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GENDER AND DEVELOPMENT- A STUDY OF MATERNAL & CHILD HEALTH CARE POLICIES IN ODISHA

Mahapatra Dr. Padmalaya

Associate Professor, P.G Department of Public Administration,
Utkal University, Vanivihar, Bhubaneswar- 751004

INTRODUCTION

Gender discourse within the field of development has come a long way from building a case of 'inclusive' growth which prevents the marginalization of women to questioning of the predominant notions of development itself. The body of feminist critique continues to traverse new terrains and posit new challenges. The neo-liberal vision of society with a strong undercurrent of economic determinism often celebrates the atomistic, unconnected, self-maximizing individual- a conception which largely inhibits the space of both culture and development. Women's limited access to and control of material resources and limited decision-making power within the household can produce high fertility rates, under-investment in aspects of family welfare such as child nutrition and education, and sub-optimal allocations of human capital in the economy. Maternal morbidity and mortality along with infant mortality rate is universally considered as human development indicators in a country and determines the health status of the people. In spite of very good plans and programmes, the reduction in MMR & IMR is much below the target set in Odisha. The present study is based on both primary &secondary sources of data. The paper attempts to analyse the impact of maternal health care policies on women's health status in Odisha. It mainly focuses on maternal mortality relating to socio-economic characteristics of deceased, status of ante natal care, major causes that led to maternal death, major steps taken through various policies & programmes initiated by Govt. of India / Govt. of Odisha & their achievement.

GENDER & DEVELOPMENT

The **Gender** Related **Development Index** (GDI) is an **index** designed to measure **gender** equality. GDI together with the **Gender Empowerment** Measure (GEM) were introduced in 1995 in the Human **Development** Report written by the United Nations **Development** Program. The **GDI** measures differences between male and female achievements in three basic dimensions of human development: health, education and command over economic resources. **GDI** is the ratio of female HDI to male HDI. To calculate it, the HDI is first calculated separately for females and for males. India ranks 130 in Gender Inequality Index: UN. According to the United Nations' Human Development Report, India is ranked **130 out of 155** countries on the Gender Inequality Index (GII). The gender index takes into account reproductive health, empowerment, and economic activity.

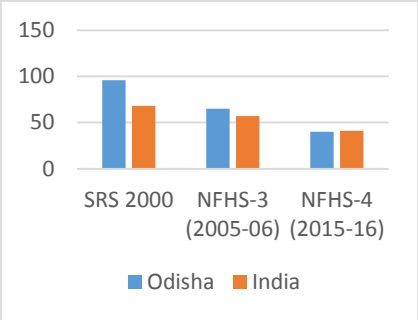
Maternal Health — Concept, definition, and components

Maternal health refers to the health of women during pregnancy, childbirth and the postpartum period. While motherhood is often a positive and fulfilling experience, for too many women it is associated with suffering, ill-health and even death. Maternal health care is a concept that encompasses family planning, preconception, prenatal, and postnatal care. Goals of preconception care can include providing education, health promotion, screening and interventions for women of reproductive age to reduce risk factors that might affect future pregnancies. Prenatal care is the comprehensive care that women receive and provide for themselves throughout their pregnancy. Women who begin prenatal care early in their pregnancies have better birth outcomes than women who receive little or no care during their pregnancies. Postnatal care issues include recovery from childbirth, concerns about newborn care, nutrition, breastfeeding, and family planning.

Women constitute nearly half (49.5 %) of the State's total population as per census 2011. As such their socio-economic development is a sine qua non for sustainable growth of the economy. Generally, women experience considerable disadvantage and discrimination in the society owing to gender differentiation. The gender bias propels disparities in terms of literacy, access to public health services and social development indicators. The female literacy of Odisha as per 2011 Census was 64% which was at par with national averages. But gender gap in literacy as per 2011 Census was the highest in Nuapada district and lowest in Khordha district.
Infant Mortality in Odisha has made quantum leap with 56 points decline by reducing IMR from 96

(SRS 2000) to 40 in 2015-16 (NFHS-4) which is the highest point decline in the country far ahead of national average decline of 27 points and better than major States like Gujarat (28 points), Rajasthan (38 points), Chhattisgarh (25 points), Jharkhand (26 points), MP (36 points), UP (19 points). This translates into 51,000 more children being saved annually compared to the year 2000. IMR in rural Odisha was 43 as compared to 21 in urban areas in 2015-16. At the national level, IMR stood at 41 and varied from 46 in rural areas to 29 in urban areas in 2015-16.

Infant Mortality Rate Point decrease: Odisha-56, India--27



Source: National Family Health Survey

Gender inequality, human rights and its effects on maternal health

Despite the country's growing economy and an ambitious rural health initiative, over 100,000 women die from pregnancy-related causes each year, more than anywhere else in the world. Many more suffer debilitating complications that they endure in silence due to impunity and lack of accountability in the health system. The medical causes of maternal mortality are well known and largely preventable, yet government policies have failed to have an impact.

Promotion of maternal and child health has been one of the most important objectives of the Family Welfare Programme in India. The current Reproductive and Child Health Programme (RCH) was launched in October 1997.In order to improve maternal health at the community level a cadre of community level skilled birth attendant who will attend to the pregnant women in the community is being considered.

REVIEW OF LITERATURE

Miller (1989), Murthi, Anne and Dreze (1995), Gupta and Bhat (1997), George (1998), Bhat and Zavier(2003), Mishra., Roy and Rutherford (2004), Dyson and Moore (1983), Krishnaji (1987), Siddhanta, Nandy and Agnihotri (2003), Pandey (2003), Hill and Upchurch (1995) and Acharaya & Kumar (2004) explained the extent of gender differences in infant and child mortality in terms of gender differences in health status ,disease incidence, preventive and curative treatment and social status.

"In many parts of the world, women receive less attention and health care than man do and particularly girls often receive very less support than boys. As a result of this gender bias, the mortality rates of females often exceed those of males in these countries. This is an important issue because gender discrimination that contributes to poorer health status for girls than for boys is likely to be the main pathway for excess female child mortality. Such discrimination occurs in (a girl) receives less attention than would be bestowed upon a son. She is less warmly clad, she is probably not so well fed as a boy would be and when ill, her parents are not likely to make the same strenuous efforts to ensure her recovery".

Sugathan, Mishra and Retherford (2001), Kishor and Parasuraman (1998), Stephenson and Tusi (2002), Bourne & Walker (1991), McNay, Arokiasamy and Cassen (2003), Dyson and Moore (1983) and Rustagi(2004) evaluated the status of women in India with different indicators such as of women's work, education, health, survival, safety and participation in public/private decision-making.

Sudha, Rajan, (1999) George (2002), Rutherford and Roy (2003), Bose (2007), Visaria (2007) examined the causes for eliminating the girl child. It indicates that they are rooted in rituals and perceptions that go back centuries: the fear of having to pay for a girl's dowry, the belief that for true salvation a son should perform the last rites, the conviction that lineage and inheritance run through the male line and that a son will look after his parents in their old age, whereas the daughters will belong to another family. Tied up to all this is the old perception of seeing only men as the bread earners.

Whatever our stance is on feminist economics, however, we need to be aware of these issues when analysing the effect of gender related issues on development at the macro level. Indeed, some of the newer fields in economics, such as behavioural economics, take some of these challenges more seriously. Another example of rising awareness of the need to consider changing social norms and culture is a recent book on economic growth by David Weil (2005), which gives considerable emphasis on culture and values.
During the 50 years from 1950 to 2000, mortality in all age groups greatly improved. The infant mortality rate (IMR) was 90% lower in 2000 than

in 1950, making infants the age group that saw the greatest changes over time. Men experienced a decline of at least one-third across all age groups. Women's death rates at ages zero to 80 fell by at least 50%, while improvements above age 80 constituted at least 30% of the decline over the 50-year period. These sex specific differences in mortality declines were also reflected in life expectancy. Women's life expectancy increase was almost linear over time. Men, on the other hand, initially experienced a slower life expectancy increase. From the late 1970s onward, male mortality declined faster in relative terms than female mortality (Luy 2004).

While at the beginning of the period, infant mortality contributed significantly to East-West differences, old age became much more important over time. Until the mid-1970s, the lower IMR and more rapid improvements in this rate in the GDR were responsible for part of the initial advantage of GDR in male life expectancy (Nolte et al. 2000a). The first few years after reunification, the IMR fell in both the East and the West, and the rates converged in 1997 (Nolte et al. 2000b, 2001).

In a cross sectional study, under-5 mortality was found to be strongly associated with maternal and infant health programs. It was also strongly associated with the proportion of births attended by trained person. To raise the public health spending remains the main challenge in developing countries for improving the quality of maternal and child healthcare. (McGuire JW, 2006).

A study was conducted to describe the association between under-5 mortality and socio-economic, political, and healthcare factors between rich and poor children. In this study, higher incomes were associated with lower under-5 mortality rates. (Houweling et al, 2005).

Global under-5 mortality has dropped from 11.9 million in 1990 to 7.7 million deaths in 2010.33% of these deaths occurred in south Asia and 49.6% in sub-Saharan Africa. Less than 1%death occurred in developed countries. Compared to 1990 to 2000, there is accelerated decline in child mortality from 2000 to2010. (Rajaratnam et al, 2010).

In a study from India, under-5 mortality rate declined at a mean rate of 3.7% per year between2001 and 2012. According to this study, 222 districts were lagging in the process of achieving Millennium Development Goals. Female mortality rate was higher by 25% in 303 districts. (Ramet al, 2013).

OBJECTIVE

The main objective of the study is to ascertain the level and pattern of maternal mortality among the selected rural groups in Odisha. More specifically the study tries to-

- Determine the level of maternal mortality among the selected population groups in Rural Odisha.
- Identify the Risk Factors of Maternal mortality, know their operational mechanism and find out their related risks
- Recommend appropriate intervention modes to prevent and control risk factors in order to reduce maternal & infant mortality.

Research Questions

To what extent maternal and child health care policies influence to improve the health status of women in Odisha?

METHOD OF STUDY

This study is based on both Primary & Secondary data. Data collected from empirical study in 2 Gram Panchayats of Cuttack district of Odisha. This study also involves personal interviews and discussions with several Women Leaders, Social Welfare Boards, and prominent members of NGOs etc.

- Field investigations, empirical surveys, direct interviews with villagers specially women, young mothers, traditional dais, Anganwadi workers, the Auxiliary nurse midwives, doctors and Self Help groups, Panchayat sarpanchas and members.
- Extensive scanning of published material on the subject.
- Scanning of a few previous and current Five Year Plan Provisions to reduce IMR& MMR. A Special attention was given to the Midterm reviews not only of the Planning Commission but also of Reports of some Ministries viz: Ministry of Health and Family Welfare, Ministry of Women and Child Development of the Centre and the States; National Rural Health Mission, selected local feedback from Panchayat Raj reviews and a few members of the Panchayats of the concerned States.

In any case, the problem of IMR & MMR is part of the Indian, "Social Complexity". To totally bring it down we need to take vigorous direct and indirect

systemic reform steps. It is high time, we took not one but several, "first steps" some of them have been recommended here as we have to walk a thousand miles to bring down IMR/ MMR in India.

Reduction of maternal and child deaths is one of the major challenges of the health system in Odisha. With several efforts from the State under the RMNCH+A campaign, it has been observed from the SRS reports, that there has been a decline in the State Maternal Mortality Ratio (MMR) and Infant Mortality Rate (IMR) over the years.

(Odisha State strategy for accelerated reduction of Maternal and Infant Mortality -Odisha 2020)

The maternal mortality has been defined by WHO as death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the cause of death (and) is intended for countries that wish to identify deaths occurring in pregnancy, child birth up to 6 weeks after the end of pregnancy but where the cause of death cannot be identified precisely. (WHO cited in Royston, Mauldin, 1994).

For women and adolescent girls of reproductive age, the biological functions of pregnancy and childbirth intersect with gender inequalities and poverty to expose women to maternal health risks. A lack of autonomy to make decisions about one's own health care, low levels of education circumscribing the ability to make informed health care decisions, limited control over financial resources, restricted mobility to access health care services and power differentials between health care providers and recipients are all factors which may preclude women from receiving the quality of care essential for ensuring healthy pregnancies and deliveries.

Though the maternal mortality ratio declined by 37 per cent between 2000 – 2015, there were an estimated 303,000 maternal deaths worldwide in 2015 due to complications in pregnancy and childbirth. Almost all (99 per cent) occurred in developing regions, with the highest level (546 per 100,000 live births) in sub-Saharan Africa, followed by South Asia (182 per 100,000 live births).

MATERNAL & NEW BORN HEALTH

SL.NO	**COMPONENT**	**RATE**
1	Proportion of women aged 15-49 who received post natal care within 2 days after giving birth (%)	62
2	Antenatal care coverage for at least four visits (%)	51
3	Proportion of births attended by skilled health personnel (%)	81
4	Caesarean section (%)	17
5	Proportion of women 20-24 years old who gave birth before age of 18	22
6	Number of women age 15-49 years with a live birth delivered in a health facility	79
7	Births who had their postnatal check-up within the first two days after birth (%)	24

(Source: Other NS 2016)

Infant mortality is an indicator of the health status not only of infants, but also of the whole population and of their poverty ridden social and economic status in the country. They face excessive vulnerability, as underprivileged, to a hostile environment and suffer malnutrition and serious health problems; all this leads to high rates of infant mortality and morbidity. Infant mortality i.e. deaths under one year of age in a year per 1000 live births, is an important indicator of child health and development.

(Source: The Socio-economic determinants behind Infant Mortality & Maternal Mortality, sponsored by the Planning Commission of India, 2006)

CHILD HEALTH

Sl No.	Component	% Rate
1	Children under age 5 whose births are registered (%)	72
2	Women aged 20-24 years who were first married on in union by age (%)	27
3	Children aged 5-17 years engaged in Child Labour (%)	12
4	Children aged 1 to 14 years who experienced any violent discipline (psychological aggression and/or physical punishment) in the past month (%)	Not Available
5	Justification of Wife beating (female) (%)	47
6	Justification of Wife beating (male) (%)	42
7	Women aged 15-49 who have undergone female genital mutilation (%)	Not Available

(Source: UNICEF/WHO 2017)

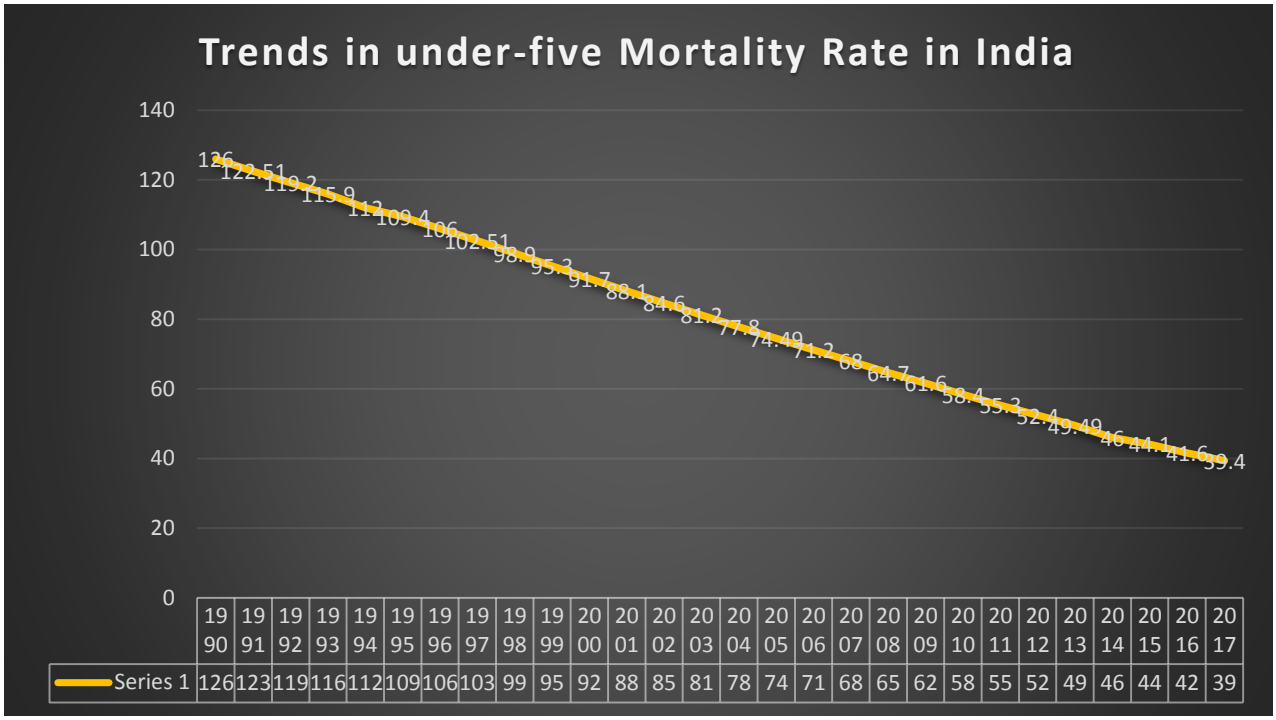
In 2015, the world began working toward a new global development agenda, seeking to achieve, by 2030, new targets set out in the Sustainable Development Goals (SDGs). The proposed SDG target for child mortality aims to end, by 2030, preventable deaths of new born and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 deaths per 1,000 live births and under-5 mortality to at least as low as 25 deaths per 1,000 live births.

CHILD SURVIVAL

SL.NO	COMPONENT	RATE
1	Under-five mortality rate (U5MR), deaths per 1000 births	39
2	Number of Under-five deaths	989,167
3	Infant Mortality Rate (IMR), deaths per 1000 live births	32
4	Neonatal Mortality rate (NMR), deaths per 1000 live births	24
5	Under-five mortality rate (U5MR), deaths per 1000 live births (male)	39
6	Under-five mortality rate (U5MR), deaths per 1000 live births (female)	40

(Source: IGME 2018)

The world made remarkable progress in child survival in the past few decades, and millions of children have better survival chances than in 1990–95. 1 in 26 children died before reaching age five in 2018, compared to 1 in 11 in 1990. Moreover, progress in reducing child mortality has been accelerated in the 2000–2018 period compared with the 1990s, with the annual rate of reduction in the global under-five mortality rate increasing from 2.0 per cent in 1990–2000 to 3.8 per cent in 2000–2018. Despite the global progress in reducing child mortality over the past few decades, an estimated 5.3 million children under age five died in 2018–roughly half of those deaths occurred in sub-Saharan Africa.



Existing Interventions for Reducing IMR & MMR in the State

State is continuing its consistent efforts for reducing MMR and IMR through different strategies at community as well as facility level. The major interventions which are implemented currently are as follows:

1.1 **Village Health and Nutrition Day (V H N D)**
These days are organized once in a month in every AWC on a fixed day basis (Tuesdays and Fridays) with joint effort of ANM, AWW and ASHA. The VHND provides quality ANC & PNC services for expecting and lactating mothers, counseling on family planning needs, Adolescent Health Day for adolescents, monitoring growth of child development where services like general health checkups (Weight for age, BMI, Anaemia detection etc), provision of essential drugs and micronutrients like IFA, albendazole, calcium are along with counseling and referral of identified high risk cases to appropriate institutions. Line listing and follow up of anaemia cases is also done in this platform.

1.2 **Comprehensive Abortion Care (CAC)**
To provide safe and accessible abortion care services, doctors and paramedics are trained in different methods of MTP up-to CHC DP level.

1.3 **Review of Maternal Deaths**
To reduce the incidence of maternal deaths, each and every cause of maternal death is analyzed and corrective action is taken accordingly at appropriate level. These reviews are undertaken at various levels so that steps can be taken for avoiding similar deaths in future.

1.4 **Screening of Syphilis and HIV in Pregnant Women**
For early management of syphilis and HIV among pregnant women, at all pregnant women are mobilized for screening test which is presently available up to delivery points. ANMs and ASHAs are mobilizing pregnant women for screening at the facility level and initiation of treatment, if found positive.

1.5 **A N M Mentoring**
This activity aims at improving knowledge & building defined skill sets of HW (F) for providing quality services in VHNDs and Sub center.

1.6 **MAMATA Yojana**
This scheme was launched in the year 2011 &is operational in the state to provide monetary support to the pregnant & lactating women of 19 years of age which enables them to seek improved nutrition and promote health seeking behavior. The beneficiary will receive a total incentive of Rs. 5000/- in four installments, subject to the fulfillment of

specific conditions. Payment is made by e-transfer from the CDPO to the beneficiary account.

1.7 **Janani SurkshyaYojana (J S K)**
JSY is a safe motherhood intervention scheme implemented with the objective of reducing maternal and neonatal mortality by promoting institutional delivery among all pregnant women with provision of cash incentive of Rs. 1400/- and Rs.1000/- for rural and urban area & Rs-500/- for home delivery cases belonging to BPL category respectively. The payment is made to the beneficiaries through Direct Bank Transfer (DBT) method only.

1.8 **Janani Sishu SurakshyaKarykram (JSSK)**
JSSK assures cashless services to pregnant women, post-natal women up-to 6 weeks after delivery and sick infants up to one year in government health institutions in both rural and urban areas.

1.9 **New born Care Corners (NBCC)**
A special corner is established in the labor room of all delivery points with a set of equipment for immediate care of the newborn and Healthcare providers conducting deliveries have been trained in Nabjat Sishu Suraksha Karyakram (NSSK) for essential newborn care and resuscitation.

1.10 **Kangaroo Mother Care (KMC) units**
KMC units have been established in all health facilities with SNCUs for ensuring warmth and early initiation of breastfeeding in low birth weight, preterm hypothermia & other sick newborns.

FINDINGS

It is estimated that about 15 percent of all pregnancies can develop complications of which five percent can be life threatening. These complications cannot be predicted but if detected and timely care is provided then maternal deaths and disability can be averted. Further, there are no evidences that antenatal care alone will have considerable impact on reduction of maternal deaths. However, antenatal care is a crucial aspect of birth preparedness and complication readiness where pregnant women can be screened, danger signs can be detected, treated or referred and to ensure that the pregnant woman and her spouse or family members are educated and counselled.
(Source: Odisha State Strategy for Accelerated reduction of Maternal and Infant Mortality, 2020)

The Maternal & Infant Mortality rate has been decreased significantly in India due to the innovative schemes adopted by the Govt. of India through the implementation of family welfare programs. To improve the accessibility and affordability of quality health care especially for those residing in rural areas particularly the poor and vulnerable women and children, the government has launched National Rural Health Mission in 2005.
(Source: Maternal Mortality in Orissa: An Epidemiological Study, by MY HEART)

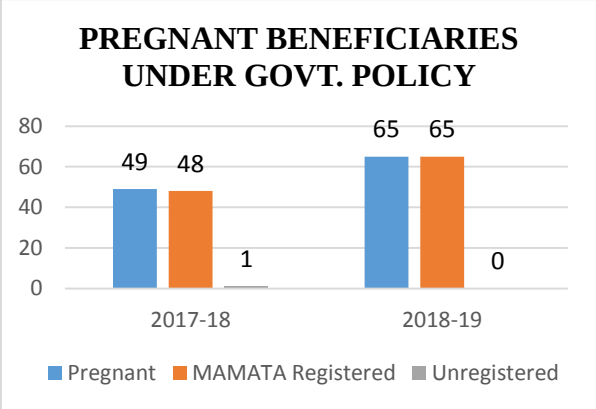
Under the study, attempt was made to collect qualitative information pertaining to maternal mortality, infant mortality and challenges faced by the pregnant women, service providers, ASHAs, ANMs, Anganwadi Workers, & other medical staffs or govt. staffs etc. Members in the focus group discussions in all the Sub-Centre villages were House wives who actively participated in the process of discussion. In all cases SHGs leaders as well as AWW/ ANM moderated the focus group discussion. The findings from each focus group discussion on the present theme have been enumerated below.

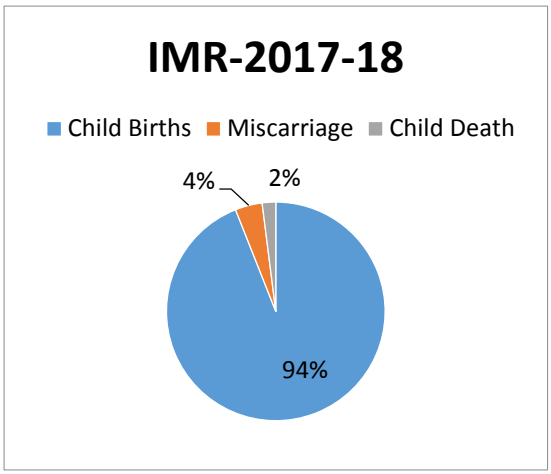
Year	Pregnant	Registered	Child Birth	%	Reason			
					Miscarriage	%	Child Death	%
2017-18	49	48	46	94%	2	4%	1	2%
2018-19	65	65	62	95%	1	2%	2	3%

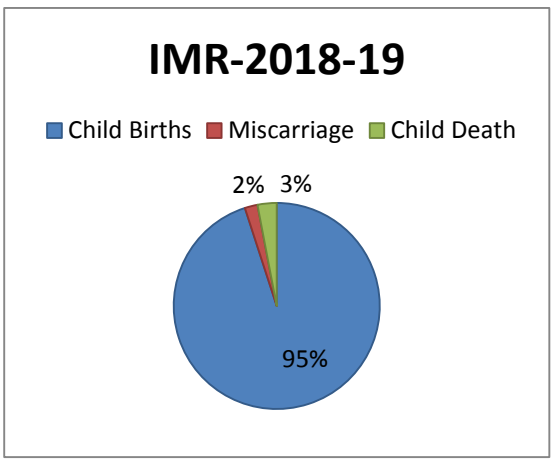
DATA: In the year 2017-18, 49 women were pregnant, 48 were covered under MAMATA Yojana (Govt. Policy) but 1 could not come under the policy due to under age (below 18). There were only 46

child births & rest 3 were child death. 2 child deaths were due to miscarriage & 1 child death was due to disease.

In the year 2018-19, 65 women were pregnant, all were covered under MAMATA Yojana, but there were only 62 child births & rest 3 were child deaths. 1 was miscarriage & 2 were child deaths due to deficiency of vitamins.







Antenatal Status of Women

Ante natal care generally implies that either a doctor, ANM or any other trained health personnel provides pregnancy related health care so as to avoid complication during pregnancy and child birth. Proper and effective counseling is also an integral part of ANC such as preventive care, diet during pregnancy, delivery and postnatal care. According to guideline envisaged in Reproductive and Child Health Program, ANC should include at least 3 health check-up, measurement of weight, height and blood pressure, administration of 2 TT, consumption of IFA tablets and preventive measures for malaria.

Survival Status of Neo Natal

About 58% of newborn were reported to be alive in the post delivery period whereas only 29% of newborn babies could not survive. It is to mention that in many of the health institutions are not properly equipped to provide neo-natal care. On the other hand, there was lack of health education program on the aspect of effective neo-natal care and a role of service providers towards community.

Concluding Observations

The present empirical study has reflected the gap between policy formulation and policy implementation. The author concludes the paper with an optimistic view point suggesting measures to remove the loopholes in Maternal and Child Health Care Policies in Odisha.

Suggestions

- There should be increased awareness program on maternal health and safe motherhood.
- Treatment at right time during pregnancy and sufficient nutritional food intake by PWs should be major responsibility of elderly members in every family including the husband.
- Services and system in sub divisional medical centers should improve to ensure quality maternal healthcare.

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SRI LANKAN YOUNG ENGINEERS' PERCEPTION ON COMMUNICATION SKILLS; A QUALITATIVE SURVEY

Praneeth S. Wijesinghe[1], Thesara VP. Jayawardane[2]

[1]University of Ruhuna, Sri Lanka, [2]University of Moratuwa, Sri Lanka

ABSTRACT— Communication skills are a basic requirement for professional practice of engineers to deliver information, knowledge and experience for effective usage of clients, staff members and society. Professional performance and career development of engineers heavily depend on the extent of communication skills possessed with each engineer. So, engineering undergraduates should develop their communication skills from the beginning of their undergraduate studies. Objective of this research was to gather and analyze the opinions from young engineers about the requirement of communication skills to perform well in Sri Lankan industrial sector as young engineers. An online open ended question was administered via e mails for young engineers who have graduated within the last five (5) years of time and working in Sri Lanka. This question was sent to 2500 young engineers in Sri Lanka and 160 responses were received. Thematic analysis of results revealed that opinions of young engineers belong to 3 main categories such as opinions suggesting undergraduates on how to improve communication skills, opinions emphasizing importance of communication skills when performing as professional engineers and opinions suggesting improvements in engineering curricula. Results of this research will definitely raise the awareness of engineering undergraduates to recognize the value of communication skills which bond with their future profession. Engineering educators also can make use this research to make improvements to the curricula in order to improve the communication skills of undergraduates effectively.

***Keywords**: Communication Skills, Engineering Undergraduates, Opinions, Young Engineers*

1. Introduction

Communication skills have become an essential soft skill required for the better performance of most of the professions available in the world. Communication can be defined as 'the imparting or interchange of thoughts, opinions or information by speech, writing, or signs. Communication is multifaceted and incorporates various elements, such as oral, written, listening, visual, intercultural and interdisciplinary.(Riemer, 2007). When interchanging information by oral or written methods, several skills like effective presentation skills and proficiency in handling the languages should be developed within each communicator.

Engineering is a profession in which career success cannot be achieved without having effective communication skills. Engineers must be able to report their ideas and designs clearly and succinctly to their subordinates, co-workers, supervisors and clients (Chetia, 2015). Communication skills can be considered as a career enhancer for engineers. Inadequate and ineffective communication skills definitely affect the engineers in individual levels and also in corporate levels. So, there is a growing demand for the engineers who are possessed with effective communication skills to cater local and international engineering firms.

Communication skills of engineers should be developed and shaped from the beginning of their undergraduate education. Communication is one of the program outcomes specified for accredited engineering degree programs by Accreditation Board for Engineering & Technology (*Criteria for Accrediting Engineering Programs, 2016 – 2017 | ABET*, 2018). So, international, as well as Sri Lankan engineering degree programs have been incorporated with communication skills development programs in curricula which already packed with technical modules.

Conventional Engineering curriculum is strongly focused on the development of technical knowledge and skills in students. However, in recent years, employers have increasingly acknowledged that this traditional preparation of Engineering students is inadequate, as graduates lack the wide range of written and spoken communication skills required to engage with members of other professional groups and with the broader community (Missingham, 2006).

Though various methods to improve communication skills of undergraduates are incorporated in engineering curricula, it is doubtful whether the graduating engineers had attained the required level of communication skills as per the requirement of the industry (Donnell *et al.*, 2011).

Most of the engineering students in Sri Lanka and also in other countries like in India do not focus on non-technical aspects of engineering education like development of communication skills within them while majorly focus on technical subject matters (Chetia, 2015). Mostly, engineering students from non-English speaking countries find it difficult to deal with English as the international language for their professional works. The growing importance placed on oral communication skills by employers has been echoed internationally in these two three decades. Since, English play a major role in engineering communication, engineers and also engineering undergraduates should work hard to improve English through development of inner urge to learn English, enriching vocabulary and sentence construction, listening, speaking, reading and writing (Patil, 2012).

Four sources of weaknesses leading to make drawbacks in engineering communication education were identified as students' attitudes to communication, insufficient course content, deficient or inappropriate teaching methods and lack of opportunity for engineering students to practise communication skills (Roulston and Black, 1992). So, identifying ways to overcome those weaknesses is very much important in that case.

Missingham, (2006) proposes strategies to develop communication skills of engineering undergraduates by incorporating communication skills development activities across the curriculum directly link with technical courses rather than having stand-alone modules like Communication Skills. It allows students to identify the communication aspects required for their future professional activities in a technical environment.

Recent research conducted focussing first year engineering undergraduates of a state university in Sri Lanka, has revealed that the most serious problem reported by undergraduates was lack of speaking skills in English. The reason for this was they were shy, anxious and not confident (Wijesinghe and Gardihewa, 2019). If they do not realize the importance of communication skills in English language during the undergraduate period, they will never try themselves to improve communication skills by overcoming above mentioned weaknesses.

This research was conducted in order to identify and disseminate the opinions of young engineers in Sri Lankan industrial sector on requirement of communication skills for professional engineering works. Findings of this research can act as a self-motivation to raise the awareness of engineering undergraduates on importance of communication skills and what they can do individually to improve communication skills within the students. This will be very important and highly beneficial for the engineering community since such kind of research has not been conducted in Sri Lanka yet.

2. Methodology

This research has followed the qualitative survey research approach which had utilized participant generated textual data for analysis. An online open ended question was administered via e mail for young engineers who have graduated within the last five (5) years of time and registered with The Institution of Engineers Sri Lanka (IESL) as Associate members. It was sent to 2500 young engineers in Sri Lanka. In this research paper, responses received for the open ended question on "What opinions would you like to give engineering undergraduates regarding communication skills?" have been discussed. Responses were thematically analysed by getting the support of NVivo qualitative data analysis software in order to identify significant and emerging themes from the responses.

3. Results and Discussion

Approximately 160 comments and responses were received from young engineers in Sri Lanka for the online open ended question. This research has generated valuable outpouring of responses that covered 7 single spaced pages. It is no doubt that, young engineers who had responded for the question must have felt strongly enough to write paragraphs of opinions regarding the importance of communication skills. Though, they have graduated within last 5 years, they were much concerned about giving their contribution for the improvement of engineering education field as far as possible through this kind of research.

Three major categories or themes could be identified when analysing the responses with thematic analysis approach. So, responses given by young engineers belong to the categories of opinions advising students on how to improve communication skills, opinions emphasizing importance of communication skills for engineers and opinions suggesting improvements for engineering curricula with the current industry requirement. About each themes followed by supporting responses of young engineers have been discussed in the following section.

3.1 Opinions advising students on how to improve communication skills

Young engineers are the people who know the industry requirement of communication skills by facing the challenge with skills which already

possessed with them. So, they have a better idea about how to improve communication skills based on the current industry requirement.

"You will get many opportunities to get improve your communication skills during the four years of time. Never think on improving these after the graduation and if you do so definitely you will see how others passing you. So don't miss the bus".

Universities offer various opportunities for undergraduates to improve their communication skills. Many students utilize those opportunities without any hesitation to improve their communication skills. But, some students do not recognize the value of such opportunities and wait to improve their communication skills after graduation during their jobs. As per the above mentioned narrative, if students wait till the last moment, they will experience the negative consequences of not having good communication skills. Engineers with good level of communication skills will definitely perform well in professional activities. So, engineers with lack of communication skills always have to underperform in front of them.

"Take part in extra-curricular activities. Eg. Gavel, Rotaract, Toastmasters etc. They would help you improve your communication skills more than any module would"

Nowadays, in Sri Lankan universities, there are lot of clubs and societies which help students to improve soft skills including communication skills required for better future of the profession. Engineering students can join those societies and work with their colleagues and with different kinds of people. Definitely, it would help them to enhance their communication skills without any extra effort.

"Use your free time to improve your communication skills rather than relying on the university to do that for you".

Many engineering undergraduate students expect that university will spoon feed all the knowledge and skills required to become a competent engineer in future, like in schools. They should realize the real situation in universities. Students have their own role to play during their undergraduate study period. They have to spend their own time and work hard to achieve some goals like be an effective communicator by their own. University, itself has a limited role in such situations.

"Improving presentation skills, report writing and other communication skills is essential and spend some time on that".

Presentation and report writing skills should be at a higher level in just passed out engineering graduates (Sageev and Romanowski, 2001). So, while paying attention on enhancing technical engineering knowledge, engineering students should focus on how to present those technical matters to others in an effective way whether in oral and written methods. There is an art in doing a presentation with technical matters, so the audience can understand it very well and finally to achieve the relevant objectives through the oral presentations. Written communication is also having an important place in the professional engineer's role. Reports, memos and e-mails are the widely used written communication methods in engineering. Failure and success of any engineer is greatly depend on the extent of communication skills possessed with them (Hansen and Zenobia, 2011).

"Improve language skills. Respect people in every aspect. Use polite and motivational words. Listen to people. Let them know you respect their ideas".

Skills in handling both native language as well as English, is an essential requirement in today's engineering profession. Fluency in native language is also important since engineers have to give instructions and advices to their subordinates, shop floor level employees etc. who do not have the proficiency in understanding English in most of the time. Same time, engineers have to communicate with their peers and superiors in English language. Communication of engineers with both parties means professional socialization and engineers are expected to bridge the communication gap between top management of the firm and the shop floor level employees (Sirbu and Alibec, 2017). Not only delivering, but also listening to others is also an important part of professional communication (Roulston and Black, 1992). Though engineers are having technically sound knowledge, there are instances where they have to listen and respect other's opinions, ideas and suggestions etc. So, future engineers should keep those advices with them in order to become competent professional engineers in their respective disciplines.

"Better to improve the knowledge on English language and specially on presentations skills. Enhance your confidence in addressing group of peoples"

English is the major medium of education, publishing and international negotiation. It is perhaps the most flexible of all languages. Therefore, people belonging different parts of the world widely use English. It is the lingua franca of the world. If engineer is good speaker in English means good in all. Therefore, engineers have to

communicate in English (Patil, 2012). Engineer is a leader in his or her workplace. As the leader, engineer has to address his or her people to motivate and get the work done in effective manner.

"Learn how to present the work that you have done and market yourself."

Weaknesses and difficulties in presenting the works, designs and researches done by engineers in an attractive manner will not give the expected outcome. Though the work is in good quality, opportunities like marketing or commercializing it, is not that easy in such environment. So, engineers should learn how to present the work they have done in an impressive way in order to exploit new dimensions in business environment.

3.2 Opinions emphasizing importance of communication skills for engineers

Importance of communication skills required for engineers is very well known by practicing engineers none other than anybody in the industry (Roulston and Black, 1992). So, there is a high value and practical importance in the narratives made by practicing engineers regarding the importance of communication skills to engineering undergraduates and engineering educators to get more insights about communication skills.

"Your technical skills can be sold by others, if your communication skills are weak".

These kinds of things are happening in the industry when engineers' communication skills are weak. Somebody else with good communication skills can get benefits by presenting some other's work due to his or her weak communication skills, although it is not ethical. These things will not be happened to engineers if he or she can present what they have done and what they are going to do in an impressive manner to relevant personnel.

"Technically sound person with better communication skills always shine in their industry and goes to the top in a very short time"

To become a successful competent engineer, one must master and demonstrate both technical skills as well as communication skills in the industry. Competency in one field is not enough to achieve career progression like promotions. According to this narrative given by one of the young engineer was clearly emphasizing the requirement of both technical and communication skills for the rapid progression of the one's profession.

"You may hide in the university but will be exposed in the industry. Your communication skills have a greater value than your academic results".

Many students try to be hidden in the university without participating for extracurricular activities while giving major priority for technical studies (Donnell *et al.*, 2011). But, they have to be exposed in the industry whether they like or not. Via communication skills, engineers develop professional relationships with others and academic results itself cannot support engineers very much on that perspectives. As the narrative explains, communication skills have a greater value than academic results in the industry.

"As engineering graduates, we all have a same kind of knowledge technically. But mainly in the industry, the difference in between two engineers is starting with soft skills and communication skills. So it is very important and compulsory to improve those skills simultaneously".

This narrative is also very much significant in identifying the importance soft skills including communication skills. It is true that all graduates of any degree program are having same kind of knowledge. When it is in engineering, they also have same set of knowledge. Their difference is significant in the fields of personality perspectives and communication skills. That is why one is selected to a job in no time and others have wait for long time.

"Technical knowledge will be useless if an engineer isn't a good communicator".

If any engineer cannot convey the technical knowledge possessed with him or her relevant to a specific task, what is the benefit of employing such person to the industry? So, it is very well clear from the above excerpt that in order to have maximum benefits of technical knowledge, engineer should be a good communicator.

"Especially communication skills are very much important for the engineers where we need present our working, findings etc. to our clients and colleague staff. If don't have proper communication skills, even though we have done hard work we won't be able to convince it while presenting"

This excerpt is also conveying the similar message regarding the importance of communication skills. Hardworking is not enough for any engineer to progress in career ladder (Roulston and Black, 1992). Hard works need to be communicated to relevant parties like peers and superiors in the work place in order to get the maximum benefits and

reputation for carrying out such works. Otherwise nobody will get to know about these things.

