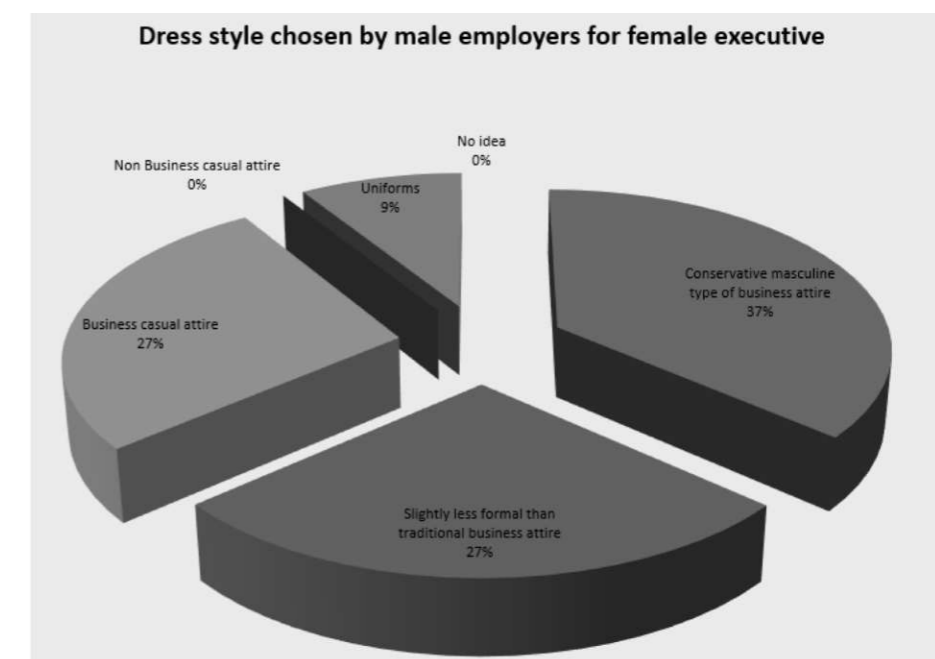


Figure 3: Dress style chosen by male employers for female executive

choices and lifestyles are appropriate to men, and other career choices and lifestyles are appropriate to women.”

Moreover, gender stereotypes are culturally dependent and are reinforced from birth (Ozkan & Lajunen, 2005; Williams & Best, 1990). As such, gender stereotypes still influence the perceptions of Mauritians. As a consequence, Mauritian women are not able to benefit from the same privileges as men in the professional arena. When women get out of their traditional feminine roles and take an executive position which is normally occupied by men, they inevitably have to face an internal conflict. They have to balance their femininity with their executive image, which is a masculine one. Sue Gerrard (2005) wrote that “women at work appear to be faced with a choice of image – either decorative or businesslike. Both are acceptable, but are mutually incompatible with each other (Kaiser, 1990).” But, the male dominated professional arena has difficulty in accepting the feminine side of women occupying executive positions.

We should not forget that the socially constructed gender roles are considered to be hierarchical and characterized as a male-advantaged gender hierarchy (Wood & Eagly, 2002). In the collective mind, characteristics like strength, dominance, confidence, competition, rationality and authority are seen as masculine (Martin B, 1984). In contrast, “female is by virtue a certain lack of quality” (Beauvoir, 1997) linked with weakness, passivity, fragility, emotion and beauty. As such, feminine characteristics are perceived as inferior for senior positions. This resulted into a rejection of feminine traits at the workplace and our survey among male employers reveal that a greater percentage of man prefer executive women to wear a masculine clothing style at work.

As already mentioned, the executive position in the corporate world usually requires what are considered typically “male characteristics” (Knight & Guiliano, 2003). In the Mauritian culture, the masculine values are the ones valued most highly for positions of power. An active role is assigned to men, whereas an appearance-centered role is assigned to women (Rosaldo, 1974). Therefore, in order to attain and maintain a senior position, executive women end up adopting a masculine dress style and renouncing their feminine image. “The identity projected may not always be one which the executive woman has chosen, but may well be ascribed (Kaiser, 1990) by the employer. According to Fairchild County Business Journal

(2005), executive women dress to promote respect, enhance their authority, and assist in gaining advancement opportunities” (Sue Gerrard, 2005). Thus, in order to have a successful career, educated and competent Mauritian women are implicitly compelled to discard their feminine traits and adopt masculine characteristics. This situation is well expressed by the Pink Magazine. It published an interview of Michelle King, the Vice President of a realty company on the internet where the interviewee was quoted: “I will not promote anyone (referring to a woman in this case) who doesn't dress appropriately. I consider it a factor in her decision-making skills.” In such cases, appropriate dress usually refers to the executive dress style approved by male dominated corporate world. In a second internet article, Judith Rasband (2010) wrote that at the workplace “the more skin you show, the less authoritative you become”. The perception of Women executive wear is directly associated with cultural beliefs, systems and traditional gender attributions. The concepts of Social psychologist Geroge Herbert Mead (Mead, 1943) and Herbert Blumer (Blumer, 1969) clearly explain that the “perception of clothing involves both the wearer and perceiver bringing to an encounter their own social constructs”. The gender discrimination faced by Mauritian women originates partly from **Christian Culture:**

religious beliefs and traditional values. The following quotations from the three main religions of Mauritius clearly explain why women with power need to hide their femininity.

Hindu Culture:

“There is no creature more sinful than women [...] They are never satisfied with one person of the opposite sex [...] Verily, women are the root of all faluts” (Vyasa, 1997)

Muslim Culture:

Qur'anic Text

From Yusuf Ali or Muhammad Asad translations:

“And say to the believing women that they should lower their gaze and guard their modesty; that they should not display their zeenah (charms, or beauty and ornaments)... Tell your wives and daughters and the believing women that they should draw over themselves their jilbab (outer garments) (when in public); this will be more conducive to their being recognized (as decent women) and not harassed. But God is indeed oft-forgiving, most merciful.” (33:59)

Timothy 2:9-10

“Likewise also that women should adorn themselves in respectable apparel, with modesty and self-control, not with braided hair and gold or pearls or costly attire, but with what is proper for women who profess godliness – with good works.”

Such religious beliefs have given way to a collective perception that sexy or attractive feminine women are low-grade. Peter Glick, a psychology Professor at Lawrence University conducted a survey and published in the “Psychology of women Quarterly” that sexy attire put women into the 'less competent' category, no matter how smart they actually were. Moreover, Susan Fiske (2008) reported that “the changes in brain activity suggest sexy images can shift the way men perceive women, turning them from people to interact with, to objects to act upon” and it has been reported that “women have more obstacles to overcome with business dress than men and, in particular, that they face double standard.” In her research Sue Gerrard (2005) wrote: “It should be noted that individuals develop implicit – that is, not articulated – personality theories about others (Arnold, Robertson & Cooper, 1991). Information may typically be organised as prototypes – a cluster of characteristics which typify a personality type (Rosch, 1977) or stereotypes- “The perceived characteristics of an extremely defined group” (Arnold et al. op cit). If one of the characteristics of a prototype or stereotype is perceived, the rest tend to be elicited, often erroneously, which is why stereotypes have such pejorative associations (Kelly, 1950).” So, if the male employer perceives a

'masculinised' woman wearing a suit as competent, he may assume that all desexualized women wearing suits are efficient. Along the same lime, if sexy and attractive women have been stereotyped as unfit for high positions, the majority of men in the patriarchal society therefore has a problem in accepting professional women who project a highly feminine image.

“In their study, DeLong & al (1980) found that men were less attracted to formally dressed women. This fact also explains why the male employers prefer female executives to adopt a more masculine dressing style. Barr (1934) found that conformity was an important criterion in choice of clothing may indeed be responsible for glass ceiling experienced by women in their careers” (Sue Gerrard, 2005). For this reason, executive women voluntarily or reluctantly accept to defeminize themselves in order to lay emphasis on their professional competence instead of distracting male colleagues by their feminine features. The impact of this deliberate or involuntary defeminisation may eventually lessen the self-esteem of women. Our survey revealed that for a majority of people dress style is linked to the self-esteem. The fact that most of the time women have heightened concern with their appearance than men, the self-esteem is more closely linked to their dress style. As a consequence, women are more affected psychologically by dress codes than men. The table below shows that for a total of 92% of women affirm that they would be affected completely or partly if they are compelled to change their clothing style.