"At a glance it's those who speak up, that get noticed. And getting noticed, although not always the best approach, is surely a trump in your hand in the work place because working hard isn't enough if you can't tell what you've done. Seize every opportunity to sharpen your communication skills. There is nothing more expensive than a missed opportunity".

Without properly speaking up, it is very difficult to secure a reputed position in any work place. They get noticed most of the time to others and receive lot of valuable opportunities. This young engineer has emphasized about an important reality in today. That is "There is nothing more expensive than a missed opportunity". Engineers may lose many valuable opportunities in their professional life like promotions, new job opportunities, scholarships and funding for projects etc. due to lack of communication skills. Missed opportunities are hardly regaining. So, it is better for engineers to grasp every opportunity to sharpen the communication skills from the beginning of the undergraduate studies.

3.3 Opinions suggesting improvements in engineering curricula for the development of communication skills in engineering undergraduates

Engineering curriculum itself can make a good impact on engineering undergraduates' communication skill development (Missingham, 2006). Many new trends like communication skills development through across the curriculum approach has been came to the engineering education field. Similarly, following advisory suggestions can be considered to make improvements in existing engineering curricula of Sri Lankan universities as per the current industry requirements on communication skills of young engineers.

"Increase the opportunity to have presentations as a part of exam rather than just written exam. Need to promote the students to use their creative ideas or solutions instead of learn by heart".

According to this excerpt, opportunities given for engineering undergraduates in Sri Lankan universities to do presentations are not sufficient. This young engineer recommends to increase that. Mostly, student evaluations are based on written examinations in Sri Lanka. But, if universities can give more opportunities for presentations instead of written examinations, students can improve their communications skills more and more. Technical modules should be revised so as students can utilize their own creative ideas and solutions instead of learn by heart or cramming.

"I suggest something to universities. Host Tech Conferences and Tech Meet ups in Universities and provide opportunities. Make blog writing and running YouTube channels part of curriculum/ assignments (to make Sri Lankan Tech stuff on internet). We do great thing in Sri Lanka but nothing documented on public internet".

"Have more events like symposiums, conferences, formal meetings where students can improve their communication skills, rather than forcing them to go for lectures on English language"

These two suggestions are rather not a new concept for Sri Lankan engineering education sector. If universities can host technical conferences and meetings where students also can participate to present their works and discuss relevant matters, such opportunities will definitely help students to improve their communication skills without any extra effort. Although Sri Lankans involve with great technical work, documented part of those work are very weak in the internet. So, dissemination of such work to international level has got restricted with that weakness. If students can involve in blog writing or running You Tube channels relevant to their technical works as a part of the assignments or curriculum, it will make a greater impact on students themselves and finally to the society.

"Engineering students should involve with industry more than industrial training".

Currently, Sri Lankan engineering students get maximum of 24 weeks of time to work with the industry as industrial training. This young engineer recommends to have more and more involvement of engineering students with industrial activities other than industrial training component. University can arrange some collaborative project or research work with industry. Students can develop solutions for different industrial problems and can present their solutions to industry by their own. It develops their communication skills while improving their confidence. It is a win-win situation for both parties. However, this concept is not much popular in Sri Lanka and only few dedicated students get the benefits from that.

"Undergraduates from the state universities are required to have a good English speaking ability, and they should be able to behave professionally and confidently in meetings".

This reveals about the two major weaknesses of engineering graduates who come from the state universities. According to the observations of this young engineer, most of the undergraduates from state universities lack good English speaking ability and skills to behave professionally and confidently in meetings. These are major points which should be focused by state universities in Sri Lanka. More and more opportunities to develop written and spoken aspects of English language should be given to students through curriculum. Students should be given practical opportunities to participate in industry related meetings. By participating and contributing to those industry meetings, students can develop their professional behaviour and confidence.

Without proper communication skills, engineers cannot sustain in the industry as competent professionals in the relevant fields. Responses of young engineers, for the given research question have revealed lot of insights relevant for the communication skills development. Hence, engineering educators and policy makers can carefully study about the outcomes of this research and evaluate the current situation of engineering curricula against the research findings. Additionally, this research paper can be utilized to raise the awareness of engineering undergraduates on the importance of communication skills for engineers.

5. Conclusion & Future Recommendations

Communication is a major graduate attribute of engineers which makes a higher impact on performance of professional engineers. Thematic analysis of responses revealed that opinions of young engineers belong to three main categories as opinions for undergraduates on how to improve communication skills, opinions emphasizing importance of communication skills when performing as professional engineers and opinions suggesting improvements in engineering curricula to improve the communication skills in engineering undergraduates. Those opinions can be utilized to raise the awareness of engineering undergraduates on importance of communication skills and make necessary revisions in engineering curricula in order to improve communication skills effectively. Researchers in engineering education sector can deeply investigate about the effectiveness of existing programs on communication skills development of undergraduates in engineering faculties of Sri Lanka to identify whether the intended outcomes are achieved by the engineering undergraduates or not. It will be beneficial to revise the curricula in more effective manner.

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LIQUID FORMULATION AND SPORE VIABILITY OF AN ANTAGONISTIC FUNGUS *Trichoderma viride*, IN FRUIT PULP OF *Tamarindus indica*

1Keerthana, R., 2Thiruchchelvan, N. and 3Mikunthan, G.

Department of Agricultural Biology, Faculty of Agriculture,
University of Jaffna, Ariviyal Nagar, Kilinochchi, 44000, Sri Lanka

ABSTRACT—
Trichoderma species are promising antagonistic fungus against soil-borne plant pathogens and more prevalent among other bio-control agents. It has great perspective to be mass-produced by using cost effective locally available substrates in Sri Lanka. Therefore, present investigation was carried out to initiate the cost effective liquid medium by using, Tamarindus indica deseeded fruit pulp for T. viride. Preliminary evaluation for conidial production was done with 10 g of pulp for 100 mL of distilled water. Then concentrations (2, 4, 6, 8, 10 g and 20, 40, 60, 80, 100 g of pulp/100 mL of distilled water) of the medium was standardized and effective range was chosen. For that selected effective range, conidial production was evaluated and viability of conidia produced on selected concentration ranges of the medium was determined by taking colony forming units (CFU/ mL). Results revealed, preliminary conidial count of 2.1 x 108/ mL was obtained at a Week After Inoculation (WAI). Conidial count from standardization was obtained as; 15.7 x 108, 12.5 x 108, 7.4 x 108, 5.7 x 108, 5.5 x 108 conidia/mL respectively for 10, 8, 6, 4, 2 g/100 mL. Conidial count was recorded as 19.5 x 108, 15.6 x 108, 12.96 x 108, 5.9 x 108, respectively for 20, 40, 60, 80 and 100 g/100 mL of distilled water at 3 WAI. The selected effective concentration range of 5 to 25 g/100 mL of distilled water was significantly promoted the conidial production from 10.1 to 31.8 x 108 /mL at 3 WAI. The productive range for mass multiplication of T. viride was 15 to 35g pulp/100mL of distilled water. The conidia was stabilized for 8 weeks in standardized tamarind pulp. This novel result would help the Trichoderma producing industries to economically feasible commercial production with the locally available natural ingredients. Further research has to be carried out to combine the tamarind pulp with other suitable ingredients to sustain the viability of the conidia in the commercial formulations for a longer period.

Keywords: *Liquid medium, Mass production, Tamarindus indica, Trichoderma viride, Viability*

1. Introduction

Trichoderma species are fortunate antagonistic fungi due to the abilities of rapid growing, cosmopolitical invasion and prolific spore production. These characters make *Trichoderma* as dominant fungal strain, ecologically ubiquitous and able to reproduce in different ecosystem [1]. Soil borne pathogens are major threat to agricultural crops by creating severe economic losses. This phenomenon tend the farmers to apply excess chemicals for immediate response. Unexpectedly this criteria end up with several drawbacks as well. In Sri Lanka recently reported Chronic Kidney Disease of Unknown etiology (CKDU) [2] is one of the typical exemplification for the drawback. To defeat issues, which are engendered by chemical means, diverse of microbial biocontrol agents are obtainable in worldwide. Among that, *Trichoderma* species are notable one with well-known profile.

In recent years, appreciable success has been achieved by using bio agents, however lack of fruitful formulation of bio agents leads to exploitation in commercial level [3]. Further, this bio-control strategy has great compatibility with sustainable agriculture and play a major role as an important component in Integrated

Pest Management (IPM). Now the agricultural producers turn their more attention toward organic and bio based products as their agricultural inputs. Due to that, by utilizing the capability of *Trichoderma* that can be multiplied with cost effective liquid or solid media, able to hold up the local green agriculture industries. To commercialize the *Trichoderma* spp. researchers and producers utilize vast range of solid and liquid substrates. Nevertheless, in solid fermentation, long time fermentation, high substrate volume, locally available and disposability are the major issues [4].

Therefore looking towards cost effective with acceptable and easily prepared formulations are essential for the commercialization of bio agents. Similarly, the formulation is expected to yield

biomass with excellent shelf life. For that, the present investigation was carried out to assess the promising performance of *T. viride* in cost effective liquid media *Tamarindus indica* fruit pulp. In Sri Lanka, *T. indica* was reported as underutilized plant [5]. This study further, ensures the value of *T. indica* and make the local producers to focus on easily accessible product, fruit pulp of *T. indica* for mass produce the bio agent, *T. viride* by using *T. indica* fruit pulp as a liquid medium.

2. Materials and Methods

All the experiments were carried-out at the Research Laboratory of Department of Agricultural Biology, Faculty of Agriculture, University of Jaffna, Kilinochchi, Sri Lanka.

2.1. Initial inoculum preparation

A mother culture of *Trichoderma viride* was obtained from the laboratory of Green Visva Lanka Farm Developers (Guaranteed) Ltd, Chankanai. From that, sub-culturing was done by using PDA medium. Conidial suspension was prepared by taking one loop-full inoculum from five days old grown culture and added into distilled water. Initial inoculum was maintained at the range of 3.0 to 4.0 x 10^6 conidia/mL.

2.2. Preliminary evaluation with Tamarind fruit pulp

From the screening of several locally available solid and liquid substrates tamarind pulp was initiated as cost effective, productive substrate for *T. viride* mass multiplication. For that, 10 g of deseeded tamarind fruit pulp was solubilized with 100 mL distilled water. Then suspension was filtered by using double folded muslin cloth and the supernatant was transferred into 180 mL of glass bottles. Finally, bottles were sterilized in the autoclave at the pressure of 1.0546 kg/cm^2, 102℃ temperature for 20 minutes.

2.3. Inoculation of *Trichoderma viride*

Sterilized medium with glass bottles were transferred into laminar flow to maintain the aseptic condition. Then the conidial suspension of T. viride (3.2 x 106 conidia/mL) was prepared from mother culture and inoculated into the medium at the rate of a milliliter per 100 mL of medium. After the inoculation, glass bottles were arranged in a tray at a slant position to increase the surface area and was allowed for incubation.

2.4. Counting of conidial yield

Conidial count was taken at the interval of 7th and 14th days after inoculation. Serial dilution method [6] was followed as, after well shaken of medium along with grown culture, 1 mL of suspension was pipetted out into 9 mL of distilled water. Then from this suspension 1 mL was taken and added in 9 mL of distilled water. A double ruled Neubauer's haemocytometer was used to count the conidial yield.

2.5. Standardization of medium

There is a requirement for standardized concentration of tamarind pulp extract to recommend for the mass production of *T. viride* by the local producers. For that, pulp amount was taken at three different ranges based on preliminary evaluation. As for low concentrations, the pulp amount was at the range of 2 to 10 g (2, 4, 6, 8, 10 g) and 20 to 100 g (20, 40, 60, 80 and 100 g) for higher concentrations. Final range was selected as in between of low and high concentrations, which was 5 to 25 g pulp (5, 10, 15, 20 and 25 g). Above ranges were denoted as Range I, II and III, respectively. Further, same procedure was followed for conidial evaluation as mentioned in section 2.2. Initial inoculum was maintained as 3.46 x 10^6 conidia/mL. Mean conidial count was evaluated at 1, 2 and 3 WAI. Based on the conidial yield, effective range of *T. indica* fruit pulp for optimum conidial production by *T. viride* was chosen.

2.6. Conidial viability of *Trichoderma viride* grown in effective concentration range of medium

Viability of *T. viride* was tested for 4th, 6th, 8th weeks from incubation by calculating the number of colony forming units in a milliliter (CFU/mL) of formulation. From each concentration 1 mL of suspension was taken and serial dilution was performed for factor of 10^{-5}. Then 1 mL of suspension was taken and spread on the PDA medium. Four replicates were maintained for each concentration. *T. viride* inoculated petridishes were incubated at room temperature at 28 ℃ for two days and number of colonies were counted [7] and calculated by using following equation.

CFU/mL = (Number of colonies plated per mL) / (Dilution factor) [8]

2.7. Statistical Analysis

All the experiments were designed according to the complete randomized design (CRD) and the data were statistically analyzed using SAS package. Significance among the treatments was determined according to the Duncan multiple test at 95 % of the confidence interval.

3. Results and Discussion

3.1. Initiation of tamarind liquid medium

From the preliminary evaluation with tamarind pulp extract as liquid medium, the conidial count 2.0965 x 10^8 and 3.9477 x 10^8 conidia/mL were obtained at

1WAI and 2 WAI, respectively. Based on the reported conidial count, *T. indica* pulp was initiated as cost effective liquid medium for mass production of *T. viride.*

3.2. Standardization of *T. indica* pulp extract medium concentration

To mass-produce the *T. viride,* standardization of the medium is essential. Figure 1, 2 and 3 interpret the conidial production of *T. viride* for different concentrations range of tamarind pulp until 3 WAI.

3.2.1. Standardized Range I

From figure 1, when concentration was increased from 2 to 10 g/100 mL the conidial production was increased up to 3 WAI. The optimum conidial count of 15.731 x 10^8 conidia/mL was obtained for 10 g/100 mL and was gradually reduced for 8,6,4,2 g/100 mL as 12.534 x 10^8, 7.412 x 10^8, 5.65 x 10^8, 5.492 x 10^8 at 3 WAI.

Plate 1 shown that mycelial growth and conidiation were comparatively low in this range due to presence of lesser amount of solutes. Lesser conidiation was indicated by the incomplete culture growth on medium surface.

Plate 1: Mycelial growth & conidiation of *T. viride* in standardized Range I

3.2.2. Standardized Range II

Figure 2 interprets that, when the concentration was increased from 20 to 100 g/100 mL the conidial production was reduced up to 3 WAI. Optimum conidial count was recorded as 28.6 x 10^8 for 20 g/100 mL and the count was gradually declined as 19.48 x 10^8, 15.64 x 10^8, 12.96 x 10^8, 5.92 x 10^8 respectively for 40, 60, 80 and 100 g/100mL.

At this range, more than half of the mycelium was remained as white colour, and lower conidiation was obtained (Plate 2). However, when concentration was reduced up to 20 g/100 mL, optimum culture growth on medium surface was observed. Because solutes present in tamarind pulp at this concentration may provide conducive environment for growth of *Trichoderma.*

Plate 2: Mycelial growth and conidiation of *T. viride* in standardized Range II.

3.2.3. Standardized Range III

Significant conidial production was obtained from this range III as 31.771 x 10^8 at 3 WAI. By using this range of pulp amount can obtain the conidial yield which was recorded for higher pulp amount (Range II). Because of that can able, to mass multiply the *T. viride* by using this less amount of pulp range.

Plate 3: Mycelial growth and conidiation of *T. viride* in standardized Range III

3.3. *In vitro* viability determination for *T. viride* in effective concentration range of *T. indica* medium

For all treatments, CFU of fungal colony was increased from 4 to 6 WAI. The viability was retained until sixth week for all concentrations. However, after 8 weeks the mean CFU was increased for 5 g/ 100mL (19.75±2.98 x10^5), 15 g/100 mL (32.75±3.50 x10^5) and 20 g/100mL (43.25±9.67 x 10^5) but for other two treatments mean CFU was gradually reduced.

All the treatments showed a similar stabilization of *T. viride* conidiation over eight WAI. No any significant difference was observed among the treatments over 6 weeks. Among the concentrations 25 g/100 mL shown a highest mean CFU of 60.75±11.08 x 10^5 and was able to retain the viability of *T. viride* until 8 weeks.

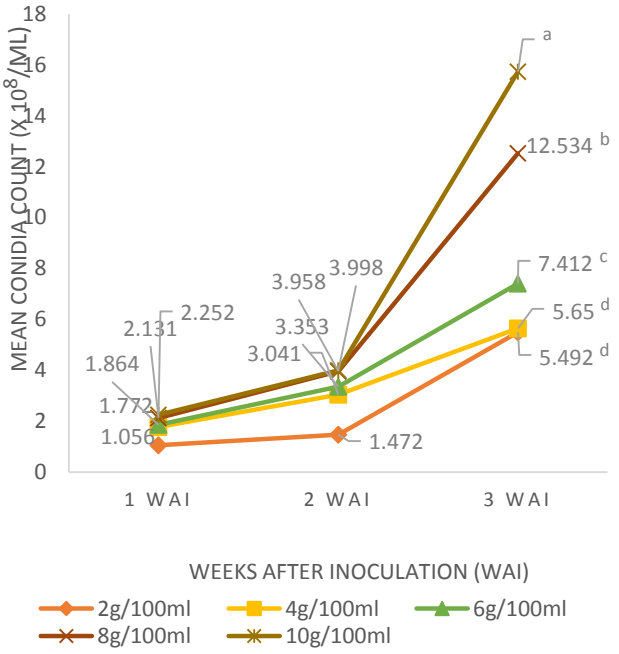

Figure 1: Mean conidial count in Range I

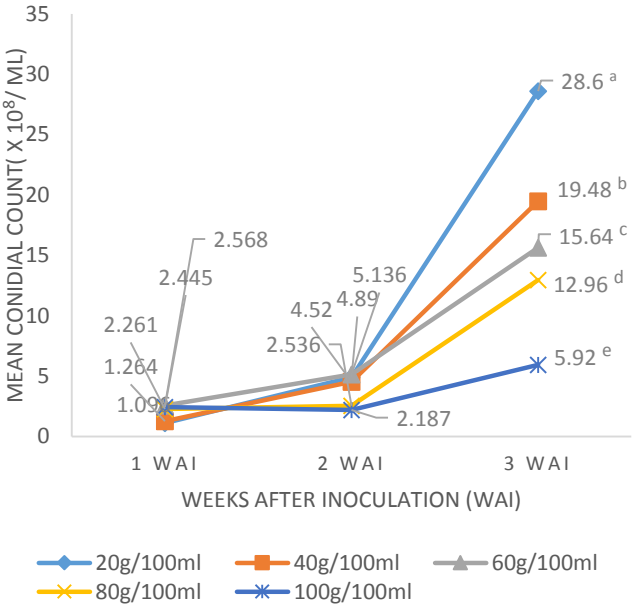

Figure 2: Mean conidial count in Range II

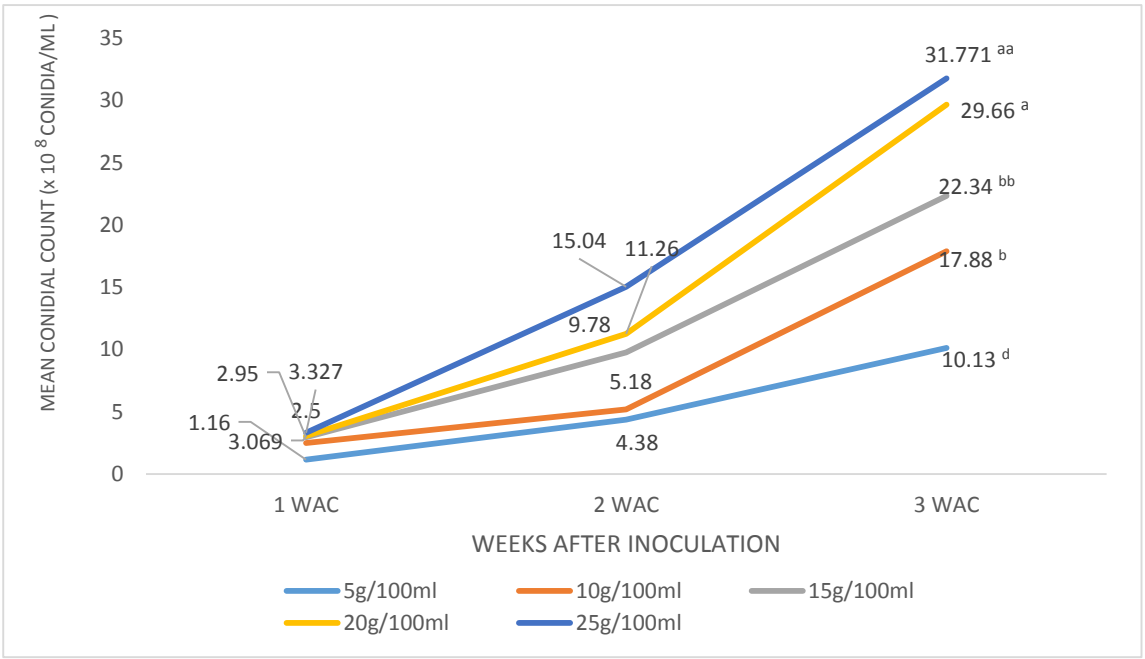

Figure 3: Mean conidial count in Range III

Table 1: CFU/mL of *T. viride* grown in effective concentration of medium

Treatments (g/100 mL)	Mean Colony Forming Units (CFU) per mL of Suspension		
	4 WAI (x 10^5)	**6 WAI (x 10^5)**	**8 WAI (x10^5)**
5	11.75±4.11[b]	18.25±4.57[c]	19.75±2.98[d]
10	15.75±6.13[b]	25.5±5.19[c]	22.0±8.04[cd]
15	21.5±7.54[b]	31.25±4.03[bc]	32.75±3.50[bc]
20	36.5±14.15[b]	42.75±10.21[b]	43.25±9.67[b]
25	41±3.91[a]	62.75±18.94[a]	60.75±11.08[a]

4. Conclusions

T. indica fruit pulp was found to be a locally available cost effective liquid medium for *T. viride* mass production. Even though range II was an effective range to promote the optimum conidial production, 15 to 35 g pulp/ 100 mL of distilled water was a productive range for mass production of *T. viride*.

Conidia were stabilized in *T. indica* fruit pulp medium for 8 weeks. Here, the medium was in acidic pH range, but can provide conducive environment for optimum conidial production by *T. viride.* This novelty in results would help the *Trichoderma* producing industries to economically feasible commercial production with the locally available natural ingredients. Further research has to be carried out to combine the *T. indica* with other suitable ingredients to sustain the viability of the conidia in the commercial formulations for a longer period.

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BUSINESS COMMUNICATION AS TOOL IN RAPID EXPANSION OF SUSTAINABLE E-COMMERCE IN INDIA

Kamma Kshamarpna Babu

National Institute of Fashion Technology, Hyderabad, India

ABSTRACT
This paper establishes the relationship between e-commerce and maintainability factors in the business associations. The creator has likewise demonstrated the medium to the high positive effect of e-commerce on a clear lion's share of twenty supportability components belonging to environmental, economic, social and general areas as per the sentiment survey. Given the effect of e-commerce on manageability factors, with an overall mean score of 3.61 out of the greatest rating of 5 out of an assessment survey, consequently the respondent generally believes that the e-commerce does have a positive effect on the overall maintainability of an association. The creator suggests e-commerce as one the supportability development measures that can be implemented by business associations. The supportability variables are arranged in the metrics that can be adopted by a business manager for measuring the extent of the e - commerce effect on the maintainability of a business association. E-commerce managers may likewise use the discoveries of this investigation to increase further knowledge into manageability aspects of e-commerce activities. The creator urges businesses to leverage e-commerce to create sustainable arrangements that address customer, environmental and societal value expectations. The creator has appeared in the measurable investigation, that overwhelming larger part of the maintainability factors (economic, environmental, social) is positively correlated with each other. Therefore, business practice will be congruent and compatible with the business initiatives for environmental and social responsibility. Merger and obtaining as a strategic choice for keeping up competitive advantage will help expand the skylines of e- commerce and acquire basic changes the economy.

Keywords: *E-commerce, E-business, Communication, Expansion, Sustainable*

Introduction

Over the years, communication technologies have been revolutionizing the management of commercial activities. In the nineteenth century, the cheap steam powered print technology and the presentation of government funded schools gave rise to print-literate workforce with the communication aptitudes to manage the increased progression of commercial movement made possible by coal and steam power technology. In the twentieth century, centralized electricity communication—the telephone, and later radio and television—became the essential communication mediums to manage more complex modern enterprises and mass consumer culture. Today, Internet communication technology has not just made the entire system interactive, integrated and seamless, however has additionally created whole new opportunities for cross-industry relationship.

Ecommerce proved its importance based on the reality time is money. Commercially, time assumes a significant role to both the business and consumers. From the business perspective, with less time spent during each exchange, more exchange can be achieved on the same day. With respect to the consumer, they will save up more time during their exchange. Because of this, Ecommerce steps in and replaced the customary commerce method where a single exchange can cost the two parties a great deal of valuable time. With only a few ticks in minutes, an exchange or an order can be placed and completed by means of the internet effortlessly. For instance, a banking exchange can be completed through the Internet inside a few minutes compared to the customary financial method which may take up to hours. This reality clearly proves that Ecommerce is beneficial to both business and consumer wise as payment and documentations can be completed with greater efficiency.

In the near future e-commerce will certainly continue to mature in the worldwide market and eventually, it will become an essential business plan for an organization so as to survive and remain competitive in the ever changing market. Just about 57 per cent of E-commerce sales come from little towns, while the eight metros represent the remainder. As indicated by IAMAI and IMRB International current E-Commerce market in India is around INR 81,525 crore in 2014 out of which travel Industry comprises practically 61%. Trailing sector has a share of 41% of the all-out revenue, closely followed by Apparels, Footwear and personal items, altogether, having 20% share. The

fast increase in the use of advanced cells and internet services has earned India a place among top 20 developing countries as stated by Global Retail Development Index (GRDI). The main Indian E-Commerce site Fabmart.com (presently known as India Plaza) was founded by Mr. K. Vaitheeswaran in 1999. With E-Commerce thriving on one side, Social Media in India has additionally rooted itself very well. Sites like Facebook, Twitter, Google+, Pinterest, etc are currently the piece of everyone day by day routine. Some of the most famous items imported by Indians include pharmaceutical items, branded and unbranded apparel, accessories, and electronic products like mobile, keen phone, PCs, iPod etc. Payments through online banking, PayPal, Paytm, PayUmoney and mobile banking are affectively adding to the development of E-Commerce. Accessibility of ebooks, tunes, games and movies are additionally accelerating the development of E-Commerce.

E-commerce is an outcome of Information and Communications Technology (ICT) revolution in economic fields or the most visible method for commitment of ICT to economic development. ICT, as an instrument of financial development, is a noteworthy issue for developing countries. Governments have formulated ICT strategies and set critical objectives to ensure the effective deployment and use of ICTs for the benefit of the enterprises and the citizens in the developing countries. A typical definition of e-commerce is to provide trade processes through information interchange, exchange of merchandise and enterprises by means of computer networks, for example, the Internet. E-commerce and online shopping in India is getting a noticeable development as more usage of internet facilities, high educational principles, changing life style and economic development of the nation reasons in the demand of e-commerce techniques and apparatuses. Versatile shopping experience and quick development of exchange facilities is further boosting opportunities for the remaining market segments. The biggest advantage of e-commerce is the capacity to provide secure shopping exchanges through the internet and coupled with practically moment verification and approval of credit card exchanges.

Increasing Internet penetration and accessibility of more payment alternatives boosted the e-commerce industry. One of the most significant issues to be addressed in electronic commerce is the area of services. The basic role of this examination is to examine and uncover the effect of e-commerce and furthermore identify the issues and areas critical to the implementation of e-commerce that may help in enhancing the profitability in the economic development of the nation.

Every young today needs to raise their ways of life. This upwardly mobile educated class have high disposable income are quite comfortable shopping online. Their love for latest gadgets and doohickeys has given a lift to the electronic industry. Youth assume a significant role in increasing the business of e-commerce and consequently contribute to poverty reduction on a sustainable premise. E-commerce is emerging as a better approach for delivering economic development and increase new business opportunities. E-commerce offers new opportunities, thus entrepreneurs should attempt to gather most extreme advantage of electronic market.

Importance of E-commerce:

E-commerce has changed our lifestyles entirely because we try not to have to spend time and money in traveling to the market. E-payments can be made with the help of e-commerce. We can expand online business with the help of e-commerce application development and web development arrangements. The e-commerce arrangements offer numerous advantages as pursues: E-commerce is one of the cheapest means of working together as it is e-commerce development that has made it possible to reduce the expense of advancement of items and services. There is no time barrier in selling the items. One can sign on to the internet even at 12 PM and can sell the items at a single tick of mouse. The on-time alerts are meant for the convenience of the consumers and illuminate the consumers about new items. E-commerce reduces delivery time and work cost therefore it has been possible to save the time of both – the vendor and the consumer. Hence, in this vicious competition, an interactive user friendly furthermore, focused website as online shops can generate you great business.

One of the principle advantages of E-commerce is that it minimizes the expense of transportation, advertising, and marketing. Electronic commerce likewise reduce the distance between buyer and seller, and along these lines permitting fast exchange of data or service between buyer and sellers in any piece of the world. E-commerce not just provides choices of merchandise and ventures at a lower cost, yet it can potentially enable substantially more alternatives to the needs of individual buyers. These days it is relatively cost low for beginning any business through Internet. For business purpose entrepreneurs can utilize the long range interpersonal communication sites, like Facebook. The person to person communication Facebook is quite prominent among the youthful

generation in BTAD area. So Facebook will act as a potential apparatus for business online, mostly for accessing the targeted wide market just as for sales and services. Mostly the entrepreneurs of BTAD area use mobile phone for business dealings. The use of mobile phone has greatly improved business by enabling both customer and suppliers a change of direct communication. That has tremendously chopped down the transportation cost. A present time Internet is easy accessible from mobile phones in affordable price. In this contest mobile internet is a very effective instrument of E-commerce for marketing as well with respect to sales and services. This study includes the impacts of business communication on the fastest growing E-business market.

Internet based E-commerce likewise offer incredible opportunities to create collaborative marketplaces in minimal effort what's more, effective way (Nicolaisen, 2001). At the same time, the quick what's more, convenient electronic deal manner can accelerate the dissemination of commodities, and lessen the hazard, and increase the competitions of agrarian items in the international market (Cao and Chen, 2001). E-commerce in agriculture could likewise potentially tighten the store network and cut marketing edges what's more, exchanges costs in way that benefit smaller, neighborhood producers just as nearby agribusinesses. Investigation of Golman Sachs (2000) discussed the general barriers citied by business to Internet based E-commerce reception and explained that these barriers to apply to agribusiness too.

Effect of E-commerce on entrepreneurship development Catching India's quickly developing e-commerce market has been a sacred goal of tech entrepreneurs for quite a long time. India is a nation with a blasting economy, quick development of internet penetration, and a market of 120 crores. It's additionally a place where consumers have a ton to pick up from not setting off to the stores. The shopping centers and neighborhood market area especially in Delhi NCR are riotous, and the contents of a shopping rundown are distributed over dozens of different stores or street stands. Basic person needs to spend a ton of time finding a stopping place which is mammoth assignment in these congested areas.

E-commerce is most likely the best thing that has happened to the changing middle class populace with higher yearning and lesser time. As a business model as well, it appeals both the value-minded Indian consumer just as Small business owners. Around the globe, e-Commerce has gotten deal chasing - which is quite beneficial for the middle-classes. The huge appropriation rate of Flipkart and Snapdeal have proved that e-commerce in India will go far. Presently, shoppers in metropolitan India are driving e-Commerce. These consumers are fundamentally purchasing consumer electronics and books online. In any case, on the off chance that you take a gander at business exchanges, it's the online ticket booking, which is leading the e-Commerce selection. However, other segments, for example, marital, classifieds, occupations all are gaining great ground.

The key drivers in Indian e-commerce development are:

1. Increased Usage of Internet - According to the Internet and Mobile Association of India (IAMAI), the Internet user base in the nation remained at 190 million toward the end of June 2013. With more and more people accessing the web through mobile phones, the Internet user base in the nation is projected to contact 243 million by June 2014, a year-on-year development of 28 per cent. The development of Internet users has additionally led to a considerable development of other computerized industries, for example, e-commerce and advanced advertising.

2. Rising Educational Level in Computer - The Government of India has placed new flat efforts in the education of instruments and techniques of computer studies. The students of urban areas, country areas and business persons are attracted towards the advance computer technologies. The development of educational gauges has enabled a great demand in the market.

3. Occupied Lifestyle - The powerful influence of different internet based life apparatuses, for example, Pinterest or Facebook enables consumers to organize their favorite items and segment it into themed collections to share it with others. This fuels personal expression in shopping and makes others reflect on their purchase decision.

4. Rising middle class with disposable income - With the rise of little and medium enterprises, foreign direct investment, and India's own powerful worldwide companies creating a huge number of new occupations, a new generation of all around minded Indian consumers has been created. With developing openings for work the income sources have additionally increased. Because of high spending power, customers are readily able to pay for the items online.

5. Awareness of Products - People are aware of the availability of various products in the markets through the help of television, newspaper, website etc.

6. Easy to Find the Review of Products - It is quite easy to discover the review of items by the help of online shopping. E–commerce has made it simpler to get data regarding the item and the customers can purchase the items after getting reviews and feedback of the item.

E-commerce has spurred employment in industries delivering software, and systems used by E-commerce what's more, other occupations associated with websites and networks. The young especially in the area of engineering and technology are benefiting from this. More and more software specialists are required in the market. The e-commerce industry is developing fundamentally in India what's more, expected to include loads of occupations in the years to come. The activity market in this relatively new industry seems to be prospering like no other industry. There are ample of opportunities available because the business is youthful and evolving ceaselessly. Profiles and sets of expectations that never existed have been created specifically for this industry and people are getting a chance to innovate and explore new opportunities since there aren't any set rules and there is a great deal of learning en route. Enlisting activities are expected to develop by over 30% in this sector and may help create up to 50,000 employment opportunities in the next two to three years. (The Times of India, 2016)

The recent surge in the number of online vendors, large just as little, favorable demographics (currently, 75% of the internet users are in the age gathering of 15 to 34 years and in this way, are more integrated to e-commerce), dispatch of 4G services and decline in the levies of information plans and prices of information cards/USB dongles, accessibility of minimal effort advanced mobile phones and the extension of internet and broadband to the remotest corners of the nation, together herald innumerable prospects for the development of e-commerce in India. The purpose of this project work is, to review the literature on e-commerce and along these lines, trace its development and furthermore to discover trends that will propel the development of e-commerce in future, in India. The project contains a prologue to e-commerce and the absence of a universally accepted definition, its categorization into different applications and the prospects for the strong development of e-commerce in India. The presentation is followed by a review of literature available on different aspects of e-commerce which is analyzed in the later segment so as to discover out components that will drive the development in future.

Review of Literature

Gupta (2014) in her paper "E-Commerce: Role of e-commerce in the present business", presents a comprehensive definition of e-commerce while confining it from e-business. The paper enlists the different ecommerce models i.e. B2B, B2C, B2G and C2C, narratively breaking down the nitty gritties of each. Rina (2016) also elaborates the different uses of e-commerce in "Challenges and Future Scope of Ecommerce in India", at the same time, defining the degree to which they are operational in the nation. Gunasekaran, Marri, McGaughey, and Nebhwani (2002) give a wide viewpoint of electronic commerce inside hierarchical systems in "E-commerce and its effect on operations management", defining it with reference to e-exchanging and elaborating-how it has permeated every field of business. The paper identifies the revolutionary role played by earlier internet applications like e-mail and electronic information interchange and details the revolutionary changes brought by the internet technologies in assembling, marketing, acquiring, design, generation, selling and dissemination, warehousing and human resource management. Internet based technologies have enabled businesses to shorten development, purchase and procurement cycles, keep up to date item what's more, market data, fundamentally increase the speed of communications and increase the nature of customer relationships by encouraging close contact and steady communication. The paper studies in depth, the significance of web based technologies in different business operations, along these lines, improving their efficiency through effective B2B e-commerce.

Mishra and Kotare (2015) trace the timeline and development of B2C e-commerce in "A Study on Current Status of E-Commerce in India: A Comparative Analysis of Flipkart and Amazon"with its inception in the mid 1990s through the advent of wedding and occupation gateways. However, due to limited internet accessibility, weak online payment systems and absence of awareness, the progress was very moderate. The Indian B2C e-commerce industry got a significant lift in mid 2000s with the expansion of online services to travel and hotel appointments which continue to be significant donors even today. Das and Ara (2015) observe in "Development of E-Commerce in India" that however online travel and hotel appointments still control the lion's share of e-commerce market, their share has comparatively fallen over the years due to the recent augmentation and consequent rise of e-following services. There has been a tremendous surge in the volume of investment in this sector. With the e-commerce markets in the west reaching

their immersion, investors see tremendous potential in the Indian market, in the light of which, many new businesses have received financing from venture industrialists and private equity firms.

Through **"Probles and Prospects of E-Commerce", Raghunath and Panga (2013)** present a comprehensive investigation of different nuances of e-commerce while accentuating that, in present time every business action, be it advertising, ordering, payment etc, can be performed in the computerized ecosystem. The paper additionally enlists numerous focuses on the importance of e-commerce which are responsible for its development as the new convention. It has enabled the creation and exploitation of new business opportunities, at the same time increasing the state of customers in the development of new items and services. E-commerce has not just augmented the performance of internal business management, yet, has additionally enabled better customer relationships by advancing a business model that is essentially based on data sharing. The accessibility of internet connectivity and other online devices herald a new revolution.

SWOT examination of e-commerce conducted by **Awais and Samin (2012)** features universality, low operating cost, improved customer interaction and time sparing as the unique strengths of e-commerce, but at the same time accentuates upon the necessity for the organizations to adjust to the changing environment and innovate always to come up with better offerings for customers.

RESEARCH METHODOLOGY

This research paper aims to give a better understanding of the impact of E-Commerce in youth. The perceptions of youth regarding the factors affecting the development and integration of entrepreneurship in the area of communication. That has tremendously chopped down the transportation cost. A present time Internet is easy accessible from mobile phones in affordable price. In this contest mobile internet is a very effective instrument of E-commerce for marketing as well with respect to sales and services. Internet based E-commerce likewise offer incredible opportunities to create collaborative marketplaces in minimal effort what's more, effective way (Nicolaisen, 2001). At the same time, the quick what's more, convenient electronic deal manner can accelerate the dissemination of commodities, and lessen the hazard, and increase the competitions of horticultural items in the international market (Cao and Chen, 2001). E-commerce in agriculture could likewise potentially tighten the store network and cut marketing edges furthermore, exchanges costs in way that benefit smaller, nearby producers just as nearby agribusinesses. Investigation of Golman Sachs (2000) discussed the general barriers citied by business to Internet based E-commerce appropriation and explained that these barriers to apply to agri-business also.

This examination is based on the meta-investigation. The secondary materials have been extensively used for this examination the secondary information has been collected from different websites, books, diary articles, thesis, day by day newspaper, and magazine. Every one of the sources of information have been acknowledged. The article has been tried to mention the talent information whenever available. The article carefully analyzed the information for presenting the status of e-commerce development. It additionally carefully identified the challenges and opportunities of e-commerce in India. The researcher team additionally interviewed same experts and e-commerce businessman for getting essential information. Every one of the information categorically presents to explore the objectives.

CONCLUSION

All specialists utilized the correspondence channel to impart to other people. In the event that they use the cutting edge specialized instruments then the impact of taking care of business has changed enormously. Consequently it is suggestion in this advanced business condition to apply legitimate specialized instruments in everyday correspondence process. In the individual or social correspondence it is set apart by custom. In this manner the achievement the business association everywhere is rely upon successful and productive business correspondence. Since every single such sort of correspondence sways the business condition. Presently in this changing business condition correspondence expertise is required to handle the business issues and business association ought to get it the equivalent to improve the cutting edge relational abilities with legitimate correspondence devices. Generally this will impacts the adversely to the business condition and association may have some poor light inside it with a long separation to the business association objectives. Specialists anticipate a promising and brilliant fate of web based business in the 21st century. Soon online business will further affirm itself a significant device of offer. Effective internet business will turn into a thought completely indistinguishable from the web, in light of the fact that e-shopping is turning out to be increasingly prominent and regular. Simultaneously serious contention in the circle of online business administrations will escalate their advancement. Hence winning future patterns of web based business will be the development of Internet deals

and advancement. Every year number of internet business arrangements develops hugely. Deals volumes of on-line stores are more than practically identical with those of "block and-concrete" ones. Furthermore, the propensity will proceed, in light of the fact that many individuals are "detained" by work and family unit obligations, while Internet spares a great deal of time and offers chance to pick merchandise at the best cost.