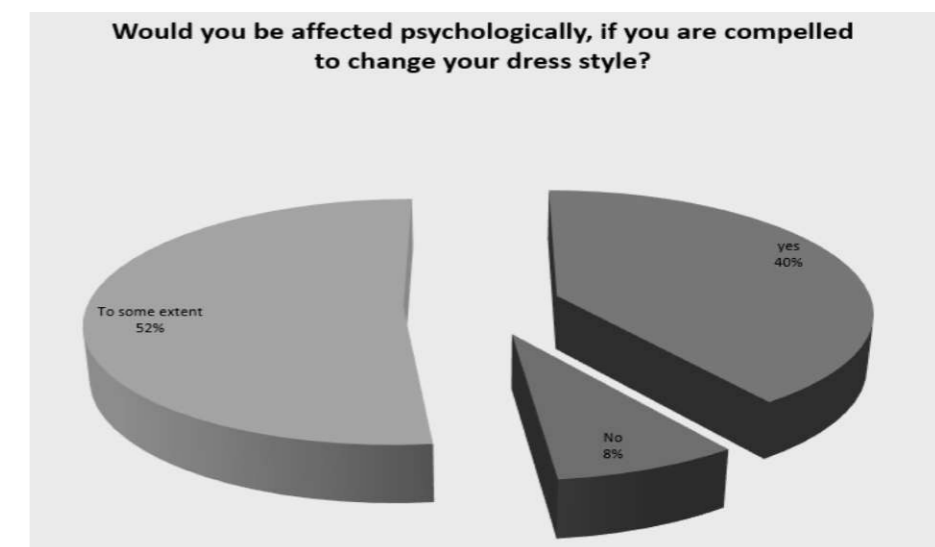


Figure 4: Impact of clothing style on women

Our survey among executive women further reveals that a total of 81% of women would not feel comfortable in wearing men clothing style every day.

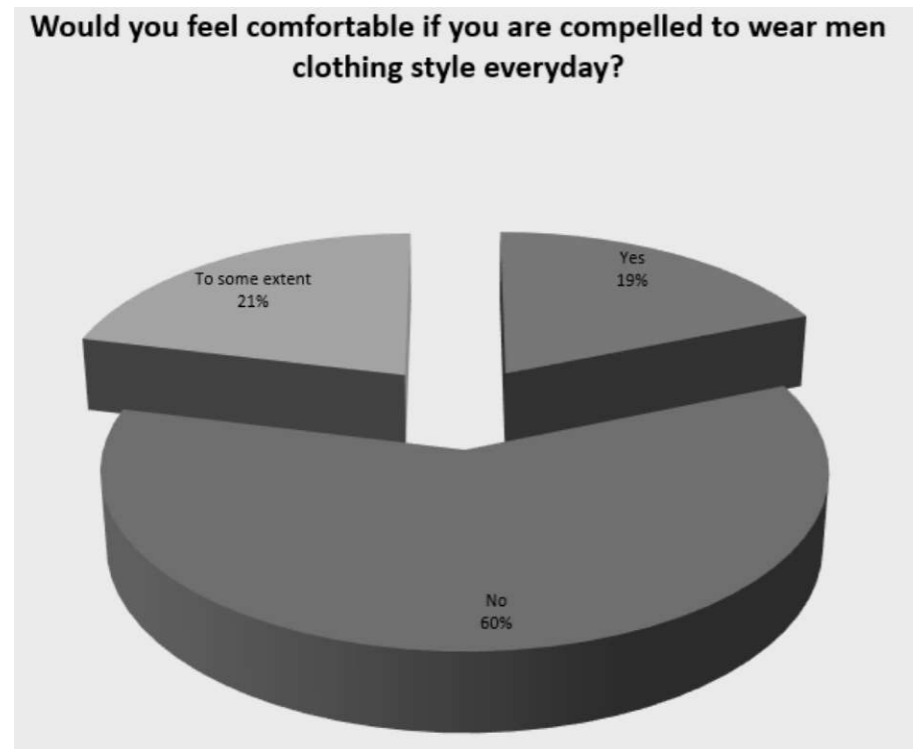


Figure 5: Women executive and men clothing

However, Figure 6 shows that the response of male employers regarding masculine dressing style for women executives is rather different. Male participants of the second survey were asked to choose the executive female image which they will promote from photographs of female models wearing different types of clothing, namely: masculine type, usual wear, sexy wear and feminine dress.

Survey result : 81.8% of male employers would promote a masculinised woman at the work place rather than a sexy or feminine one



Figure 6: Male employers' choice for executive women's clothing

81.8 % of men opted for the masculine type, where as nobody selected the sexy wear or the feminine dress. Furthermore, 54% of the male employers believe that women are not affected by a change in the clothing style. The symbolic interactionist approach developed by George Herbert (Mead, 1934) explains

that the perception of clothing involves both the wearer and the perceiver and brings to an encounter their own social constructs. Our two surveys reveal a significant difference between males' and females' perceptions and choices. Men perceive the feminine clothing style attractive but inappropriate for an

executive position, whilst women perceive the feminine clothing style as comfortable and a way of expressing themselves.

The consequences of women's mimicking male attire could have dramatic effects on the contribution made by women in the work place. Social perceptions and gender stereotypes regarding dress code help in sustaining the male power over women in the business world. But unfortunately, no in-depth research has been done whereby the executive wear was linked to gender discrimination. The psychology of masculinized domination is maintained by making women feel uncomfortable in the working environment through the following:

- Perpetuation of sex discrimination through defeminization of executive women;
- Affecting the self-esteem, self-confidence and comfort level of women through implicitly imposed masculine dress style; and
- Decreasing feminine women's chance to climb the career ladder & impedes achievement of equality at the workplace.

It is appropriate to quote Mc Craiken (1985) again who said "that by mimicking the male business attire, women are reinforcing all that the masculine stereotype symbolizes, including their subordinate status".

CONCLUSION

Audrey Nelson (2010) wrote: "fifty years of research tells us that you can change perceptions of a person by changing their clothes. There is no getting around it. Dress has persuasive value that influences the behavior of others. Clothing may influence the extent to which another person may consider us credible. It is often read as a sign of character" and I order to send the right signal at the work place, women have to sacrifice their femininity.

Unfortunately for women, they are still manipulated by the patriarchal society. On one hand, they are brought up to be feminine, and on the other hand they are asked to reject the acquired femininity and adopt masculine clothing at work. The reason lies in the fact that their values differ from that of men and regrettably for them, "it is the masculine values that prevail" (Virginia wolf, 1929). We have seen that although the Mauritian society has allowed the emancipation of women, its

perception about the role and image of women has not yet evolved. This has implications for both the well-being of executive women and the performance of women at the work place.

It seems that legislations have not been able to eradicate deep rooted social perceptions on gender stereotypes. This situation is playing a major role in the perpetuation of gender discrimination and resulting into the following:

- Influencing the training & Occupational Choices of women;
- Affecting women's chance to participate in the professional job market;
- Indirectly maintaining both work and family responsibilities on women; and
- Impeding the achievement of gender equality in the working environment.

The data obtained from our two surveys make us aware of unnoticed issues and opens the way to address overlooked problems that prevents women from delivering their full potential in the working environment. This paper has highlighted multiple areas for further research which can help in the eradication of sexist perceptions, namely: a psychological analysis of the impact of the desexualisation process on executive women, an insight into the fashion world and the designing of women's corporate wear, and a research on the influence of religious beliefs on women's position in the professional world.

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Enabling Criteria for Modal Shift in Surface Cargo Transportation and Effect of RoadRailer

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Shiv Kumar Chowdhri**

Preeti Dwivedi***

Purpose – The purpose of this paper is twofold: to identify the criteria of choice and enablers for modal shift from road to rail between Delhi and Chennai in India, and to understand the requirements of users who might adopt the new bimodal RoadRailer.

Design/methodology/approach – With the help of questionnaires responses of 251 shippers, who moved automobile and components, electrical and electronics, capital goods and fast moving consumer goods (FMCG)/retail, were collected. Shippers with more than 5 years of experience in logistics industry and who mostly used road transport between Delhi and Chennai, but had experience of using other modes, were selected. Structural equation modeling is used to find out the causal relationship between criteria of choice and profile of the shippers.

Findings – Six criteria of selecting a particular mode and three profiles of shippers were uncovered. The six criteria are: safety; direct cost; value added services; seamless convenience - transit time trade off; seamless convenience - external cost trade off and direct cost-value added services trade off. Three distinct profiles of users were found to be: those who wish to switch from road to intermodal container; those who wish to stick to road and those who wish to switch from road to rail. Causal relationships between the criteria and shippers' profile as determined by structural equation modeling helped the researcher to identify enablers of shift from one mode to another.

Further, the profiles of users, who are likely to adopt RoadRailer bi-modal transport and their motivational triggers to switch have been identified.

Research limitations/implications – Findings pertain to only one study done on Delhi-Chennai route which is over 2200 kilometers long. For other destinations and shorter routes the motivating factors to shift between modes may vary. While the six criteria influencing the modal choice may hold well, the effect on different profiles of users may vary. The influence of bimodal RoadRailer has been estimated by capturing perception. To understand the reality, the study should be repeated after the RoadRailer is introduced.

Practical implications – The findings will help Indian Railways (IR) to formulate strategies to enhance its percentage share in freight transportation on Delhi-Chennai route. The study distinguishes between the expectations of road users who are potential users of Intermodal transport, rail wagon and RoadRailer when introduced. Separate strategies will be needed to convert them. The findings will also help the providers of road transport service to strategize by adopting the bimodal RoadRailer because bimodal RoadRailer is the missing link between road and rail mode of transport, hence complements both modes of road & rail modes.

Originality/value – This work introduces 'seamless convenience' as a new criterion for selection of mode of transport. It further suggests that many criteria are not used as standalone parameters for exercising modal choice. There is always a trade-off. Accordingly, six criteria for mode selection have been identified.