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ENTERPRISE READY CONTAINERIZED AND MICROSERVICES ARCHITECTURAL DEVOPS ENGINE DESIGNING

W.M.C.J.T. Kithulwatta[1], D. Jayawickrama[2]

[1]Software Engineering Teaching Unit, Faculty of Science, University of Kelaniya, Dalugama, Kelaniya, Sri Lanka
[2]mvv Information Technology, Level 9, East Tower, World Trade Center, Echelon Square, Colombo 01, Sri Lanka

ABSTRACT Seamlessly software delivery and maintaining without any delay, is the major task of DevOps engineers in industrialization. In the traditional way, it is using bare metal hardware or cloud services to farm the computer system infrastructure. While using those modules, the main problems arising are, huge cloud service charges, disability to use infrastructure in the cross-platform, difficulty of infrastructure migration, system archiving problem, data persisting problems and smooth scalability issue. Main objectives of the research study are to create portable system infrastructure modules, to create technical and theoretical containerized DevOps engine, apply long-time data persisting approach to the enterprise applications and to apply high-velocity innovation to the computer systems infrastructure. The proposed DevOps engine was designed with the Docker container management system on top of the Linux operating system as the host. It was used Docker trusted images to deploy, isolated containers by using microservices architecture with advanced software engineering concepts with industrialized software applications. It was used enterprise-ready software applications and services on the proposed engine to validate the concept over the same configurations on the cloud service. With the usage of encapsulated components container approach, all internal data was secured on top of the host operating system. Due to the portability of Docker containers, it was easy to migrate the monolithic computer system to microservices architecture. By using fast Docker containers, it was facilitated to DevOps engineers on the engine to improve the scalability and security across the system infrastructure.

Keywords: *DevOps, Microservices, Containerization, Docker, Distributed computing*

1. Introduction

By reducing more complex computer system infrastructure, organizing the DevOps platform is one of the major tasks of DevOps engineers in the industrial approach. Involving with more advanced and high-velocity software application delivery mechanism is causing to increase the customer/ end-user satisfaction regarding the company.

Usually, in-house bare metal hardware or cloud services use to design the DevOps platform for the production-ready environment. In the DevOps platforms, DevOps engineers had to face several problems and issues: huge cloud service charges, disability to use infrastructure in the cross-platform, difficulty of infrastructure migration, system archiving problem, data persisting problems and smooth scalability issue. To create portable system infrastructure modules, to create technical and theoretical containerized DevOps engine, to apply long-time data persisting approach to the enterprise applications and to apply high-velocity innovation to the computer systems infrastructure: are the research objectives of this research study.

As mentioned in the [13], a software application or services reusability is a major preliminary of software system evolution. Since it is also applicable inside the DevOps environment to reduce the process and effort of the DevOps activities. According to the authors of [13], in the DevOps platform can reuse data, architecture, design and program under both concepts of *for-reuse* and *with-reuse*. Furthermore, reliability and maintainability can be enhanced in the DevOps platform with reusability. The authors of the [21] has mentioned that containers are very lightweight than virtual machines (VM). The same paper was presented that containers has consisted of fundamentally necessary software dependencies which needed to run by allocating all resources on top of a Linux kernel.

Omitting traditional and monolithic architectural software applications, microservices software applications has conceived in the industry. Microservices software applications were benefited to the enterprise community by providing major four characteristics [9]. Those benefits: organization around business capability, automated deployment, intelligence in the endpoints and decentralized languages and data. With the

collaboration of those, microservices was provided with an easier platform to design, develop, test and release the services with great agility capacity. Furthermore, in the paper [9] has presented that microservices architecture was presented decentralized government and independent data management service. Microservices architecture has helped to omit the standardized for one single technology. Changing the technology for an application was very difficult on the monolithic architecture. The author of [12] has presented that the approach of microservices architecture was more suitable for the development tests and deployments.

Docker is a modern technology which was built for high-velocity innovations to deliver to the end-users. With enhancing developer productivity, deployment velocity, operational efficiency, infrastructure reduction and faster issue resolution [5]. According to the official website for the Docker [7] has presented that Docker volumes are the most preferred way to persist data in Docker containers and services. On the host operating system (OS), data has archived the particular data directory in the path of */val/lib/docker/volume_name/_data/*. As presented in the paper [9], the authors say that Docker is a good approach for microservices applications.

In term of distributed computing, it uses physically separated multiple computers by linking together via a network to accomplish a particular goal [19]. According to the [17], the authors have presented that the engagement of the container technology and Docker are making a profound impact on the distributed systems and cloud systems. Containers and microservices are a greater pair in the distributed computing systems.

2. Methods and materials

To design the enterprise-ready DevOps engine, a large enterprise-ready software application was used for experimental purposes. The software applications were developed using loosely coupled components/services by integrating microservices architecture. In the application, its own database (DB) were used for each service instead of sharing one DB with all services to get the benefit from the microservices. The software application was developed with *AngualrJS* for frontend application, Java-based *spring-boot* framework technology for the backend components and *MySQL* for DB services. *Jenkins* and *Jfrog artifactory* were used as services for deployments in DevOps activities. For the easiness and commonly used in industry, those software and services were selected. Using three different scenarios with the equal host OS resources, the research study was conducted. Case 01 is the proposed engine.

Case 01: To design the proposed DevOps engine, Docker container management platform was launched on top of a Linux x86_64 Ubuntu 18.04.2 LTS OS. Eight separate Docker containers were used by mounting Docker volumes for each container to archive key data directories [5]. On one host OS, distributed containers were launched. Figure 1 presents the architecture for the application and DB containers for the proposed DevOps engine.

To launch each container, Docker trusted images were used from the local Docker registry and Docker Hub: Ubuntu bionic containers for back-end services, *Apache HTTPD* container for front-end service, *MySQL* container for DBs, *Jenkins* container and *Jfrog Artifactory* container.

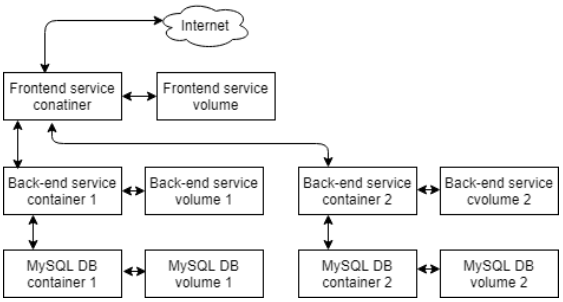

Figure 1: The basic architecture for the proposed engine

Figure 2 has shown that the artifacts delivery and sharing procedure within the containers from the *Jenkins* to application containers. Theoretically and according to the proposed methodology, the artifacts were delivered from the *Jenkins* volume to application container volumes.

For the data communication among the containers and link containers together, an internal Docker network was established in the local Docker engine with subnet 192.168.0.0/16 and the gateway as 192.168.0.1 instead of default Docker network. To open the containers to the outside world, containers were mapped with a host port. For the internal communication, containers were mapped with container ports. In the following Table1 presents the internet protocols (IP) and port mapping for each container.

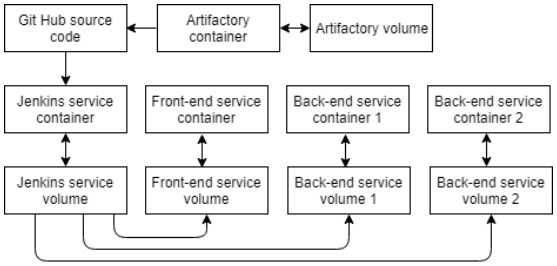

Figure 2: Artifacts delivery mechanism

Container	Internal IP	Host port	Container port
MySQL container 1	192.168.0.1	13306	3306
MySQL container 1	192.168.0.2	23306	3306
Back-end service container 1	192.168.0.3	-	28088
Back-end service container 2	192.168.0.4	-	18088
Front-end service container	192.168.0.5	8000	80
Jenkins container	192.168.0.6	8090	8080
Artifactory container	192.168.0.7	8082	8081
Portainer container	192.168.0.8	9000	9000

Table 1: IPs and port mapping for the proposed engine

To access each service from the outside world, *"host IP:host-port*" was needed to use. To access the service within the Docker environment, *"internal IP: container-port"* was used. *Portainer* container was used to govern the Docker platform.

After created a stable Docker platform, all containers were archived as images in local Docker environment.

To evaluate the proposed engine, two corresponding cases were used as discussed below. For all cases: same software applications, DBs and other supporting services were used excepting the deployed platform and architecture of infrastructure.

Case 02: The platform was designed with three cloud instances according to the traditional distributed computing approach in the DevOps practices. In the traditional approach does not launch more separated instances for each service due to the large payments of the cloud service and to optimize the computer resource utilization. Payment optimization was a key task of DevOps engineers in the traditional approach.

Instance 1: continuous delivery and artifactory storing (as miscellaneous services: *Jenkins* & *Jfrog artifactory*)

Instance 2: all microservices software applications

Instance 3: DB services

The second instance was launched to deploy microservices software applications in separate directories. Instance 3 was facilitated with DB service to each component by keeping two databases. Artifacts delivery mechanism was the same in the Case 01 but in here, both *Jenkins* and *artifactory* services were launched in one instance.

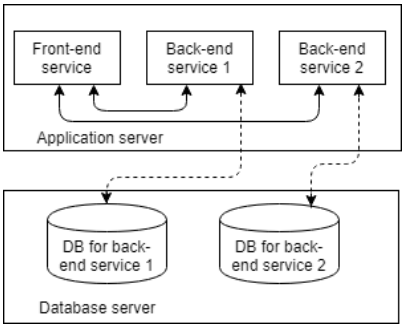

Figure 3: Used architecture for Case 02

Case 03: The platform was designed with seven separated cloud instances with the same configuration of Case 01 as distributed manner**.** Only differentiate is the deployed platform and no used third-party platform monitoring tool: in Case 01, the governing tool was the *portainer* tool as a container.

In both Case 02 & 03, for the network creation and monitoring the infrastructure, cloud service providers' facilities were used. To archive data of instances, cloud storages were used with payments.

To evaluate the proposed DevOps engine, all containers and cloud instances were archived in all cases. For the performance evaluation of the Docker platform, results of *docker stats* command and *portainer* tool was used. To evaluate the cloud machines in all cases, the default machine monitoring facility was used.

3. Results & discussion

For the evaluation of the proposed engine, the performances of the engine were evaluated by considering basic Docker container metrics as

shown in Table 2., below. For the ease of presentation results, the following abbreviations were used for Docker containers namely CPU % and MEM % (the percentage of the host's CPU and memory the container is using), MEM USAGE /LIMIT (the total memory the container is using, and the total amount of memory it is allowed to use), NET I/O (the amount of data the container has sent and received over its network interface), BLOCK I/O (the amount of data the container has read to and written from block devices on the host) and PIDs (the number of processes or threads the container has created)[6].

By collecting the mean values for each metrics by using *docker stats* command on the host OS, the above Table 2, was created. According to Table 2, each container was executed using a minimum number of hardware and software resources while executing a large number of processes inside the containers. Sometimes, containers were presented more than 100% CPU usage since *docker stats* command presents the CPU usage as a percentage of a single CPU. Host OS for the proposed engine was a multi-core OS and it was parallelized the all the processes with many cores to get the benefit of the containerized approach. Within the Docker container approach, some containers were used extra resources of other containers to be scaled when the container was needed more hardware resources.

Furthermore, the proposed DevOps engine was evaluated against previously discussed Case 02 & Case 03. By considering host OSs performances for all 03 cases, Table 3 was created. To generate the experimental results, the mean values for each metrics were calculated by considering 30 days of performance with a one-hour interval per day. Particular metrics are CPU utilization [Activity level from CPU. Expressed as a percentage of total time (busy and idle) versus idle time.], memory utilization (Space currently in use. Measured by pages. Expressed as a percentage of used pages versus unused pages), disk read I/O (Activity level from I/O reads. Expressed as reads per second.), disk write I/O (Activity level from I/O writes. Expressed as writes per second.), disk read bytes (Read throughput. Expressed as bytes read per second.), disk write bytes (Write throughput. Expressed as bytes written per second), network receive bytes (Network receipt throughput. Expressed as bytes received per second.) and network transmit bytes (Network transmission throughput. Expressed as bytes transmitted per second.).

According to Table 03, in Case 01, the CPU utilization and memory utilization of Docker installed host computer instance was higher than all other instances in Case 02 & 03. But in Case 02 was performed more CPU and memory utilization against the Case 03. It depicts that, the host OS of Docker engine (in Case 01) uses the CPU and memory resources more efficiently and effectively than other cases by sharing all processors of Docker containers on the host OS. Due to Case 01 host, OS was executed more containers and processors than others. Without wasting the host OS resources in Case 01, it was utilized the host OS highly the Docker platform.

As mentioned in below Table 3, the Case 01 was consumed higher disk read I/O, disk write I/O, disk read bytes, disk write bytes, network receive bytes and network transmit bytes than others. Reason is: host instance was performed more containers with more workload. To perform high fast execution for the Docker engine, the host was needed to consume higher resources usage in Case 01 than other cases. By giving an isolated environment to the microservices software applications, the Docker platform was presented most suitable nature than separated cloud instances.

To transfer the files between distributed Docker containers, volumes were used since all key data/files were attached to Docker volumes. Linux *cp* command was used to send artifacts at each software version deployments to each application containers from the *Jenkins* container in Case 01. Due to, data artifacts transferring was happened between volumes on the host OS. At both Case 02 & 03, to send build artifacts from the *Jenkins* to each application instance (among distributed nodes), Linux *scp* command was used. The due reason was for that is the artifacts sending happened between two computers. In Linux *scp* command approach, credentials of the instances were needed to share with other instances: username-password or SSH key files of the instances. In Case 01 the data was shared without opening to the outside world. But in Case 02 & 03, the data could be opened to the outside world.

Container name	Container ID	CPU %	Memory usage/ Limit	MEM%	Net I/O	Block I/O	PIDs
Container for front-end	8aa9962bbc45	0.54	209.8MiB / 14.68BiB	1.4	329MB / 3.77MB	1.94MB / 1.36MB	89
Container for Back-end1	aef156e5eb1c	1.4	744MiB / 14.68GiB	4.95	226MB / 2.01MB	16.6MB / 1.5GB	38
Container for Back-end2	705a0f4d7d97	1.29	807.6MiB / 14.68GiB	5.37	969kB / 2.64MB	165MB / 173MB	103
Container for MySQL1	9b2296637611	2.45	1.64BiB / 14.68GiB	11.17	17.7MB / 176kB	46.7MB / 14.9MB	148
Container for MySQL2	fed771dda68a	3.07	806.9MiB / 14.68GiB	5.37	20.4MB / 6.43MB	14.2MB / 227MB	134
Container for Jenkins	b4d6ba6100c3	2.84	2.035GiB / 14.68GiB	13.86	1.09GB / 2.28GB	4.71GB / 1.55GB	51
Container for Artifactory	4b23863a0758	0.65	1.308GiB / 14.68GiB	8.9	742MB / 3.08GB	1.17GB / 12.7GB	74
Container for Portainer.io tool	a93c20a25dbb	0.14	15.23MiB / 14.68GiB	0.1	22.8MB / 175MB	17.74 MB / 2.44GB	11

Table 2: Docker container resource usage

Cases	Cloud Instance Name	CPU utilization (%)	Memory utilization (%)	Disk Read IO	Disk Write IO	Disk Read Bytes	Disk Write Bytes	Network Receive Bytes	Network Transmit Bytes
Case01	Docker Host instance	14.106	54.5	1.169M	16.907M	26.761G	291.307G	32.014G	39.165G
Case02	Application Instance	0.486	17.453	45.03K	1.158M	573.13M	16.683G	4.457G	3.671G
	DB Instance	0.427	14.181	96.353K	4.594M	829.335M	48.257G	74.330G	76.033G
	Miscellaneous Instance	0.71	6.646	87.436K	1.215M	1.226G	15.978G	20.544G	6.743G
Case03	Instance for Front end	0.129	3.356	30.489K	388.233K	266.042M	449.011M	958.294M	1.377G
	Instance for Backend 1	0.229	4.119	34.229K	229.762K	472.329M	603.873M	1.420G	1.383G
	Instance for Backend2	0.307	4.015	35.157K	303.117K	389.566M	785.418M	1.257G	1.567G
	Instance for MySQL01	0.291	6.115	41.121K	442.221K	498.338M	788.356M	1.56G	1.884G
	Instance for MySQL02	0.274	5.475	38.416K	376.556K	406.881M	677.854M	1.48G	1.854G
	Instance for Jenkins	0.266	3.066	31.844K	406.889K	376.674M	686.312M	1.69G	1.669G
	Instance for Atifactory	0.197	3.688	28.574K	364.637K	501.984M	853.112M	1.72G	1.828G

Table 3: Host computer resource usage and utilization

Without sharing public IPs, data transmission was happened with using internal IPs of containers or instances in all three cases. Hence among three approaches, the approach of Case 01 is more secure than others since all data transmission is happening inside the host OS.

After launched the Docker engine on top of the host OS, the *portainer* tool was launched on the Docker engine as a container. The tool was facilitated to manage all activities of the Docker platform with a web-based graphical user interface without using the command-line interface of the host OS. As shown in Table 2, *portainer* tool was consumed very low resources from the host OS. Hence it does not have any effect on other containers regarding the host computer resources.

Due to the usage of Docker templates for containers (e.g.: *MySQL* template of Docker, *Jenkins* templates of Docker and etc.) in local Docker registry (inside the host OS) and Docker Hub (open community), software reusability was applied to create the engine as an advanced software engineering practice to the DevOps platform. Due to those templates are already configured with all packages which are needed to launch the container without installing manually. Particular containers were launched immediately as an easy function in the DevOps platform. Since the software reusability is one of major preliminaries of the software evolution in the software engineering domain. With the engagement of the reusability components in the proposed DevOps engine, the infrastructure designing and development were with both *with reuse* and *for reuse*. Due to the mounted data volumes could attach to another container, *data reuse* was applied. After migrated the platform, the new platform could implement with the same configuration in the new platform. Hence *architectural reuse* and *design reuse* was applied. After migrated the DevOps engine any containers did not lose any executable code or processing tool. Therefore, *program reuse* was applied to the proposed DevOps engine.

If a container was destroyed or crashed, a new container was able to launch by attaching originally attached Docker volume. The reason was, all mounted data on the Docker volumes were protected on the host OS, without destroying even the container was destroyed. If there were more data in different directories, attaching more volumes was possible without attaching all directories to one volume to protect the data without any crash. If the host OS of Docker was crashed or volumes were destroyed directly, the mounted volumes were lost with data.

After created a stable platform on the Docker, all containers were archived as images, on the local Docker registry. Corresponding cloud instances were also able to archive as images/snapshots in both Case 02 & 03. They were able to use as base templates to create another container/instance on the platform, the image creation was used as container/instance backups on the platform. To extend the backup process furthermore, the containers were converted to *.tar* format. The converted format was able to migrate from the local Docker engine to the host OS. The converted format was able to migrate from the host OS to any another computer (any OS platform) easily as portable modules. After migrated the containers were able to launch on a new platform without losing any data with the same configurations. But archived instances were not able to convert any format or migrate from the platform to another one. It depicts that the proposed DevOps engine presents more backup options. The engine has easy & fast migration capabilities with portable modules.

With the applied theoretical concepts for the proposed DevOps engine, a technically feasible DevOps engine was able to develop and deploy. The engine was exhibited environmental independency due to the engine was able to deploy and migrate on any OS platform with more lightweight and portable modules. Since all those portable modules were able to migrate from the platform to another, without touching to basic configurations, both low coupling and high cohesion were embedded. Due to excepting large and complex configurations, easy understandability was with the proposed DevOps engine. According to the long-time data persistence of the proposed engine, the reliability of the engine was increased.

For the DevOps engineer's perspective, by architecting a DevOps engine for enterprise-ready microservices software applications most kinds of advantages were received. Since the easiness of the used tools to govern the architecture, the productivity was increased and the development of the architecture was accelerated. By investing less maintenance effort and time, the maintainability was improved. Since the more backup procedures of the proposed engine, process risk was reduced and reliability was increased by following more standards of the DevOps domain.

4. Conclusion & recommendations

As discussed above with the evidence, Docker containerized approach is an alternative for VMs/cloud instances with better performances. To get the benefit of the enterprise-ready microservices software applications, the distributed

containerized engine provides the most suitable environment rather than cloud instances due to containers are with more virtualization benefits. Containers are with easy and automated scaling capability without touching to basic configurations of the infrastructure. To implement a high-velocity innovative DevOps engine with enterprise-ready microservices applications, Docker container approach is more benefited.

After created stable Docker containerized DevOps engine, the author recommends to archive the containers as Docker images and *.tar* format. Those archived *.tar* format can use to extend the backup process of the engine and migrate the engine from the host platform to another platform (to any OS platform). For the long-time data persistence of the engine, one or more Docker volume attaching is recommended before launching a container. Without using the traditional command-line interface, usage of a Docker monitoring tool is recommended (e.g.: *portainer*.io tool).

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MANAGEMENT OF A CASE WITH GRADE II CHRONIC LATERAL ANKLE SPRAIN USING THREE TRACK CLINICAL REASONING

Dasanayaka D.A.R.K[1], Herath H.M.K.B[2], Shamima Islam Nipa[3]

[1]Department of Physiotherapy, Faculty of Allied Health Sciences, University of Peradeniya, Peradeniya, Sri Lanka, [2]The National Hospital of Sri Lanka, Sri Lanka, [3]Department of M.Sc in Rehabilitation Sceince, Bangladesh Health Professions Institute, Savar, Dhaka, Bangladesh

ABSTRACT- Clinical reasoning is a process where clinicians are using their knowledge, cognition and metacognition to assess, diagnose, plan and treat patients. Deductive reasoning, inductive reasoning, three track reasoning and narrative reasoning are most commonly used clinical reasoning processes. Hence, aim of this study was to interpret a clinical case with type II chronic lateral ankle sprain using various types of clinical reasoning processes and find out the most suitable process. Diagnosis of the condition, goal setting and treatment planning, application of treatments and adjustment of treatments according to the patient requirements can be consider as the procedural reasoning, interactive reasoning and conditional reasoning of three tracks reasoning process respectively. Hypothetical deductive reasoning was excluded since first step of procedural reasoning of three track reasoning is explaining the same concept. Since five common elements of pattern recognition; proper timing, results, reliance, basis and direction were not applied in the diagnosis and management, inductive and forward reasoning was excluded. Narrative reasoning was excluded as this reasoning is explained by conditional reasoning of three track reasoning process. According to the analysis, three track reasoning process has been used to manage this patient combining with International Classification of Functioning (ICF). The study was concluded that clinician's bio medical and clinical knowledge as well as the patient's physical, psychological and social information have to be considered to find the most appropriate clinical reasoning process since most of the process is overlapping at some stages.

Keywords: *Ankle sprain, Clinical reasoning processes, International Classification of Functioning (ICF), Patient management, Three-track reasoning*

1. INTRODUCTION

Clinical reasoning is a process where clinicians are using their knowledge, cognition and metacognition to assess, diagnose, plan and treat patients for better outcome (Jones, 1995; Mendez and Neufeld, 2003; *Clinical reasoning; instructor resources*, 2009).

There are internal as well as external factors which influence in clinical reasoning process. Common elements of clinical reasoning; clinician's knowledge, cognition and metacognition are consider as internal factors. Needs, expectation, values, and beliefs of patients, professional and institutional barriers, needs and expectation, and resource availability and funding of the community are considered as external factors. Each step of the reasoning process interrelated with clinicians' knowledge, cognition and metacognition as well as with information gathering through subjective and objective assessment of the patient (Jones, 1995) (Figure 1).

Deductive reasoning, inductive reasoning, three track reasoning and narrative reasoning are most commonly used clinical reasoning types (Jones, 1995; Mendez and Neufeld, 2003).

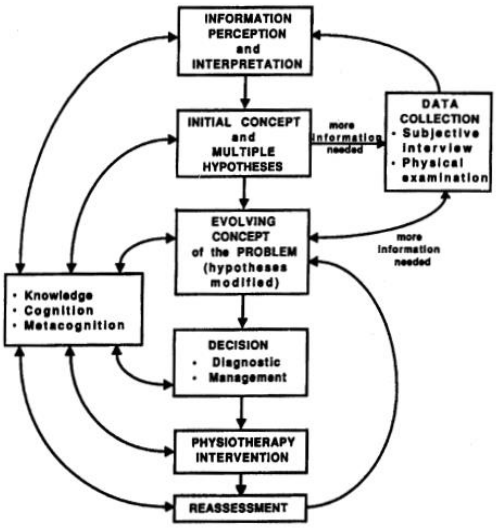

Figure 1. The clinical reasoning process

(Jones, 1995)

Hypothetical deductive reasoning is one of the frequently use deductive reasoning process by novice as well as expert clinicians when they meet a new clinical condition which is rare or was not manage before. Differential diagnosis or hypothesis are made according to the clues of patient followed by application of related biomedical knowledge to confirm the diagnosis and deliver the management (Jones, 1995; Rahman *et al.*, 2016). Pattern recognition; is used to diagnose the condition accurately and immediately with simple clues by expert clinicians using their clinical experience and vast knowledge which embedded in inductive reasoning process. Timing, results, reliance, utilizes, basis and direction are the six common elements of pattern recognition (Jones, 1995).
Procedural reasoning, interactive reasoning and conditional reasoning are the three branches of three track reasoning process. Problem identification, goal setting and treatment planning are the three steps of procedural reasoning which has similarities to the hypothetical deductive reasoning. Patient-therapist interaction to deliver the treatment is known as interactive reasoning. The process, conditional reasoning includes modifications of the treatment according to the patient's social and psychological status (Fleming, 1991; Mendez and Neufeld, 2003; Nipa *et al.*, 2015).

Moreover, some special cases can be met with special stories to carry out the management with a special care and some cases make a special remark in the clinical setup which falls under the category of narrative reasoning (Schell and Cervero, 1993; Mckay and Ryan, 1995; Mendez and Neufeld, 2003).

All the clinical reasoning processes are overlapping each other in some stage and it is difficult to identify the exact process related to one case or a condition. Therefore the objective of this study was to discuss the types of clinical reasoning processes by analyzing and managing a case with type II chronic lateral ankle sprain.

2. CASE REPORT

The patient was 55 year old woman who has suffering from left side ankle pain and swelling lasting for 6 months. Patient was assessed using the common format of musculoskeletal assessment, and International Classification of Functioning and Disability (ICF) model. According to the analysis, the condition was diagnosed as grade II chronic lateral collateral ligament injury. She had impairments such as pain and swelling in the left ankle, reduced ankle range of motion (ROM), reduced strength of muscle around ankle complex, left ankle instability and limping gait. She has faced to limitations such as difficulty in walking and engage in activities of daily living (ADL) as well as restrictions such as difficulties to take part in the outside activities with peer groups, friends and family, difficulties in take care of the grand children and play with them and difficulty in participation with various religious activities due to her impairments. In addition to that environmental factors; lack of family support, poor income, long traveling time to hospital, social influence to change the treatment to traditional method, and personal factors; poor education, older age were found as barriers while doing management. Nevertheless, she had high self-motivation and confident to continue the treatment and finally she achieved more than 80% recovery within five weeks.

3. PHYSIOTHERAPY MANAGEMENT

Different methods were used to manage the impairments which led to improve the level of activities and participation. The goals of the first stage were to reduce the swelling, pain and improve the healing of that chronic injury. Hence she was asked to attend the treatment for 3 days per week. Infrared radiation (IR) was applied to improve the circulation and lymphatic drainage, and to reduce the pain. Soft tissue mobilization and bandaging were applied to reduce swelling in the ankle. Deep friction massage and Ultrasound were applied on left lateral ankle to reduce the tenderness and improve the healing. Home exercise program was planned and she was instructed to do hot water fermentation and massage at least 2 times per day. Advised to rest, elevate and bandage the ankle as much as possible at home. These treatments were continued for one week.

After reduction of swelling, ankle locking tapping was applied to immobilize the ankle to reach proper healing of the injury minimizing the recurrence. In addition to that joint mobilization for ankle complex and stretching exercises for leg muscles commenced at hospital session. She was explained to continue self-stretching at home and advised to continue the treatment at home same as previously. Treatment was continued for another 2 weeks and sessions reduced up to 2 days per week.
Then new techniques were added; Thera band exercises and towel exercises, lunging, double leg squatting, single leg stance, single leg squatting and step-up along with the ultrasound and deep friction massage, and all other treatments were dropped. At the beginning of the fourth week treatments were continued with Thera band exercises and towel exercises, and basic proprioception stimulation exercises such as forward lunges. Treatment sessions were reduced up to once a week and patient was advised to continue all the exercises at

home. Following week side lunges, double leg squatting, single leg stance, single leg squatting and step-up were added gradually. Patient was reassessed after 5th week and discontinued the treatment since she have achieved more than 80% progress and advised to continue all the exercises at home. The sequence of application of these different treatment methods is shown in Figure 2.

Several obstacles had to be addressed during the period of management. Exercises have been taught several times with demonstrations to overcome the low level of understanding. Ankle taping was started as soon as possible, and advised to do exercises just get up in the morning and at night before going to the bed since day time she is engaging with more household activities with grandchildren and less time to do exercises and have a rest. Most convenient appointment times had been given and gradually reduced the number of sessions since she was living in faraway place from the hospital as well as there was no one at home to take care of grandchildren. She was advised to do more exercise by herself to improve the condition and appointments were given only for the modifications of the treatments.

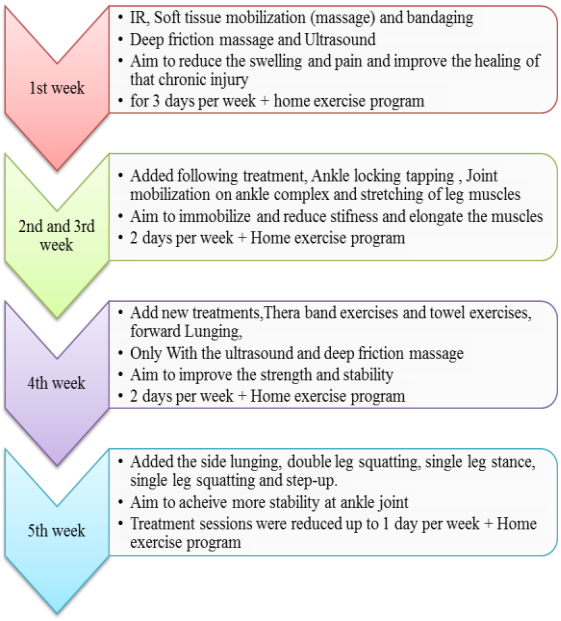

Figure 2. Physiotherapy management process

4. ANALYSIS AND DISCUSSION

General questions were asked to find the clues about the condition as a novice practitioner when met this patient on very first day. Nevertheless, exact condition was not found at first day and sent her back after application of IR to left lateral ankle just to reduce pain and swelling. Later, books were referred regarding ankle injury assessment and came to the conclusion that patient might have the lateral ankle sprain. Assessment was completed in the second session and multiple differential diagnoses were made before finalizing the exact condition.

According to the signs and symptoms of this patient, several differential diagnoses were made such as ankle sprain of lateral side, talus fracture, fibular fracture of distal area, 5th metatarsal base fracture, peroneal tendon injury, compression of the sural or fibular nerve, subluxation of the cuboid bone, injury of achilles tendon, ligament injury of subtalar area. When patients have any of above mention condition, most of them are complaining lateral ankle pain, swelling of ankle and foot, difficulty to give weight to affected leg and chronic history of symptoms.

Hypothesis testing was done to exclude conditions one by one after read-through specific symptoms, special orthopaedic tests and investigations. According to the patient history of slipped down from the stirs, she had been recommended to take X-rays in the left ankle complex which has confirmed no history of fractures. Hence, conditions such as talus fracture, fibular fracture of distal area, 5th metatarsal base fracture and cuboid subluxation were able to exclude from the differential diagnosis list.

She had severe tenderness over left lateral ankle while palpating and found no tenderness over achilles tendon. Hence, achilles tendon injury was excluded from the differential diagnosis. Though she complained about the common symptoms, she did not complain about numbness or tingling sensation over the lateral ankle. Furthermore fibular and sural nerve tension test were performed which were negative. Therefore fibular and sural nerve compression was excluded.

Hence the stress test and ankle instability test were positive, lateral ankle sprain, peroneal tendon injury and subtalar joint ligament injury could be the suspected diagnosis and it was a difficult task to differentiate them. Later the application of resisted eversion (isometric contraction of peroneal tendons) test was resulted negative. Therefore peroneal tendon injury was excluded. Subsequently, manipulation of the subtalar joint was performed and tenderness or pain was not elicited and similarly joint subluxation was not identified on x-ray. Hence subtalar joint ligament injury was excluded.

Ultimate diagnosis was made as type II chronic lateral ankle sprain due to mild instability of the left ankle and severe tenderness over lateral collateral ligaments fallowing the problem solving;

the first step of procedural reasoning. Goals were set and treatments were planned to reduce the complications and improve the healing of the injury and instability as the second and third step respectively. Then treatments were applied by dividing into stages according to the patient's progression which comes under interactive reasoning as per mentioned in the physiotherapy management. Moreover, modification of treatments, teaching method of home exercise program and appointment time were arranged according to the patient social, psychological and future requirements which follow the conditional reasoning. According to the findings, three track reasoning process has been implemented trough out the management of this patient.

Hypothetical deductive reasoning was not used in this case study since ankle sprain is a common and familiar condition among most of clinicians as well as it is similar to the problem solving step in procedural reasoning. Books were referred throughout the treatment process to achieve utmost progression of the patient. Therefore, proper timing, results, reliance, utilizes, basis and direction were not applied in the diagnosis and management process. Since it was failed to meet those six common elements of pattern recognition, inductive and forward reasoning was not used in management of this patient. Narrative reasoning was not used in the management of this case due to the following reasons. Ankle sprain is a very common musculoskeletal condition and not a novel clinical remark in the setup. In addition to that special care and modifications were made according to the patient's story which describes in the conditional reasoning process.

5. CONCLUSION

Clinical reasoning is a process where clinician's critical thinking leads to have a proper prognosis of the clients. Clinician's knowledge, cognition and metacognition is using throughout the management while maintaining the better patient involvement and communication in every step of assessment and management. There are various types of clinical reasoning processes; deductive reasoning, inductive reasoning, three track reasoning and narrative reasoning. The type of clinical reasoning depends on the case or the patient. The client will be benefitted via application of all the steps of the identified relevant reasoning process for particular condition

The aim of this study was to understand the most appropriate reasoning processes for the management of grade II chronic lateral ankle sprain patient. The study concluded that three track reasoning process has been used to manage this patient and had more than 80% improvement within 5 weeks. Clinician's bio medical and clinical knowledge as well as the patients' physical, psychological and social information is important to understand the appropriate clinical reasoning process for particular individual. Moreover, understanding and application of proper clinical reasoning process leads to minimize clinical errors and maximize the outcomes in clinical settings.

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FEMINIZATION OF AGRICULTURE: CHANGING TRENDS IN INDIAN AGRICULTURE

Sahoo Soumya Sagarika

PhD Research Scholar, P.G Department of Public. Administration
Utkal University, Bhubaneswar, Odisha, India

ABSTRACT:
Agriculture sector as a whole has developed and emerged immensely with the infusion of science and technology. But this latest emergence is not capable of plummeting the ignorance of women labour as an integral part of this industry. In developing countries like India, agriculture continues to absorb and employ female work force but fails to give them recognition of employed / hired labour. Long standing obstacles faced by rural women in terms of limited access to productive resources (Land, Credit, Inputs, Transport, Extension Services, Storage and Technical Assistance) prevent them from adopting new technologies or encoring them economies of scale. The high levels of women employed in this industry and their segregation into certain tasks and occupations reduces production costs because women's wages are lower than men's and their employment is highly temporary. This research involves quantitative approach. This paper is based on both secondary & primary data. A total of 100 women farmers of Western belt of Odisha will be selected & their participation in agricultural activities other than daily household chores, factors responsible for participation in different agricultural activities& their recognition or status as agriculturist will be examined through questionnaire method. This paper examines whether women's participation in income-producing activities, whether as wage workers or as family workers in cash cropping, contributes to empowerment and improves their status within the household. This paper concludes that women's growing contribution of labour in agriculture adds to the already heavy work burdens of most rural women, thereby further undermining their well-being, and suggests policy implications for their upliftment.

Keywords: *Agriculture, Women, Feminization, Labour, Participation*

Introduction

"When women are empowered and can claim their rights and access to land, leadership, opportunities and choices, economies grow, food security is enhanced and prospects are improved for current and future generations"-Michelet Bachelet, Under-Secretary-General and Executive Director of UN Women.

Agriculture is the vertical backbone of the country. Major part of the country's population earns its livelihood from agriculture. Our country has a wide and very old setting of agriculture of about 10 thousand years. At present in terms of agriculture production the country holds second position across the world. The rural population of our country is mostly dependent on agricultural activity. Despite the fact that there has been steady slump in the contribution of agriculture in country's GDP, Indian agriculture continues to remain the leading industry in the country contributing vastly in the socio-economic growth of India. States like Punjab, Uttar Pradesh, Madhya Pradesh, Andhra Pradesh, Haryana, Bihar and West Bengal are the leading states in terms of agricultural contribution of the country followed by the rest. Thus agriculture in India is the key industry and in recent times with implementation and initiatives of various government policies, NGO's and private agencies immense growth is recorded in this industry. The scenario of agriculture has completely changed with change in time but from centuries one thing that didn't change is the visualization of women as key labour in this industry. Agriculture sector as a whole has developed and emerged immensely with the infusion of science and technology. But this latest emergence is not capable of plummeting the ignorance of women labour as an integral part of this industry. Women constitute 38% of the agricultural labour force in developing countries. But a large number of women have remained as "invisible workers". In developing countries like India, agriculture continues to absorb and employ 2/3rd of the female work force but fails to give them recognition of employed labour. The female labour force in developing nations still faces the oppressive status of being majorly responsible for family and household maintenance. In addition to that their contribution of being an agriculture labour is suppressed under the status of family labour who works in farm in addition to her regular household chores. These problems of the rural women are further accentuated by the tribulations of illiteracy, underdevelopment, unemployment and poverty. Despite the major productive women labour force in agriculture their needs and problems

are somewhat ignored by the rural development initiatives. Many of the systematic studies identify the trends of working female labour in agriculture. Empirical studies were conducted and explained on gender roles and gender analysis. This piece of research will highlight the trend of female participation in agriculture across India.

Method of the Study

This paper is based on both secondary & primary data.

Primary Data: A total of 100 women farmers of Western belt of Odisha are selected & their participation in agricultural activities other than daily household chores, factors responsible for participation in different agricultural activities & their recognition or status as agriculturist will be examined through questionnaire method.

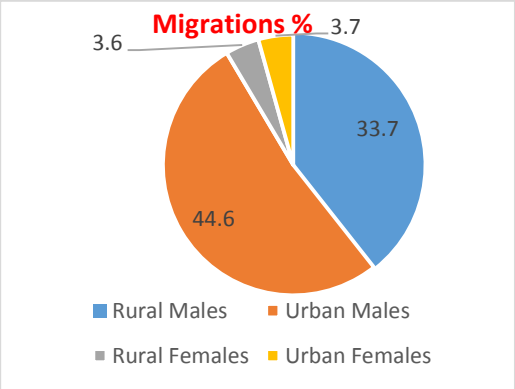
Secondary Data: Data has been collected from different Government reports like Economic Survey, Agricultural Policy & Policy Visions etc., journals, newspapers, publications, books &websites.

Objectives of the Study

- To find out the role of women in agriculture and its allied fields.
- To find out main obstacles in women growth in agriculture sector.
- To analyse the gender differences in roles and activities in agriculture sector.