Keywords – Bimodal, RoadRailer, Intermodal container, Rail wagon, Road truck, Structural equation model

INTRODUCTION

The major cause of concern for the freight marketing division of Indian Railways is rapidly losing share of freight cargo to road transport. The percentage freight share of railways in India has continuously declined from 89% in 1950-51 to 30% in 2015-16. Cargo movement in India is unevenly skewed in

favour of road. It makes roads congested, prone to accidents, unsafe and contributes to atmospheric pollution besides affecting the drivers' personal lives. Currently, movement by road has to pass through many check posts and barriers that make total transit time highly unpredictable and pushes the cost up. Implementation of Goods and Services Tax (GST) may bring some relief. Further, road transportation sector in India is highly unorganized. Over 82% of the total road fleet is owned by small transporters who have 2-3 trucks. Due to lack of resources deployed by small transporters, the quality of service is poor. If the share of rail in freight transport is increased, it will benefit the railways as well as the society. This is the primary motivation

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for undertaking this research. The study identifies the criteria of choice of modes of transport and determines the possible enabling parameters that can influence users of road transport to shift to rail mode.

In surface transportation, rail and road are considered as the two modes of transportation but the authors of this research paper have categorized surface transportation in India based on the unit in which cargo is stuffed and its medium of transportation, therefore, have considered four modes i.e. road truck, rail wagon, intermodal container and bimodal RoadRailer.

Indian Railways has also announced introduction of new mode of transport i.e. RoadRailer which is a bimodal form of surface transport. In RoadRailer, the same equipment is used on rail tracks as well as on road providing seamless and safe transport of goods with no human intervention; handling or stuffing-destuffing enroute (Štrumberger, Perić, & Štefančić, 2012). This study maps the perception based acceptance of RoadRailer among the potential users so that railways can develop a suitable communication pitch for marketing the capacity of RoadRailer. The choice of modes of surface transport is an under researched area in India (Cook, Das, Aeppli, & Martland, 1999). This study fills the gap by studying shippers' perspective to

find out the various criteria in choosing mode of surface transportation; the enabling parameters for inter modal shift of cargo and the shippers' perception about bimodal transportation system (figure 1).

The longest route of Delhi and Chennai in India and four commodity segments, the major users of road transport, of automobile and components; electrical and electronics; capital goods; fast moving consumer goods (FMCG)/retail along with logistics service providers have been selected for the research.

REVIEW OF LITERATURE

The review of literature is divided into three sections: introduction to modes of surface transport; criteria for modal choice and review of the methodology. The review of literature led to the gaps in knowledge in the area that has dictated the identification of research topic.

Introduction to modes of surface transport operational definitions

Users of the surface mode of transport decide to transport their cargo not merely by selection of mode of transport i.e. road or rail mode but also the type of the equipment used for cargo stuffing and its further mode of transportation enroute (Johnston &

Marshall, 1993). Hence four modes of surface transport are under study viz: road truck, rail wagon, intermodal container and bimodal RoadRailer.

Road Truck: In this mode, the cargo {Full Truck Load (FTL) or Less than Truck Load (LTL)} moves only by road truck mode either from origin to destination directly or transshipped at various hub locations en-route (Harper & Evers, 1993).

Rail Wagon: In this mode, cargo loading in rail wagons takes place in two ways: (a) the commodities like automobiles, bagged cargo, parcel etc are stuffed/de-stuffed in rail wagons at the rail siding which is situated away from cargo generating areas and the cargo is brought to the point of loading by truck loads (b) the commodities like coal, cement, ore etc are loaded/unloaded in rail wagons at the rail siding which is situated within users' premises where cargo is generated and no further transportation is required by road truck (Raghuram & Shukla, 2008). The respondents using only category (a) were included for study because cargo of these respondents can be transported using any mode of surface transport. The commodities like coal, cement, ore etc (belonging to category b) which normally move as full train load, are excluded from study.

Intermodal Container: In this mode, cargo is stuffed in a container at end users' premises and locked by the user to ensure safety. It is then loaded onto the road trailer. Trailer is pulled by a prime mover. Prime mover is a motor vehicle which draws the trailer on road. The container is transshipped at the rail terminal from a road trailer to 'trailer on a flat car (TOFC)' of rail. At the destination rail terminal, container is again transshipped from TOFC to road trailer for further delivery to the end user. It is important to note that prime mover, trailer, container and TOFC are four independent equipments, which are used in cargo transportation. Intermodal transport is defined as the use of at least two different modes of transport in an integrated manner, in a door-to-door transport chain (Organization for Economic Development and Cooperation, 2001). Holcomb and Jennings (1995) provided the most appropriate definition of intermodalism as "a logistically linked movement using two or more modes of transportation."

Bimodal RoadRailer: A vehicle which operates both on the road and on the rail tracks had been

called RoadRailer (Štrumberger, Perić, and Štefančić 1998). In this mode, the cargo is stuffed in the RoadRailer, which operates as a wagon on rail, while the same unit operates as a semi-trailer on road. RoadRailer provides seamless door-to-door transportation of goods because it does not require any handling or transshipment at rail terminals (www.indianrailways.gov.in). This kind of transportation is called bimodal system. Unlike the conventional road-railway system, the bimodal transport technology has certain advantages due to the hassle free of transition from road to railway and vice versa, without needing any special handling equipment and specially constructed terminals.

Comparison among modes of surface transport: Intermodal routings helped shippers to minimize the total transportation costs (Barnhart & Ratliff, 1993). The initial capital costs, in terms of track and mobile equipment, were significantly higher in the case of conventional container terminals than RoadRailer terminals (Ferreira & Sigut, 1995). By combining the advantages of each mode, intermodal transport enabled the system to be more efficient, cost-effective and sustainable (Jugovic, Debelic, & Brdar, 2011). Johnston and Marshall (1993) concluded that there was no single type of equipment that dominated the shipper favor. Preference for Trailer-on-flat car (TOFC) was perceived to be high for cubic and weight capacity and flexibility between modes, but low for protection at loading stage and cleanliness. Containers were perceived to be high on ease of loading and unloading, protection at loading and cleanliness, but low for flexibility. RoadRailer trailers were perceived high for modal flexibility, safety and cleanliness, but low for capacity. The authors concluded that shipper perceptions of intermodal equipment were mixed, but some general impressions could be derived. RoadRailer technology might be a missing link that makes intermodal transport work (Albright, 1992).

Review of criteria for modal choice

The intense competition at the global level has turned the relationship between manufacturers and suppliers from antagonist to cooperative (Wu & Weng, 2010). Service quality and price are important factors influencing the choice of mode (Buehler, Pucher, & Kunert, 2009; Eng-Larsson & Kohn, 2012). Cost, transit time, reliability and frequency were considered to be the most relevant aspects in deciding which mode to adopt (Bergantino & Bolis,

1. First RR unit is aligned with RR rail bogie positioned on track. It is then pushed back by PM to couple with top of RR rail bogie
2. With the RR unit resting on its landing gear & bogie, PM couples 2nd RR Unit with another RR bogie further ahead on track and the combination is pushed back to couple with the first unit.
3. Likewise 50 RR units are coupled together in blocks to form a rake.
4. RoadRailer rake is pulled by a locomotive to destination where reverse operations are carried out and individual RR unit is taken for door delivery of cargo.

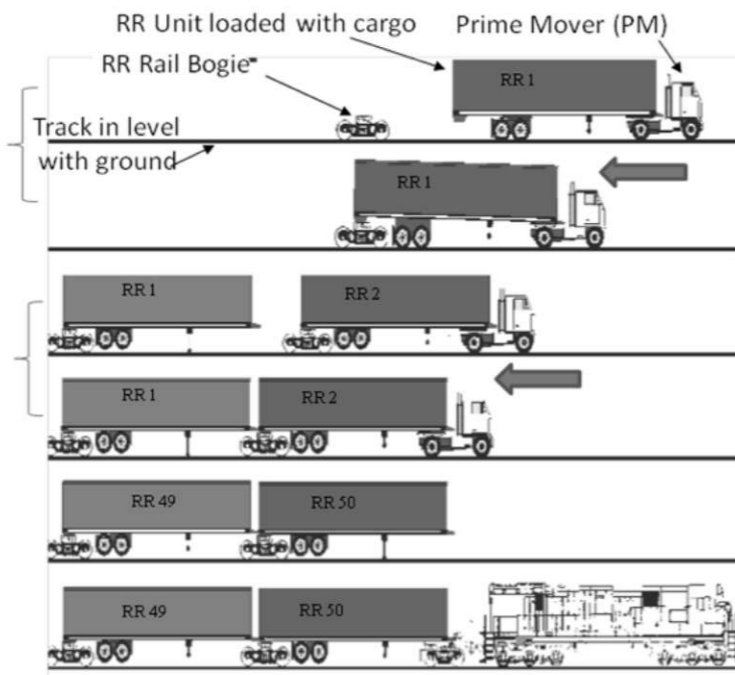


Figure 1: A brief overview of bimodal RoadRailer operations

(Source: www.indianrailways.gov.in RoadRailer services on Indian Railways: No 2000/M (N)/60/2/Wagon Census New Delhi, 2013).