Discussion

As a result of rapid industrialisation, urbanization took place, and a migratory change began to take shape following the gender lines. Men migrated first, for long durations and far–off destinations as the social structure of India permits them to seek off-farm employment opportunities. This results in what is called the 'feminisation of agriculture'. This is basically a socio-economic structural change found in rural households and farming patterns with respect to the role of women. As the pressure on the poor households to contribute to the commercial economy increases, men start migrating to cities, wherein they get a higher pay. The bias towards male migration has its roots in patriarchal expectations. Women are thus seen as assuming a larger responsibility to meet the family needs back in the rural pockets. About 33.7% of rural males and 44.6% of the urban males migrate for reasons of employment and better economic opportunities. However, in the case of females, it is as low as 3.6% for rural females and around 3.7% for urban migrants. Their upward mobility for employment is restricted.



(Source: International Labour Organization, Sixth Edition)

The role of women can be traced from agricultural production to even food security. Women are active in both the cash and subsistence agricultural sectors. Their work in household activities and most importantly in food security is not accounted for in the country statistics (Food and Agricultural Organisation). The changing trend of feminisation of agriculture has helped to enhance women's role in this field. Excluding India and China, Asia has a relatively low percentage of female- headed households. Though looking at it sociologically, apart from working for the commercial economy, women play multiple roles. They work on family farms as well as paid agricultural labourers. They also lease in land for cultivation. The majority of labourers involved in collection of non-timber forest produce are particularly tribal women. Women also supplement family resources through collection of fodder and fuel and water for family and domestic animals. (Planning Commission, 2007).

Increasing participation by women in farming has been documented in many countries. This phenomenon raises the question:

Does the feminization of agriculture affect (either positively or negatively) agricultural productivity?

The concern is that women may face multiple limitations in their participation, thus also limiting overall agricultural production. Beyond concerns about agricultural productivity (and the related issues of domestic food prices and food security), scholars are also concerned about the potential effects that agricultural feminization can have on women's welfare. Women might be forced to work more hours and take on increased responsibilities in addition to traditional roles, which in many cases would be expected to reduce their welfare. Furthermore, the feminization of agricultural labour could have negative effects on women's income,

especially since women have less access to resources, such as high-quality land and credit (Katz 2003). If women are denied opportunities to participate in the off-farm sector (where returns to labour are higher) and are relegated to working on the farm without access to modern inputs, the indirect link between effort and income from farm activities may also reduce their status.

In this paper, we define agricultural feminization in two ways. First, the feminisation of agricultural labour is assumed to occur when the proportion of farm work done by women increases on a specific farm. Second, the feminization of farm management occurs when women begin to make decisions about farm production, such as what crops to produce, the amount of inputs to use, and how much produce to sell. The latter concept is more difficult to measure, so here we define managerial feminisation as occurring when the household is headed by a female. Our ambitious objectives are tempered by several data limitations. First, the findings in the paper are either descriptive or should be interpreted as conditional correlations, rather than as causal. We lack instruments to identify female headship, and clearly there may be unobservable factors associated with female farm management that might also affect grain yields.

Women Welfare in Odisha State

Women constitute nearly half (49.5 %) of the State's total population as per census 2011. As such their socio-economic development is a sine qua non for sustainable growth of the economy. The following table shows the Status of women in the total workforce in Odisha during the period from 1981 to 2011. The %age of women workers in Urban and Rural areas stood at 29.7 and 14.1 % respectively in the total workforce has been consistently increasing except 1981. The proportion of women in total main workers has increased from 16.18 % in 1981 to 17.87 % in 2011, while the proportion of women marginal workers as compared to total marginal workers has declined from 85.80 % in 1981 to 54.52 %in 2011.

Distribution of Female Workers

Census Year	Female Workers (in Lakh)			Female Workers in Agriculture (in Lakh)			% of Female Workers in Agriculture to Total Female Workers		
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
1981	25.87	24.51	1.36	11.06	10.8	0.26	42.75	44	19.12
1991	32.42	30.82	1.59	15.26	14.94	0.32	47.07	48.48	20.13
2001	44.75	42.13	2.61	9.59	9.45	0.14	21.43	22.43	5.36
2011	56.39	51.62	4.77	39.87	39.32	0.55	70.70	76.17	11.52

FINDINGS OF INDEPTH INTERVIEW & GROUP DISCUSSION OF FEMALE FARMERS:

The study attempted to collect qualitative information pertaining to reason or circumstances faced by female farmers for which they have involved themselves in to agriculture. Respondents of this interview were all female farmers who were also members of some Self Help Groups (SHGs) & they actively participated in the process & discussed their problems & demands on their involvement in agricultural activities. The findings from the interview & group discussion are discussed below.

Causes of Feminization of Indian Agriculture:

1. **Poverty**: Poverty is a major factor due to which women are forced to work as agricultural labourers to supplement the family's income. Women also work as unremunerated workers in family fields. 38% female farmers are involved to fulfil the basic need or to feed their families, 14% farmers were involved to support their family during financial crisis, 34% were of the reason to increase the family income.

Reason of Involvement in Agriculture	Numbers	Total	%
Basic Need	38	100	38%
Avoid Financial Crisis	14	100	14%
Family Income Increment	34	100	34%
Migration of Male Farmer	14	100	14%

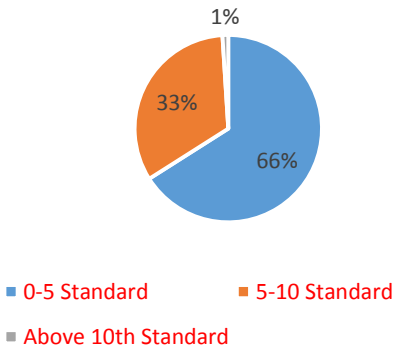
2. **Agrarian Distress and Shift of men to Casual work:** Agrarian distress is a predominant factor for disruption of farm labour or de-peasantisation i.e. migration of males from agriculture towards casual work. According to a 2013 report published in The Hindu, between 2001 and 2011, a total of 7.7 million farmers left agriculture. With rising shift of men from farm to non-farm activities, women have got absorbed in agricultural and allied activities. According to the study, 14% women farmers are getting in to the agricultural field because of the migration of the male farmers to other fields to get better opportunity.

3. **Migration to Urban Areas**: According to the Economic Survey 2017-18, with growing rural to urban migration by men, there has been 'feminisation' of agriculture sector; there has been an increase in participation of women as cultivators, labourers and entrepreneurs

4. **Mechanization of agriculture:** With increased mechanisation of agriculture, men have moved to other non-farm activities while women have been confined to traditional roles such as winnowing, harvesting, sowing seeds and rearing livestock.

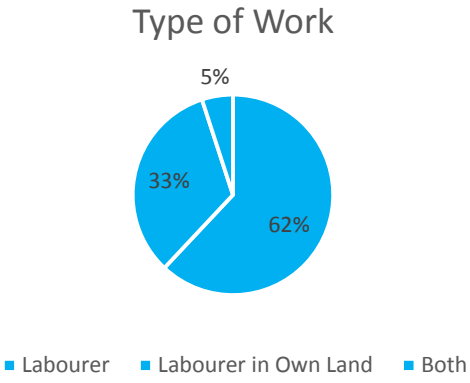
5. **Mobility:** The upward mobility of women for employment is restricted and is further constrained by gender wage differentials. As per Census, about 33.7% of rural males migrate for reasons of employment and better economic opportunities. However, in the case of females, it is as low as 3.6% for rural females.

6. **Education:** Education is also a main factor for increased numbers of feminization in this field. Because, the study finds out 67% women are either uneducated or merely educated till 5th class. The % rate is given in below chart:



Role of Women in Agriculture and Allied Activities: Rural women are engaged in agricultural activities in three different ways depending on the socio-economic status: They work as:

- Agricultural Labourers.
- Cultivator doing labour on their own land.
- Managers of certain aspects of agricultural production by way of labour supervision and the participation in post-harvest operations.



As per the study, 33% women farmers are working in their own land as labourer, 62% women farmers are working as labourer in other's land to get some daily wages & 5% women farmers do both the works to save or earn some more financial benefits so that they can support their families.

Functions performed:

- Agricultural Activities: Sowing, transplanting, weeding, irrigation, fertilizer application, plant protection, harvesting, winnowing, storing etc.
- Allied Activities: Cattle management, fodder collection, milking etc.

- Women play an important role in agricultural development, in ensuring food security and preserving local agro-biodiversity.
- Rural women are also responsible for the integrated management and use of diverse natural resources to meet the daily household needs.

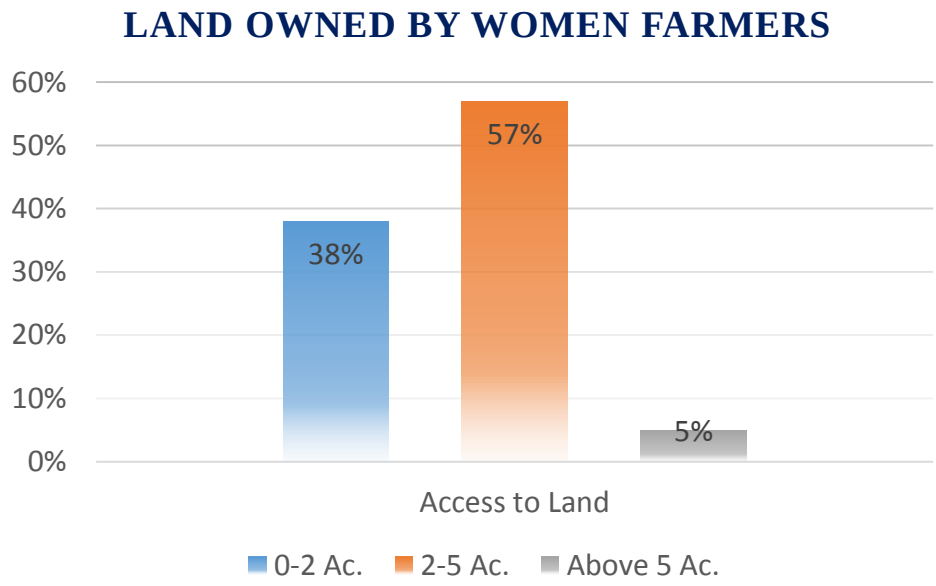
Involved in Allied Activity	Numbers	Total No.	%
Making ***"Bidi"***	14	100	14
Construction Work	10	100	10
More than One Activity (ie., Collection Sal Leaves, Tailoring etc.)	62	100	62
Not Involved	14	100	14

Issues:

1. **Access to land:** Lack of access to land is the major challenge faced by women in Indian agriculture. As per the Agricultural Census (2015-16), out of a total 146 million operational holdings, the percentage share of female operational holders is only 13.87%.

As per the study the data is given below in the following chart:-

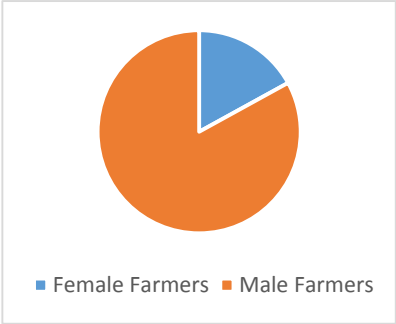
Land Owned (In Ac.)	Numbers	Total No.	%
0-2	38	100	38%
2-5	57	100	57%
Above 5 Ac.	5	100	5%



2. **Access to credit:** A lack of ownership of land does not allow women farmers to approach banks for institutional loans as banks usually consider land as collateral.

LOANEE / NON-LOANNEE	Numbers	Total No.	%
LOANEE	62	100	62%
NON-LOANEE	34	100	34%

According to the India Human Development Survey (IHDS, 2018), 83 per cent of agricultural land in the country is inherited by male members of the family and less than two per cent by their female counterparts.



Source: Indian Human Development Survey (IHDS, 2018)

3. **Access to agricultural inputs:** When compared to men, women generally have less access to resources and modern inputs (seeds, fertilizers, pesticides) to make farming more productive.

4. **Access to technology:** Mechanization of agriculture has resulted in confinement of women in low paying traditional works. Further, most farm machinery is difficult for women to operate.

5. **Access to education, training and extension services:** Access to education, agricultural training and extension services for women has been predominantly low as compared to men. 14% of women farmers demanded some scope for learning new technology to start new work so that they can earn little more.

6. **Managing different roles:** In addition to intensive work on the farm all day, women are also expected to fulfil domestic obligations like cooking, child rearing, water collection, fuel wood gathering, household maintenance etc. According to the study, women spend almost 4 hours per day in household chores & 3 hours in gathering fodder & collecting "***Sal***" leaves which is an extra source of income.

7. **Wage:** Despite more work for longer hours when compared to male farmers, women farmers have lower wage rates and at times remain unpaid. According to the study, women farmers get less wage as comparison to male farmers, i.e, Rs. 150/- per day whereas male farmers get Rs. 200/- per day for the same work in the same field.

8. **Marketing:** Small and marginal farmers in India lack adequate access to marketing facilities due to lack of basic infrastructure like market yards, roads and transportation, and storage including freezers and presence of middlemen. Additional constraints for women include seclusion, lack of literacy, knowledge and information. Further, women have no representation in agricultural marketing committees and other similar bodies.

Participation in Marketing	Number of Farmers Involved	Total No. of Farmers	%
Indirect Marketing	81	100	81%
Direct Marketing	19	100	19%
Not involved	0	0	0

9. **Feminization of poverty:** Women lack viable livelihood alternatives, and are forced to undertake farm activities that have been left by men due to agrarian distress. According to scholars, feminization of agriculture in India is actually ***"feminization of agrarian distress"*** or can also be termed as ***"feminization of poverty".***

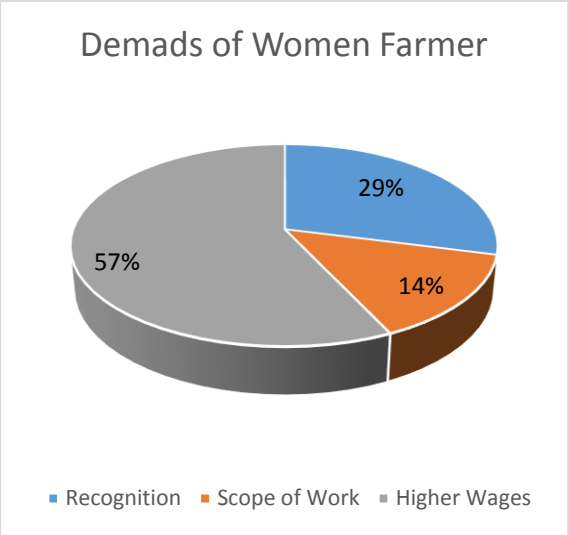
10. **Violence:** Violence and sexual harassment at workplace is a major issue faced by women agricultural labours and cultivators in India which mostly goes unreported.

11. **Health and Occupational Hazards:** Women face health hazards in the cultivation of many crops and plantations due to

Women in agriculture are affected by issues of recognition and in the absence of land rights, female agricultural labourers, farm widows, and tenant farmers are left bereft of recognition as farmers, and the consequent entitlements.

The root of the problem begins at the official lack of recognition of the female agricultural worker, and the resultant exclusion from rights and entitlements, such as institutional credit, pension, irrigation sources, increased per day wages, etc. As per the study, nearly 34% women farmers are not satisfied with their status of being involved in agricultural activities & they also show some changes. The data collected out of the study is given below.

DEMAND	Numbers	Total No.	%
Recognition	29	100	29%
Scope for Work	14	100	14%
Higher Wage	57	100	57%



In the absence of any recognition, women such as Chandravati, Manju, Ramrati Devi, and Sumitra Devi are left out of entitlements related to access to rural credit, assets, technology, irrigation, and inputs.

Issues in rural 'Women Land Rights' (WLR)

In 2011, M S Swaminathan, RajyaSabha member (2007-13) proposed the 'Women Farmers Entitlement Bill', which lapsed in 2013. With increasing recognition being given to the contribution of women in agriculture such as by commemorating the 'Rashtriya Mahila Kisan Divas', it is time that such legislations and institutional reform in agriculture are addressed.

Concluding Observations

1. A gender analysis is important for development policies and programs directed at agriculture. The Economic Survey (2017-18) recommended that there is an urgent need for 'inclusive transformative agricultural policy' aimed at gender-specific interventions.

2. The government should ensure access to secure land and property rights. A formal access to land will help increase productivity by facilitating investments and would ensure household food security and nutrition.

3. Provision of credit without collateral under the micro-finance initiative of the National Bank for Agriculture and Rural Development should be encouraged.

4. The training of rural women to help them adopt modern agricultural techniques that are tailored to local conditions and that use natural resources in a sustainable manner. KrishiVigyanKendras in every district can be assigned an additional task to educate and train women farmers about innovative technology along with extension services.

5. It is important to have gender-friendly tools and machinery for various farm operations. Manufacturers should be incentivised to come up with more women-friendly machineries.

6. Legal measures should be taken to ensure equal pay for work of equal value. Women should be made aware to help them negotiate equal wages and women organizations and unions can play an important role in this. The ILO has developed a program named Women's Education for Integrating Women Members in Rural Workers' Organizations with the objective of increasing empowerment of rural women in Tamil Nadu and Madhya Pradesh.

7. To achieve the full economic benefit from employment, rural women should be provided a greater choice over their occupations so that they are not forced to do the work left behind by men. It is thus important to have overall women empowerment through education, awareness and doing away with gender biases.

Participation of both men and women in agriculture has declined, but the rate of decline has been faster among men than it has among women. Furthermore, and importantly, the decline among women has been specifically in relation to their roles as cultivators, responsible for decision-making and the allocation of resources, while the number of women working as agricultural labourers has remained stagnant. This implies that where women have the financial and other capacity to do so they are leaving the agricultural sector. However, involvement in agriculture should not be confused with women's empowerment. Women's involvement as cultivators may not be financially empowering due to the sector is already experiencing severe decline and is no longer considered a profitable occupation. They may be

denied significant decision-making powers in relation to household assets, lack viable livelihood alternatives, and be forced to undertake economic activities that have been left by men. Such involvement occurs under duress and could be termed 'feminization out of compulsion' or the 'feminization of agrarian distresses. Furthermore, the type of feminization of agriculture implies a concentration of women either in agricultural labour or 'other-work', and could be related to what the Gimenez (1987) described as 'feminization of poverty'. The analysis presented here supports arguments that basic social and economic protection is missing for a large portion of the rural population, because of which women, as the cheapest and weakest labour in households and communities are falling back on agriculture whereas men are moving out of farms altogether. To transform the situation, it is essential to put the focus on women in the overall development plans and policies of agriculture. If the face of India's agricultural labour in future is, indeed, to be feminine, policy debates on agricultural growth will need to better reflects women's roles, practices, needs and interests. Feminization of Indian agriculture has been taking shape in the context of a complex interplay of shrinking land holdings; degraded soils and water resources; declining accessibility to traditional seeds and other inputs; distorted market incentives for crop choice and technology; growing labour shortages; and mechanization. It has also been occurring within a deepening crisis of gender relations. Efforts to enhance women's agency without addressing these broader rural crises will achieve only limited outcomes.

Recognizing the critical role of women in agriculture, the Ministry of Agriculture and Farmers Welfare has declared 15thOctober of every year as Women Farmer's Day.

With women predominant at all levels-production, pre-harvest, post-harvest processing, packaging, marketing –of the agricultural value chain, to increase productivity in agriculture, it is imperative to adopt gender specific interventions. An inclusive transformative agricultural policy' should aim at gender-specific intervention to raise productivity of small farm holdings, integrate women as active agents in rural transformation, and engage men and women in extension services with gender expertise.

"When women move forward, the family moves, the village moves, and the nation moves."

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SCREENING OF IMPROVED AND TRADITIONAL RICE VARIETIES AGAINST BROWN PLANTHOPPER, *Nilaparvata lugens* (Stål) FOR ITS MANAGEMENT

Sarathchandra, S.R.[1], Themalka G. Kavindya[1,2], Amani Mannakkara[2] , Rebaka P. Bandaranayake[1], Nilanka H. Madhuvanthi[1], Oshadi K. B. Dissananyake[1]

[1]Rice Research and Development Institute, Batalagoda, Sri Lanka
[2]Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka

ABSTRACT

Rice (*Oryza sativa* L.) is one of the most important food crops grown widely throughout the world, providing a staple food for nearly half of the global population. Pests and diseases as major constraints for increasing its production worldwide. Brown Planthopper (BPH) is the serious pest of rice among others. Although the host plant resistant is an important strategy to manage BPH, chemical control is the most effective practice to manage their outbreaks. However, due to indiscriminate use of insecticides, BPH has evolved high levels of resistance to number of chemicals grouped into major classes of insecticides. Therefore, the study was conducted to evaluate the resistant levels of selected improved and traditional rice varieties against BPH. Total 59 varieties including 52 improved rice varieties and 7 traditional rice varieties were screened using parafilm sachet method of honey dew test with known susceptible (Bg 380) and resistant (Ptb 33) check varieties. The study revealed the earliest Moderately resistant varieties; Ld 253, Ld 356, Ld 355, At 373, Pachchaperumal, Bw 273- 6B, Bw 363, Ld 371 were changed into Susceptible. Although earlier other rice varieties belongs to different categories, Bw 451, Bg 305, Bg 310, Bg 304, Bw 302, Bg 38, Bw 372, Bg 300, H 4, Bg 250, Bg 90-2, Bg 369, Bw 367, H 10 and Bw 267- 3 were changed into Moderately resistant level. And At 306, Bw 364, and Bg 745 varieties showed resistant to *N. lugens.*

***Keywords: Nilaparvata lugens**, Resistant, Rice varieties, Screening*

1. Introduction

Rice (*Oryza sativa* L.) is the second most important cereal crop in the world. It is a dietary staple crop more than half of the world's population (Muttaya *et al.*, 2014). It provides 35- 75% of calories and 15% of protein for human diet. Rice production is an important part of national economy of Sri Lanka and to ensure the food security for increasing population, raising the yield of rice ceiling remains a priority in the country. More than 90% of world's rice is grown in Asia where the 60% of population lives. Rice provides about 80% of the calories for two billion people in Asia and one third of the caloric intake of one billion people in African and Latin American countries (Kumari *et al*., 2018). Rice production is an important part of national economy of Sri Lanka and to ensure the food security for increasing population, raising the yield of rice ceiling remains a priority in the country. The need for improving rice production and the productivity of rice fields in the country is immense and the achievement of self-sufficiency through domestic production of rice remains a major objective in the country.

Now a days, there are many problems associated with the paddy cultivation, which are affect for reduction in the yield. Insect pests are serious threat to increase rice yield and cause significant damage to the rice production annually. The BPH is one of the most serious economically important rice pests in Sri Lanka. BPH problem was reported since the 1960s (Otake *et al.*, 1976) and annually BPH damage leads to a loss of about 5-10% of national rice production with the occurrence of several epidemics at regular intervals causing high yield losses (Nugaliyadda *et al*., 2001; Madurangi *et al*., 2011). The insect is mainly based on phloem feeding as a sucking pest. It also caused the hopper burn, complete wilting and drying of the rice plants which lead for reduction in rice production. It is a monophagous, migratory rice herbivore. According to the length of wings adult BPH are dimorphic with varying wing lengths. The short winged BPH cannot migrate, but produces large amount of eggs, the BPH having long wings are migrate by wind over long distances, able to fly between regions and bridge gaps in subsequent cropping seasons (Hu *et al*., 2016).

Although, Sri Lanka has been experiencing rice plant hopper problems since the 1960s; has not developed a very effective strategy to manage them. At present, farmers mostly depend on chemical pesticides for the control of this pest because of the lack of resistant varieties as well as the perception of farmers on pesticides. With the increasing awareness of detrimental effect of chemical based management practices, research effects are directed to developed environmental friendly management practices. Study on rice breeding for BPH resistant is priority research area in Sri Lanka, but quick adaptation to resistant rice varieties is one of the main problem in BPH management. The most effective way of BPH management is considered as host plant resistance. Among that, varietal resistance is the most economic, least complicated and environmentally friendly approach for the control of pest damage. Traditional varieties have most valuable traits to give the new characters for development of improved varieties. One of the important traits is level of resistance to insect pests and diseases. Therefore, the identification of resistance level of varieties is most important for future works. Checking of resistance and susceptibility of rice varieties for BPH is really important aspect in present scenario.

2. Materials and Methods

The experiment was conducted under the laboratory conditions in the Yala season at the Rice Research and Development Institute, Batalagoda. Fifty-nine **(**59) improved and traditional rice varieties were used in the study.

Table 1. Selected improved and traditional rice varieties for screening test.

1.Bg 380*	16.At 401	31.Bg 370	46.Bw 302
2.Ld 408	17. At 362	32. Bg 406	47. Bg 451
3.Ld 355	18. Ptb 33**	33. Bg 250	48. Bg 742
4.Ld 253	19. Suwadel	34. Bg 251	49. Bg 38
5.Ld 371	20. Kaluheenati	35. Bw 272-6B	50. Bg 407 H
6.Ld 356	21. Pachchaperumal	36. Bw 367	51. Bg 94-1
7. At 368	22. Suduru samba	37. Bg 305	52. Bg 3-5
8. At 354	23. Rathdel	38. Bg 369	53. Bg 90-2
9. At 306	24. Sulai	39. H-4	54. Bg 310
10. At 303	25. Herath banda	40. H-10	55. Bg 304
11. At 309	26. Bg 352	41. Bw 363	56. Bw 374
12. At 405	27. Bg 358	42. Bw 372	57. Bw 361
13. At 373	28. Bg 357	43. Bw 452	58. Bw 266-7
14. At 311	29. Bg 366	44. Bw 364	59.Bg 300
15. At 308	30. Bg 359	45. Bw 267-3	

***** -Susceptible variety ******-Resistant variety

Initial BPH population was collected from farmer field at Batalagoda near to Rice Research and Development Institute. The BPH were reared in rearing cages. Bg 380 variety was planted in pots and they were transferred into BPH rearing cages. Adult BPH were introduced to potted rice plants and allowed them to reproduce.

Nursery was established in galvanized tray using sterilized soil. Selected varieties were put and kept until 14 days in age. After 14 days of sowing, seedlings were transplanted in a standard rice-growing soil in plastic pots (Dimension: 10 * 6 cm) and each pot was labeled properly. All the pots were arranged according to the complete randomized design under laboratory with 3 replicates. Then parafilm was cut into desired size.

Petri dish was inserted to the plant base and parafilm was placed on the petri dish. It should be noted that, avoid contact with water or soil during placing the parafilm on the petri dish. The base of the plant was covered by disposable cup. Then adult female BPH were introduced to each plant with the help of aspirator (1-2 BPH/ one plant). That BPH were staved 2 hrs before introduce to the plants. Then allowed to feed for 24 hrs. After 24 hrs, honeydew excreted by BPH were weighted and analyzed by SAS statistical package.

3. Results and Discussion

The results were taken according to weight of the honey dew excreted by BPH within 24 hour and evaluation procedure was prepared by considering the SAS output which based on mean weight of honey dew. There were 5 categories according to level of resistant.

0- Resistant (R), 1- Moderately resistant (MR), 2- Moderately resistant/ moderately susceptible (MR/MS), 3- Moderately susceptible (MS), 4- Susceptible(S). Categories were grouped according to mean weight of honey dew by comparing the susceptible (Bg 380) and resistant check (Ptb 33) variety. Among the all varieties, Bg 380 has shown high rate of honey dew excretion indicating that is highly susceptible to BPH whereas, insects on Ptb 33 showed least level of honey dew excretion indicating its resistance (Balaravi and Sharma., 2013). By considering honey dew screening test the level of resistance were categorized and it indicated as below.

Table 2. Level of resistance showed in rice varieties

Variety	Current resistant level	Past resistant level (DOA, 1958- 2016)	Mean weight of honeydew in g
Bg 380	S	S	0.5345^{a}
Ld 408	MS	R	0.5178^{d}
Ld 355	S	-	0.5332^{ab}
Ld 253	S	MR	0.533^{ab}
Ld 371	S	R	0.5294^{ab}
Ld 356	S	MR	0.5338^{ab}
Ld 368	MS	MR	0.5233^{c}
At 354	MR/MS	MR	0.5050^{ifhkgi}
At 306	R	R	0.5014^{k}
At 303	MS	MR	0.5116^{e}
At 309	MS	MR/MS	0.5087^{fe}
At 405	MS	R	0.5083^{feg}
At 373	S	MR	0.5329^{ab}
At 311	MS	MR/MS	0.5230^{c}
At 308	MS	MR	0.5241^{c}
At 401	MR/MS	-	0.5046^{ifhkgj}
At 362	MS	R	0.5079^{fheg}
Suwadel	MS	-	0.5068^{ifhegj}
Kaluheenati	MR/MS	MR	0.5035^{ihkj}
Pachchaperumal	S	MR	0.5326^{ab}
Suduru samba	MR/MS	MR/MS	0.5050^{ifhkgj}
Rathdel	MS	MR	0.5069^{ifhegj}
Sulai	MR/MS	MR	0.5053^{ifhkgj}
Herath banda	MS	R	0.5079^{fheg}
Bg 352	MS	R	0.5068^{ifhegj}
Bg 358	MR/MS	R	0.5042^{ifhkgj}
Bg 357	MS	-	0.5072^{ifheg}
Bg 366	MR/MS	MR	0.5039^{ifhkgj}
Bg 359	MR/MS	R	0.5035^{ihkj}
Bg 370	MS	-	0.5231^{c}
Bg 406	MS	R	0.5241^{c}
Bg 250	MR	MR	0.5023^{ikj}
Bg 251	MR/MS	MR	0.5032^{ihkj}
Bg 305	MR	-	0.5030^{ihkj}
Bg 369	MR	R	0.5021^{ikj}

H 4	MR	-	0.5023^{ikj}
H 10	MR	-	0.5019^{ikj}
Bw 363	S	MR	0.532^{ab}
Bw 272- 6B	S	MR/MS	0.5322^{ab}
Bw 367	MR	-	0.5020^{ikj}
Bw 372	MR	-	0.5026^{ihkj}
Bw 452	MR/MS	-	0.5033^{ihkj}
Bw 364	R	R	0.5005^{k}
Bw 267- 3	MR	R	0.5018^{ikj}
Bw 302	MR	-	0.5029^{ihkj}
Bw 451	MR	-	0.5031^{ihkj}
Bg 745	R	-	0.5004^{k}
Bg 38	MR	-	0.5028^{ihkj}
Bg 407 H	MR/MS	R	0.5036^{ifhkgj}
Bg 94- 1	MS	MR	0.5221^{dc}
Bg 3-5	MR/MS	-	0.5043^{ifhkgj}
Bg 90- 2	MR	-	0.5022^{ikj}
Bg 310	MR	R/MR	0.5030^{ihkj}
Bg 304	MR	-	0.5029^{ihkj}
Bg 374	MR/MS	-	0.5032^{ihkj}
Bw 361	MR/MS	MR	0.5033^{ihkj}
Bw 266-7	MR/MS	-	0.5041^{ifhkgj}
Bg 300	MR	R	0.5026^{ihkj}
Ptb 33	R	R	0.5001^{k}
CV (%)			0.25

Note: R-Resistant, MR- Moderately resistant, MS- Moderately susceptible, S- Susceptible

Means with the same letters are not significantly different at 5% level by Duncan multiple range test.

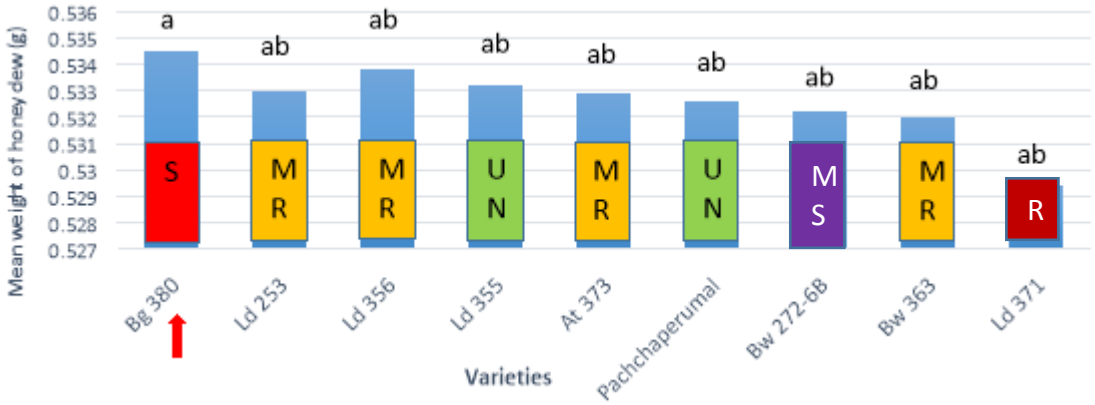

Figure 1. Susceptible varieties (S)

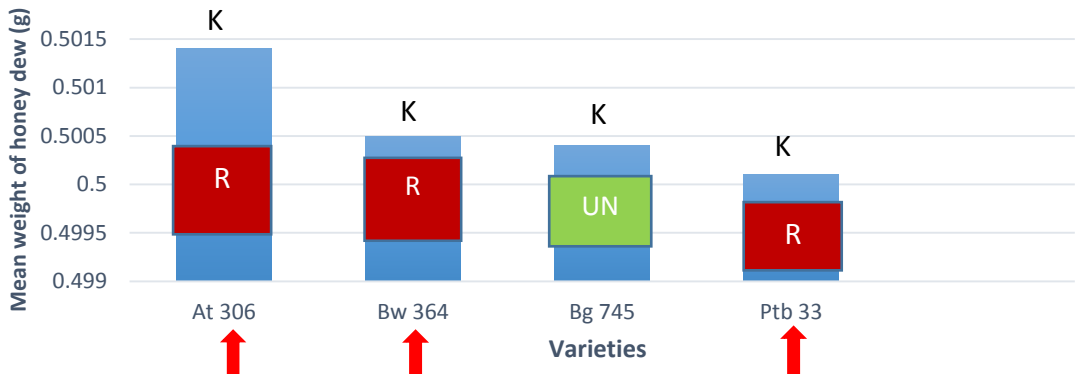

Figure 2. Resistant Varieties (R)

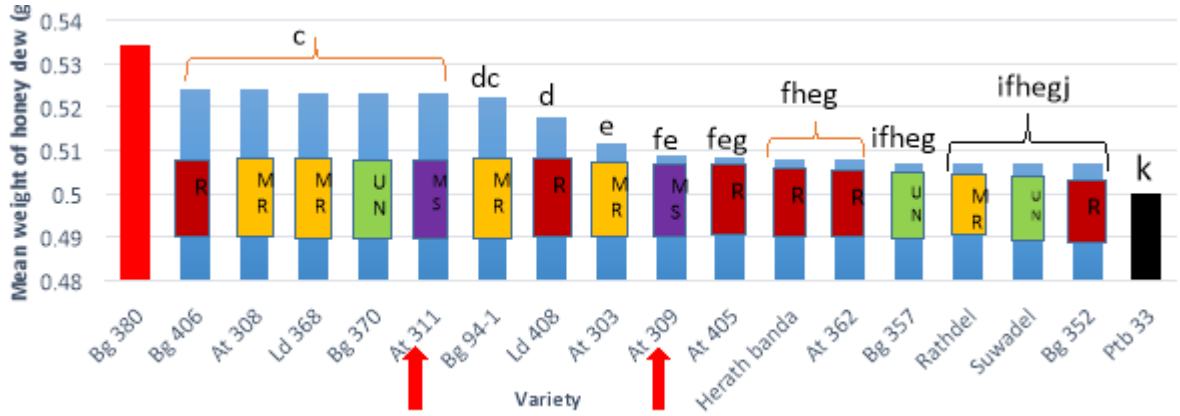

Figure 3. Moderately Susceptible varieties (MS)

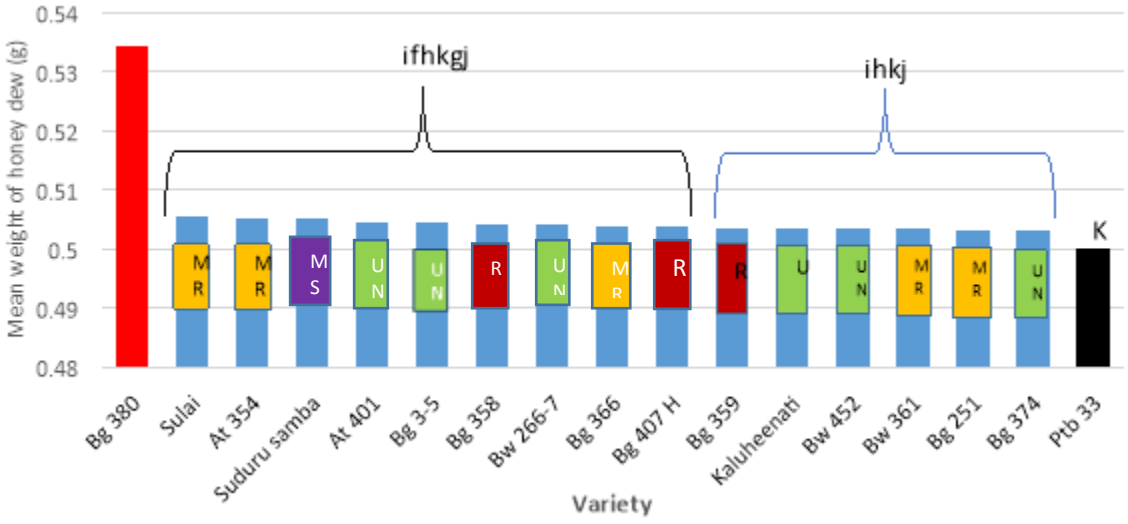

Figure 4. Moderately Resistant / Moderately Susceptible varieties (MR/MS)

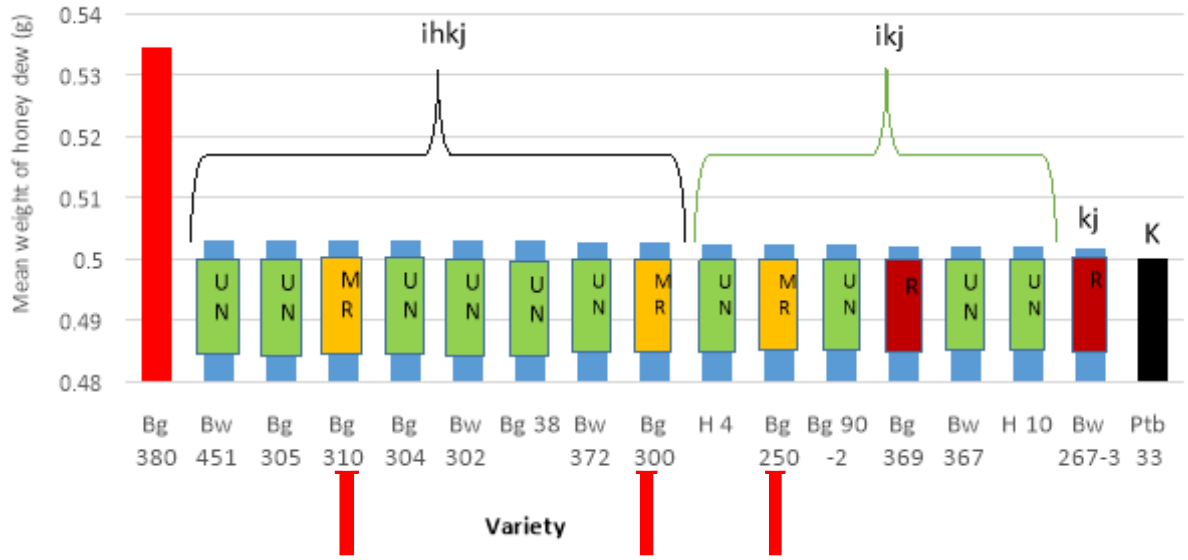

Figure 5. Moderately Resistant varieties (MR)

On resistant rice varieties significantly less honey dew was excreted than on susceptible varieties suggesting on its significantly reduced feeding rate (Pathak et *al.*, 1982). According to the results, the level of resistance between the past and current status of rice varieties. Ld 371, Ld 253, Ld 356, At 373, Bw 363, Bg 406, At 405, Herath banda, At 362, Bg 352, At 308, Ld 368, Bg 94- 1, At 303, Rathdel, Bg 358, Bg 407 H, Bg 359, Sulai, At 354, Bg 366, Bw 361, Bg 251, Suduru samba, Bg 369, Bw 267- 3 and Bw 272- 6B shown significant differences of level of resistant. In earlier, Ld 371 was shown R and that variety changed resistant level into S. Ld 253, Ld 356, At 373 and Bw 363 varieties earliest shown MR but at present it was changed into S. The variety Bw 272- 6B resistant level was changed into MR/MS to S.
At 311, At 309, At 306, Bw 364, Bg 310, Bg 300 and Bg 250 varieties were not shown any significant differences of past and current resistant level.