2008; Feo, Espino, & García, 2011). Several scheduling combinations repeatedly demonstrated a significant impact on shipper modal selection (Strasser, 1992). López-Navarro (2013) found that modal choice did not take environmental aspects into account as a parameter that could affect the decisions made. Several criteria like freight charges, inland charges, schedule flexibility, warehousing capacity, track and trace system, port presence and custom clearance are considered important to select a suitable logistics service provider (Vijayvargiya & Dey, 2010). Çakir, Tozan, and Vayvay (2009) identified the decision criteria of cost of service, financial performance, operational performance, reputation of the 3PL service provider and long term relationships for selection of logistics service provider and mode of transport. Some important themes i.e. concerns about polluting the environment and use of energy; security in the supply chain; resilience of a chain; supply chain integration; international growth; and the role of the internet and emerging information technologies are under-represented as revealed by Meixell and Norbis (2008). Johnston and Marshall (1993) examined six characteristics of equipment i.e. cubic capacity; gross weight capacity; ease of loading and unloading; protection of loading; cleanliness and flexibility. Liberatore and Miller (1995) developed a methodology for evaluating the basic trade-off among inventory carrying cost, inventory investment cost and transportation cost. The methodology emphasized the significance of considering both total network logistics cost and inventory investment costs in making decisions about the mode of transport and carrier. The decision to select carrier alternative was based on the direct cost and quality factors (Liberatore & Miller, 1995). Yang, Hui, Leung, and Chen (2010) examined the significance of integration and consolidation of shipments, the trade-offs between costs, benefits and risks within activities of the logistics process and the differing roles of traditional freight forwarders and integrators. Modal decisions for exports are impacted by the cost of capital and the gross margin ratio (Ke, Windle, Han, & Britto, 2012). Premeaux and Phelps (2005) focused on the identification of significant differences in the assessment of the importance of 36 carrier selection variables by both carriers and shippers. Shippers were increasingly demanding better quality service from carriers (Crum & Allen, 1997). Evans and Southard (1974) found that there were five perceptual differences between shippers

and carriers. Shippers rated carrier response in emergency or unexpected situations, carrier's leadership in offering more flexible rates, information provided by carriers, computerized billing and tracing and a web-enhanced electronic data interchange (EDI) higher than mode of transport. The concept of innovation was regarded in most organizations as an effective tool to create and sustain competitive advantages. Adding value through innovation has transformed from the business concept of transportation to that of serving the entire logistical needs of customers (Soosay & Hyland, 2004). The service component offered a very good chance of gaining sustainable competitive advantage in the hypercompetitive global market. Conversely, poor service or a reluctance to innovate offered a fairly good chance of losing customers (Chapman & Corso, 2005; Esper, Fugate, & Davis-Sramek, 2007). Chapman & Corso (2005) also found that the advances in technology and communication have compelled this industry to strive permanently for new products and solutions. The optimal choice of mode was shown to involve a trade-off among freight rates, speed, dependability (variance in speed) and en-route losses (Baumol and Vinod, 1970). It was shown that faster, more dependable service simply reduced the shipper's or receiver's inventories, including his safety stock and his inventory in transit. Hence inventory theory made possible a direct comparison of the attributes on which mode selection was based and led to a model of rational choice in transport demand. There have been major changes in the share of road and rail traffic in India as the economy and the population has grown and become more urbanized (Cook, Das, Aeppli and Martland, 1999). Researchers identified cost, service, product characteristics, relationships, and capacity as some of the primary factors influencing the choice of mode. However, an important finding of Roberts (2012) was that many of these factors often influenced the mode and carrier selection decision simultaneously. For choice of mode, the first level of choice depends on the nature of the product. It must make economic sense given product characteristics to ship on a given mode. If product characteristics allow a modal choice to exist, the decision was heavily weighted towards cost and capacity. With environmental awareness on the rise, firms are increasingly motivated, both by regulations and corporate citizenship, to factor in environmental concerns in their decision. It was the economic variable that appeared to influence modal choice in

freight transportation in expected manner with shippers patronizing the qualitatively superior road mode when per capita state domestic product goes up (Chaudhary, 2005). The author found that freight share of rail did not go up with increase in user cost difference or cost ratio between road and rail. Vashist and Dey (2016) reported eight criteria i.e. transit time, direct cost, external cost, safety, reliability, capacity, value added services and seamless convenience for modal selection in India.

Review of Modal Shift

The focus of this study is to determine parameters that will enable shifting traffic from road to rail – be it intermodal container or rail wagon. All respondents of this study have experience of using all the three modes but more than 50% of their cargo moves by road between Delhi and Chennai. Hence, they are mainly users of road transport. A little probing suggests that such a user can be grouped into three types of profiles based on the intended behavior to shift to another mode: (1) those that are willing to switch to intermodal container or (2) stick to road or (3) switch to rail wagon. For these three profiles, the triggers to shift will also vary.

The study by Vannieuwenhuysen et al. (2003) revealed that users of a specific transport mode gave that mode a higher score than non-users, thus implying that often the bias towards other modes is due to lack of experience or knowledge about other modes. On the other hand, study by Golias and Yannis (1998) found that a majority (78%) of the carriers included in the study were ready to transfer from road to intermodal road-rail transport if it would positively affect their profits. Forwarders' study showed that willingness to switch was much weaker (52%), and both groups indicated that more financial support is necessary to enable the shift.

Experiences of shippers with a particular mode of transport shape their attitudes. Attitudes and perceptions play important roles in the selection of a mode. Gaining and distributing information and knowledge about different modes is crucial to breaking these barriers (Jensen, 2008).

Review of Methodology

Structural Equation Modelling (SEM) is a valuable tool for analyzing problems in operations management (Shah and Goldstein, 2006).

Punniyamoorthy, Mathiyalagan and Parthiban (2011) used SEM and fuzzy analytic hierarchy process technique to develop a composite model, based on criteria that influence the selection of a supplier. They further stated that the number of available alternatives in the current market is on a rise, and hence it was difficult to select a supplier from among a large lot because of increasing global competition. Wu, Huang, and Hsu (2007) proposed a supplier selection model. Through exploratory factor analysis (EFA), the key factors affecting supplier and modal selection were identified. These factors included capabilities of price response, quality management, technological issues, delivery commitment, flexibility, management support, commercial image and financial. Joreskog and Sorbom (1996) mentioned that the structural equation model specifies the causal relationships among the latent variables, describes the causal effects on the basis of the explained and unexplained variances. Structural equation modeling resembles path analysis by providing parameter estimates of the direct and indirect links between observed variables.

Fit indices of a structural equation model are relative to progress in the field. Although there are rules of thumb for acceptance of model fit (e.g. CFI should be at least .90). Bollen (1989) observed that these cut-offs are arbitrary. A more salient criterion may be simply to compare the fit of one's model to the fit of other, prior models of the same phenomenon. For example, a CFI of 0.85 may represent progress in a field where the best prior model had a fit of 0.70.

RESEARCH OBJECTIVES

The overall aim of this study is to investigate the motivational triggers that will enable shift of road transport users to intermodal or rail wagon. The specific research objectives are:

1. To identify the reduced set of selection criteria for the mode of transport from the perspective of shippers after taking cognizance of the trade-off among the criteria
2. To determine the enabling parameters to shift the modal choice for cargo transportation in favour of rail
3. To study the shippers' perception about bimodal transportation system (RoadRailer) at pre-launch stage

RESEARCH METHODOLOGY

Through survey with a structured questionnaire responses of 251 participants were captured. The questionnaire had three sections. Total 32 statements were used to find out criteria for modal choice; 28 statements were used to determine the shippers' profiles and 13 statements were used to map the perception about RoadRailer. Causal relationship is established using structural equation modeling to find the factors influencing the modal choice. SPSS and AMOS software were used to analyze the data. Target shippers included respondents from four commodity groups of the market which are mainly (more than 50% by value) moving their cargo by road. The respondents represented their companies and these companies are using more than one mode of surface transport and the respondents have experienced all the three modes of surface transport i.e. road truck; rail wagon and intermodal container. Four commodity groups included are: automobiles and components; electrical & electronics; capital & engineering goods and fast moving consumer goods (FMCG)/Retail. These four groups have been selected because these commodities move mainly by road and most of them do not figure in commodities carried by Indian Railways (IR). Two stage sampling is used i.e. stratified sampling to select firms in a sector for ensuring representativeness and purposive sampling within a stratum (respondents with specified characteristics are selected). Data is collected from respondents who have minimum 5 years experience in logistics function; respondents 'companies having minimum turnover of \$10 million; location of the manufacturing facility is within 100 km radius of Delhi and Chennai and respondents' company was having minimum one full truck/wagon/container load of shipment between Delhi and Chennai. Data is analyzed using t-test, correlation, Exploratory Factor Analysis (EFA); Confirmatory Factor Analysis (CFA) and Structural Equation Modelling (SEM).

DATA ANALYSIS AND RESULTS

The data analysis and the results have been divided into three sections. All the 32 variables in first section; 28 variables in second section and 13 variables in third section, obtained from the review of literature and from interviews of the experts, are subjected to the exploratory factor analysis to determine the criteria for modal choice, the shippers' profiles and the perception about bimodal

RoadRailer respectively. The section 1, which determines the final 6 criteria for modal choice and three shipper profiles using exploratory factor analysis, which is then confirmed by confirmatory factor analysis (CFA). Section 2 develops the measurement model of criteria for modal choice and the shipper profiles, followed by development of the structural equation model (SEM) to find out the enabling parameters for modal shift. The last section studies the perception of shippers for RoadRailer by developing a measurement model and structural equation model of criteria for modal choice and all modes of surface transport including RoadRailer.