4. Conclusion

Earliest MR Ld 253, Ld 356, Bw 363, earlier R Ld 371 and MS Bw 272-6B resistant level were changed into Susceptible (S). Bw 451, Bg 305, Bg 310, Bg 304, Bg 38, Bw 372, Bg 300, H 4, Bg 250, Bg 90-2, Bg 369, H 10, Bw 267- 3, Bw 302 showed MR at present. At 306, Bw 364, Bg 745 showed R to BPH. At 306, Bw 364 and Bg 745 rice varieties are more effective for future breeding programmes to generate the resistant rice varieties against BPH. However, an incessant programme is necessary to confirm the finding, because micro-environmental condition directly affect to the pest population.

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THE EFFECT OF BMI BASED NUTRITIONAL STATUS ON LUNG FUNCTIONS OF HEALTHY ADULTS IN SRI LANKA

Herath H.M.K.B[1], Dasanayaka D.A.R.K[2], Walgampaya C.K[3]

[1]The National Hospital of Sri Lanka, [2]Department of Physiotherapy, Faculty of Allied Health Sciences, University of Peradeniya, Peradeniya, Sri Lanka, [3]Department of Engineering Mathematics, Faculty of Engineering, University of Peradeniya, Peradeniya, Sri Lanka

ABSTRACT

Respiratory system is one of the most important systems of the body which can be affected by different physiological and anatomical changes. There are claims that nutritional status affects the lung function parameters of individuals. One of the key methods of categorizing nutritional status is Body Mass Index (BMI). Hence objective of the study was to assess influences of BMI based nutritional status on lung functions among Sri Lankan adults. Spirometric data of 509 subjects (293 males and 216 females) aged between 20 and 35 years were collected based on Underweight (<18.5), Normal weight (18.5-22.9), Overweight (23.0 -24.9), Pre-obese (25 -29.9) and Obese (30-40) nutritional status categories. Variations of Pulmonary function test results; Forced Vital Capacity (FVC), Forced Expiratory Volume in One Second (FEV1), Peak Expiratory Flow Rate (PEFR), FEV1/FVC % with those categories were analyzed using non parametric tests. Results show significant difference of FEV1/FVC% ($p<0.05$) among categorized male groups. FEV1/FVC% significantly higher in underweight and normal weight groups than overweight, pre-obese and obese groups. Significant difference ($p<0.05$) of PEFR were identified among female categories. Pre-obese group shows significantly higher ($p<0.05$) PEFR than underweight and normal weight groups. The study concluded that though there is a significant different of PEFR among female categories and FEV1/FVC% among male categories, there no significant difference of FVC and FEV1 spirometric values among BMI based nutritional categories of healthy Sri Lankan adults.

Keywords: *BMI, Nutritional status, Lung function, Healthy adult*

1. INTRODUCTION

Respiratory system is one of the most important systems of the body .The respiratory system with the key function of gas exchange consist with the bony thorax, respiratory muscles, the upper and the lower airways and the pulmonary circulation. Ventilation includes both inspiration and expiration. Primary muscles that activate during the inspiration at rest are the diaphragm and external intercostals. Quite Expiration is a passive process and no primary muscles for expiration. The muscles that require for forceful expiration are Internal Intercostals and abdominal muscles. The level of the diaphragm and the amount of movement during inspiration vary as a result of factors such as body position, obesity, and size of various gastrointestinal organs present below the diaphragm(Hillegass, 2011).

Spirometry is a consistently used pulmonary function test (PFT) to measure speed and amount of air that an individual can inhale and exhale. Result of this is used to diagnose various respiratory disorders. According to National health and Nutrition Examination Survey in 2011, Forced Vital Capacity (FVC), Forced Expiratory Volume in One Second (FEV1), Peak Expiratory Flow Rate(PEFR), and FEV1/FVC% are standard measurements used in spirometry(Centers for Disease Control and Prevention, 2011).

There are various factors which influence the lung function of an individual. Gender, height, weight, ethnicity, health status, smoking and environmental factors are some common factors. Some studies stated that gender and height are the most important predictors of lung function. The predictor; age consider as a confounding factor and age dependent changes in lung function reveals distinctive differences throughout the lifespan(Ostrowski and Barud, 2006). Obesity is a another factor which increases the workload of breathing thus causing respiratory symptoms though the subject does not have any respiratory illness(Zammit*et al.*, 2010).

The Body Mass Index (BMI) is commonly used anthropometric tool for measuring the body composition. There are different classifications of Nutritional status according to the Body Mass Index (BMI).Hence the author considering the Sri Lankan population for the study Asian Cutoff

points of BMI has been selected for the study (Llido and Mirasol, 2010)(Table1).

Table 1.Nutritional Status based on "Asian Criteria"

Nutritional Status	**BMI cutoff**
Underweight	<18.5
Normal	18.5-22.9
Overweight	23-24.9
Pre-Obese	25-29.9
Obese Type 1 (Obese)	30-40
Obese Type 2 (Morbid Obese)	40.1-50
Obese Type 3 (Super Obese)	>50

There are several studies carried out to check the association between BMI and Lung Function(Littleton, 2012)(Jones and Nzekwu, 2006)(Wang *et al.*, 2017)(Wang *et al.*, 2014).There are lack of such studies in Sri Lanka as well as studies on assessing relationship between Lung Function and nutritional status. Hence, the objective of this study was to assess nutritional status based on BMI influences on Lung Functions with respect FVC, FEV1, FEV1/FVC%, PEFR.

2. METHODOLOGY

This is a retrospective study conducted by evaluating the PFT data of healthy Sri Lankan adults between ages 20-35 years. 509 nonsmoking healthy adults were taken as subjects including 293 males and 216 females in various hospitals in Sri Lanka. Data was classified into 5 groups according to the calculated BMI with the Asian Criteria (Table 2).

Table 2.Grouping according to the BMI

Groups	**Notation**	**Nutritional Status**
Group 1	G1	Underweight
Group 2	G2	Normal weight
Group 3	G3	Overweight
Group 4	G4	Pre obese
Group 5	G5	Obese

Male and Female data analyzed separately using R version 3.4.2.Shapiro-Wilk normality test used to check the normality of the data which has ties. Hence the data was not normally distributed non parametric tests were used for statistical analysis. Male and female subgroups were tested using Mann Whitney U Test. Kruskal-Wallis Test was used to identify group population distributions among 5 groups. Pairwise comparisons were done using Wilcoxon rank sum test.

3. RESULTS

Normality of the data set checked using 5% significant level. Results depict all the variables are not normally distributed. Thereafter Male and female subgroups were tested using Mann Whitney U Test(Table 3).Obtained result implies that there is a significance difference between Male and Female groups at 5% significance level. Data visualized using box-plot also figure out the difference of male and female group clearly (Figure 1).

Table 3. Mann Whitney U Test Results

Variable	W statistic	P value
FVC	2259.5	< 2.2e-16
FEV1	2382.5	< 2.2e-16
FEV1/FVC	37859	0.000151
PEFR	5131.5	< 2.2e-16

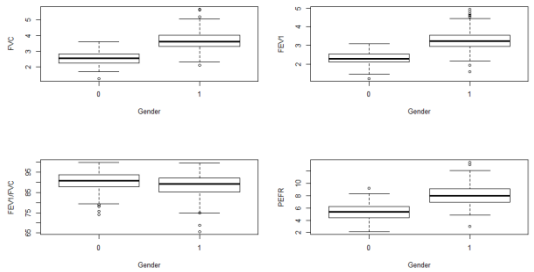

Figure 1.Male and Female Box plots (Male=1, Female=0)

Kruskal-Wallis Test was used to identify whether the group population distributions are identical. Results imply that FEV1/FVC% of males and PEFR of females are not identically distributed among groups at 5% significant level (Table 4).

Table 4.Kruskal-Wallis rank sum test Results

Variable	**Kruskal-Wallis chi-squared**	
	Male	**Female**
FVC	5.7442 (p>0.05)	2.9585 (p>0.05)
FEV1	8.2704 (p>0.05)	1.9824 (p>0.05)
FEV1/FVC%	18.677 (p<0.05)*	2.0355 (p>0.05)
PEFR	2.1039 (p>0.05)	10.165 (p<0.05)*

* - Values with significance difference

Pairwise comparisons were done using Wilcoxon rank sum test for the variable FEV1/FVC% in males. G1-G3, G1-G4, G1-G5, G2-G3, G2-G4 and G2-G5 are significantly different from each other at the 5% significant level (Table 5) (Figure2). Test

result for PEFR in females shows G1-G4 and G2-G4 are significantly different from each other at the 5% significant level (Table 5) (Figure3).

Table 5. Pairwise comparisons between groups

Group (i)	Group (j)	Female (PEFR)	Male (FEV1/FVC %)
G1	G2	0.797	0.558
	G3	0.455	0.022*
	G4	0.037*	0.022*
	G5	0.797	0.022*
G2	G3	0.455	0.022*
	G4	0.037*	0.022*
	G5	0.797	0.022*
G3	G4	0.531	0.558
	G5	0.797	0.995
G4	G5	0.531	0.554

* - Values with significance difference

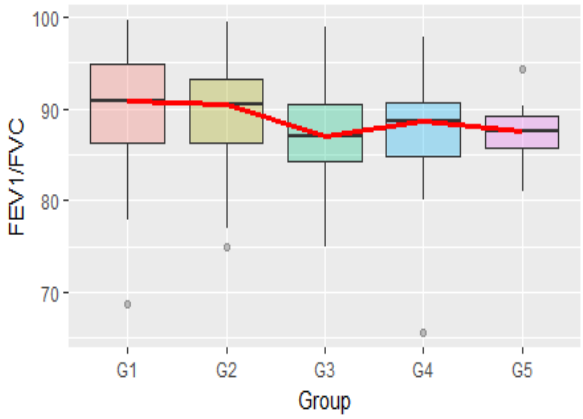

Figure 2. Box Plot of variation of FEV1/FVC% among male groups

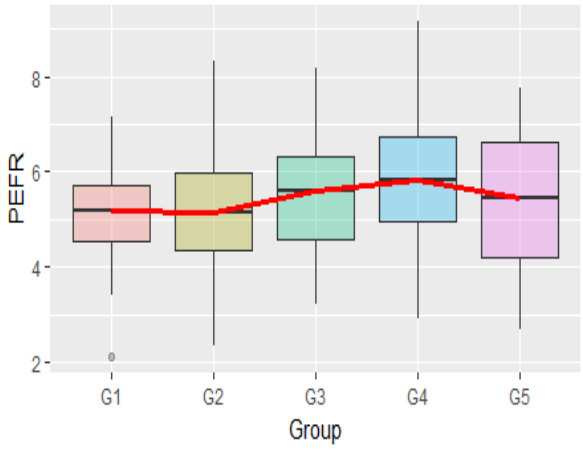

Figure 3.Box Plot of variation of PEFR among Female groups

4. DISCUSSION

There are various ways to evaluate the nutritional status of an individual such as anthropometric method, biochemical method, clinical method, and demographic factors method, environmental and social factors method. BMI which comes under anthropometric measure of checking the nutritional status is the easiest and simplest method which has been used in this study. Asian Cut off for BMI has been used since the study population consists with native Sri Lankans. This study specifically carried out to evaluate how the nutritional status based on BMI affect the lung function though several studies have been carried out to evaluate influence of obesity on lung function(Forno*et al.*, 2018)

Usually females achieve their maximum lung function around twenty years of age and males around twenty five years of age from the birth throughout their growth and the development. These maximum lung volumes will be maintained and started decline around the age of thirty five(Sharma and Goodwin, 2006). Hence for the present study researchers has selected the subject age between 20 to 35 years to minimize the effect of aging on lung function. At the same time nonsmokers has been selected to avoid the effect of smoking on lung function. The subjects who have been with good health are taken as the sample.

The obtained results imply that FEV1/FVC% of males and PEFR of females have significant difference between groups while FVC, FEV1 values remain unchanged in both the genders. Accordingly some studies found that there were no significance influence of obesity on vital capacity (VC) and FEV1(Sgariboldi *et al.*, 2016).

Results depicted that males FEV1/FVC% is higher in underweight and normal weight groups than the overweight, pre obese and obese groups, which showing decline of FEV1/FVC% with the increased BMI. Nevertheless some studies found BMI was positively associated with FEV1/FVC% at all ages and negatively with FVC in men(Lazarus, Sparrow and Weiss, 1997).

Among females, PEFR gradually increased with the BMI by showing significantly higher in pre obese group and then reduced in the obese group. Nevertheless the reduction of PEFR in obese group is comparatively higher than underweight and normal weight group's .FVC, FEV1, FEV1/FVC% values remain unchanged among female groups. Some studies reported that VC and FEV1were significantly lower in obese women than in normal-weight women, arguing that obesity can reduce VC as it can interfere with the movement of the diaphragm and exertion of the chest wall (Rasslan,

Saad and Stirbulov, 2004). A study conducted among Chinese population has found that there is no significant difference in FEV1, FEV1/FVC%, PEFR values among the two groups; non obesity (BMI<24kg/m2) and obesity (BMI≥24kg/m2). Only FVC decreased significantly in obesity group than in non-obesity group(Wang *et al.*, 2017).

The study concluded that though there is a significant different of PEFR among female categories and FEV1/FVC% among male categories, there no significant difference of FVC and FEV1 spirometric values among BMI based nutritional categories of healthy Sri Lankan adults. Since the study conducted nutritional status in Asian categorization up to obese category further studies needed to identify influence of lung function on morbid obese and super obese including larger samples.

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IMPACT OF FINANCIAL INTERMEDIATION ON ECONOMIC GROWTH: EVIDENCE FROM SRI LANKA

Achchi Mohamed Inun Jariya[1], Narawla Haththotage Nelusha Priyanjali[2]

[1 & 2]South Eastern University of Sri Lanka, University Park, Oluvil, Sri Lanka

ABSTRACT - The main objective of this study is to investigate the impact of financial intermediation on economic growth of Sri Lanka. Economic growth is represented by gross domestic product (GDP) rate as the dependent variable and financial intermediation is represented through three indicators which are Domestic Credit to Private Sector (DCPS), Domestic Credit Provided by Banking Sector (DCBS) and Broad Money (M2) as the independent variables. Investment Rate and Inflation Rate are used as the control variables in this study. The study used annual data which is collected from the World Bank Indicator report covering the period from 1977 to 2018. The study made use of correlation analysis and linear multiple regression analysis. Overall results suggest that financial intermediation and economic growth in Sri Lanka are significantly related. It is observed that GDP significantly and positively relates to broad money while investment has significant control. However, DCPS and DCBS are found to be insignificant in determining the GDP in Sri Lanka.

Keywords: *Broad Money, Domestic Credit Provided by Banking Sector, Domestic Credit to Private Sector, Economic Growth, Financial Intermediation*

1. INTRODUCTION

Economic growth has been considered as an important goal of economic policy of a country. Policy makers and economists of a country are always vigilant in the economic growth of a country. Generally economic growth of a country is measured based on its gross domestic products (GDP). Countries around the world, more specifically emerging economies, are trying to stabilize the economic growth through their various reforms. One such reformation is on the services of financial institutions which provide the financial intermediation.

Financial intermediation is called as capital transportation from savers to borrowers. It is usually understood as a process of connecting lenders and borrowers performed by banks and other financial intermediaries (Alpha, Ding, Abdrahmane, & Kargbo, 2016).

In this regards, Schumpeter (1996) states that financial intermediation is helpful for economic growth of a country. The financial intermediation theory also focuses the duty of financial intermediaries in an economy for the development of a country (Gurley & Shaw, 1960). One of the initial model of economic growth was made by (Solow, 1956) who describes financial intermediation help to positive growth of total output manufactured by a country.

Driven by the theoretical background, there are various empirical investigations that concluded that financial intermediation is connected to economic growth of a country.

Most studies on impact of financial intermediation on economic growth such as Chenery, (1960); Andrew & Osuji, (2013); Michael & Jhon (2004); Robinson (1952) have been drawn from developed counties. Further, a number of studies such as Acha (2011); Arabi (2014); Beck & Hesse (2006); Haruna; (2012); Ikechukwu (2013); Marshal, Onyinye, & Ifechi (2016); Odedokun (1998), have been drawn from developing counties. However, very few studies focus on the impact of financial intermediation on economic growth in Sri Lankan perspectives.

2. PROBLEM STATEMENT

Since the liberalization of Sri Lanka in 1977, several reforms were implemented in the financial systems of Sri Lanka such as legal process, technological advancement, efficient fund channeling system with an attractive and competitive product for savers and borrowers with less information cost for the purpose of boosting up the economic growth of Sri Lanka (Central Bank of Sri Lanka (CBSL), 1978).

However, the financial sector showered only 8.7 percent of contribution to the GDP, compared only 1.5 percent in 1977 (Annual Report, CBSL, 2018). Further, Sri Lankan financial intermediation

indicators and economic growth rate of the contribution of financial services to GDP show irregular changes during the same period (1977-2018) (CBSL, 2018 & World Development Indicators, 2018).

Thus, the investigation on "how does and to what extent the economic growth of Sri Lanka responds to financial intermediation?" still remains an open empirical questions.

3. RESEARCH OBJECTIVE

The main objective of this study is to investigate the impact of financial intermediation on economic growth in Sri Lanka.

4. REVIEW OF LITERATURE

Review of recent empirical findings are concerned relevant to financial intermediation and economic growth.

McKinnon & Shaw (1973) investigated the impact of financial intermediation on economic growth for 67 emerged and emerging countries during the period of 1967-1974. They investigated the relationship with respect to broad money supply and changes in GDP. The finding of this study indicates that the broad money has significant positive relationship with GDP.

Fritz (1984) examined the relationship between financial intermediation and economic growth in Philippines. Financial intermediation was measured with demand deposits (DD) and savings deposits (SD). At the same time changes in GDP was used to measure economic growth. The study found that DD and SD have positive relationship with GDP.

Jayaratne & Strahan (1996) studied the impact of financial intermediation on economic growth in US. Degree of real per capita growth in income was used to represent financial intermediation and value of banking lending was used to represent economic growth. It was found that the degree of per capita growth in income positively relates to economic growth, represented by banking lending.

Odedokun (1998) aslo studied the impact of financial intermediation on economic growth in the low-income countries. The financial intermediation was measured with labor force development, investment-GDP ratio, real export development, and financial depth. At the same time economic growth was measured with changes of GDP. The findings of this study indicate that labor force development and real export development have positive relationship with economic growth while investment-GDP ratio has negative relationship with economic growth. However, financial depth has no relationship with economic growth.

Hao (2006) investigated the relationship between financial intermediation and economic growth of China over the time period 1985 to 1999 and post 1978 improvement period. Banks' savings and loan-budget ratio is used to measure the financial intermediation which is the independent variable while economic growth was measured with households' savings mobilization and substitution of loans for state budget assumptions. The study finds that financial intermediation positively significantly relates to economic growth over the networks of households' savings mobilization and substitution of loans for state budget assumptions.

Beck & Hesse (2006) examined the cost of financial intermediation cost in Uganda. The study performed by use of a unique bank level data set on the Uganda banking system over the period 1999 to 2005. The financial intermediation was measured with bank level appearances, such as operating costs, bank size, and configuration of loan portfolio movements. The economic growth was measured with changes of foreign bank ownership, market structure and bank efficiency. The study found that financial intermediation costs have no strong and economic significant relationship by foreign bank ownership, market structure and bank efficiency in Uganda. This study does not emphasize the effects of financial intermediation on economic growth by credit to private sector, lending rate and interest rate margin as independent variables in the country.

Rathnasiri & Rexiang (2011) investigated the impact of financial intermediation and economic growth in Sri Lanka over the period of 1977 to 2008. They find that there exists a long-term positive association between financial intermediation and economic growth. Nwite (2014) studied the effect of financial intermediation on economic growth in Nigeria using ordinary least square regression analysis. The financial intermediation was represented with interest rate margin, credit to private sector and the level of lending rate. Economic growth was represented with changes in GDP. The study found that Nigerian financial intermediation impacts in three different ways on the economic growth where interest rate margin significantly impacts while credit to private sector positively impacts on the economic growth and the level of lending rate negatively related on economic growth in Nigeria.

Arabi (2014) evaluated the association between economic growth and financial development in Sudan over the period 1970 to 2012. Three signs namely; deposit liability to GDP, domestic credit to the private sector to GDP, and money supply to

GDP were used to measure the financial development. At the same time economic growth was measured with GDP ratio. The finding shows that there exists a long run positive relationship between financial development and economic growth. Tonye & Andabai (2014) investigated the effect of financial intermediation on economic growth in Nigeria using vector error correction model. Credit to private sector, lending rate and interest rate margin were used as the proxies of financial intermediation while changes in GDP was used as the proxy variable for economic growth. They find that the credit to private sector and lending rate positively relate GDP while interest rate negatively relates to economic growth.

Alpha, Ding, Abdrahmane, & Kargbo (2016) identified the impact of financial intermediation on economic growth in West African countries using the panel data over the period from 1985 to 2013. Financial intermediation was measured with five proxy variables such as interest rate spread, inflation, credit supply, broad money and level of financial intermediation while economic growth was measured with changes of GDP. Employing dynamic panel growth regression model, the findings of the study indicate that broad money and the level of financial intermediation impact positively on growth while credit supply, inflation, and interest rate spread impact negatively on economic growth of West Africa.

Marshal, Onyinye, & Ifechi (2016) identified the long run and short run dynamics between financial intermediation development and economic growth in Nigeria. Using credit to private sector and broad money as the proxies for financial intermediation and changes of capital on GDP as the proxy for economic growth, the study finds that financial intermediation development indicators significantly and positively contribute to economic growth.

Yeboah (2017) studied the impact of financial sector development on economic growth. The financial intermediation factors were namely domestic credit to private sector, domestic credit provided by banking sector and broad money while economic growth factor was measured as the changes of GDP. The results show that all three variables significantly and positively relate to economic growth.

5. CONCEPTUAL FRAMEWORK AND HYPOTHESES

The following conceptual framework is developed by reviewing the literatures.
Gross domestic product (GDP) was used to measure the economic growth which is the dependent variable. Gross domestic product (GDP) is defined as a monetary measure of the market value of all final goods and services produced in a period of time (Harper, 2011). The independent variable, financial intermediation is represented by three such variables, domestic credit provided to the private sector (DCPS), domestic credit provided by banking sector (DCBS) and broad money (M2). Domestic credit to private sector by banks is defined as the provision of financial resources by deposit taking corporations (except central banks) to the private sector (Nwite, 2014). Domestic credit provided by the financial sector refers to all gross credit grants to various sectors (except credit to the government (Silva, 2014). Broad money is the sum of currency outside banks, demand deposits other than those of the central government, and the time, savings, and resident sectors other than the central government (World Development Indicator, 2016).

In addition, inflation and investment are also employed as the control variables. Inflation is the rate of increase of the general price level (Madurapperuma, 2017). Investment is the outlays on addition to the fixed assets of the economy plus net changes in the level of inventories (Taiwo, 2011).

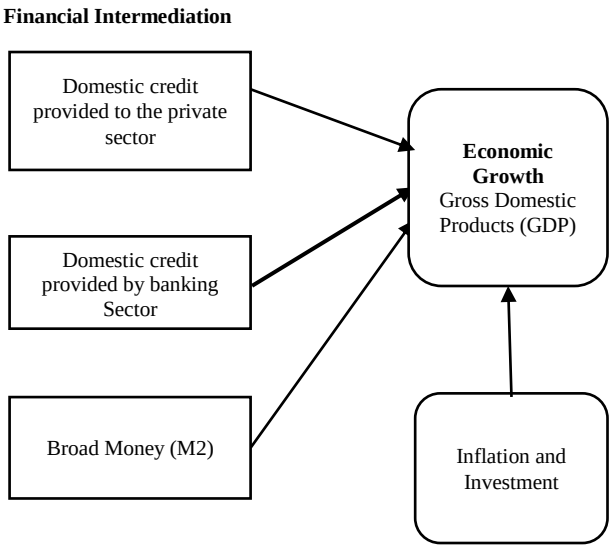

Figure 1. Conceptual framework
Source: Constructed by researchers based on literature review

Based on the literature and conceptual framework a set of following hypotheses have been developed.

H_1: There is a relationship between domestic credit to private sector and economic growth.
H_2: There is a relationship between domestic credit provided by banking sector and economic growth.
H_3: There is a relationship between money supply and economic growth.

6. METHODOLOGY

6.1 Sample and Data Collection

The data for the period of 1977 to 2018 are gathered through the secondary sources as the International Financial Statistics of the International Monetary Fund (IMF) (2016), World Development Indicators of the World Bank (2016) and Annual Report of the Central Bank of Sri Lanka. Banking sectors which provide financial intermediation in Sri Lanka are considered for this study. There are 26 licensed commercial banks, 7 licensed specialized banks in Sri Lanka. All 33 banks are taken for this study.

6.2 Model Specification

Both correlation and regression analysis are used to investigate the relationship between financial intermediation and economic growth in Sri Lanka. Regression analysis is used to measure the impact of independent variables and dependent variable. Using the Ordinary Least Square (OLS) method the parameters of the regression model is estimated. Data analysis was performed with the help of SPSS 22 version. The relationship between these variable can be represented by a linear regression model (1) specified below.

$$GDP_{it} = \alpha + \beta_1 DCPS + \beta_2 BCBS + \beta_3 M2 + \beta_4 In + \beta_5 If + ei \quad (1)$$

7. RESULTS AND DISCUSSION

The results of correlation and regression analysis are presented in table 1 and table 2.

Variables	DCPS	DCBS	M2	INF	INV	GDP
DCPS	1.000					
DCBS	0.769 (0.000)	1.000				
M2	-0.145 (0.361)	-0.132 (0.404)	1.000			
INF	-0.463 (0.002)	-0.441 (0.003)	0.149 (0.348)	1.000		
INV	0.329 (0.033)	0.248 (0.113)	-0.123 (0.439)	-0.117 (0.460)	1.000	
GDP	0.329 (0.808)	-0.078 (0.623)	0.360 (0.019)** *	0.199 (0.206)	0.274 (0.079) *	1.000
* significant at the alpha value of 0.05 **significant at the alpha value of 0.10						

Table 1. Results of correlation analysis

	Coefficient	t-statistic	p-value	Std. Error
DCPS	0.45	1.016	0.316	0.045
DCBS	-0.33	-0.892	0.378	0.036
M2	0.077	2.624	0.013*	0.029
INF	0.068	1.250	0.219	0.054
INV	1.040	2.105	0.042*	0.494
α	2.018	1.231	0.226	1.639
R			0.535	
R square			0.287	
Adjusted R square			0.187	
SE of estimate			1.681	
F-statistic			2.892	
Prob. (F-statistic)			0.027	

Table 2. Results of regression analysis

As per the results the discussion in relation to each variable is described and hypotheses are also tested as follows.

7.1 Domestic Credit to Private Sector & GDP

The correlation value in between DCPS and GDP is 0.45. Gross domestic product has a positive relationship with the domestic credit to private sector however it is statistically insignificant at 95% confidence level ($p>0.05$). As per the regression analysis DCPS is insignificantly associated with GDP with the estimated coefficient of 0.45 ($p = 0.316>0.05$).

This finding implies that even though the private sector is concerned as emerging sector of economy it is not significant enough to accelerate the gross domestic product in Sri Lankan context.

The deficiency of technical supports, regulatory barriers and unorganized administrations may influence as reasons for this insignificant relationship.

The finding does not support to the hypothesis that there is a relationship between domestic credit to private sector and economic growth. The finding supports that there is no significant relationship between domestic credit to private sector and economic growth which is consistent with *Inter alia* Hashim, (2012); Bogdan & Opris (2013); Koivu (2002).

7.2 Domestic Credit provided by Banking Sector & GDP

As per the correlation analysis presented in table 1 correlation value between DCPB and GDP is -0.078 with the alpha value of 0.623 and the coefficient of regression in between DCPS and GDP is -0.33 with the alpha value of 0.378. Thus, DCPS is insignificantly correlated with GDP at 95% confidence level ($p>0.05$).

This implies that the domestic credit which was provided by banks to private sector except government parties, have not been utilized efficiently by the parties who received the funds. The finding does not support to the hypothesis that there is a relationship between domestic credit provided by banking sector and economic growth.
The finding supports that there is no significant relationship between domestic credit provided by banking sector and economic growth which is consistent with *Inter alia* Bogdan & Opris (2013); and in contrary to Ding, Abdrahmane & Kargbo (2016) which shows significant negative relationship.

7.3 Broad Money Supply and GDP

A significant positive relationship found between broad money supply and GDP based on the correlation value of 0.360 (p=0.019>0.05)) and estimated coefficient of regression 0.077 (p=0.013 >0.05).

These finding indicates that 1% increase in M2 will increase GDP by 0.360, which is higher in magnitude of impact and in terms of significant (p = 0.019) as compared to other factors of financial intermediation under this study.

The finding supports to the hypothesis that there is a relationship between broad money supply and economic growth. The finding is consistent with that of *Inter alia* Rathnasiri & Rexiang (2011); Silva (2014) Ding, Abdrahmane & Kargbo (2016) and in connection with Nwite (2014).

7.4 Investment and GDP

As a control variable, investment indicates positively and significantly correlated with GDP with the correlation value of 0.274 (p=0.079>0.10) and estimated coefficient of regression 1.040 (p= 0.042>0.05). This implies that when investment increases, the gross domestic product of the country also increases.

7.4 Inflation and GDP

Inflation does not have significant impact on GDP as a control variable which has correlation value of 0.199 (p=0.206>0.05) and estimated coefficient of regression is 0.068 (0.219>0.05).

In general, it is found that variables of financial intermediaries such as domestic credit provided to private sector, domestic credit provided by banking sector and broad money significantly influence the economic growth of Sri Lanka during the period of 1977-2018 based on the probability (f-statistics) 0. 027 of linear regression model along with the control variable of inflation and investment.

However, GDP of Sri Lanka is predicted only with 18.7% (adjusted r^2 value) by variables of financial intermediaries such as domestic credit provided to private sector, domestic credit provided by banking sector and broad money with the control of inflation and investment.

It can also be concluded that accuracy of the model is moderate because R^2 is not much near to 1. It indicated that there is a moderate degree of goodness of fit of this regression model. The standard error of the estimate is 1.68.

8. CONCLUSION

The objective of this study was to explore financial intermediation on economic growth in Sri Lanka during the period of 1977-2018. Overall result of the study confirms that there exists a significant relationship between financial intermediation and economic growth in Sri Lanka during the period under studied. Broad money is an important factor in influencing the economic growth of Sri Lanka while investment is being as a significant control variable. The finding of the study could assist the policy makers to efficiently manage the process of financial intermediation towards the economic growth of Sri Lanka. The finding of this study also contributed to the existing literature on relationship between variables of financial intermediation and economic growth with the latest evidence from a developing country's perspective. However, the limitations of this study should not be ignored.

The present study is limited to only three selected variables of financial intermediation and only multiple linear regression model has been employed to predict the impact of financial intermediation on economic growth. Inclusion of more variables and employing log-log, or liner-log or log-linear models or any other advanced techniques of analysis may improve the results in the expansion of future studies.

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EVALUATION OF INTELLIGIBILITY AND NATURALNESS OF SYNTHESIZED SPEECH BASED ON ARMA MODEL

Lakmini N.K. Herath[1],

[1] *Department of Computer Sciences, Faculty of Natural Sciences, Open University of Sri Lanka*

ABSTRACT
This study is designed to measure the intelligibility and naturalness of artificially generated speech using Rhyme test. The artificial speech was reformed by sinusoidal noise model. The speech parameters of sinusoidal noise model were estimated using the Autoregressive Moving Average (ARMA) model. The results indicate that all subjects identified most of the generated words in all six categories of the Rhyme Test. Moreover the Correlation results show higher correlation of reconstructed speech signals with recorded speech signal for all words.

Keywords: *Autoregressive Moving Average (ARMA) model, Correlation Coefficient, Intelligibility, Naturalness, Rhyme Test, Synthesized Speech*

1. Introduction

'Speech' is the ultimate tool of communication between two parties. Synthesizing speech artificially is new way of communicating between machines and humans in various ways. Last few decades researchers have made new developments on speech production using various techniques, hardware and software. Those systems completely imitate human voice mechanically or electronically. Some of these systems produce output that sound relatively close to human speech while some systems produce monotonous, incoherent and mechanical sounding speech. The evaluation of quality of synthetic speech and its appropriateness for the needs of the user remains a challenging task.

So, the current ambition in speech synthesis research is to improve the intelligibility and naturalness of the synthesized speech. Naturalness is described as how much the synthetic voice is similar to the human voice. Speech intelligibility is the measure of the effectiveness of speech. It is important to note that intelligibility is more important than the naturalness, since a naturally sounding message that nobody can understand is useless. The measurement is usually expressed as a percentage of a message that is understood correctly. Speech intelligibility does not imply speech quality. A synthesized voice message may be completely understood by the listener, but may be judged to be harsh, unnatural and of low quality. A message that lacks quality may still be intelligible. Improving both intelligibility and naturalness in one system is a challenge to speech synthesis community.

There are many motivations and reasons why people generate synthetic speech and listen to synthetic voices. One useful area is Text-To-Speech (TTS) systems for blind people. Because, those people can read and communicate with outside world with the help of speech synthesis systems. Also, they use it as a reading device. The first commercial TTS application, the Kurzweil Reading Machine for the blind was introduced by Raymond Kurzweil in late 1970's [1]. The intangibility of the TTS system is more important for blind people because they understand the context by listing to the speech and it should be clear and understandable. Most of the TTS systems were developed for blind people, produce unnatural speech signals, which affect the emotion component of speech communication. Individuals who are unable to produce speech with their own bodies can use TTS as a speech prosthesis. Not only them but also for hearing impaired (HI) listeners it is highly important, as they find it difficult to deal in a noisy environment. For them not only quality is important but also intelligibility is most important. Beyond this, TTS systems have been used for reading World Wide Web pages, news, weather reports, navigation devices, audio books and wide variety of other applications.

Speech synthesis is used with interactive educational applications like tutorial systems, language learning and literacy training. It can be programmed for special tasks like spelling and pronunciation teaching for different languages. Especially with people who are impaired to read (dyslexics), speech synthesis may be very helpful because some children may feel themselves very embarrassed when they have to be helped by a teacher [1]. In addition, speech synthesis systems are used to assist language teachers in certain

language learning exercises. Speech synthesizers can slow down stretches of speech to ease up the familiarization and articulatory training with novel sound sequences [2]. For any of the above applications the intelligibility and the naturalness of the system are very important. This is due to the fact that, when the output quality of the system is poor, the listeners cannot identify the words, punctuations and grammatical phases clearly.

Hence the main goal of speech synthesis research at present is to improve the intangibility and naturalness of the synthetic speech. In addition to this, most synthesizers currently manipulate a small number of parameters in a highly constrained manner to produce speech and thus it lacks flexibility.

Speech can be generated using various methods. Formant Synthesis was the first synthesis technique to be developed and was the dominant technique until the early 1980's, one such example is the DEC Talk System. It is often called synthesis by rule. The basic assumption of Formant Synthesis is to model vocal tract transfer function by simulating formant frequencies and formant amplitudes [3]. These systems make speech intelligible but very unnatural. Instead of using some production rules, next generation systems generated speech from the concatenation of natural speech components. In the concatenation synthesis [1] [2] procedure, the optimum set of raw waveform segments (units) corresponding to each phoneme is stored in a database. The synthetic speech is generated by concatenating the selected waveform segments either by phonemes, diaphones or syllables. The naturalness of the concatenation synthesis systems depends greatly on the database recording. Auditory discontinuity is the main issue that was faced in concatenation synthesis. In addition to that, designed voices for particular applications may often sound inappropriate for another application. For an example, if voice built from news reader's speech is used in automated mobile service provider's system, it may make the user think they have been interviewed on CNN rather than getting assistance for recharging their mobile account's credit. Selecting different voices for different applications are time and space consuming with this method. Although it produces more natural speech than the mathematical coding based models, the high capacity needed for storing speech and high bit rates involved in transmission of the speech was a main concern [3].

In contrast, another paradigm for creating speech was derived based on units from statistical models. It was introduced at the end of the 1990s, the models were used to generate a low dimensional parametric representation of speech. Instead of storing a large database of units this system represented units of speech by model parameters of lower dimensionality. The most widely used statistical model for statistical parametric TTS is the Hidden Markov Model (HMM)[4]. Synthetic speech produced based on HMM, can be grouped into two parts: a training part and a synthesis part. There are two main advantages of using HMMs to generate speech synthesizers. One is that the synthesized speech can be smoothed and made to sound natural. The other is that, since the synthetic speech is created from HMM models with parameters, the characteristics of the voice can be modified easily with adequate parameter transformations. Nowadays, the latest version of the HTS (HMM-based Speech Synthesis System) used in the Blizzard Challenge is the HTS-2008. HTS-2008 use the adaptive speaker-independent approach, rather than the speaker-dependent method, to generate HMM-based synthesizers. But still the performance of the HMM base systems were not natural and intelligible as natural speech.

The main problem of statistical model when modeling speech in more intelligent and more natural waveform is extracting parameters from a speech waveform and reconstructing an approximation that is closer to the original speech. In most of the cases the parameters must often be extracted from a speech signal that has is belong to include a certain phoneme or phoneme transitions]. Then using the extracted parameters reconstructs the word by concatenating the phonemes and phoneme transition. This lead to reduce the intelligibility and the naturalness of the synthetic speech. The proposed parametric method extracts the speech parameters considering the whole word and tries to reconstruct it using minimum speech parameters with high intelligibility and the naturalness. The intelligibility of the generated speech is measured using the Diagnostic Rhyme tests.

2. Methodology

The study was carried out to evaluate the ARMA based speech synthesis model. The experimental process is illustrated in the figure 1, which consists of analyzing speech signals using ARMA method, determine the speech parameters, synthesizing the artificial speech and testing the synthesized speech. The process is explained in the section 2.2

2.1 Subjects

The Diagnostic Rhyme Test was carried out in order to evaluate the ARMA based speech synthesis model. The test was carried out to check the intelligibility of the synthesized voice. A total of 10 non-native English speakers participated in the experiment, with 2 male and 8 females. All

participants were graduates between 25 to 30 years of age. They have not participated in any subjective test whatever for at least the previous six months and not in any listening-opinion test for at least one year. They have never heard the same word lists before.

The words were played from the PC to the test participant via headphones in laboratory conditions. The Diagnostic Rhyme Test subjective tests participants choose the correct word between two presented words, the word pair defined by DRT test.

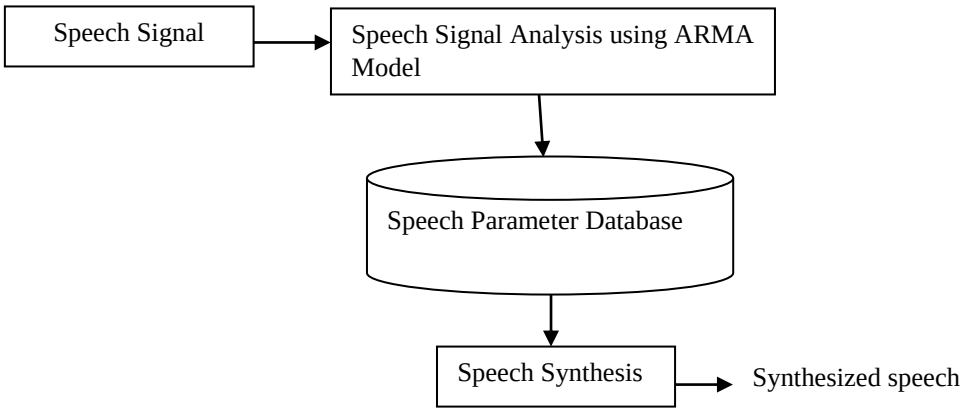

Figure 1: The Experimental Process

2.2 Speech Material

The Diagnostic Rhyme Test, or DRT, is a test which consists of 96 monosyllabic (single-syllable) word pairs which are distinct from each other only by one acoustic feature in the initial consonant. These fall into one of the six categories of Voicing, Nasality, Sustenation (whether the consonant is sustained or interrupted), Sibilation (turbulence in high frequencies), Graveness (concentration of formant energy in low frequencies) and Compactness (concentration of formant energy in a narrow frequency range). Some illustrative word pairs from the DRT are shown in Table 1; note the similarities and differences between the initial consonants of each word pair.