Section 1 determines the criteria for modal choice which is six. The shippers do not always take decisions to select a particular mode of transport based on single criterion; therefore, there is a trade-off between two criteria in some constructs.

The six criteria determined for modal choice (Table 1) are: C1:- Seamless Convenience - Transit Time Trade off: The extent to which shippers make a trade-off between seamless convenience and transit time for modal choice; C2:- Seamless Convenience-External Cost Trade off: The extent to which shippers make a trade-off between seamless convenience and external cost for modal choice; C3:- Safety: The extent to which shipper pays attention to the safety of their cargo in selecting a mode of transport; C4:- Direct Cost: The extent to which shippers pay attention to the direct cost for transporting the cargo through a particular mode of transport; C5:- Value Added Services: The extent to which the shippers pay attention to the value added services in modal choice; C6:- Direct Cost-Value Added Services Trade off: The extent to which shippers make a trade-off between direct cost and value added services for modal choice.

The model fit parameters (Table 2) of the criteria for modal choice have been found satisfactory i.e. normed $\chi^2 = 2.407$; GFI = .922; CFI = .807; RMSEA = .075 and SRMR = .066. Fit indexes are relative to progress in the field: Although there are rules of thumb for acceptance of model fit (ex., that CFI should be at least .90), Bollen (1989) observes that these cut-offs are arbitrary. A more salient criterion may be simply to compare the fit of one's model to the fit of other, prior models of the same phenomenon. For example, a CFI of .85 may represent progress in a field where the best prior model had a fit of .70.

Table 1: Constructs & Variables loadings of Criteria for Modal Choice

Constructs and Variables loadings of Criteria for Modal Choice				
Variables		Construct Loadings		
Variable Code	Variable Name	Construct Name	Construct Code	Loadings
csc29	c29. Number of trans-shipments of my cargo is an important factor	Seamless Convenience - Transit Time Trade-off	c1	0.74
csc32	c32. I do not mind dealing with more number of service providers for single shipment			0.71
ctt01	c01. Time spent for first mile connectivity is an issue for my cargo & needs improvement immediately			0.69
csc30	c30. Number of documents involved per shipment does not make me uncomfortable	External Cost - Seamless Convenience Trade-off	c2	0.76
cec16	c16. For cargo transportation I do not worry about minimizing social (pollution, quality of life etc.) cost			0.74
cec15	c15. I am not concerned about the cost due to under-utilization of equipment (truck, wagon, container)			0.71
csf21	c21. Pilferage of goods during transit is rampant and it is a serious matter of concern	Safety	c3	0.75
csf20	c20. I experience damages during my cargo transportation quite often			0.69
cdc08	c08. Cost incurred to collect from the destination hub is a matter of concern	Direct Cost	c4	0.78
cdc09	c09. I am concerned about my total direct cost only			0.77
cec17	c17. I will change my mode of transport for better fringe benefits	Value Added Services	c5	0.84
cvs28	c28. A customized transport equipment reduces my cost of logistics			0.73
cdc07	c07. Cost of first mile connectivity is an important factor for modal choice	Direct Cost - Value Added Services Trade-off	c6	0.81
cec12	c12. Fringe benefits play crucial role in selection of mode of transport			0.62

Table 2: Model fit summary of Criteria for Modal Choice

Model fit summary of Criteria for Modal Choice	
Particulars	Criteria for Modal Choice
CMIN/df	2.407
GFI	0.922
CFI	0.807
RMSEA	0.075
SRMR	0.066

Table 3: Construct Validity of Criteria for Modal Choice

Construct Validity of Criteria for Modal Choice			
Factor Name	Factor Code	Average Variance Extracted (AVE) for Discriminant Validity	Construct Reliability (CR) for Convergent Validity
Seamless Convenience-Transit Time Trade off	c1	0.51	0.76
External Cost-Seamless Convenience Trade off	c2	0.54	0.78
Safety	c3	0.52	0.68
Direct Cost	c4	0.60	0.75
Value Added Services	c5	0.62	0.76
Direct Cost-Value Added Services Trade off	c6	0.52	0.68

Almost all AVE and CR values (Table 3) are above 0.5 and 0.7 respectively, which establishes the construct validity.

The three identified shippers' profiles (Table 4) for modal choice are: Profile m1:- Users of truck (road mode of transport) who are willing to switch to intermodal container service; Profile m2:- Users of truck (road mode of transport) who would like to continue with road transport; Profile m3:- Users of truck (road mode of transport) who would like to switch to rail wagons.

The model fit parameters and construct validity of the shippers' profile for modal choice have also been found satisfactory as shown in Table 5 & Table 6 respectively.

Section 2 identified the significant paths to find out the causal relationship between criteria for modal choice and the shippers' profiles for modal choice for existing modes of surface transport. The model fit parameters for structural equation modeling

(Table 7) i.e. normed $\chi^2 = 2.851$; GFI = .863; CFI = .760; RMSEA = .086 and SRMR = .075 have been accepted for this kind of pioneer empirical study of this complex nature.

Section 3 identified the shipper perception about the bimodal RoadRailer. Eight paths are significant for SEM model of criteria for modal choice and the shippers' profiles for existing three modes (Figure 2) and also for all the modes including RoadRailer (Figure 3).

Standardized regression weights for significant paths are within the acceptable limit. Squared multiple correlations are within the allowable limits. The four absolute fit statistics are i.e. Normed $\chi^2 = 2.768$; GFI = 0.851; RMSEA = 0.084; SRMR = 0.075 and Incremental fit index CFI is = 0.745. Table 7 includes the model fit parameters at CFA and SEM level of criteria of modal choice and the shipper profiles for modal choice including bimodal RoadRailer.

Table 4: Constructs & Variables loadings for the Shippers' profiles

Constructs & Variable Loadings for Shippers' Profile				
Variables		Construct Loadings		
Variable Code	Variable Name	Construct Name	Construct Code	Loadings
mtwvs27	m27. I do not prefer road truck because value added services are better in intermodal container	Switch from road to intermodal container (r2ic)	m1	0.77
mtsc11	m11. Road truck service does not provide me seamless equipment & seamless agency dealing			0.75
mcsf03	m03. Intermodal Container service is the safest mode of transport			-0.73
mwrl15	m15. Rail wagon service will have more users if it becomes more flexible in terms of door to door connectivity	Stick to road (s2r)	m2	0.84
mcr02	m02. Container service by rail is inflexible			0.80
mwsc12	m12. Rail mode (rail wagon or intermodal container) is not preferred due to multiple handlings of the cargo	Switch from road to rail wagon (r2rw)	m3	0.88
mwsc13	m13. I prefer rail wagon or intermodal container due to lesser number of statutory compliances & documents			0.66

Table 5: Model fit summary of the Shippers' Profiles

Model fit summary of the Shippers' Profiles	
Particulars	The Modal Preference
CMIN/df	4.153
GFI	0.954
CFI	0.893
RMSEA	0.112
SRMR	0.073

Table 6: Construct Validity for the Shippers' Profile

Construct Validity for the Shippers' Profiles			
Construct Name	Construct Code	Average Variance Extracted (AVE) for Discriminant Validity	Construct Reliability (CR) for Convergent Validity
Road to intermodal container (r2ic)	m1	0.564	0.795
Stick to road (s2r)	m2	0.674	0.805
road to rail wagon (r2rw)	m3	0.610	0.754

Table 7: Model fit parameters with & without RoadRailer at CFA & SEM level

Model fit summary of Criteria for Modal Choice & existing Modes			Model fit summary for Criteria for Modal Choice, existing Modes & RoadRailer		
Particulars	CFA level	SEM Level	Particulars	CFA level	SEM Level
CMIN/df	2.866	2.851	CMIN/df	2.811	2.768
GFI	0.860	0.863	GFI	0.850	0.851
CFI	0.761	0.760	CFI	0.748	0.745
RMSEA	0.086	0.086	RMSEA	0.085	0.084
SRMR	0.076	0.075	SRMR	0.076	0.075

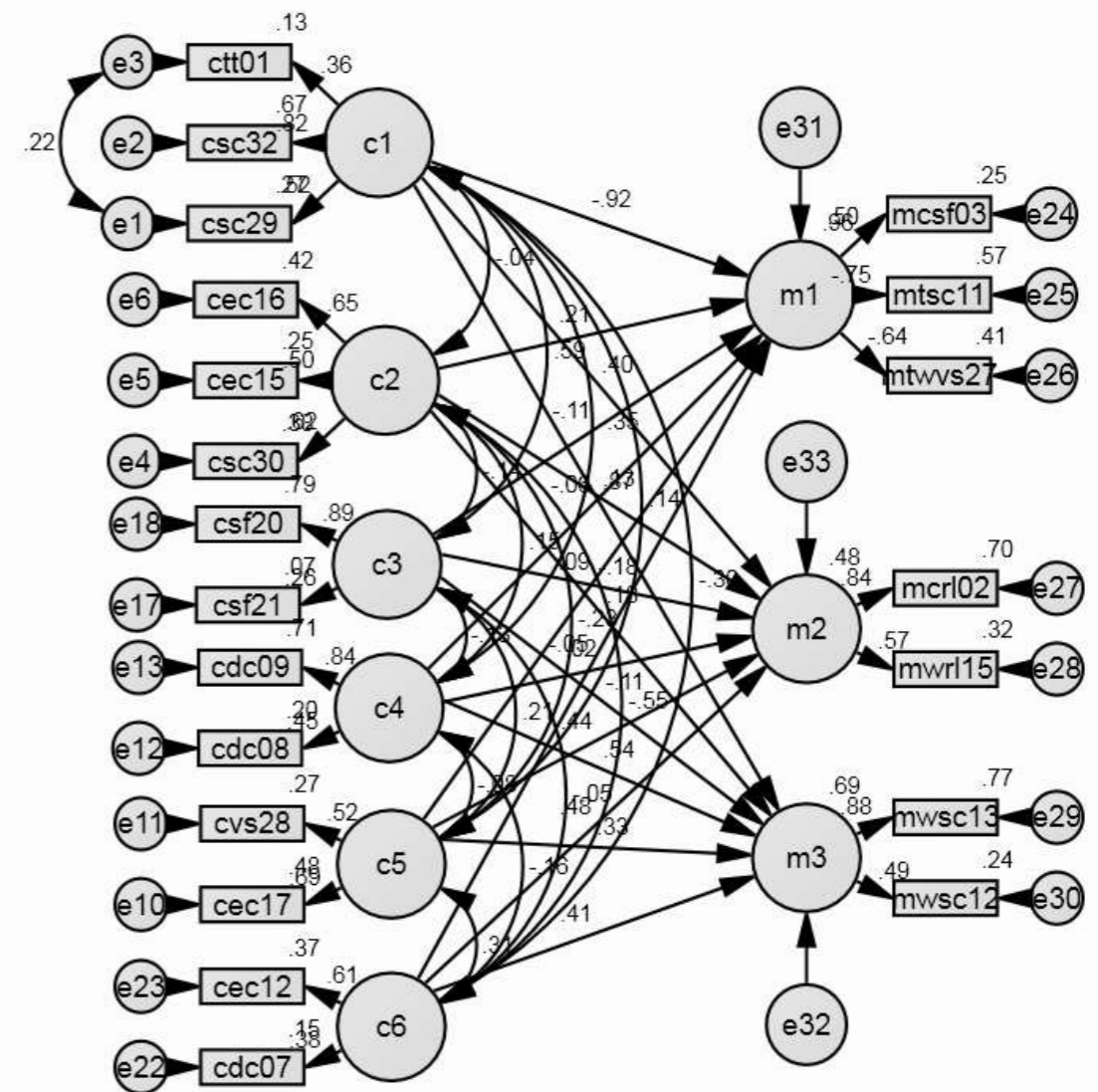


Figure 2: SEM of Criteria for Modal Choice & the Shippers' Profile for existing modes of transport

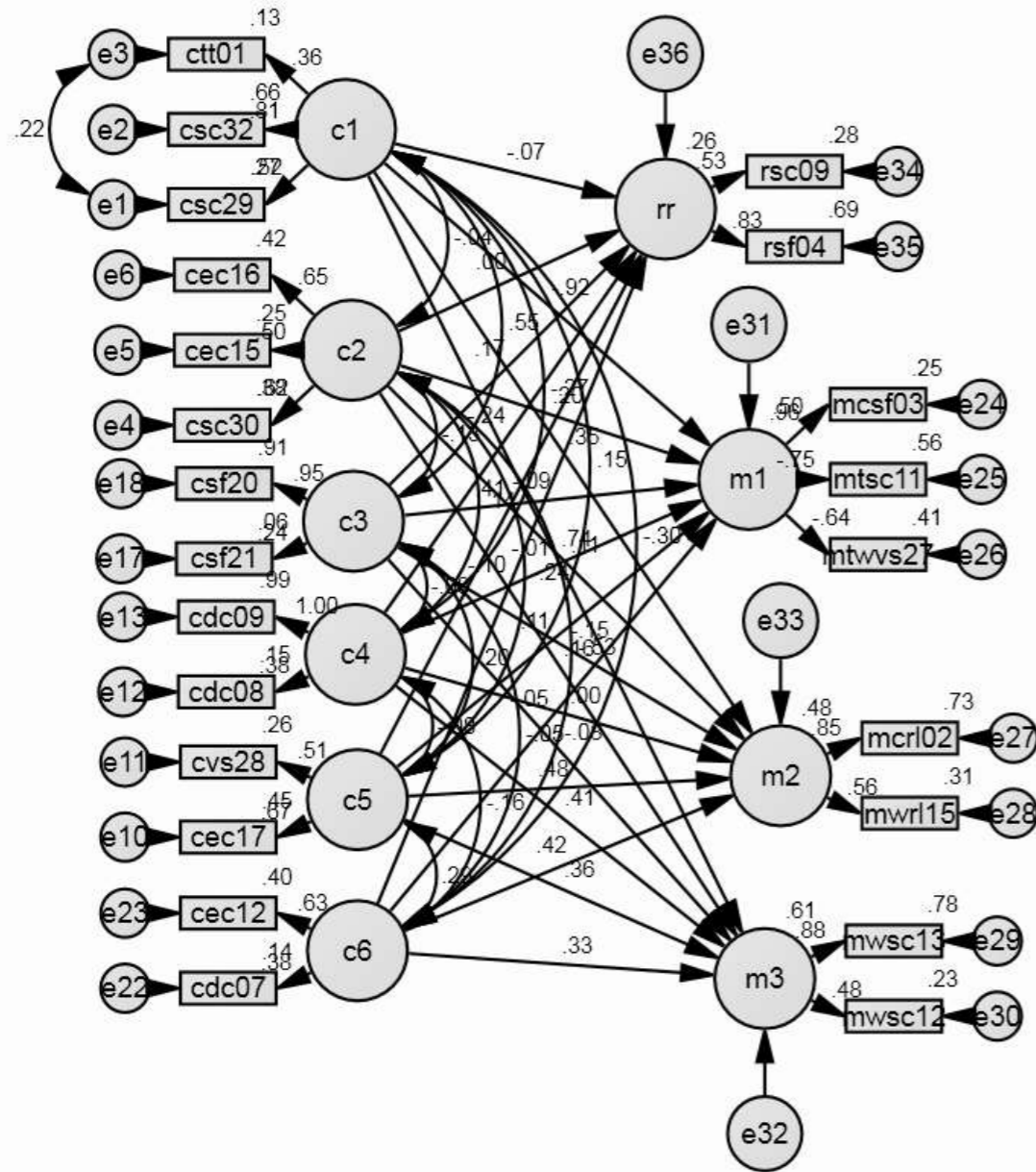


Figure 3: SEM of Criteria for Modal Choice & the Shippers' Profiles including bimodal RoadRailer

DISCUSSIONS

Profile of shippers who wish to switch from road to intermodal container is influenced by criteria of seamless convenience-transit time trade off. This means that if a road transport user feels absence of seamless convenience, improper value added services and lack of safety, then he can be motivated to try out intermodal container service. Profile of shippers who wish stick to road is influenced by criteria of seamless convenience-transit time trade-off; value added services and direct cost-value added services trade off). They are comfortable with road transport because of flexible service and door-to-door pick up and drop facility. They can revise their decision and use rail if they get convinced of seamless convenience, value added services and

lower direct cost. Profile of the shippers who wish to switch from road to rail is influenced by seamless convenience-transit time trade off; lower direct cost and value added services. This class of users are ready to switch to rail because they think that there are less number of statutory compliances and documents. But they are scared of multiple handling of cargo. The decision of such users can be influenced by making them aware about seamless conveniences of rail, lower cost and Value added services. All categories of users are influenced by seamless convenience-transit time trade off. When RoadRailer is introduced, the influencing criteria remain almost same except for one change. The criteria i.e. direct cost-value added services trade off, no longer influences profile of the shippers who wish to stick to road. Perhaps for this class of users

RoadRailer becomes more attractive. Further, two criteria i.e. direct cost and value added services influence the choice of RoadRailer.

CONCLUSIONS

Problem statement is appropriate since no such previous research could be found, particularly in India. Primarily, the modes of surface transport are categorized as road and rail but a new dimension has been added in categorization of the mode of surface transportation which is based on the unit in which the cargo is stuffed for further transportation and unit's mode of transportation. EFA, CFA and SEM are widely used analytical tools but perhaps for the first time these tools have been used to solve the problem under discussion. Sample size almost maps the eligible population i.e. respondents which had minimum 5 years in industry; companies having minimum turnover of \$10 million; location of the manufacturing facility was within 100 km radius of Delhi and Chennai and respondents' company was having minimum one full truck/wagon/container load of shipment between Delhi and Chennai. Users of road mode of transport are willing to switch to intermodal container service due to safety and seamless convenience. Shippers would like to continue with road transport because they feel road mode of transport is more flexible and has less number of handling of the cargo. Shipper would also like to switch to rail wagons due to less number of statutory compliances and documents. RoadRailer is expected to increase rail share due to the perceived benefits of seamless convenience and reduced exposure to risk. It is also perceived that bimodal RoadRailer truly provides seamless transportation, which complements both modes of road and rail transportation; hence it is expected to be embraced by road as well as rail users. This study has added a new criterion of "seamless convenience" for modal choice in the field of logistics. This study will help the freight marketing of Indian Railways to devise strategies to capture cargo from road to rail and at the same time will assist the road transporters to strategise to retain their customers which can be through use of bimodal transportation. It will also help the logistics service providers to understand the customer behaviour in logistics sector and will guide them to select the modes of transportation suitably for servicing their customers efficiently. However, there are some limitation and future scope of

research in this field. First the study is based on sample of experts from Delhi and Chennai therefore, cannot be generalized to other regions or countries. The second limitation is due to the selection of one time survey method of data collection. Satisfaction level of users may vary due to prolonged use of a service particularly in the presence of competitive offers. A longitudinal study would be useful to capture the varying intensity of factors of choice. There is a scope to recapture the feedback of the actual experience of bimodal RoadRailer, once the bimodal service is introduced in India.