Speech synthesizer was constructed by collecting the voice from a single male speaker with British accent. The recording was at laboratory conditions. The voice was recorded through the MKH800 microphone, with the volume set at 60 dB. The recording wav files were all in single channel, with frequency at 16 kHz.

2.3 Speech Signal Analysis

Autoregressive Moving Average filter models the human vocal tract in terms of both poles and zeros. In ARMA modeling, an unknown system is described with a pole-zero filter as following form

$$y(n) = = \sum_{k=0}^{q} b_k\, x(n-k) + \sum_{k=1}^{p} a_k\, y(n-k) \quad (1)$$

x(n) and y(n) are the input output signal of the unknown system { a_k,k=1, ..,p}and { b_k, k=0, ..,q} are the filter coefficients corresponding to poles and zeros. Performing z transforms on both sides of equation (1), the equation becomes

$$Y(z) = \frac{B(z)}{A(z)} . X(z) \quad (2)$$

Where, $A(z) = 1 - \sum_{k=1}^{p} a_k\ z^{-k}$

$$B(z) = \sum_{k=0}^{q} b_k\ z^{-k}$$

Y(z) and X(z) are the z transform of y(z) and x(z) respectively. The system transfer function is given

by B(z) / A(z), where B(z) and A(z) are called the Moving Average part and Auto Regressive part of the model;

$$H(z) = \frac{Y(z)}{x(z)} = \frac{B(z)}{A(z)} = \frac{\sum_{k=0}^{q} b_k\ z^{-k}}{1 - \sum_{k=1}^{p} a_k\ z^{-k}} \quad (3)$$

Equation (3) can be express as follows,

$$H(z) = \frac{y(z)}{x(z)} = \frac{b_0 + b_1 z^1 + \cdots + b_q z^{-q}}{1 - a_1 z^1 - \cdots - a_p z^p} \quad (4)$$

Zeros of a transfer function H(*z*) are the values of the variable *z* for which the transfer function (or equivalently its numerator) is zero. Therefore, the zeros are the roots of numerator polynomial in Eq. (3). The poles of H(*z*) are the values of the variable *z* for which H(*z*) is infinite. This happens when the denominator of H(*z*) is zero. Therefore, the poles of H(*z*) are the roots of the denominator polynomial of equation (3).

Speech parameters frequency, phase, amplitude and attenuation coefficient derived according to the equation (4) given in ARMA model, the partial fraction representation H(z) express as,

$$H(z) = \frac{B(z)}{A(z)} = \frac{r_m}{s-p_m} + \frac{r_{m-1}}{s-p_{m-1}} + \cdots + \frac{r_0}{s-p_0} + k(z) \quad (5)$$

Where, the values $r_m \ldots r_0$represents the residues, the values $p_m \ldots p_0$ are poles and *k(z)* is a polynomial in z, which is usually 0 or constant. The real and imaginary parts of the complex transform of residues r_m are used to estimate the amplitude A_n and the phase ϕ_n

$$A_n = |r_m| \quad (6)$$

$$\phi_n = \tan^{-1}\left(\frac{r_{im_n}}{r_{Re_n}}\right) \quad (7)$$

Pole locations p_m used to calculate the frequency and attenuation coefficient r_n

$$f_n = \tan^{-1}\left(\frac{p_{im_n}}{pl_{Re_n}}\right) \times ((Fs/2)/\pi) \quad (8)$$

$$r_n = |p_m| \quad (9)$$

Where, *fs* sampling frequency, *n* designate the frequency increment (*n*= 0, 1,…,N) and *Re* an *Im* are the real and the imaginary parts of the $r_m \ldots r_0$and $p_m \ldots p_0$ transform.

To capture the most important features from the speech signals it needs to extract the most dominate poles gain from ARMA model. First the residuals were converted to frequency, phase, amplitude and exponential decay values. Then the nonnegative frequency values and exponential decay (attenuation coefficient) greater than 0.95and the corresponding phase, amplitude values were found. In order to find the most dominant values, speech information was sorted considering amplitude and frequency values.

2.5 Speech Signal Synthesis

Speech signals were re-synthesized using a parametric speech synthesis model called Sinusoidal noise model [5]. It models the speech or music signals as sum of sinusoids each with time-varying amplitude, frequency and phase. Since the sinusoidal noise model has the ability to remove irrelevant data and encode signals with lower bit rate, it has also been successfully used in audio and speech coding. Most of the available models based on the sinusoidal model are capable of synthesizing vowels and the phonemes in high quality.

Sounds that are produced by auditory systems are modeled as sum of the deterministic and the stochastic parts, or as a set of sinusoids plus the noise residual [6]. In the standard sinusoidal noise model, the deterministic part is represented as a sum of sinusoidal trajectories with time varying parameters. The trajectory is a sinusoidal component with time-varying frequencies, amplitudes and phases. It appears in a time-frequency spectrogram as a trajectory. The stochastic part is represented by the residual.

$$x(t) = \sum_{i=0}^{N} A_i(t) \cos\left(\theta_i(t)\right) + r(t) \quad (10)$$

where, $A_i(t)$and $\theta_i(t)$ areamplitude and phase of sinusoidal *i* at time *t*, and *r*(*t*) is a noise residual, which is represented with a stochastic model. Further it can be represented as,

$$x(t) = \sum_{i=0}^{N} A_i(t) \cos\left(\omega_i t + \phi_i\right) + r(t) \quad (11)$$

where, $A_i$denotes the amplitude,ω_i is the frequency in radians /s (radian frequency), ϕ_i is the phasein radians of sinusoidal *i* at time *t*. The radian frequency ω_i is denoted as $2\pi f_i$ and the equation can be written as,

$$x(t) = \sum_{i=0}^{N} A_i(t) \cos\left(2\pi f_i t + \phi_i\right) + r(t) \quad (12)$$

Where, f_i is the oscillation frequency in i^{th} sinusoidal component?

$$x(t) = \sum_{i=0}^{N} A_i(t)\, e^{-\alpha t} \cos\left(2\pi f_i t + \phi_i\right) + r(t) \quad (13)$$

Equation (4) represents a decaying sinusoidal wave. Where, α is the exponential Decay and $e^{-\alpha t}$ is the decay rate.

Thereafter Pearson's Correlation Coefficient values between source signal and the synthesized signal were calculated. Also, the capacity ratio between the source signal and the parameter of the proposed method was evaluated. The rhyme test was done to test the intangibility of the synthesized words.

3. Results and Discussion

The research mainly focusing on testing the intelligibility of the proposed method using Diagnostic Rhyme Test. The subjects were Identified the synthesized word among the two words that are given to them in all six categories. Each category consists of 16-word pairs. The percentage of no of words identified by each subject is as follows in table 1.

Subject	Voicing	Nasility	Sustenation	Sibilation	Graveness	Compactness
S1	87.5	100	81.25	87.5	87.5	100
S2	100	100	81.25	100	81.25	87.5
S3	93.75	100	87.5	81.25	68.75	93.75
S3	87.5	100	93.75	87.5	87.5	100
S4	93.75	93.75	87.5	87.5	81.25	93.75
S5	87.5	93.75	75	87.5	87.5	87.5
S6	87.5	100	81.25	93.75	100	93.75
S7	81.25	100	81.25	87.5	100	93.75
S8	93.75	100	81.25	100	100	93.75
S9	87.5	93.75	75	93.75	93.75	87.5
S10	87.5	100	81.25	87.5	87.5	100

Table 1: The percentage of no of words identified by each subject

According to the above table all of the subjects identified 75% the words accurately. For some categories like Nasility more than 90% of the words identified by all the subjects. The following figure shows the average percentage of identification of words in each category.

The average percentage of identification of words (figure 2) in each category is more than 80% for all categories. The Nasality category hast the highest percentage value (98%) among all other categories. The Sustenation category has 82% of word identification percentage and it is lower than all other categories. The difference between the word pair is a one phoneme and most of the time they are pronounced to be small difference. According to the above result any of the words that are belong to any category can be identified clearly.

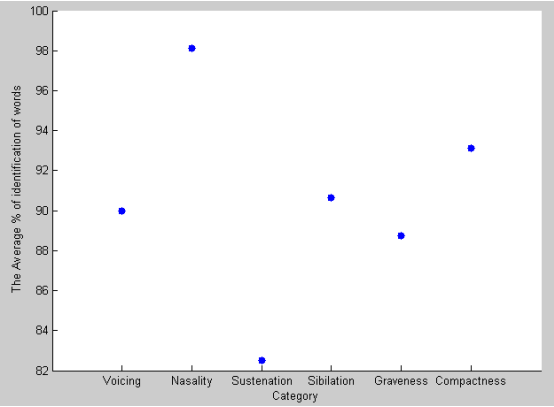

Figure 2: The Average percentage of identified words in each category

According to the Figure 3, the Pearson's Correlation values for all the categories are greater than 0.85. Compactness category is depicted by a shorter box plot, suggesting the variation of the correlation values was small. Also median of the correlation values for compactness category were more than 0.99, which explains that concentration of formant energy in a narrow frequency range words can be synthesized closer to its original word. Voicining and Naslity category has the median value nearly 0.99 but the voicing category has a higher variation of the correlation coefficient than Naslity category. All other three categories Sustention, Sibilation and Graveness have similar box plots with 0.98 or less median correlation value. The variation of the correlation of all three categories is higher than other three categories Voicining, Naslity and Compactness. As a summary it can be stated that using this method it can be synthesized the wave signals similar to the original signal.

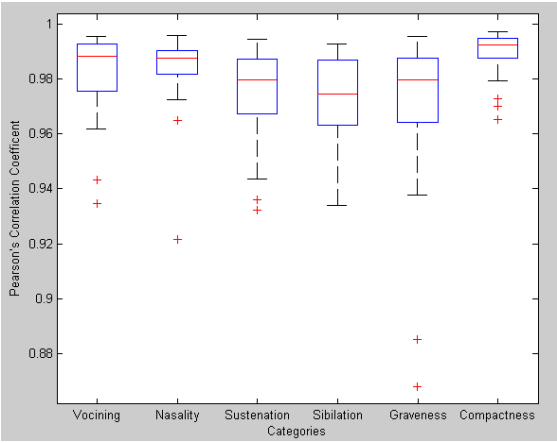

Figure 3: Pearson's Correlation Coefficient between the synthesized speech signal and the recorded signals in each category

4. Conclusion

The study investigates the naturalness and the intangibility of synthesized speech. The Diagnostic Rhyme test results clearly shown that the identification of the synthesized by the subjects are greater than 80%. It implies that the intangibility of the synthesized speech in higher level for any of the categories. Higher correlation coefficient was

obtained between the synthesized wave signal and the recorded signal. That indicates the speech signals that were reconstructed are more similar to the recorded speech signals. This point out that the ARMA model, Steiglitz-McBride algorithm extracts the most dominant speech components from the recorded speech signals and the proposed method determine the speech parameters and reconstruct the speech signals using sinusoidal noise model. It is concluded that the ARMA method extracts most dominant values of speech parameters and Sinusoidal Noise Model synthesizes the speech waves with more intelligibility and more naturalness.

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COMPOSTING AS AN ENVIRONMENTALLY-FRIENDLY METHOD TO RECYCLE HOME-MADE BIODEGRADABLES INFLUENCE ON PLANT GROWTH PARAMETERS

Vijitharan. S[1] and Kayanan. S[2]

1,2Faculty of Applied Science, Vavuniya Campus of the University of Jaffna, Sri Lanka

ABSTRACT— Composting is a conventional method to produce nutrient enriched product from household organics as an efficient way to overcome waste management issues in Sri Lanka. The study focused on preparing the compost using barrel-composting method, and to assess the nutrition value of the prepared compost and measure its efficiency on water spinach growth and yield. The different proportions of garden and kitchen organics were used to produce the compost with ratios 1:1, 1:2, 1:3, 1:4, 1:0 and 0:1 respectively. The water spinach pot experiment was designed in a completely randomized block with seven treatments including control and three replicates. Measurements on water spinach data were recorded once a fortnight after germination. The statistical software Minitab 17 was used to analyze the obtained data. The chemical properties of compost such as pH (7.6 to 8.8), EC (2.4 to 4.5), phosphorous (1.7 to 4.7 %), nitrogen (1.3 to 2.3 %), potassium (2.8 to 7.9 %) were ranged within the reference limits of Sri Lanka standard 1246: 2003. The produced compost carbon nitrogen ratio of 1:3 type was around 20 which falls within the preferred standard 10 to 25. This field oriented study revealed that domestic waste could be used to produce the compost having favorable nutritional values which were essentials to crops and considerably increased the economic yield.

Keywords: *Barrel composting, Compost, Chemical properties, Growth and yield*

1. Introduction

Home composting is traditionally being a low cost approach to home gardener's to fulfill their crop requirements and minimize the domestic organic residues by converting a nutrient rich amendment for both soil and plants. In developing countries, the massive production of solid waste is an environmentally sensitive problem and creates numerous potential impacts on ecological and environmental aspects. Compost manufacturing is a convenient way to reduce and recycle the household wastes which is a sustainable platform to satisfy the requirements of fertilizers and pesticides application. In Sri Lanka, management of solid waste strategies are developed by various methods such as sanitary landfills and composting, etc. Nutrients and minerals in the compost can improve the soil physical, chemical and biological properties such as increase the water holding capacity, improve soil fertility, microbial degradation, suppress plant diseases, boost soil tilt, recycling the nutrients, increase the organic matter content and further more improve the growth and yields of crops (Peter Moon, 1997).

In composting, Microbial degradation of compost generally involves aerobic respiration and thermophilic stage under controlled conditions (Finstein and Morris, 1975; Mac' Safley *et al*., 1992; Pace *et al*., 1995; Misra *et al*., 2003). Home composting provided an opportunity for managing domestic biodegradable waste and reduce the amount of waste collected at household level (CEC, 1999). This environmentally friendly approach gives a path to organic gardener's to recycle their kitchen and garden residues without influencing some environmental problems (Baldwin and Greenfield, 2000) and also reduce the expenses on purchasing synthetic harmful fertilizers (Baldwin and Greenfield, 2000). The microbiologically degraded residues, resulting the nutrient enriched final product consisting stabilized primary macro nutrients (N, P and K) and other micro nutrients in the small fraction, moreover, the stability depends on the compost maturity (Zwart, 2003). The methods of home composting relied on availability of land, characteristics and quantity of generated organic waste, financial conditions, obtainable workforce and the desired quality of the ultimate produce (Evans, 2001). This research was carried out to recycle the household biodegradable waste using kitchen and garden waste with different proportions by barrel composting method and analyze the nutrient contents in prepared compost and measure the efficiency by applying to crops in terms of growth and yield.

2. Materials and Method

2.1 Study Area and Primary Data Collection

Around 250 households were randomly selected from three Grama Niladhari divisions in Valikamam east to obtain the existing domestic

waste management and their willingness to recycle the household biodegradable waste with the support of family members. The required data were collected through the questionnaire survey and direct field observation.

2.2 Compost Preparation and Management

The six plastic barrels (50L) were taken for compost preparation. The modifications carried out to ensure the aerobic digestion inside of the barrels (Moqsud, 2015). Then the kitchen and garden residues collected from the study area and different propositions of compost prepared by barrel composting method (Sharaniya and Sivarajah, 2017). Kitchen wastes and garden residues mixed into each barrel in different ratios such as 1:1(C1), 1:2(C2), 1:3(C3), 1:4(C4), 1:0(C5) and 0:1(C6) respectively. Initially compost bed was established by adding inoculated compost (first layer) and cow dung (second layer). After one week the collected waste items were added to it according to the weight basis method. Watering and turning were carried out on weekly basis and watering was done to maintain the moisture level while turning was carried out to aerate the compost and increase the decomposition. A soil thermometer was used to monitor the temperature throughout the composting period to determine when the compost materials were ready for curing. The compost was harvested after three months of establishment.

Components	(% in total weight)					
	C_1	C_2	C_3	C_4	C_5	C_6
Kitchen waste	40	26.6	20	16	80	0
Garden waste (leaf litter)	40	53.4	60	64	0	80
Cow dung	10	10	10	10	10	10
Paddy straw	5	5	5	5	5	5
Compost (inoculums)	5	5	5	5	5	5

Table 1. Composition of six composting barrel units

2.3 Sample Analysis

Characteristics of compost were analyzed by chemical examinations such as pH, EC, Carbon Nitrogen (C/N) ratio, primary macro nutrients such as available nitrogen, available potassium and available phosphorous (Olsen and Sommers, 1982 and Dharmakeerthi *et al.*, 2007). The moisture content and organic matter content were measured by Walky and Black method. Temperature was measured by soil thermometer.

2.4 Cropping Method and Management

Water spinach (*Ipomoea aquatic)* seeds were sown in seed tray and seedlings were germinated after 5 - 7 days from sowing date. This leafy vegetable cultivation was carried out in polybag method. After germination, seedlings of water spinach were transplanted into polybags in a Complete Randomized Design with seven treatments including control and three replicates for each treatment (Tr) whereas Tr1-control, Tr2, Tr3, Tr4, Tr5, Tr6 and Tr7. The harvested different ratios of compost were applied to all replicates once in two weeks and applied amount was 270g per pod which was calculated according to the weight ratio method. In addition to that, during the growth period, mean height, mean number of leaves and weight of leaves were recorded in the intervals of two weeks, four weeks and eight weeks.

2.5 Analysis

The collected data were analyzed by statistical software packages Minitab or SASS and findings were presented in tables and graphs. Mean separation was carried out by Turkey pair-wise comparison and Duncan's multiple range test (DMRT).

3. Result and Discussion

3.1 Decomposition of Waste

Initially, the color of raw materials turned to brown color in the second week and then a sharp volume reduction was observed after four weeks from establishment. The rate of decomposition shoot up to two months and then dropped down, thereafter, finely powered compost harvested in three months. The collected compost obtained after the decomposition of wastes was evaluated for nutrient parameters.

3.2 pH and Electrical Conductivity (EC)

Table 3.1 revealed that pH values of compost varied from 7.6 to 8.7 and however, C2, C4 and C5 type compost showed slightly alkaline nature. These values were agreed by Oroka and Frank (2012). According to the Sri Lanka Standard 1246: 2003 noticed that pH value of compost should be fall within the range of 6.6 – 8.5. Therefore, C1, C3 and C6 had the pH range within 6.6 – 8.5 and except C2, C4 and C5. Despite these finding, the highest pH was recorded in C5 because it was fully filled with only the kitchen waste with high content of avocado, cucumber and spoiled leafy vegetables. It may be the reason for the high pH value resulted in this experiment (Stevens, 2010).

Electrical conductivity (EC)

Electrical conductivity indicates that the amount of salts presence in different types of compost. All electrical conductivity values varied from 2.4 – 4.5 dS/m. The highest electrical conductivity was recorded in C5 because it has the high exchangeable Potassium content (4.5 dS/m). The lowest value was reported in C1 (2.4 dS/m) type of compost. For soil, the recommended conductivity range was 0.4-0.8 dS/m. Compost with an EC

range of 0-2 dS/m can be applied at any rate to salt sensitive plants without having any impact. In most circumstances, an EC in the range of 2-4 will not cause any problems and if the compost has the value beyond 4 ds/m, then the application rate should be considered (Association, 2011).

3.3 Temperature

As is shown in Figure 1, the temperature in each compost type varied in a similar way during the experiment, and each had three degradation phases namely, mesophilic phase, thermophilic phase, and curing phase (Hammed *et al.*, 2019). The temperature of the system determines the rate at which many of the biological processes take place and plays a selective role on evolution and succession on the microbiological communities (Hassen, 2001). The temperature was reached to 50°C and then entered into thermophilic phase, within a day indicating quick establishment of microbial activities. Higher rise in temperature at the beginning of composting was attributed to higher content of easily biodegradable carbon (Kalamdhad and Kazmi, 2009). Afterwards, cooling period was observed until the end of the composting process.

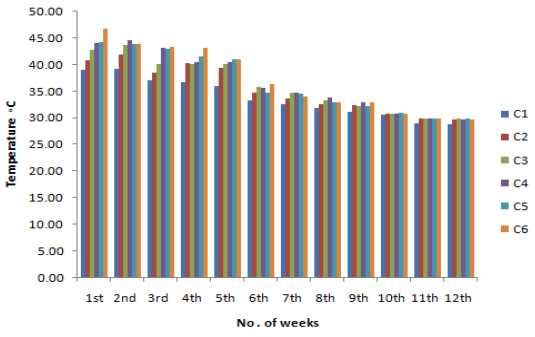


Figure 1. Temperature variation of different types of water hyacinth compost

3.3 Moisture Content

The research finding revealed that the moisture content/ dry mass of compost ratio values varied from 7.88%-43.37%. The Sri Lanka standard 1246: 2003 standard noticed the maximum value should be 25. Hence, C2, C3 and C5 types satisfied the aforesaid requirement. The available water content represented by the moisture content and the highest value showed by C_5 (43.37%) due to the presence of more perishable kitchen waste materials and those have contained high moisture. Bertoldi, *et al.* (1983) stated that good compost the moisture content/dry mass of compost% value should be near or below 30% within and also the reseacher stated that optimal moisture content in composting varies and depended on the physical state and the size of the particles present.

3.5 Organic Carbon %

The proportion of organic carbon differed from 39%- 47 % with referred to the Sri Lanka standard 1246: 2003, the minimum organic carbon should be 20%. All observed organic carbon % values were exceeded the recommended optimum value.

3.6 Available Nitrogen

Nitrogen, Phosphorous and Potassium were primary macro nutrients which were important to determine the crops growth, health and yield. Figure 2 showed that, available nitrogen of all types of compost ranged from around 1.3 – 2.3 %. The Sri Lanka Standard 1246:2003 recommended that nitrogen content should be present with the minimum level of 1.0 %. Research findings revealed that C5 has the lowest nitrogen content (1.3 %) and highest nitrogen content was recorded in C3 (2.3 %). Nitrogen content of all six types of compost were exceeded the minimum level which was noticed by Sri Lanka Standard. The level of available nitrogen was increased with the combination of kitchen and garden waste while the lowest level was recorded in C5 and C6 which contained either garden or kitchen waste.

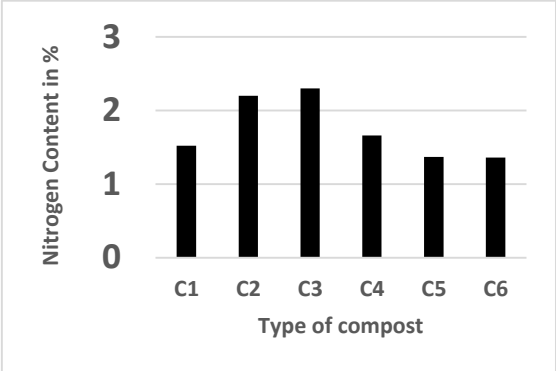


Figure 2. Nitrogen content in different types of compost

3.7 Available Potassium

The present study found that potassium content of different propositions of compost were ranged from 1.7 – 4.7% (Figure 3). The minimum level of potassium was 1.0% which was noticed in the Sri Lanka Standard 1246:2003. The measured values of potassium content was exceeded the minimum standard level. C6 has the highest potassium content which was contained fully garden residues.

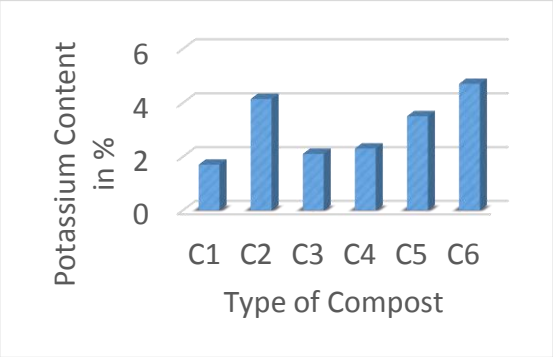


Figure 3. Potassium content in different types of compost

3.8 Available Phosphorous

The given figure 4 showed that the measured values of phosphorous content were varied from 0.63 – 0.73%. The phosphorous content should be present with the minimum level of 0.5% with reference to the Sri Lanka Standard 1246:2003 and the obtained values were exceeded the minimum level of standard. Saikrithika, et al. (2015) stated that available phosphorus was very high in kitchen waste compared to other substrates.

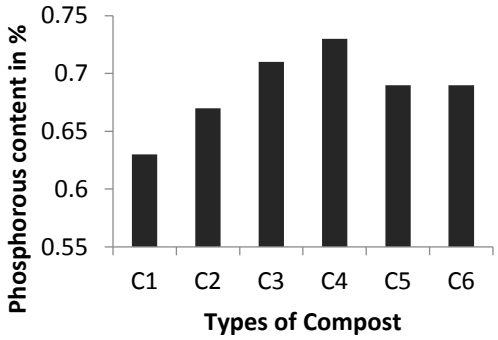


Figure 4. Phosphorous content in different types of compost

3.9 Carbon/ Nitrogen Ratio (C/N Ratio)

As the figure 5 outlined that the C/N ratio of prepared propositions of compost ranged within 20–30 which were within the reference level of 10 – 25. C1 has highest C/N ratio than other propositions whilst lowest C/N ratio was observed in C2. The researcher Anon. (2004) said that if the C: N ratio is too high (excess carbon), decomposition slows down while If the C: N ratio is too low (excess nitrogen) this could be ended up with a stinky pile.
Brinton (2000) noticed that C:N ratio of harvested compost less than 20:1 would prevent the nutrient immobilization in the soil while C:N ratio greater than 30:1 could cause lack of nutrients to plant uptake.

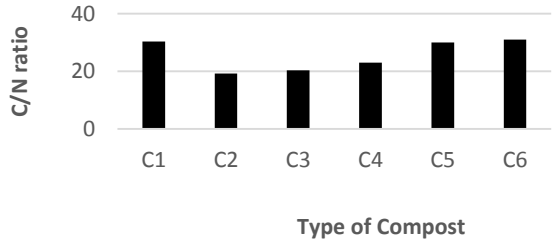


Figure 5. C/N ratio in different types of water hyacinth

3.10 Growth and Yield measurements

As in plant growth parameters, plant height, number of leaves and weight of leaves were measured. Harvesting was scheduled on two weeks, four weeks, six and eight weeks from planting. The table 2 showed that the highest mean height was recorded from Trt 4 (1:3) and Trt 6 (1:0) showed the lowest mean height among the seven treatments. In addition to that, the highest total number of leaves were recorded from Trt 3 (1:3) as 33 while the lowest total number of leaves was recorded from Trt 1 (control) as 26 due to nutritional deficiency in soil (Figure 6). The greatest yield was obtained from Trt 4 (1:3) as around 4.00 g and it was highly deviated from other treatments yield weights while showing significant difference (Figure 7). The lowest yield weight was belonged to Trt 1 (control) as 2.7 g and the yield reduction may be due to the lack of sufficient nutrient uptake from soil.

Treatment	Two weeks	Four weeks	Six weeks (after 1st Harvesting)	Eight weeks (2nd Harvesting)
Trt1 (Control)	20.667 (a)	34.667 (a)	16.667 (a)	20.333 (c)
Trt2 (C_1:1:1)	17.333 (a,b)	32.667 (a)	18.667 (a)	28.333 (a,b)
Trt3 (C_2 :1:2)	17.00 (a,b)	34 (a)	18 (a)	30.667 (a)
Trt4 (C_3:1:3)	21.00 (a)	35.333 (a)	18.667(a)	31.333 (a)
Trt5 (C_4:1:4)	16.00 (a,b)	34 (a)	19 (a)	29 (a,b)
Trt6 (C_5 :1:0)	10.33 (c)	21.333 (a)	16.8 (a)	28.667 (a,b)
Trt7 (C_6 :0:1)	15.667 (a,b)	28 (a)	17 (a)	28 (a,b)

Means with the same letter are not significantly different.

Table 2. Variations in mean height of the Kankung leafy vegetable with time

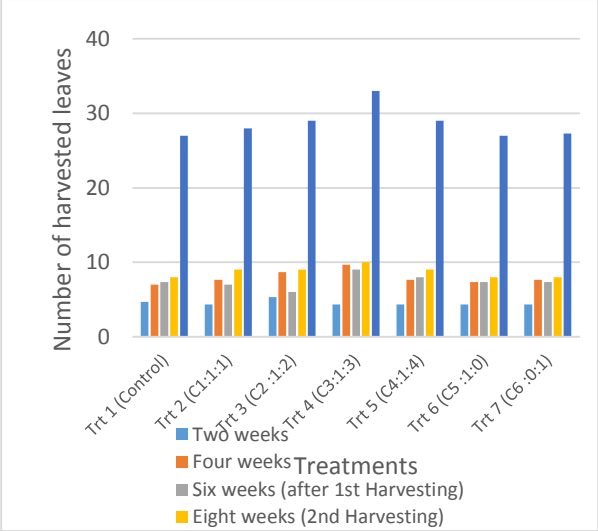
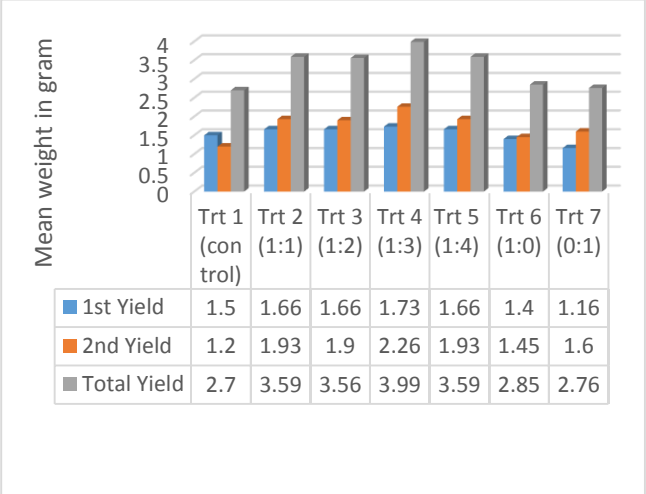


Figure 6. Mean height of the Kankung leafy vegetable with time



	Trt 1 (control)	Trt 2 (1:1)	Trt 3 (1:2)	Trt 4 (1:3)	Trt 5 (1:4)	Trt 6 (1:0)	Trt 7 (0:1)
1st Yield	1.5	1.66	1.66	1.73	1.66	1.4	1.16
2nd Yield	1.2	1.93	1.9	2.26	1.93	1.45	1.6
Total Yield	2.7	3.59	3.56	3.99	3.59	2.85	2.76

Figure 7. Variations in the weight of the Kankung leafy vegetable with time

4. Conclusion

The result of the study carried out to identify the suitable combination ratio of kitchen and garden waste to make the compost at household level and to measure the efficiency of compost through analyzing the crop growth and yield. The compost type C3 (1:3) has the optimum C/N ratio and adequate percent of macro nutrients and showed the significant yield in the crop. This method could be suggested to householders to recycle their degradable waste in a cost effective and environmentally friendly manner.

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VIOLENT NOTES: IMAGES AND LYRICS IN M.I.A'S SONGS

Sureshika D. Piyasena

Independent Researcher, Sri Lanka, 20/18 Fairfield Gardens, Colombo 08

ABSTRACT
The Sri Lankan born British singer Mathangi Arulpragasam (M.I.A)'s music videos/ albums are very provocative and controversial. Also known as Maya, her songs have stood out for its promotion and/or use of violence in its lyrics and images. It is also very interesting that M.I.A's father Arul Pragasam, politically known as Arular, was one of the founding members of EROS (Eelam Revolutionary Organization of Students), a political group affiliated with the LTTE. This paper looks into the kind of violent imagery and lyrics that have been used by her in her albums and songs. Do they promote violence or is she appropriating a kind of language, which is considered 'unfit' for a woman and using it as a tool of rebellion? Where does the promotion of violence fit in to in music and can feminists justify the use of violence? Is she using music as a medium to disseminate her ideologies? These are some of the questions that this paper will attempt to answer.

Keywords: *Gender, Images, Lyrics, Militarism, Violence*

1. Introduction

MIA began her career as a visual artist, filmmaker and designer in 2000 and began her recording career in 2002. Her singles "Sunshowers" and "Galang" brought her fame in early 2004, and she released her debut album "Arular" in 2005, and her second album "Kala" in 2007, both to critical acclaim. *Kala* was certified silver in the UK and gold in Canada and the USA. The single "Paper Planes" reached number four in the US and sold over four million copies. M.I.A.'s third album "Maya," named after herself, was released in 2010 soon after the controversial single-short film "Born Free." The album received less favourable critical response compared to her previous records, but was M.I.A.'s best-charting effort, reaching the top 10 in countries including America, Canada, and Norway. Its single "XXXO" reached the top 40 in the UK. She has embarked on five global headlining tours and is the founder of her own multimedia label, N.E.E.T. Her fourth studio album, "Matangi" was released in 2013 and produced the single "Bad Girls." She released her fifth studio album, "AIM" in 2016 and many others afterwards (Wikipedia).

Her music lyrically incorporates a range of political, social, philosophical and cultural references. She has been nominated for an Academy Award, three Grammy Awards and the Mercury Prize. M.I.A. was named one of the defining artists of the 2000s decade by Rolling Stone in its "Best of the Decade" list in December 2009. "Time" named her one of the world's 100 most influential people in 2009, and "Esquire" ranked M.I.A. on its list of the 75 most influential people of the 21st century in January 2010. She was appointed Member of the Order of the British Empire (MBE) in the 2019 Birthday Honors for her services to music.

2. Songs of Rebellion

Her songs have stood out for its promotion and/or use of violence. M.I.A's controversial music denied her entry into the U.S.A in 2006 June when she wanted to perform for a U.S audience. For M.I.A the reasons for supporting the oppressed are very clear. In an interview she says "You can't grab someone by the neck and choke them and then complain they're kicking you. If you're going around oppressing people, they will fight back" (Repliderium). In the song "Bucky Done Gun" the lyrics read as: "I'll fight you just to get peace," and "I'm armed and I'm equal." This reflects a validation of armed struggles and gives a voice to the marginalised other. The video also shows people protesting in a violent manner.

Unlike "Bucky Done Gun," "Sunshowers" is directly related to militancy. She connects her anger at being a refugee with that of the LTTE movement. The opening line "I bongo with my lingo" refers to the migrant or the refugee experience. The video shows a jungle and women militants in camouflage uniform. The women are south Asian women who have tied their hair in two plaits and the video is interspersed with the images of a tiger and a lion. The lyrics mention "P.L.O" and "Colombo" which make it very political and country specific. The picture used for the album has a picture of her amongst the female militants of the LTTE. Another comprises of a few soldiers of which the backdrop is a few palm trees which were mostly found in LTTE controlled northern parts of the country. The portrait of the tiger very

frequently occurs in her posters, which was the symbol of the LTTE.

As her songs belong to the hip-hop kind the lyrics do not flow into one another. They are a series of statements which go well with the militaristic atmosphere and visuals. The genre that she presents her songs in are also apt for this. Ethnicity and race has long been connected to musical production and dissemination since slavery. The Sorrow Songs focused on the slave's existence and their daily experiences, but also gave the slaves a sense of hope, belonging, and empowerment. Likewise the first manifestations of rap and hip hop emerged in the early 1970's when Africa Bambaataa, a member of the New York street gang, the Black Spades, organized the "Zulu Nation" (Lipsitz, 1997). "Created by poor black and Latino youth in the South Bronx in New York City, rap emerged as a reaction to the social and political conditions people of colour were subjected to during this time" (Francoso 2012). "Rap and hip-hop can germinate interest in its listernership to explore their culture and identity" (McDonnell, 1992). "Despite the potentialities of rap, many critics have charged that rap is sexist, vulgar, homophobic, and anti-Semitic, as well as promoting violence and misogyny" (Lelend, 1992; Nelson and Gonzalez, 1991; Costello and Wallace, 1990).

In the album "Arular" which is named after her father's rebel name, the song "Fire Fire" reads as:

You should a been good to me
Then I wouldn't get so rowdy rowdy
You should a kept ya eye on me
Then I wouldn't get so baddy baddy

The language itself is one that rejects authority and status quo, and the lyrics justify violent retaliation. For Maya violent retaliation is justified if you have been oppressed and not been given a fair hearing. She is part of the Tamil diaspora which contributed immensely to the war. These images and music contributed to its ideology not by taking up the gun but justifying the acts of those who have taken up the gun. Smith and Stares point out that "Diasporas intervene in conflict because they can. Diasporas without access to power of some sort, whether direct or surrogate, do not intervene in conflicts" (3). This intervention can be in many different ways. If one is financially supporting a war in one's homeland then they may not be someone who is politically powerful but who is intervening in the conflict indirectly. It is well known that most of the funding for the LTTE came from Tamil expatriates.

As to what extent Maya supports the LTTE is almost purely speculative, as most of it involves over-analytical dissections of her lyrical output. The fact that she has named an album "Piracy Funds Terrorism" (2004) adds to this confusion. The song "Pull up the People" in the album "Arular" has lyrics such as, "Every gun in a battle is a Son and daughter too" but it also says "I got the bombs to make you blow." However, Simons is of the opinion that the album "Arular" tends to be more concerned with "conjuring up striking militant imagery rather than making blatant political declarations." However images are powerful and convey a message and cannot be treated as neutral. "I am the lady killa" also celebrates the empowered woman but empowered through violence.

According to Mattern (1998), music has the potential to allow for the sharing of histories and experiences, be a record of civilization, and unite groups who have a shared reality. With the ability to share ones lived experience through music, one is able to tell and recreate oral histories of both one's own life and the life of that particular community. She is through her music and lyrics giving voice to the refugees and the oppressed of the world.

M.I.A is also appropriating the image of the 'Femme fetale' and subversively appropriating it in her videos. She uses music and visuals to construct a new vision of femininity, one that is not ashamed of her body and she challenges the view of traditional womanhood. Can you celebrate your body as sexy and still be feminist? Yes I suppose as it is about choice but how do you negate the objectification of a woman's body that is sold in these videos? It is also important to remember that the basic premise of feminism goes against the notion of violence.

Maya is of rebellious nature off stage as well. Tom Lamont's interview with her reveals that she will not accept anything without challenging it. He writes, "While she eats, Arulpragasam tells stories about her trip. The time airport police in Delhi almost shot her. The time she argued with a production manager, in Leh, and threatened to burn his house down." This rebellious nature has got her into trouble many times. In 2012, when MIA joined Madonna on stage as part of the event's halftime show and, during some very limited time on screen, showed her middle finger to 167 million viewers (Lamont).

The sports world has been going after M.I.A. for being disrespectful and mouthing "I don't give a shit" during her guest appearance in Madonna's Super Bowl XLVI halftime show. She

had made her appearance during "Give Me All Your Luvin"' – a track off the Material Girl's 2012 album MDNA , and after the show, the FCC received over 200 complaints, many of which addressed M.I.A.'s sign language on stage. The NFL and broadcaster NBC apologised shortly after the show, and the Football League began seeking a fine from M.I.A. (Grow).

M.I.A'S response to these accusations cited several other examples of musicians pushing the limits of decency in situations – unlike Janet Jackson's infamous 'Nipplegate' affair that the NFL allegedly could have predicted. For instance, it said Michael Jackson grabbed his crotch – or "genitalia adjustments," in legal terminology – during "Billie Jean" at the 1993 Super Bowl. Prince, it claimed, simulated masturbation on his guitar behind a sheet "as if stroking an erect oversized phallus in a manner reminiscent of Jimi Hendrix." And it said that Madonna's show, in which M.I.A took part, included female dancers of indeterminate age who would "lewdly thrust their elevated pelvic areas in a manner unmistakably evocative of sexual acts." It also called out the League's policies regarding the N-word and bullying (Grow).