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Pollution in River Ganga due to Human intervention: A study

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The national river of India, known by the name of Ganga is considered to be a life-line of 1.336 billion of people, is altered and polluted on a daily basis by certain human activities. These activities range from construction of dams, cremation of dead bodies to discharge of industrial and municipal waste. This research paper is based on exploratory research design that studies the problem of pollution in river Ganga due to human intervention.

Keywords:- Ganga River, Environment, Pollution, Anthropogenic, BOD (Biological Oxygen Demand).

INTRODUCTION

The Ganga river covers an area of approximately 1086 thousand km square and 2511km in length across northern India from the Himalayas to the Indian Ocean. And it empties into the Bay of Bengal and considered to be the third largest river in the world and longest river in India. It has its source at Gaumukh, Gangotri Glacier known by the name of Bhagirathi River (in the top of Himalayas) and has an elevation of 3800 m above sea level. The river joins Alaknanda river and the sangam is known by the name of river Ganga. After flowing from Himalayas mountain, it reaches to plain at Haridwar where the elevation is 300m above the mean sea level. And after covering an area of 108600000 km square it flows to Bay of Bengal.

The River Ganga is altered and polluted biologically, chemically and physically on a daily basis by various human activities also known by 'Anthropogenic activities'. These human activities which lead to pollution in river ecosystem is considered inappropriate and hazardous for animals and aquatic life. And therefore the perseverance of river Ganga is very important. It is

considered to be a life-line to 1.336 billion of Indians who depend on it for the daily necessities, and also considered to be a home to approximately ninety amphibian species, one hundred and forty fish species, and endangered Ganges river dolphin. According to a research by Munendra Singh and Amrit K. Singh (2005), over 25,000 species including animals, mammals and micro organisms. The government of India has also taken various initiatives to clean river Ganga like The Ganga Action Plan, 1985. The Ganga Action Plan was considered a failure irrespective of the fact that it was the largest single initiative, to clean and improve quality of water of a polluted river, in the world. Even now the Government of India has taken new initiatives to clean river Ganga (known by Clean Ganga Project 2014 by PM Narendra Modi. In this situation the dilemma is that the man himself is the one who is taking conscious initiative to preserve the river Ganga and at the same time polluting it at a much higher degree. This means the act of polluting is very high in term of size and volume than the mere act of perseverance (or so called initiative). The other reasons for the failure in perseverance of river Ganga could be corruption, poor environmental planning, lack of support from various (religious) authorities, lack of proper equipments or technical expertise, etc.

The Ganga River basin experiences three seasons, which are summer, monsoon and winter and has a humid climate. The basin experiences heavy rainfall during monsoon (July, August and September) and supports the housing of approximately 0.5 billion people (i.e. approximately one third of the India's population).

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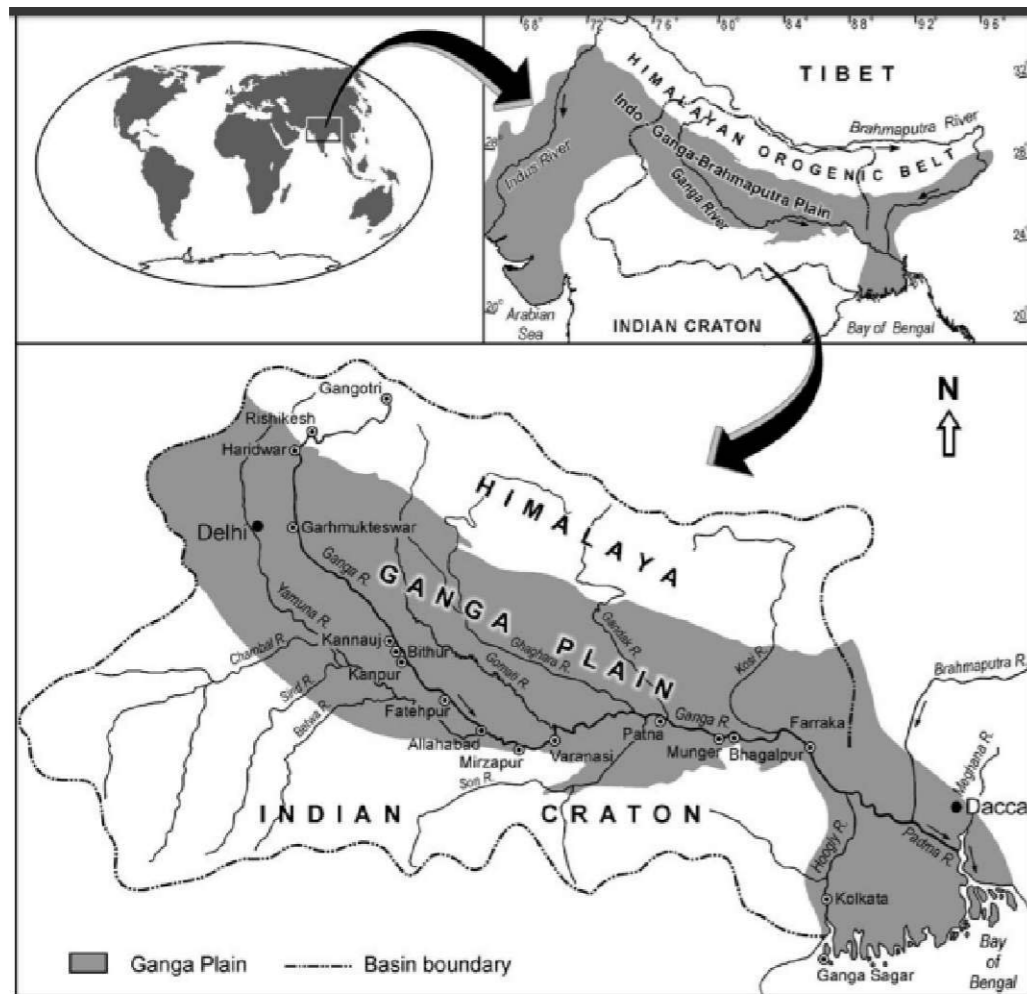


Figure 1 Location map of the Ganga River showing important riverbank sites used in several research studies.

According to a research by Munendra and Amit (2006) approximately 1.3 billion litres of sewage goes into river Ganga per day out of which 0.26 billion litres is of industrial sewage, .906 billion tons of agricultural waste (fertilisers and pesticides). The causes could be over yet increasing population, corruption, poor environmental planning, unplanned urban or rural growth, lack in waste management, lack of support from various (religious) authorities, lack of proper equipments or technical expertise, mass bathing or high use of chemical fertilisers, etc.

OBJECTIVES

1. To understand the current scenario of river Ganga.
2. To study the causes for pollution in river Ganga due to human intervention.
3. To study effects of human intervention on river Ganga.
4. Possible solutions- to reduce pollution in river Ganga

LITERATURE REVIEW

The Ganga River is the national river of India, and is regarded as holy and sacred river. Also known as Ganga Ma (Mother Ganges) and worshipped as goddess Ganga, whose purity cleanses the sins and help the soul of dead to their path towards paradise. It symbolises Indian Culture and civilisation.

It is considered to be a life-line to 1.336 billion of Indians who depends on it for the daily necessities. The Ganga river flows through Bangladesh and India. It covers an area of approximately 1086 thousand km square and 2511km in length across northern India from the Himalayas to the Indian Ocean. And it empties into the Bay of Bengal and considered to be the third largest river in the world and longest river in India.

When it comes to pollution, as per the current scenario the river Ganga is ranked second most polluted river in the world by Gursimran Kaur, listovative and ranked 1st by Kelley, soapboxie.

There are many initiative, from The Ganga Action

Plan 1985 to The Clean Ganga Project 2014, taken to clean Ganga river but all seems to be a failure based on the fact that the river is ranked 1st in most polluted river in 2016 whereas it was ranked 5th in 2007. The reasons for the failure in perseverance of river Ganga could be corruption, poor environmental planning, lack of support from various (religious) authorities, lack of proper equipments or technical expertise, etc. Thesad part is that it is not only effecting the quality and quantity of water in river Ganga, but also the life of approximately ninety amphibian species, one hundred and forty fish species, endangered Ganges river dolphin and the same time life of human itself.