Horner and Swiss have pointed out that it is important when analyzing popular music to examine text, images, and performance (1999). Lyrical content analysis has allowed for academics to develop analytic meanings of songs. But there are inherent problems with this method, as Frith (1988; 107) states, "content analysts are not innocent readers and there are obvious flaws in the method... they treat lyrics too simply: the words of all songs are given equal value; their meaning is taken to be transparent." Shepherd (1999; 172) adds that content analysts also assume "that music fans actually listen, or listen in full, to the lyrics of popular songs." Shepherd (1999) continues that we need to think of popular music more than just text. One has to consider the cultural process, the context of the musical creation in social, economic, and political terms, as well as listening to the delivery of the lyrics. For example, are the lyrics being sung, whispered, screamed, growled, or simply recited, for Shepherd, these elements should play a part in the analysis of the song as a whole. (8-9)

When taking image into consideration, one must analyze how artists choose to represent themselves, as well as how the mass media represents musical artists. Artists can create a style that is their own. For example, Madonna has portrayed a number of images. From the material girl, to platinum blonde, to stripper, then back to dark hair with S/M gear, to portraying spirituality through Kabala. She has made and remade herself to create and fit current trends. Prince, or the artist formerly Known as Prince, has also under gone a number of changes. From talented musician, to sexually ambiguous, hypersexual, homoerotic, and then undertaking a spiritual awakening (Fuchs, 1999), in this way Prince has been able to stay relevant by creatively recreating himself. The media takes these images, interprets them, and will either promote or criticize the artists' representation. An example of the media challenging an artist's image was Madonna being criticized for burning a cross in her Like a Prayer video. When analyzing music and image in combination, one must understand "music and images are social, commercial, and political representations. They correspond, intersect, and inform each other, impure and inviting. They depict, bear, and transform cultures and cultural values" (Fuchs, 1999; 185).

The performance itself is crucial for musicians/ artists to solidify identity, create bonds with the audience, share history and experiences, challenge inequalities, as well as create scenes. Performance helps develop scenes since identities are being created and shared, allowing for larger communities to develop. Scenes can be local, homogenous, and based on specific cultures, they can be global and culturally dynamic as well (Cohen, 1999). Scenes can also create sub-cultures (Cohen, 1999) or politicized communities (Viesca, 2004). M.I.A seems to be consciously doing this.

Crime, drugs, racism, sexism, deindustrialization, and unemployment for example, form the content for much of today's rap/hip hop music. Descending from an African oral tradition (McDonnell, 1992; DiPrima, 1990; Rose, 1989) rap/hip hop allowed for a voice to emerge, a "form of resistance and self-identification for young working-class black communities who are completely marginalized, and until the explosion of hip hop have been largely spoken for by the dominant culture" (Rose, 1989, pp. 37). Rap has been a form of communication and empowerment for a powerless, voiceless marginalized segment of American society (McDonnell, 1992), giving the young African American population hope, increased pride, and self-esteem (Dyson, 1991), as well as seeking to increase self-respect and self-determination (Leland, 1992).

3. Gender and Violence

For feminists, 'The feminist theory' of war does not exist. Rather a number of feminist arguments provide sometimes contradictory explanations and prescriptions. Feminist political

theorist Jean Elshtain describes it as a "polyphonic chorus of female voices… At the moment [1987], feminists are not only at war with war but with one another" (Goldstein 38). Liberal feminists feel that denying women combat positions is sexist discrimination as women can be capable warriors. This stand has been criticized for asking women to exchange major aspects of their gender identity for the masculine version - without prescribing a similar 'degendering' project for men (Goldstein 41). Difference feminism takes on the attitude that it is deep rooted and partly due to biological gender differences while postmodern feminists feel that it is an arbitrary cultural construction favouring those men in power (Goldstein 39). Difference feminists prescribe to the notion that women, because of their greater experience with nurturing and human relations, are generally more effective than men in conflict resolution and group decision making, and less effective than men in combat" (Goldstein 41). This has brought about a lot of criticism for linking women with peace movements, further reinforcing patriarchal notions of women. Difference feminism and liberal feminism are not so different in that, they both believe that the abilities of an individual are not determined by her or his group (Goldstein 49).

In 1792 Mary Wollstonecraft argued that women deserved equal rights with men, but should not participate in war (Goldstein 43). However in the case of Sri Lanka many civilians are relieved to see a woman soldier at a check point. Human rights activists have noticed a decline of sexual harassment cases at check points since female soldiers took up their posts. "Civilians also tend to relax when they see a woman officer" says Sunila Abeyesekera, a human rights activist in Sri Lanka.

Goldstein questions as to why the connection between war and gender is the same in almost all countries, while other aspects of war are very diverse in different cultures. He says that, "The answer in a nutshell is that killing in war does not come naturally for either gender, yet the potential for war has been universal in human societies. To help overcome soldier's reluctance to fight, cultures develop gender roles that equate "manhood" with toughness under fire. Across cultures and throughout time, the selection of men as potential combatants (and of women for feminine war support roles) has helped shape the war system. In turn, the pervasive war in history has influenced gender profoundly - especially gender norms in child rearing" (Goldstein 9). Therefore war engenders gender roles while gender roles engender the combat system.

One line of argument explains the gendering of war by the divided loyalties of women in inter-group conflicts. In the majority of cultures women move to another community and men stay with their family (patrilocality). In such a case, in the event of war, women might have mixed loyalties - to their current husband's community and to their birth families and therefore are seen as dangerous to be let out on the battlefield. An alternative way to resolve this dilemma is endogamy, to draw marriage partners from within one's own community (Goldstein 225). But this way of life, marrying only from your own clan, is another kind of ghettoisation which we subscribe to today.

In Sri Lanka, although many women participated in the JVP insurrection of April-June 1971 and to a lesser extent in the 87-89 insurrection "the issue of women militants came to the fore in the 1990's with the increased participation of Tamil women militants in combat" (Jayawardene and De Alwis 264).

4. Conclusion

It is apparent that M.I.A is using her music videos to propagate the notion of the femme fetale or a woman that is comfortable about her sexuality. It is rebellious and challenging the notion of the traditional obedient woman. However it does not move away from the objectification of women that happen in music videos of today. However there is a certain amount of autonomy because she is portraying herself as sexy and violent rather than another most of the time. These conflicting paradigms of women resisting violence is addressed by subscribing to violence. Her songs therefore harbour a political attitude and can be read as a mode of cultural reproduction. The genre of the music complicates her stance but we cannot deduce that it is apolitical.

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ETHNIC AND POLITICAL DRESS OF WOMEN: SOCIO-CULTURAL INFLUENCES AND ARTISTIC REVIEW IN SRI LANKAN CONTEXT DURING AND AFTER POSTCOLONIAL PERIOD

Wickramasinghe, A. T. P.

Department of Textile and Clothing Technology, University of Moratuwa, Sri Lanka

Abstract-Sri Lanka was governed by three nations and British impact was enormous on dress culture of women during early 20th century. However, after independency in 1948 it was dramatically changed due to the patriotic influences on female dress and highly impacted on ethnic and political dress of women. That was a turning point of female dress fashion and this study focused to analyze Sri Lankan women's dress culture and its influencing factors during and after postcolonial period. The analysis of this study is based on how and why the dress of women who lived during and after postcolonial period was changed in style. Further, argued the causes that were affected to change the dress code and different kind of dress preferences of women. The objectives of this study are to examine the influences of dress fluctuations and style preferences of women with special reference to political and ethnic dress. Inductive qualitative methodology was determined as data analyzing process and multiple methods used to gather the data. As conclusion, predicted ethnic and political dress fashion of women and its' influencing factors based on formation in Sri Lanka during and after postcolonial period.

***Keywords**: Women, Fashion, Sri Lanka, Ethnic and Political Dress*

1. Introduction

Sri Lanka is a multinational country situated south Asian region in the globe. It's culture highly cultivated multi ethnic influences and nourished from past to present with its influences. The women and dress undoubtedly recognized as emblem which showcased country's socio-cultural fluctuations. When consider the history of Sri Lanka, the Portuguese, Dutch and British were ruled and its impact changed conventional women's clothing styles into western styles during Colonial period. Further, some of the conventional dress codes were merged with western styles and developed into novel dress forms. The British influence through their culture enormously cultivated western fashion into the local styles due to the longer period of their rule. This formation of dress is materialized constantly according to the social and cultural context in early Sri Lanka.

Later this sense of fashion selection diminished gradually and imitating became foremost. In the postcolonial period, female dress was influenced by the morality-based dress codes related to independence and nationalism. Nationalists and revival leaders who took power were embarrassed by western dress codes. Adversely male politicians interfered to develop ethnic dress for women and that was become well regarded dress code for elected women to gain attraction from the public convincing that they were nation lovers. Therefore, the national dress of women eventually becomes the emblem of patriotic. As a result, most western clothing designs gradually declined in the fashion cycle and European influence gradually diminished from society. However, sweeping away the colonial attitudes of society was not simple.

2. Aims and Objectives

The duration considered was during and after postcolonial period in Sri Lanka and the main objectives as follows:

Analyze the style preferences of local women with special reference to political and ethnic dress

Examine the causes affected on female dress fluctuations

3. Methodology

The data gathering process was begun to discover raw data from archival materials, journals and books. Those were used as secondary data and live samples, oral history, personal experiences, observations, visual and object analysis and museum observations used as primary data. Inductive qualitative methodology under narrative style has been used to analyze the raw data. By accumulating multiple methods have been categorized raw data in most methodical and spatial manner. Then, initially, analyzed the gathered data and classified them to develop memos by considering the weight of content. Ultimately, develop the conclusion by considering memos into constructive viewpoints.

4. Data Analysis

4.1 Decolonization of Dress

Sri Lanka became an independent country on 4 February 1948, but psychologically people observed colonial culture and behaviour, especially in dress. After independence, national or ethnic dress (*ariya Sinhala aduma*) became the main dress code for males. However, women still dressed as they had under the British. Besides, Sri Lankan Buddhist women used British dress to demonstrate their high civilization to society. Jayawardena (2007) explained that Sri Lankan Buddhist women were influenced by English dress and took English dress as their priority. Further, due to influences of western dress, Buddhist Sinhalese women did not wear the sari and *ohoriya* (Jayawardena, 2007). However, due to misinterpreting some of the western dress ideas, Buddhist revival leaders condemned it and introduced a national dress for Sri Lankan women based on the *ohoriya* and sari. Criak (2009: 301) argued, "One of the stylistic consequences of post colonialism has been the invigoration of ethnic dress and ethnicity as fashion inspiration". Thus, female dress of a country is the most important phenomenon to identify the cultural pluralism.

Anagarika Dharmapala one of the patriotic leaders led a campaign and lampooned local women's attire in his journal. The 'Lanka *Watti* Hat' cartoon published in *Sri Lanka Nation* (Gomes and Wimalaratne, 2001; fig. 1), which was made of fruits and vegetables, insulted Sinhalese women who imitated British fashion (Gomes and Wimalaratne, 2001). When compared to Sinhalese women Tamil and Muslim women retained their traditions and did not abandon their traditional dress. The magazine *Thorathuru Sinhala Balaya* in 1944 stated: "Divest mother Sinhala of her fine and magnificent jewellery, and remove her silken garments, to dress her up only in a 'simple' loincloth" (Dharmadasa, 1992: 302). This statement shows the mindset regarding colonial dress codes. Further, it reveals that Sri Lankan society looked at women in a different perspective to males. This was due to different public mentalities; the attire of women was criticized, rather than trying to develop it according to nationalism. There, the gender difference was identical due to the insistency build up on female dress. Further, it is evident that, female dress was most prominent to articulate social and cultural inheritance of a country to the world than the male dress. On the other hand, dress is the vehicle to express authenticity of a country to the outer world.

Fig. 1: Lanka *Watti* Hat.

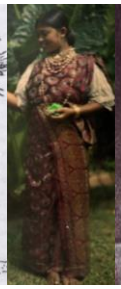

Fig. 2: A woman wearing traditional *ohoriya*, mid of the 20th century.

Fig. 3: Mrs. Mallika Hewavitharana, Mother of Anagarika Dharmapala dressed *ohoriya* as national dress, 1936.

However, upper-class Kandyan women wore the *ohoriya* as their attire for public and day-to-day life, because they believed that it reflected their highly reputed Kandyan social status. This was called *ariya Sinhala anduma* or national dress because Kandyan aristocratic women wore this draped garment with a fully covered upper jacket and a distinguished set of Kandyan jewellery (fig. 2). Thus, *ohoriya* dominated the female clothing during the postcolonial era and it was the moral dress of women. Short dresses, skirts, shorts and miniskirts were attire that had come from colonials to Sri Lankan fashion. Local women preferred to wear those styles due to femininity of the designs, tranquil ergonomic factors and ease of wearing at any time. However, society claimed that the short dresses aroused male passion and that this was a nationwide problem. Westernization of the dress code is an important strategy in the modern world. At present views of the femininity have been consequences of the past.

However, the patriotic power was enormous on the society at that time because nation was enthralled with the independence. However, patriots assumed that the sari was the attire for well-mannered women and that it could be worn graciously with a proper blouse. Regrettably, it arrived in Sri Lanka as per the Indian and Tamil influences, as mentioned. This convinced that, even the patriots' unawareness of female dress guided them to take attire originated from India as Sri Lankan female national dress. This fact arouses argument whether the sari can be referred as to female national dress in Sri Lanka. Ultimately, the sari and *ohoriya* became the national dress. Later, the Kandyan dress or *ohoriya* became the 'moral dresses of Sri Lankan women. Most aristocratic women dropped their colonial dress and wore the *ohoriya* for social or cultural events. Anagarika Dharmapala's mother was used as an icon to prove the worthiness of wearing the *ohoriya* (fig. 3). Therefore, even now women wear the *ohoriya* to show that they are from highly reputed families and to express their dignity to the public. This was a result of the patriotic

influences of *ohoriya* as the 'moral dresses of women.

4.1.1 Ohoriya

The *ohoriya* and sari were women's national attire in Sri Lanka after 1948. Therefore, they were the moral attire, while both can be categorized as draped attire. Further, these are the functioning silhouettes of Sri Lankan women from the past to the present, and thus classic silhouettes of women. The *ohoriya* was pure Sinhalese female attire and the authentic and ethical dress of Sinhalese women (fig.4). This attire was unique to Sri Lanka and conveys the dignity, family status and caste of the wearer. At the beginning of the 20th century the *ohoriya* was a ten *riyans* long rectangular piece of cloth, with a width of four to six *viyath* (measurement between the tips of thumb and little finger). Later, the length decreased and becomes 5 to 6 yards. When wearing the *ohoriya*, first one end of the cloth is taken and thrown over the left or right shoulder as the chest piece, and the balance fabric is wrapped around the waist leaving a waist frill, called *neriya* or *odokkuwa*.

Fig. 4: Traditional *Ohoriya.*

4.1.2 Sari

The sari originated in India and was introduced to Sri Lanka during the 20th century by migrants from India, and it has spread all over the country due to its feminine qualities. According to Anagarika Dharmapala the sari was one of the most suitable attires for Sri Lankan women (Wickramasinghe, 2003). The most alluring piece of six-yard drapery cloth that is still in vogue is the sari. The sari remains as one traditional women's attire in Sri Lanka, and it has a lasting charm since it is not cut or tailored for a particular size. This graceful feminine attire can also be worn in several ways, and its manner of wearing, colour and texture are indicative of caste, age, occupation, ethnicity and religion. There are remarkable segments of the sari: the border, body or ground, outer end-piece, inner end-piece, selvedge, end fringe, parting-strip of warp without weft and sari fold. The size of cloth varies, from 72 inches long by 18 inches wide, to 288-360 inches long by 54 inches wide (Chishti and Singh, 2010).

4.2 Socio-Cultural Influences

4.2.1 Caste, Profession and Social Distinction

The caste system in Sri Lanka was influenced by Indian tradition and extended throughout the country. Nagodavithana (2010) stated that the early Ceylonese closely associated with Indian Tamils, and the latter influenced the caste system and transformed the local culture. However, the philosophy of Buddhism was opposed to caste classification. Yet due to the communal and national influences, society maintained it to enforce hierarchy. Therefore, the dress of women had differences based on the caste system. Knox (1817) explained how women's attire varied by caste: the women's dress was a white calico jacket for the upper bodice and cloth for the lower bodice, and the lower cloth was a draped one in mostly blue or red, hanging below the knees or above the knees according to the caste.

With reference to the Sinhalese caste system, the *Radhala* and *Govigama* were the high castes. However, there was another social division: upcountry and low country. This was a colonial categorization. The *Govigama* were the highest caste in the low country, and *Radhala* the highest in the upcountry. These two castes' female dress codes show slight differences in style and silhouette. During the 20th century low-caste communities were marginalized as being impure. This was an influence from Indian culture. The length and width of the fabric used differed according to the caste of the wearer in ancient society: narrower width and shorter length for low-caste women, and wider and longer length for upper-caste women (Hettiaratchi, 1967). Therefore, the length and width of the *ohoriya* showed the caste of the wearer. On the other hand, only upper-caste women wore the ohoriya, and there were differences even within the upper caste. Therefore, the length and width of cloth showed the wearer's level in the social hierarchy. In addition, the widths of the waist frill of the *ohoriya* varied by region according to caste.

During the 19th century, Kandyan noble women wore the *ohoriya* as their traditional dress, and low-country women were not permitted to do so. This led to the popularity of the sari among low country and middle-caste women in the 20th century. However, after Independence nationalists were insisting women to wear the sari or ohoriya as their national dress. In Sri Lanka, the dress code of women varied according to the caste of the wearer. Therefore, by analysing the caste system of Sri Lanka, women's different clothing styles and

variations during the 20th century can be explored.

As De Silva (2014) points out, until the late 19th century women's dress consisted mainly of a lower garment and an upper garment. In early Sri Lanka, the upper castes held the higher-level professions, and the lower castes were their retainers. Therefore, lower caste women who were employed by the upper castes held the lower professions. Thus, the formal wear of Sinhalese women in the mid-20th century differed according to the hierarchy of profession. The lower professions of women were those engaged in agricultural labour, selling fish, vegetables and fruits, weaving, lace making and housework. Women in the higher income, elite class stayed home and employed low-caste women as housemaids. With more access to education after 1977 the gap between castes in formal wear was lessened and were influenced by more western styles.

The colour of attire was important in ancient society to illustrate place in the caste hierarchy. Upper-caste women wore white as a mark of purity. Further, Wickramasinghe (2003) stated that at the beginning of the 20th century, upper-caste Sinhalese women wore white, since low-caste women tended to wear multicoloured clothes. Upper caste *Govigama* women wore black attire for funerals as a Dutch colonial influence (Peiris, 2001). Blue and white were considered as dignified by the upper caste, and were used in the embroidery of upper-caste women's clothes. Red, blue, white, gold and black were the main colours used in textiles woven for upper-caste women. Heavy embroidery in gold and silver thread, plentiful hand-decorated work and precious stones were only used in upper-caste w Low-caste women were not allowed to wear *ohoriya*, sari or undergarments; these were only permitted to upper and middle-caste women's clothes. In the beginning of the 20th century, low-caste *Rodi* women did not cover their breasts, and only covered the lower part of the body with a cloth. The uncovered upper bodice was a gesture of respect to the upper caste, and was the practice even when meeting clergy. Now, the more respectful manner is to go fully covered to a religious place. Thus, it is clear that customs change with the evolving society. The style of dress notably varied according to caste and profession of women.

4.2.2 Ethnicity

Dress and ethnicity have a firm interconnection, since Sri Lanka is a multiethnic country. During the 19th century the variation in dress was racial and diversified due to social distinction, and gradually transformed in the 20th century with modifications. Women pursued many dress styles and followed the latest fashion trends according to their ethnic diversity. In the 20th century, Sinhalese was the major ethnic group, with Tamil second while and, other smaller minorities were Muslims, Burghers, Malays, Chetties and other mixed Sinhalese (marriage to Portuguese, Dutch and British) (Demographics of Sri Lanka, 2014). Ethnicity inevitably is bonded with religion. Most Sinhalese are Buddhists, while some are Christians. The majority of Tamils were Hindus, while some were Christians. The term 'Moor' was used to indicate Muslims in the Portuguese period, and they were inspired by Muslim culture. Further, Malays, Borahs, some Sindhis (some Sindhis are Hindus) and Indian Moors are Muslim. Moreover, Burghers and Christians followed British culture (Gunawardena, 2006). Thus, ethnicity and religious conviction seems to intertwine each other. Ethnicity inevitably is bonded with religion.

Tamils have different sari draping styles according to caste. In fact, several novel sari-draping styles gradually developed due to the Tamil influence. Some were 'mix and match' styles inspired by merging two different sari drapes together or mixing different blouse and sari styles. The Indian influence greatly affected Tamil women's clothes. Thus, they mostly used South Indian sari drapes. Upper-caste women wore saris with jackets, and while low castes did not. In addition, upper-caste women covered their head using the fall of the sari, while low-caste women did not. *Brahmin* women of the upper caste wore the *Madisar* sari drape, which was nine yards long. These saris were highly decorated with gold and silver thread work. For ceremonies, they wore expensive silk saris, and cotton saris were used as casual wear. However, the *Vellalar* caste women's sari drape differed from the *Brahmin*; *Vellalar* women used the *nivi* style drape inspired from India. In addition, *Brahmin* women wore much jewellery (Selkirk, 1844). *Vellalar* women's saris were inexpensive as compared to the *Brahmin*. The young women of both castes wore half sari or the full-length skirt with blouse.

Tamil middle-caste women too wore saris, and the drapes differed from that of the upper-caste women. The drape of middle-caste women mostly had no front pleats. The drape was disorderly arranged and sometimes the length of the sari was shorter according to their occupation. Therefore, most middle-caste sari drapes were loose and inappropriate to body proportions. Medium-caste women mostly wore *lungis* or a cloth similar to a *redda* with a blouse. This blouse was shorter but sometimes the length varied. The *lungi* was longer than knee level and sometimes extended to ankle level.

Tamil low-caste women were not allowed to wear the sari. They were considered as 'unclean,' and according to Hindu custom should dress to distinguish themselves clearly from other castes (Cartman, 1957). Later, low-caste women were allowed to wear the sari, although draping styles differed from upper and middle-caste women. As low castes, the *Palla* and *Nalava* women in Jaffna wore a sari above the breasts, leaving their shoulders bare. This was a norm enforced by the upper castes. However, *Palla* and *Nalava* educated women were able to wear the sari over their shoulders until the mid-20th century (Cartman, 1957). Gradually, during the latter part of the 20th century they wore the sari similar to how the medium-caste women would drape. However, the sari colours were dulls, none as bright as dark orange, bottle green and mauve.

Therefore, Sri Lankan women's dress was a hybrid of these subcultures, producing novel styles of local fashion during the 20th century. The sari became the casual, occasional, formal and religious dress of Moor women. This tradition continued until the mid-20th century. Later, they covered their head using the loose end of the sari as a sign of purdah or *hijab*. In India, upper-class Moor women tended to cover their head using the fall of the sari, and Sri Lankan Moor women were influenced by this as they believed it to be a custom of Muslim women. In early Sri Lanka, the shawl worn over the woman's head was known as a *mottappiliya*, and some upper-class Sinhalese women too covered their head by using the fall of the sari during the mid-20th century as a fashion trend influenced from Muslims. Ethnicity and caste during the 20th century produced different dress cultures among women. At the beginning of the century ethnic and caste divergence was great, and women's dress was the prominent communicator. Lynch (2005) argued that ethnic dress continuously uses a conventional approach to organize social life and marks the importance of the wearer. Thus, dress is the mark of ethnic and caste identity. After 1977 this changed, and dress became the common communicator of the fashionability of the wearer, rather than an indicator of social position.

4.2.3 Open Economy

Social modernization occurred after 1977 as a result of the open economy, which opened employment opportunities for more women. Thus, many women adopted the sari without concern for caste or dignity. Eventually, it became the common attire of Sri Lankan women. However, some Kandyan noble women refused to wear the sari, because they believed it reflected their caste level. Later, draping styles of the sari merged, and the sari and other clothing styles became an expression of fashion, rather than caste or family background. Women's attire and social etiquette were highly modernized by westernized attitudes. Due to the Cultural Revolution that occurred around 1977, the gaps between ethnic groups, religious conviction, cultural barriers and caste variation became gradually minimized. This happened mainly due to access to free education and opportunities for women. The increase in the freedom of women globally obtained after the Second World War affected women in Sri Lanka. As a result, women's dress and social patterns were greatly transformed. De Alwis (2002) explained that after the introduction of the open economy in 1977, women's role changed, resulting in the employment of young women. After 1977 the job market diversified. Since then, more women had access to education and employment thus giving them the opportunity to mix up with other ranks of the society. Women who worked were very quick to adopt new styles of clothing because they mixed up with different levels of the society. Initially, women stylized the traditional outfit, thus women in employment initially stylized the sari and later adopted the western attire. This was seen more profoundly among those employed in the private sector. These attires were mixed and matched types of westernized, local and hybrid attires. The earning power of women enabled them to purchase what they preferred to wear.

4.3 Political Dress

Politically a national dress was needed, but psychologically people lived with colonial impacts. National dress also revolutionized nationally devoted political leaders. This was an ironic situation, since in Sri Lankan politics the society preferred the national dress wearing decolonized women as opposed to those who wore western dress. In 1960, twelve years after independence, Sirimavo Bandaranaike (wife of former Prime Minister Bandaranaike, 1956-1959) became world's first female prime minister. She was a prominent political personage who wore only the traditional *ohoriya* to parliament and to local and foreign political meetings. The world thus looked at Sri Lankan women with respect, with enormous publicity given to the dress code. Thus, the *ohoriya* became the prevalent attire of women's national dress. The photograph of Prime Minister Sirimavo Bandaranaike meeting with Indian Prime Minister Indira Gandhi in 1974 (Muthiah, 2003; fig. 5) was a momentous view of women leaders from neighbouring countries discussing the demarcation of the maritime boundary. Mrs. Bandaranaike was dressed in the *ohoriya*, Prime Minister Gandhi wore the Indian sari. The Sri Lankan prime minister kept her fall over the right-hand side shoulder while the Indian prime minister on the left-hand side shoulder. She covered her other shoulder with the sari's fall by draping it around

over the right-hand side shoulder. Thus, it can be seen that the sari and *ohoriya* were the most significant South Asian attire of women political leaders.

Further, Sirimavo Bandaranaike wore the traditional *ohoriya* (Fernando, 2010; fig. 6) with a proper jacket in public, proving that the *ohoriya* was the most prominent female political attire during the 20th century. The significant factor was that she wore a fully covered jacket with a properly draped *ohoriya* for public appearances. The midriff was fully covered and the front fall covered the bosom entirely. The appearance was graceful, and she was a political manifestation to the public of a well-mannered look wearing the national dress. For this manifestation, the patriotic influences too associated with the attire.

Fig. 5: Sri Lankan Prime Minister Sirimavo Bandaranaike met with Indian Prime Minister Indira Gandhi, Indian Heritage Foundation, 1974.

The photograph of Sirimavo Bandaranaike with her two daughters – the younger Chandrika Bandaranaike Kumaratunge, former president, and the eldest Sunethra Bandaranaike (Chandrarathne, 2007; fig. 7) – shows two generations of women political leaders. The significant point is that Sirimavo and Chandrika wore the *ohoriya* while Sunethra draped an Indian sari worn with a sleeveless blouse. This shows that the national dress or *ohoriya* was the most prominent dress of politicians. Former President Chandrika Bandaranaike Kumaratunge (De Mel, 2004; fig. 8) wearing an Indian sari shows that the sari also has a high position in Sri Lankan society. However, with reference to both attires, the *ohoriya* became the leading political women's attire during the 20th century and the national dress of women. Thus, the three photographs show that women politicians wore the *ohoriya* or sari rather than western dress in public to ensure reputation and to raise their profile.

Fig. 6: Former prime minister Sirimavo Bandaranaike with two daughters Sunethra and Chandrika

Fig. 7: Former prime minister Sirimavo Bandaranaike of Sri Lanka.

Fig. 8: President Chandrika Bandaranayaika Kumaranatunga

Agnes De Silva, who battled to gain the vote for women (won in 1931), and Adlin Molamure, who was the first lady minister in Sri Lanka, too, influenced women's public national dress as the sari. Elina Bandara Rupasinghe Jayewardene, the wife of former President J.R. Jayewardene, wore the sari with elegance (Sri Lankan Sinhalese Family Genealogy, 2011; fig. 9). Another noticeable first woman was the wife of former President Ranasinghe Premadasa, who wore the *ohoriya* in different styles to show that public dress could convey a legacy of power (Hatana: Mawbima, 2014; fig. 10). She was a fashion icon in the 1990s for her styles of *ohoriya*. She wore the *ohoriya* with unique draping styles and set-in sleeve jackets. Her *ohori* fall was usually pinned a little lower down from the shoulder, leaving the fall or *pota* to hang down without pleating.

This tradition continues in the 21st century, with most women politicians wearing the sari or *ohoriya* to present themselves as nationally devoted politicians. Further, the political attitude regarding national dress has not changed to date. Craik (2009: 297) argues that 'The history over fashion from past two three centuries has been intimately bound up with the political and economic shifts under colonization and post colonialism-and cultural politics of fashion entailed therein'. Further she stated:

> Fashion has been a highly charged political tool in successive scenarios that have accompanied encounters between Western and Eastern forms of civility, especially in situations of colonial occupation and transformation and subsequent moves toward regaining independence and a sense of national identity (2009: 298-300)

Fig. 9: Elina Bandara Rupasinghe spouse of former president J. R. Jayawardena.

Fig. 10: Spouse of former president Ranasinghe Premedasa.

With regard to the dress of women politicians and first women during the 20th century, Sri Lanka shows that dress and legacy of power developed synchronously. National dress has enormous power to uplift a person's social and political appearance in Sri Lankan culture. Thus, national dress was developed as a political apparatus and people urge to respect it. Therefore, national dress is a highly influenced phenomenon of political attire of a woman. It always uplifts patriotic consciousness of wearer and encourage enthusiasm of the onlooker.

4.4 Conclusion

The women in any country assist to transcribe the socio-economic culture of the country they belong to. The powerfulness and attractiveness of native women of a country always persuaded pride to the socio-economic culture. The following graph transcribes the formation of female dress with influencing factors. These socio-cultural influences have been discussed in above and summarized in this graph to understand the common scenario.

Due to this scenario dress of women evidently cultivated cultural propaganda to the recluses. The postcolonial period of Sri Lanka was one of the most imperative eras of the country as that period was able to generated physical and mental exaggerations of natives. As most culturally prominent apparatus of dress systematically rehabilitated from colonization to decolonization during the post-colonial period was incredible and the causes, which influenced on those translations were transpired due to nationalistic movement. This movement makes people more transparent from their attitude and brain stormed to articulate dress as moving sculpture of any society and further convinced the dress has enormous power to build the flawless.

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EVALUATION OF LARVICIDAL EFFECTS OF *PARTHENIUM HYSTEROPHORUS* L. LEAF EXTRACTS AGAINST *AEDES AEGYPTI* LARVAE USING DIFFERENT SOLVENTS

U.D.S.S Ranasinghe[1*], J. Nimalan[1] and S.N. Surendran[2]

[1]Department of Bio-Science, Faculty of Applied Science,
Vavuniya Campus, University of Jaffna, Sri Lanka
[2]Department of Zoology, Faculty of Science, University of Jaffna, Sri Lanka

ABSTRACT - Plant extracts can be used to control the larvae of dengue mosquito. The study was conducted to evaluate the larvicidal effects of *Parthenium histerophorus* L. (*Parthenium*) leaf extracts against *Aedes aegypti* larvae using different solvents. Dried powder of leaves was subjected for sequential extraction using hexane, ethanol and water for 24 hours seperately in Soxhlet apparatus and evaporated to obtain crude extract. Five different concentrations (0.1% to 0.5%) were prepared from stock solutions based on preliminary study. *Aedes aegypti* larvae were introduced (n=10) in triplicates. Mortality was observed after 48 and 72 hours of exposure. Mean larval mortalities were compared for different concentrations and exposure time using Duncan Multiple Range Test (DMRT). LC_{50} and LC_{90} values were determined for each extract at 48 and 72 hours. The larval mortality was significantly increased with the time and the concentrations of the leaves extracts ($P < 0.05$). There were correlations between concentrations and probit mortalities in each extracts ($R^2 > 70\%$). The highest larval mortality was observed in the water extract at 48 hours (LC50 -146.43ppm and LC90 - 389.71ppm) and in ethanol extract after 72 hours (LC50-132.84ppm and LC90 -329.30ppm). Hexane extract showed low larval mortality at each time. Less than 10% mortality rate was observed in the control. As larvicidal activity was observed in all studied solvents, sequentilal extration of leaf extracts using all solvent is effective and use of water as a solvent is more economical and applicable.Water leaf extracts of *Parthenium* has potential to be utilized as a larvicide to control *Aedes aegypti*.

Keywords: *Parthenium hysterophorus, Aedes aegypti, Larvicide, Sequential extraction*

1. Introduction

Vector borne diseases are diseases caused by parasites, viruses and bacteria. They can be transmitted by mosquitoes, sandflies, triatomine, bugs, blackflies, ticks, mites, snails and lice [15]. Among that, mosquito is a one of the major insect that has ability to carry and spread mosquito borne viral diseases to human. They are acting as vectors for many mosquito-borne viral diseases such as Malaria, Filariasis, Dengue fever, Chikungunya, Yellow fever and Japanese Encephalitis etc[5].

According to the World Health Organization (WHO), the incidence of dengue has grown dramatically around the world in recent decades. It is transmitted by female mosquitoes mainly by *Aedes aegypti* and, to a lesser extent, *Aedes albopictus*. Its risk can be influenced by rainfall, temperature and unplanned rapid urbanization [15] and although socio-economic conditions of the community can be contribute to the mosquito breeding either directly or indirectly [13].

According to the data obtained from the National Dengue Control Unit, the reported dengue cases in Sri Lanka in 2004 was 15 463 and that was increased in 2009 up to 35 095. In year 2014 it was recorded as 47 502 and the highest number of dengue cases reported in year 2016 as 55 150 [7]. So the people were admitted to hospitals with sever dengue and the mortality rate of people was increased these years. This situation was affected mostly to the lifestyle of people and also to the developing economies of the country.

Mosquito control reduces the population of mosquitoes and it is a vital public-health practice throughout the world and especially in the tropical countries. Source reduction, biological control, larviciding or adulticiding may be used to manage mosquito populations depending on the situation.

The outbreak of disease can be reduced through the controlling of vector responsible for the particular disease. Application of synthetic insecticides such as organochlorine and organophosphate compounds are in use in current world for the controlling of vector. But this has not been very successful due to their ability to cause human health effects such as immune system disorders, leukemia, breast cancer, asthma etc, technical and operational limitations, ecological effects such as imbalance of the ecosystem by

killing non-targeted organisms, bioaccumulation and biological magnification etc and also due to economic factors because of the high cost of these synthetic insecticides [3].

Vector control by the application of natural products instead to the application of synthetic chemicals had been identified as an ecofriendly method in current world and under the biological controlling programme, one of the most effective alternative approach is to explore the floral biodiversity and use of insecticides of botanical origin as a simple and sustainable method of mosquito control [3]. Pyrethroid chemicals which were originally utilized as compounds extracted from the flowers of *Chrysanthemum coccineum* L and *C. cinerariifolium* are now available as synthetic chemicals as permethrin [4]. Extracts from the seed oil of the neem tree *Azadiracta indica*, have a number of biologically active compounds that have been shown to be effective against mosquitoes as well as other insects [4].

The use of natural product that reduces mosquito populations at the larval stage can provide many associated benefits to vector control. The limitation of environmental impacts of pesticides by natural products due to their shorter persistence may be beneficial in preventing the evaluation of resistance [4].

Parthenium hysterophorus L. is an invasive alian plant species at global level and also in Sri Lanka [10]. *Parthenium hysterophorus* L. has also been listed in the "Weeds of National Significance (WONS)" by the Sri Lanka Council for Agricultural Research Policy (SLCARP) in its National Weed Strategy for 2009-2014[9] and National Priorities in Plant Protection Research 2011-2013 [6]. Parthenium has emerged as a major biotic constraint to the vegetable growing farmers in the Nothern Province of Sri Lanka resulting in extra effort on time and financial investment in order to ensure favourable growing conditions to the vegetable crops to reap greater harvests [8]. The pollens of Parthenium weeds was reported to induce respiratory disease in human [1]. Thus this Parthenium weeds should be eliminate from the environment. Hence, as a solution for this Parthenium weed infestation and for the dengue outbreak, this study was focused to evaluate the larvicidal effect of Parthenium weed against *Aedes aegypti* larvae.

The overall objective of this study was to evaluate the larvicidal effect of *Parthenium hysterophorus* L. against *Aedes aegypti* larvae with different solvents.

2. Materials and methods

2.1. Collection of mosquito larvae

All the tests were conducted using second instar larvae of *Aedes aegypti* and they were obtained from the Medical and Research Entomology Laboratory, Department of Zoology, Faculty of Science, University of Jaffna, Sri Lanka.

2.2. Identification of the plant and plant leaves collection

Parthenium hysterophorus plant was identified with the help of a botanist in university of Jaffna and by previous literatures.

Parthenium hysterophorus leaves were collected from the surroundings of Kurumankadu area in Vavuniya district located in Northern Province, Sri Lanka for larvicidal bioassays.

2.3. Preparation of leaves extract

The collected *Parthenium hysterophorus* L. leaves were washed with tap water, dried in shade and powdered. 50g of powdered leaves sample was extracted by Sequential extraction using 300 ml of hexane, ethanol and water separately in Soxhlet apparatus [14] for 24 hours for each extract. The obtained leaves extracts were evaporated -in rotary evaporator at low pressure and high temperature. The dried crude extracts were measured and stock solutions were prepared.

2.4. Larvicidal Assay

The required concentrations (0.1%, 0.2%, 0.3%, 0.4% and 0.5%) for the mosquito larvicidal assay were determined based on the mortality percentage obtained in the preliminary test. Experimental set up for larvidal assay contained five different concentrations of leaves extracts and control. Different volumes (100 µl, 200 µl, 300 µl, 400 µl, 500 µl) from each stock solutions were added in to five plastic cups separately and filled with distilled water up to 100 ml. Distilled water (100ml) filled in plastic cup was used as control. Ten Second instar larvae of *Aedes aegypti* were transferred into each test solutions and control. Larval mortality was recorded after 48 and 72 hours of exposure duration. Food was not provided to larvae during this bioassay. Experiment was carried out in laboratory condition with 3 triplicates.

2.5. Statistical Analysis

The average larval mortality data were subjected to probit analysis for calculating LC_{50} and LC_{90}, and other statistics at 95% fiducial limits of the upper confidence limit (UCL) and lower confidence limit (LCL), and chi-square values were calculated by using SPSS 22 software package.

All the data were subjected to the one-way ANOVA. Values of $p < 0.05$ were considered to be statistically significant. The mean larval mortalities of *Aedes aegypti* for exposure duration and different concentrations of hexane, ethanol and water extracts were compared by mean comparison using Duncan's Multiple Range Test.

The average mortalities for each concentration for each solvent were not corrected since for all extracts, the average mortality of control was not more than 10% mortality rate.

3. Results

3.1. Probit analysis

Probit analysis was done in order to find out the larvicidal activity of *Parthenium hysterophorus* against *Aedes aegypti* larvae.

According to the results obtained for LC_{50} and LC_{90} values for the three plant extracts for each time periods (Table 1), the least LC_{50} and LC_{90} values were observed in water extracts at 48 hours with LC_{50} and LC_{90} of 146.43ppm and 389.71ppm respectively, while the ethanol extract had the least values at 72 hours with LC_{50} and LC_{90} of 132.84ppm and 329.30ppm respectively. Hexane extract showed highest LC_{50} and LC_{90} values at 48 and 72 hours compared with other solvent extracts.

Table 1: Larvicidal activity of *Parthenium hysterophorus* against *Aedes aegypti* larvae.

Solvent	Time	LC_{50} (ppm)	LC_{90} (ppm)	95% Fiducial limit				R^2 (%)
				LC_{50}		LC_{90}		
				LFL	UFL	LFL	UFL	
Hexane	48h	347.50	1379.42	155.6	539.2	762.5	2362.4	94.70
	72h	277.94	963.00	114.6	401.9	602.6	1669.0	94.00
Ethanol	48h	155.33	423.50	58.5	221.4	298.1	1080.5	86.80
	72h	**132.84**	**329.30**	443.0	312.0	333.7	744.6	91.80
Water	48h	**146.43**	**389.71**	683.0	203.2	276.3	966.7	80.90
	72h	142.74	381.81	64.2	198.9	270.5	949.3	72.10

LC50=Lethal concentration required to kill 50% of the test organisms; LC90 = Lethal concentration required to kill 50% of the test organisms; LFL = Lower fiducial limit; UFL = Upper fiducial limit; R^2 = Regression coefficient.