India's population of 1.336 billion and increasing every second, ranked second highest populated country by Internet World Stats. India's cultural ideologies and its population of 1.336 billion is a major reason for the pollution caused in river Ganga. It is highly polluted and even knowing this fact, people of India are still indulged in the cultural and religious practices that is polluting the river more day by day. This is due to the mere belief of the people (indulged in such activities) that the holy and pure river Ganga Ma can never be polluted by mere human actions (specially the religious or cultural act).

The government and the considered authorities should take certain initiative in order to motivate and guide the people of India about the importance of the preservation of river Ganga without offending the view of the people related to religion and culture. It would be tough and government is still working on such initiatives, especially at the time of festivals, such as eco-friendly Lord Ganesh idol at the time of the auspicious festival of Ganesh Chaturthi. But still they need to put more efforts and focus, irrespective of the time, day, or festival to guide the people of India to stop such activities that may cause pollution in river Ganga and form a community to preserve the river, both by stopping others and self causing any harm (pollution) to the river and cleaning the river Ganga considering it their moral duty or value or responsibility.

India and Germany signed an agreement for cleaning Ganga

- The agreement was signed on April 13, 2016 between ministry of resources, river

development and Ganga Rejuvenation and German international cooperation (GIZ), in the presence of water ministry secretary Shashi Shekhar and German ambassador to India Martin Ney. According to the agreement, India will allow Indo-German Knowledge exchange on strategic river basin management issues, effective data management system and public engagement. German contribution in 3 year long project is 22.5 crore.

- The initiative was pitched during Indo European water forum organised by national water mission co-partnered with the environment directorate-General of the European Commission in November 2015.
- The project begin from Uttarakhand with the expansion of other states in downstream. India plans to adopt successful river basin management strategies to clean river and replicate the Rhine and Danube model.

The Cause of pollution on the Ganges River

Organic waste

Organic waste, or sewage is one of the major cause for the pollution of river Ganga. Around 2900 million kilogram of sewage are pumped into Ganga river. Out of this 31% of sewage is received in the form of treatment (Pokharel) and the rest 69% is dumped into the Ganga as raw sewage, just like what we flush down into the toilet. The count of coliform bacteria at the confluence of the Salori sewage with the Ganges river is 15,000 mpn/100 ml, as compared to the government limit of 500 mpn/100 ml, is an indication of human or animal waste. In addition, BOD (Biological Oxygen Demand) level increased to 5mg/l from 3.5mg between the year 2006 and 2011.

Industrial waste

Chemical waste is another major source of pollution, 20% of the pollution entering the Ganges are of this type and come from the sources such as paper mills, sugar mills, and tanneries. Chemicals like arsenic, cadmium, mercury, sulphuric acid. Chemical dyes and other effective metals are frequently find their way into the river which is a major threat.

Companies like pharmaceutical dump hydrochloric acid and acetone into the river. All these chemicals are very dangerous to the environment as well as to the people who drink the water.

- **Death Rituals**

The rituals of believing mother Ganga as goddess in many parts of India, believing that she will purify souls, many people hope to be placed in waters after their death to raise the souls up in the caste system in their upcoming lives and then acquire Moksha. After people's death, their astita are dumped in Ganga water to get mukti from the world. Khumbha Mela is a big gathering in India as is celebrated as a festival where billion peoples come to take bath as Ganga Snans. People throw many materials like waste, food, flowers, leaves, fruits (or prashad) and even take bath (snan) at Ganges river for spiritualistic reason.

- **Agriculture runoff and improper agriculture practices**

During the monsoons or whenever there are heavy showers, we will find the traces of fertilisers and pesticides which are washed into the holy river Ganga. When the agriculture inputs are diffused throughout the river basin, such point is known as the non-point sources of pollution. It's not only about Ganges but for the other rivers of the country. In Haryana, the concentration of chlorides is 250,000 kg/day which is drained into the Yamuna river 32mg/l just upstream drain confluence to 150mg/l just downstream of it.

According to CPCB, some of the seepage contains over 15,000mg/l of chlorides. Large use of chemical fertilisers, pesticides, weedicides are the new dimension to such pollution. Flood-plain cultivation is another contributor to water pollution.

When more doses of chemical fertilisers are used, then it not only pollute water but it also pollute land and air, as said by A.K. DIKSHIT, scientist with Indian agricultural research institute (IARI), New Delhi.

- **Withdrawal of water**

In the upper course areas, particularly Himalayan rivers have plenty of water. They are, however, starved of water when they enter the plain area. Irrigation whisk away clean water and denying water to flow in the river downstream. As the quantity of fresh water is very small, pollution either from urban and rural areas, industries—cannot get diluted and its ill effect are not reduced. Upper Ganga canal and lower Ganga canal have left the downstream of Ganga almost dry. When the Yamuna and Ganga flow passes through Delhi and Kanpur, they are turned into sinking sewers. Therefore, it is essential that minimum level of water is maintained in river. According to a report of the Ministry of water Resources on the study of minimum flows in the Ganga, there is huge impact on the water quality. Further, the study has expressed the view that it is not possible to fix the minimum flow of water in the entire course of river because it depends on the discharged of pollutants which creates pollution at different points of river. For example, the existing minimum flow of Ganga at Kanpur in May is hardly 50 cubic meters per second whereas minimum requirement is 350. The study further says that further we cannot add fresh water for dilution.

Effects of pollution in River Ganga

- **Riverine Life** – The pollution in the river Ganga has increased day by day and by this pollution marine life would be lost in coming future and this contaminated water disturb and affect the river's ecosystem. And Hydroelectric and irrigation dams offer struggle to life in their life cycle. River Ganga is considered to be a home to approximately ninety amphibian species, one hundred and forty fish species, and endangered Ganges river dolphin.
- **Bio Life** – Many dams are built along the Ganga basin. A large volume of water is collected in the dams and this is dangerous for wild life that are living around river Ganga. About 1200 hectares of forest would be submerged by Kotli Bhel dam at Devprayag. There has been warning that wild animals will find it troublesome to cope with the changing scenario.

- **Human Beings** – An analysis of the river Ganga in 2016 displayed vital associations between enteric/water-borne disease incidence and the use of river water for washing, bathing, laundry, eating, brushing teeth and cleaning utensils. Exposure factors such as lack of sewerage toilets at residence, washing clothes, bathing and children defecating outdoors, poor sanitation, low income and low education levels additionally showed vital associations with enteric disease outcome. Ganges water has been correlated to catching infectious diseases, hepatitis, cholera, and severe diarrhoea that still a leading cause of death of children in India.
- Although irrigation has increased considerably in the country, because of which there is problem of high salinity in the river Ganga.

Possible solutions- to reduce pollution in river Ganga

Cleaning the Ganga step by step

- Firstly the basin-scale management as we know Ganges is a complex transboundary basin which flows across different states. Therefore basin-scale approach would help to manage the water resources in much better way. It requires close coordination among all the countries which are sharing Ganga, such as Nepal and Bangladesh, so that upstream and downstream users are taken into consideration. We can say that existing treaties on 'sharing water resources' could be retermed or renegotiated as 'shared management of water resources'.
- Secondly the river Ganga is highly polluted, still 400 million people living along the banks of the river rely on its natural system for their livelihoods. World bank report says that a number of efforts by government (Ganga action plan phase 1 and 2) have address the pollution problem, but the results so far are very disappointing. Sewage constitutes 80% of pollution load caused by industrial discharge activities. With agriculture activities near Ganga river, particularly in urban and peri-urban areas, farmers basically rely on waste water for irrigation which poses serious public health risk.
- Thirdly, environmental flows are essentially the

water requirements of aquatic ecosystems and of basic human and social needs. The concept behind the environmental flow only refers to the quantity of water required to maintain river ecology under different environmental conditions. Different innovative methods for maintaining environmental flows and the water quality during environmentally critical periods, along with procedures for implementing these methods, need to be investigated. Cities, towns and industrial estates are most vulnerable to flooding in the Ganges river basin. Major investments are done to address climate variability. Existing flood forecasts are too much technical and not easily understood by the public. Innovative approaches such as underground taming of floods for irrigation and aquifer management could offer solutions to the flood problems.

- Lastly towards the common goal, the steps taken by the government to clean the river Ganga. Successful implementation of this task would be possible only if there would be partnerships with various stakeholders. The private sector and civil society groups has also shown their interest in cleaning of the river Ganga, especially at critical points (Varanasi). By taking small steps, we can still reduce the pollution load and restore the river to people.

CONCLUSION

There are certain human activities which are hindering the success of initiatives of cleaning river Ganga. The anthropogenic activities, which are done deliberately or even unconsciously, have adverse effects, not only on the quality of drinking water for humans but also on the life of many species. In order to work on certain possible solutions to reduce pollution in river Ganga, the government of India along with the considered authorities should take certain steps in order to clean river Ganga. The people of India should understand the importance of the preservation of river Ganga and should take actions accordingly. Government of India need to put more efforts and focus to aware the Indian citizens to stop activities that causes pollution in river Ganga and form a community to preserve the river, both by stopping others and self, causing any harm to the river Ganga. There must be a proper environmental planning of

the Ganga River in future. The industrial and agricultural waste management programme and law should be form and implement as soon as possible so that the industries and farmers must not dispose hazardous and harmful chemical waste in the rivers without knowing the repercussions.

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