3.2. Larvicidal activity of different solvent leaf extracts of *Parthenium hysterophorus* against *Aedes aegypti* with the exposure duration

Larvicidal assay of hexane leaves extracts showed a significant difference ($p > 0.05$) in larval mortalities in each concentration with the exposure duration except in the highest concentration level (0.5%) (Figure 1) and ethanol extract showed a significant difference ($p > 0.05$) in larval mortalities in all concentration levels with the time (Figure 2). In water extract there was no significant difference observed in 0.1% and in the highest concentration levels of 0.3%, 0.4% and 0.5% with the time while in the concentration level of 0.2% only showed a significant difference of larval mortalities with the exposure duration (Figure 3).

3.3. Larvicidal activity of different solvent leaf extracts of *Parthenium hysterophorus* against *Aedes aegypti* with the concentrations

According to the results of this analysis each concentration levels in each extract had higher larval mortality compared to the mortality in control solution (0%). It was observed that the larval mortality was significantly increased with the exposure concentration level in each solvent extracts at 48 hour and 72 hour of exposure duration (Figure 4, Figure 5, Figure 6).

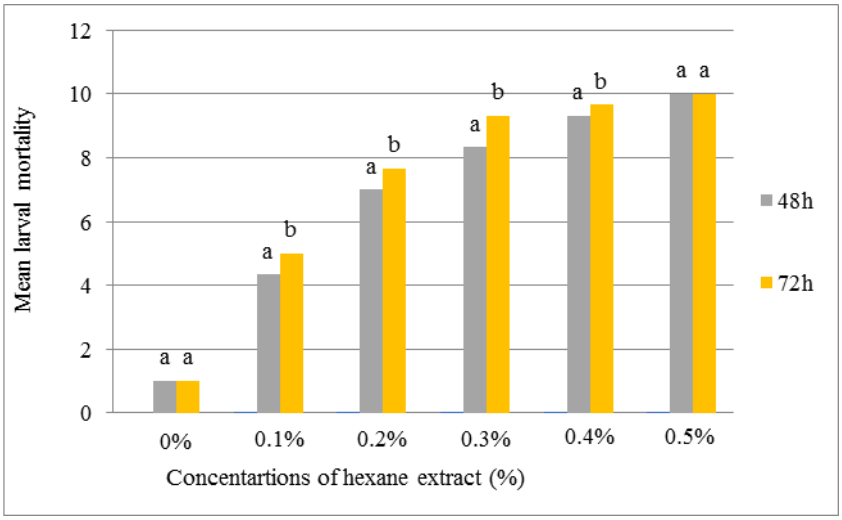

Figure 1: Variation of larvicidal activity of hexane extract with exposure duration

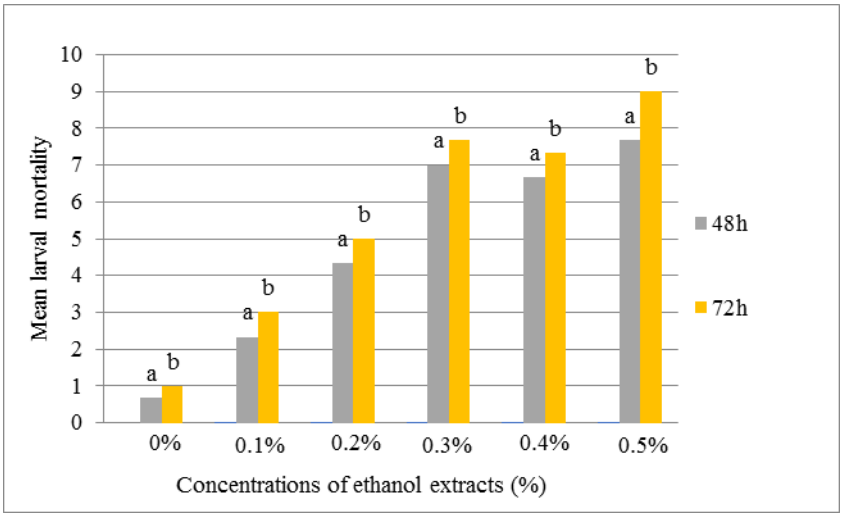

Figure 2: Variation of larvicidal activity of ethanol extract with exposure duration

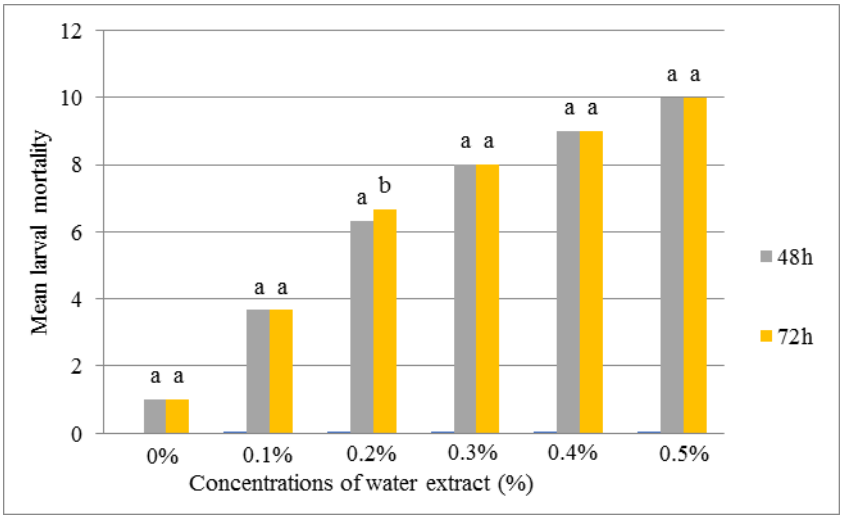

Figure 3: Variation of larvicidal activity of water extract with exposure duration

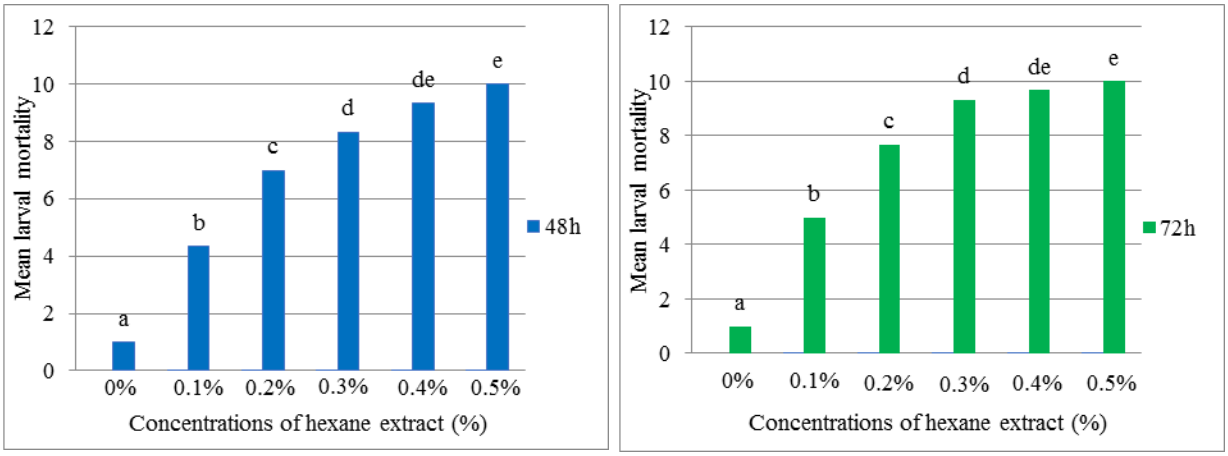

Figure 4: Variation of larvicidal activity of hexane extract with exposure concentration levels at 48 hours (48h) and 72 hours (72h)

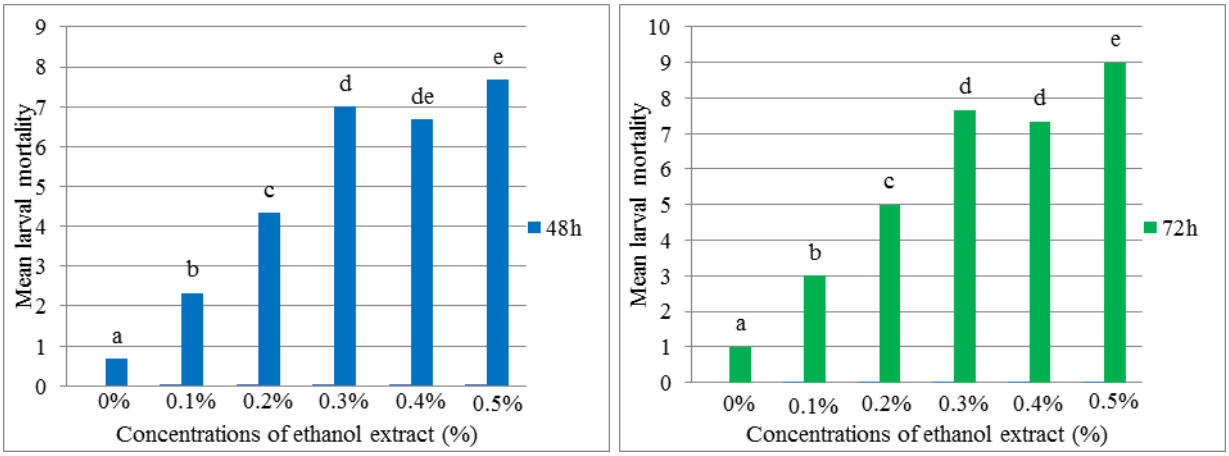

Figure 5: Variation of larvicidal activity of ethanol extract with exposure concentration levels at 48 hours (48h) and 72 hours (72h)

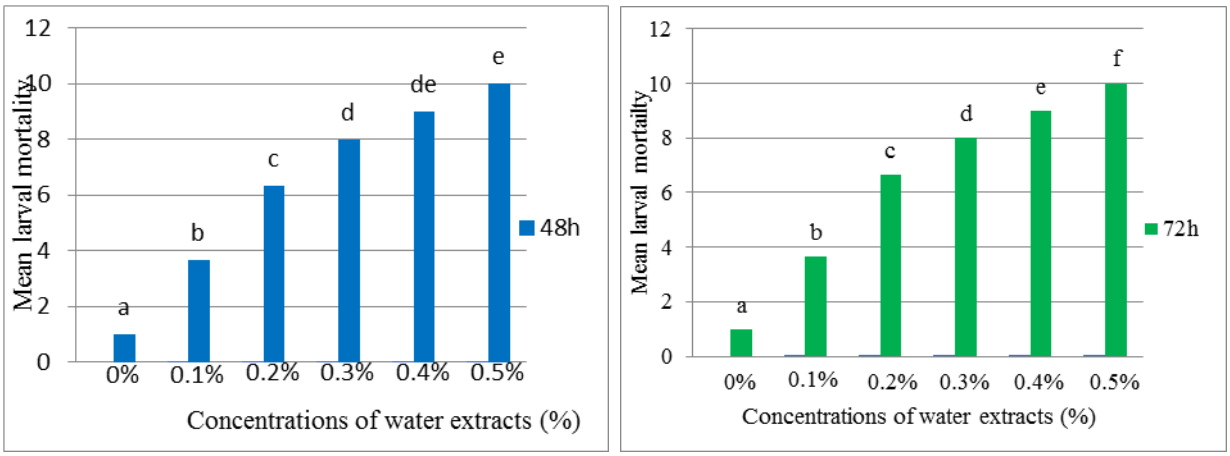

Figure 6: Variation of larvicidal activity of waterl extract with exposure concentration levels at 48 hours (48h) and 72 hours (72h)

Note: Different superscript alphabets in bars indicate statistical significant difference at $P < 0.05$ level based on Duncan's Multiple Range test (DMRT).

4. Discussion

Three solvents with different polarity ranges were used for the extraction of plant extract by sequential extraction method and the results obtained from the probit analysis for all three extracts differ with each other. Among the extracts tested, the extracts obtained by using water and ethanol solvents were highly effective against *Aedes aegypti* larvae since the least LC_{50} and LC_{90} values observed in water extract at 48 hours of the exposure duration while at 72 hours it was observed from ethanol extract.

Being the ethanol and the water are polar solvents while the hexane is a non-polar solvent, the bioactive compound/s responsible for the *Aedes aegypti* larval death mostly could be a polar compound/s. But there could be some non-polar bioactive compound/s responsible for the *Aedes aegypti* larval death in *Parthenium hysterophorus* leaves extract since hexane extract also showed larval activities lower than the water and ethanol extracts.

Insecticidal effects of plant extract depend not only according to plant species, mosquito species, geographical varieties and parts used. It also varied due to extraction methodology adopted and the polarity of the solvents used during extraction [12]. Hence, for the extraction of bio-active compound from *Parthenium hysterophorus* leaves responsible for the *Aedes aegypti* larval death can be perform effectively by using polar solvents since water and ethanol being the polar solvents used in this study resulting least LC_{50} and LC_{90} values with high larval mortality rates.

The analyzed results in mean larval comparison in hexane and ethanol extracts revealed the larval mortality of *Aedes aegypti* is significantly increased with exposure period as revealed by most of the previous studies with the extracts of different plant species [11]. This showed the larval mortality of ethanol and hexane extracts are depending on the exposure duration.

But the larval mortality of water extract is not depending on the exposure duration since it was not showed significant difference with the exposure duration.

The significant increment of larval mortality of *Aedes aegypti* with the exposure concentrations in each extract of *Parthenium hysterophorus* leaves showed that the larval mortality is dose dependent. Tennyson, *et al*., (2012) showed through their study, there is a direct proportional in between the larval mortality and the concentration of plant extracts [12].

Studies done by Connell, *et al*., (2016) showed that the toxicity of a substance was constant all the time, but the chemical composition was increasing with the increasing concentration [2]. Hence, the increment of the composition of bioactive compound responsible for the *Aedes aegypti* larval death with the increasing concentrations may be the reason behind the significant increment of larval mortality with the exposure concentrations in this study. Hence, larvicidal activities of the *Parthenium hysterophorus* leaves extracts are depend on the exposure concentration levels.

5. Conclusion

The finding of this study revealed that there is a larvicidal effect in *Parthenium hysterophorus* leaves extract against *Aedes aegypti* larvae.

It was concluded as polar solvents are the most suitable solvents for the extraction of the active ingredient/s responsible for the *Aedes aegypti* larval death efficiently and non-polar solvent can be used for the extraction of remaining non polar active ingredient/s present in the leaf extracts, though by using both types of solvents, all the bioactive compounds responsible for the *Aedes aegypti* larval death relevant to the polar and non-polar bioactive compounds can be extract effectively by performing the sequential extraction method.

The results obtained from the mean larval comparison was concluded that the larval mortality is significantly depending on the exposure concentration of the particular plant extract and larval mortalities of ethanol and hexane extracts are depending on the exposure duration, but the larval mortalities of water extract is not depending on the exposure duration. This reveals that the concentration of the particular plant extract and the exposed duration are the important factors when evaluating the toxicity (LC_{50} and LC_{90}) of the plant extract.

The leaves extract of *Parthenium hysterophorus* L. have great potential to be utilized as a sustainable eco-friendly biopesticide to control dengue mosquito and in this way population of *Parthenium hysterophorus* L. can also be managed since it is an invasive alien species in Sri Lanka.

Further studies are suggested to conduct to find the bioactive compound/s of *Parthenium hysterophorus* L. responsible for the larval mortality of the *Aedes aegypti* larvae, find the larvicidal effect of *Parthenium hysterophorus* L. for another variety of mosquito larvae and to find whether any toxic effects to the non-targeted organisms by this *Parthenium hysterophorus* L. leaf extract.

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INVESTORS' DEMOGRAPHIC AND RISK TOLERANCE: EVIDENCE FROM SRI LANKA

Achchi Mohamed Inun Jariya [1], Fathima Zainab Abdul Nazar[2]

[1 & 2]*South Eastern University of Sri Lanka, University Park, Oluvil, Sri Lanka*

ABSTRACT - The purpose of this study is to examine the implications of investors' demographic information over their risk tolerance level. The researcher adopted a quantitative approach and surveyed using structured questionnaire, such demographics as age, gender, income, civil status, occupation, financial literacy and investment experience of 291 household investors residing in Matale Municipal Council in Sri Lanka. The data on such demographic factors were associated with financial risk tolerance using such appropriate parametric and non-parametric tests as correlation analysis, t-tests, one-way analysis of variance and chi-square analysis. Findings revealed that the age of investors negatively associate with their financial risk tolerance whereas that association is positive when it comes to income, financial literacy and investment experience. The study also informs that civil status occupation do not associate with investors' tolerance of financial risk. The findings indicate that financial risk tolerance of male investors is more than that of their female counterpart.

Keywords: *Demographic Characteristic, Financial Literacy, Financial Risk Tolerance, Investment Experience*

1. INTRODUCTION

Investment is one of the essential terms in the day-to-day operation of every household. Mainly people with saving enter into the world of investment. Investors invest their saving for earning more money with high return in order to finance their future consumption by scarifying current consumption. Investors provide more importance for risk related with various investment opportunities. The level of risk tolerance differs from person to person and the potency of risk can be minimum, maximum and average level (Awais, Laber, Rasheed, & Khursheed, 2016). An important matter, which is necessary to understand, is degree of risk taking. Risk taking means the degree to which an investor can absorb the risk. Grable & Lytton, (1999) define risk tolerance as "the willingness of an investor to suffer the negative impact of the investment, or the return earns different with expectation." Besides that, Davies (2014) stated risk tolerance as "a wide psychological trait and also fundamental degree for the individual ready to accept the risk could reduce their profit". Investor's investment decision mostly depends on the nature of risk tolerance of investors. Investors' demographics such as age, gender, civil status, income etc. are said to be one of the major factors influencing the investors' attitude towards risk or handling of risks. A traditional view of investment theory is that investors are rational human beings who always attempt to maximize expected returns based on their expectation of future risk.

Opposing this argument, Anuradha & Anju (2015) state that "investors are irrational in investment decision making and there are various factors including inventors' behavioral factors influence their decision to save and invest". Supporting this argument, Perera (2016) pointed out that one of the important factors, which determines the investment decision, is risk tolerance level of individual and in turn, risk tolerance depends on demographics of individual. Risk tolerance is the investor's ability to take or tolerate risk. Financial risk tolerance (FRT) is usually use as the measurement of risk tolerance of investment decisions. The FRT may differ from one investor to another based on their demographic characters. For example, Kannashasan (2015) argues, "the younger potential investors have higher risk tolerance compare to the veteran potential investors".

Moreover, Kannashasan (2015); Chen & Volpe (1998) stated, "Male has higher risk tolerance compared to female".

Driven by these arguments, there are various empirical investigations both from developed and developing counties, for examples; Grable and Roszkowski (2008); Van de Venter, (2013); Dickason and Ferreira (2018); Ansari and Phatak (2017) concluded that demographic characters of individuals are connected to financial risk tolerance level. However, the findings are not similar in all countries. Some studies such as Zhuan, Ying, Boon, & Hong (2016) observe positive relationship, while some other studies such as Sulaiman (2012) finds negative relationship between demographic characters of individuals and financial risk tolerance level. However, there are empirical studies such as Subramaniam and Athiyaman (2016) focuses on

demographic factors and FRT within the context of Sri Lanka, different findings were observed due to the different socio-cultural background of investors during different time period and different frequency of data. With this backdrop, this study sought to fill the gap by exploring "whether individuals' demographics influence the risk tolerance level of individual in their investment decision in Sri Lanka, a developing nation."

2. RESEARCH OBJECTIVE

The aim of this study therefore is to identity the relationship between demographic characters of individual investors and their risk tolerance and to assess the financial risk tolerance level of individual investors in Sri Lanka.

3. REVIEW OF LITERATURE

A review of widely studied demographic factors such as age, gender, civil status, income, occupation, financial literacy, investment experience and their relationship with risk tolerance are concerned in this section.

Dickason & Ferreira (2018) investigated the influence of some demographic characters such as age and gender on financial risk tolerance among the South African investors. Using a non-probability convenience sampling data were gathered from 600 investors by administering questionnaire. With the help of descriptive statistics such as cross tabulations, as well as logistic regression the collected data were analyzed. Based on the binary regression results, the study found that financial risk tolerance differs not only between male and female investors, but also within different age groups and it is due to the fact that young investors have more time to recover from financial losses which leads more willingness to take more risks. However, the results of the cross tabulation showed that majority of young investors are not willing to take any risk or just average risk and male investors are willing to take more generous risks compared to female investors.

Ansari & Phatak (2017) also studied the effect of demographic characteristics namely age, gender, income, occupation and education on financial risk tolerance of individual investors in India. Using convenient sampling data were collected from 1000 individual investors. Based on the T-test and ANOVA the study found that demographic characteristics of investors significantly related with the risk tolerance level in India.

Zhuan (2016) examined the impact of personality traits and demographic characteristics on risk tolerance and investment decision making in Kampar, Perak. The questionnaire survey was conducted and data were obtained from 340 respondents. The results show that personality, openness to experience; financial literacy and investment decision are significantly affecting the risk tolerance of the young potential investors while gender and investment experience are insignificantly explaining the risk tolerance.

Subramaniam & Athiyaman (2016) attempted to identify the effect of demographic factors on investors' risk tolerance in Sri Lanka. They examined the relationship with respect to age, education, gender, occupation, civil status investment experience and income of the investors. The findings of this study indicate that age, education investment experience and income of the investors are correlating with risk tolerance while other variables such as gender, occupation and civil status were not related with risk tolerance.

Thanki (2015) evaluated to find out whether the risk tolerance level differs among different demographic components or not. A questionnaire survey was used and data was collected from 258 investors. Employing independent t-test and ANNOVA, the study finds that females are more risk averse than man, Single/unmarried investors take higher risk than married and investors among 25-45 ages have lowest risk tolerance capability. The study also finds a positive relationship between income and risk tolerance while education was founded to be irrelevant in determining investor's attitude towards risk. Further, this finds that business people have high-risk tolerance ability whereas salaried people take calculated risk.

Kannadhasam (2015) investigated the relationship between demographic characteristics and financial risk tolerance level of retail investors. The findings of the study indicate that the risk tolerance level have a significant impact on investment decision making and demographic characteristics have an important role in risk taking capacity of investors. Sadiq & Ishaq (2014) also identified that demographic factors influence the investors' decisions and investors' level of risk tolerance.

Larkin, Lucey & Mulholland (2012) studied how the demographic characters such as age, gender, and education affects risk tolerance among the Ireland investors. Their finding from the questionnaire survey show that risk tolerance was affected by age while it was not affected by gender. Further, the findings indicate that some of the demographic characters such as household earnings and educational level have a negative relation with risk tolerance of investors while home ownership has a positive relationship with risk tolerance of investors.

Hawley and Fujii (1993) examined the effects of demographic factors on risk tolerance. Employing the ordered logit model, the study finds that education, income and debt are positively associated with risk tolerance, married couples and households headed by a single male seems to be more risk tolerant than similar households headed by a single female. In addition, the findings of this study indicate that age does not significantly relate to risk tolerance; predicted risk tolerance is almost same for all age groups and was increased with education.

Sulaiman (2012) investigated the association between the demographic characteristics and the risk tolerance level of investors. The study finds that education, income and marital status are significantly associated with risk taking capacity of investors.

Ramachandran, Rajeswari & Chinnathambi (2011) studied the factors affecting decision-making and risk perception among 100 investors in equity shares in India. The study finds that gender and religious factors are the most important characteristics in determining the investment decisions.

4. CONCEPTUAL FRAMEWORK

The following conceptual framework has been derived based on the literature review.

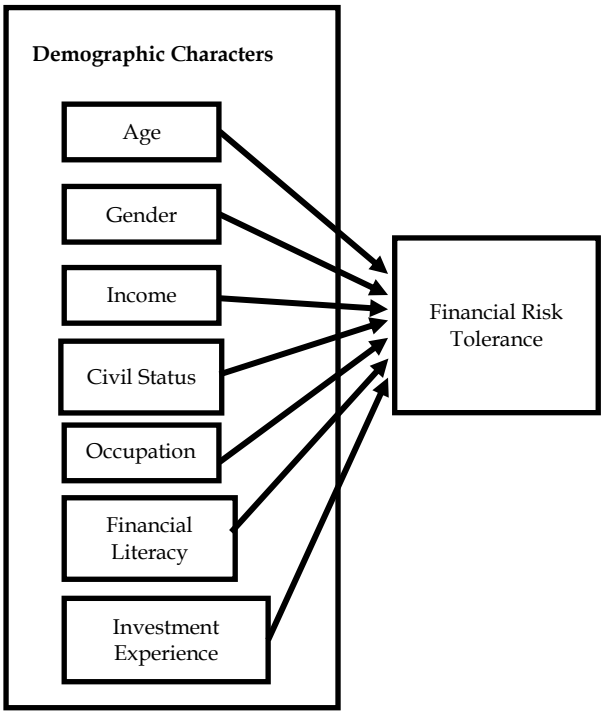

Figure 1. Conceptual framework between demographic characters and financial risk tolerance
Source: Review of literature & authors construction

5. DEVELOPMENT OF HYPOTHESES

The following hypotheses were developed based on the review of literature and conceptual framework.

H_1: There is negative relationship between age of individual investors and their risk tolerance level
H_2: The mean FRT score of Male is higher than female.
H_3: There is positive relationship between income of individual investors and their risk tolerance level.
H_4: There is relationship between civil status of individual investors and their risk tolerance level.
H_5: There is relationship between occupation of individual investors and their risk tolerance level.
H_6: Financial literacy of individual investors has impact on risk tolerance level.
H_7: Investment experience has relation with risk tolerance level.

6. OPERATIONALIZATION OF THE VARIABLES

The variables were operationalized as shown in table 1.

Variable	Measurement	Supportive evidence
Age	Scale	Subramaniam & Athiyaman (2016); Mabalance (2015)
Gender	Nominal	Thanki (2015); Ansari & Phatak, (2017)
Civil status	Nominal	Thanki (2015); Mabalance (2015)
Income	Ordinal	Prasad (2015); Ansari & Phatak (2017)
Occupation	Nominal	Thanki(2015); Subramaniam & Athiyaman (2016)
Financial literacy	Nominal	Ansari & Phatak (2017); Mabalance (2015)
Investment experience	Ordinal	Subramaniam & Athiyaman (2016)
Financial risk tolerance	Index (Score of 10 questions ranging from 20-100 scores)	Gilliam, Chatterjee, & Grable, (2010)

Table 1. Operationalization of variables
Source: Constructed by researchers based on literature review

7. METHODOLOGY

7.1 Sample Size

The target population of this study is household investors, residents and students in Sri Lanka. However, Matale Municipal Council area of Sri Lanka was considered for this study. According to Matale Municipal Council Record (2018), there are 1200 household investors. Using convenience-sampling technique, data were collected from 291 respondents. This is in accordance with Uma Sekaran (2014) who states that there should be 291-sample size when the population exceeds 1000.

7.2 Data Collection Method

A structured questionnaire was used to collect the data. The questionnaire was designed with two parts. The first part was related with the data of demographic variables namely, age, gender, income, civil status, occupation, financial literacy and investment experience and second part was related with questions of risk tolerance i.e. financial risk tolerance.

7.3 Method of Analysis

Both Parametric and non-parametric tests were used to analyze the collected data with the help of Statistical Package for Science Social (SPSS) version of 22.

8. RESULTS AND DISCUSSION

8.1 Reliability Analysis

To measure the reliability of the scale of risk tolerance level, the test of Cronbach's alpha (α) was used. Since the value of Cronbach's Alpha is greater than 0.7 (α = 0.935) sample taken in this study is found to be reliable for further analysis. The table – 2 was developed to show the reliability assessment of financial risk tolerance using the Cronbach's alpha test.

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.936	0.937	10

Table 2. Reliability assessment of financial risk tolerance

8.2 Age and Financial Risk Tolerance

The relationship between Age and FRT was investigated using the Pearson correlation coefficient.

		Financial Risk Tolerance
Age	Pearson Correlation	-0.519*
	Sig.(2-tailed)	0.000
	N	291
*Correlation is significant at the 0.01 level (2-tailed).		

Table 3. Correlation between age and financial risk tolerance

As per the table 3, there is a negative relationship between age and FRT, which is statistically significant with the p value of 0.000 at 1% 2-tailed level of significant. Further, younger investors who are within the age range of 18-25 have the highest risk tolerance level with the mean value of 82.67. On the other hand, the lower FRT mean scores (62.18) are associated with older age group of 55 & above. The data for the level of risk tolerance was presented in table 12.

Therefore, the null hypothesis was rejected and the alternative hypothesis is accepted. This finding is consistent with that of *Inter alia* Dickason & Ferreira (2018); Subramaniam & Athiyaman (2016); Sharma (2006). This finding indicates that younger individuals are more risk tolerant compared to older individuals. In line with above authors, it is believed that younger individuals might have more confident, technical knowledge, IT skills and are therefore more willing to do investments and bear the financial risk. Thus, younger investors are encouraging to take more risk because they may feel that future returns may affect their financial well beings.

8.2 Gender and Financial Risk Tolerance

Independent samples t-test is used to determine the relationship between gender and FRT. The result of the t-test was summarized in table 4. The significance value for the Levene's test for homogeneity of variance is more than 0.05. The p-value for the Levene's test for equality of variance is 0.390. Thus, equality of variances was assumed. The degree of freedom is 291 and the significant p-value of the test is 0.000, which is less than 0.01, therefore it is statistically significant.

	Levene's test for equality of variances		t-test for equality of means	
	F	Sig	Df	Sig.(2-tailed)
FRT Equal variances assumed	0.74	0.39	291	0.000

Table 4. Independent sample t-test for gender and financial risk tolerance

Further, the mean FRT score of Male is 76.76 which is higher than female (mean = 70.51) (see table 11). It can be inferred from the results that there is a significant relationship in mean FRT level between male and female. That is the mean FRT score of Male is higher than female.
Thus, the null hypothesis is rejected and the alternative hypothesis is accepted.

These findings go with that of *Inter alia* Cooper, Kingyens, & Paradi, (2014); Grable (2000); Grable & Lytton (1998); Hawley & Fujii, 1993; Jianakoplos & Bernasek, (1998); Powell & Ansic, (1997). These findings imply that women crave a higher sense of security and are therefore less willing to take on financial risk

8.3 Civil Status and Financial Risk Tolerance

To find the relationship between civil status and FRT independent t-test was used. Table 5 provides the result of the t-test.

The p-value of the independent sample t-test is 0.928, which is higher than at the significant level of 0.05. Further, the mean FRT for single is 75.40 and married is 73.17, which are different from each other (see table 12). However, this value is also statistically insignificant.

It can be inferred from the results that there is no significant relationship in mean FRT level between single and married respondent from the total sample.

Thus, null hypothesis fails to be rejected. This finding goes with that of *Inter alia* Subramaniam & Athiyaman (2016). However, there are different arguments exist. Grable & Joo (2004); Sulaiman(2012); Hallahan et al (2004) found single or unmarried individuals are more risk tolerant. In contrast, Hallahan & McKenzie (2011) concluded that married couples have a greater ability to withstand financial difficulties and are thus likely to have higher FRT. The most common conclusion is that married individuals are less financial risk tolerant compared to single individuals (Faff et al., 2008; Grable & Joo, 2004; Hallahan et al., 2004; Hawley & Fujii, 1993; Yao et al., 2011). Within Sri Lanka, it seems no difference between married and unmarried individual's risk tolerance level. It may be due to the different socio-cultural perspective of Sri Lanka.

	Levene's test for equality of variances		**t-test for equality of means**	
	F	**Sig**	**Df**	**Sig. (2-tailed)**
FRT Equal variances assumed	13.432	0.000	289	0.928

Table 5. Independent sample t-test for civil status and financial risk tolerance

8.4 Income and Financial Risk Tolerance

A one-way ANOVA group analysis of variance was conducted to explore the relationship between income level and FRT. The result of test of homogeneity and one-way ANOVA were presented in Table 6 and table 7 respectively.

Test of Homogeneity of Variances			
Levene Statistic	df1	df2	Sig.
.482	4	286	.688

Table 6. Test of homogeneity of variances

The p-value for the Levene's test for equality of variance is 0.688, which is more than 0.05. Thus, equality of variances assumed. The F-value is 15.7 and the degrees of freedoms are 4 and 286.The p-value of the one-way ANOVA test is 0.000, which is less than 0.01. Hence, at least one pair of means differ significantly. When there is a difference, there is a need to identify the pair(s) that differs significantly. This is done using **post hoc tests.**

Post-hoc comparison is done with the help of figure 2, which indicates that the mean score for the income level below Rs. 360,000 is 63.26. This is significantly different from income level of Rs. 600,000 which shows the mean value as 75.5; Rs. 600,000 - Rs. 840,000 with the men value of 76.06; Rs. 840,000 -Rs. 1,200,000 carrying the mean value of 77.94 and over Rs. 1,200,000 having the mean value of 78.60. These values are also shown in the table 12.

ANOVA					
	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	9529.294	4	2382.324	15.7	0
Within Groups	43397.83	286	151.741		

Table 7. One-way ANOVA for income and financial risk tolerance

This indicates that higher income levels are associated with higher mean FRT score. It can be inferred from the result of post-hoc that higher mean FRT scores are associated with higher income levels for total sample. Thus, the mean FRT are positively related to income levels and since the null hypothesis is rejected.

This finding is similar to the finding of Thanki (2015) and implies that when there is higher annual income individual are motivated towards more investment.

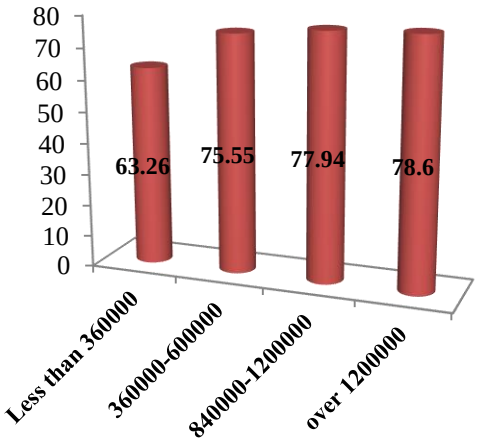

Figure 2. Mean score for income level

8.5 Occupation and Financial Risk tolerance

A chi-square cross tab analysis was conducted to explore the relationship between occupation and FRT. According to the results of Chi-Square tests for occupation and risk tolerance in table 12 test result, SPSS also tells that "3" cells have expected count less than 5 and the minimum expected count is 2.45. The sample size requirement for the chi-square test of independence is satisfied.

The probability of the chi-square test statistic (person chi square is = 18.042), with the p value of 0.114 which is more than alpha level of significance at 0.05. Further, other occupation group indicates highest risk tolerance with mean value of 74.91 as compared to the other groups; however, occupation shows statistically insignificant relationship with FRT.

Chi-Square Tests			
	Value	**Df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	18.042[a]	12	.114
Likelihood Ratio	17.531	12	.131
N of Valid Cases	291		
a. 3 cells (15.0%) have expected count less than 5. The minimum expected count is 2.45.			

Table 8 chi-square tests for occupation and financial risk tolerance

These results show that there is no statistically significant association between occupation and FRT, the null hypothesis is accepted. Which indicates that there is no correlation between occupation and risk tolerance. This finding is consistent with that of *Inter alia* Subramaniam & Athiyaman (2016).

8.6 Financial Literacy and Financial Risk Tolerance

An independent sample t-test was employed to compare the FRT scores between respondents' financial literacy (with and without).

	Levene's test for equality of variances		**t-test for equality of means**	
	F	Sig	Df	Sig.
RT Equal variances assumed	2.902	0.09	289	0.000

Table 9. Independent sample t-test for financial literacy and financial risk tolerance

The p-value of the t-test is 0.000, which is, less than 0.01and therefore it is statistically significant. Further, investors with financial literacy have higher tolerance levels with the mean value of 77.20 (see table 12). The result indicates that there is a significant positive relationship found between financial literacy and risk tolerance level.

Thus, since the mean FRT is positively related to financial literacy and the null hypothesis was rejected. This finding is consistent with that of *Inter alia* Zhuan (2016); Gustafsson & Omark (2015). Moreover, it implied that higher level of financial literacy of investors increases their ability to analyze information and lead them to expend the risk tolerance.

8.5 Investment Experience and Financial Risk Tolerance

A chi-square cross tab analysis was conducted to explore the relationship between investment experience and FRT. The result of the chi-square test was produced in table 10. According to the results of chi-square test, "4" cells have expected count less than 5 and the minimum expected count is 0.05.

Thus, the sample size requirement for the chi-square test of independence is satisfied. The person chi square vale is 74.311 with the p value of 0.000, which is less than the alpha level of significance of 0.01. This shows that there is statistically significant association between investment experience and FRT. Further, Investors with the highest experience have highest risk tolerance as compared to the other groups with the mean score of 88.09 (see table 12). Thus, the null hypothesis was rejected and alternative hypothesis was accepted.

Chi-Square Tests			
	Value	**Df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	74.311[a]	16	.000
Likelihood Ratio	76.619	16	.000
N of Valid Cases	291		
a. 4 cells (16.0%) have expected count less than 5. The minimum expected count is .05.			

Table 10. Chi-square tests for investment experience and financial risk tolerance

This finding is consistent with that of *Inter alia* Subramaniam & Athiyaman(2016); Awais, Laber, Rasheed, & Khursheed, (2016). One of the reason behind this finding might be that the young potential investors have lesser investment opportunity than the older investors. Thus, the investment experience does not affect much on the young potential investors' risk tolerance because they never experience before.

Hypothesis	**Statistical Analysis Technique**	**Results**	
		Significant Values	Hypothesis supported / not supported
H1: Age	Pearson correlation	0.000 (-0.519)	Supported
H2: Gender	t-test	0.000	Supported
H3: Civil Status	t-test	0.928	Not Supported
H4: Income	ANOVA	0.000	Supported
H5: Occupation	Chi-square	0.114	Not Supported
H6: Financial Literacy	t-test	0.000	Supported
H7: Investment Experience	Chi-square	0.000	Supported

Table 11. Relationship between demographics and financial risk tolerance.

Based on the above results and findings of discussion the relationship between demographic factors and investors' financial risk tolerance and the acceptance of hypotheses are summarized in table 11.

Demographic factors		**Number of respondents**	**Percentage**	**Risk tolerance score of descriptive statistic**		
Variable	**Range**			**Mean**	**S.D**	**SIG.**
Age	18-25	39	13.40	82.67	13.253	0.096
	26-35	106	36.43	78.72	10.776	0.200
	36-45	39	13.40	77.69	10.048	0.200
	46-55	62	21.31	67	12.828	0.200
	55 & above	45	15.46	62.18	10.701	0.200
Gender	Male	165	56.70	76.76	12.779	0.004
	Female	126	43.30	70.51	13.668	0.200
Income	Lessthan360000	62	21.31	63.26	11.952	0.200
	360000-600000	58	19.93	75.55	12.42	0.200
	600000-840000	64	21.99	76.06	13.238	0.200
	8400001200000	60	20.62	77.94	11.64	0.200
	over 1200000	47	16.15	78.60	12.222	0.019
Occupation	Self employed	67	22.95	76.09	13.282	0.176
	Private sector employee	54	18.79	72.67	12.261	0.200
	Government sector employee	51	17.47	70.86	14.518	0.200
	Other	119	40.75	74.91	13.589	0.200
Civil status	Single	83	28.52	75.40	14.836	0.200
	Married	208	71.48	73.17	12.518	0.030
Financial Literacy	With FL	235	80.76	77.20	12.299	0.099
	Without FL	56	19.24	60.86	9.959	0.200
Investment experience	Below 1 year	48	16.49	62.87	11.016	0.200
	1-4 years	110	37.80	73.62	13.112	0.200
	4-7 years	110	37.80	76.36	11.8	0.016
	7-10 years	23	7.91	88.09	9.471	0.048

Table 12. Level of risk tolerance

9. CONCLUSION

This paper provides insight into the specific demographic factors and the individual's risk tolerance levels, including the importance of identifying important aspects of the investment and financial decisions faced by individuals.

The findings of the study confirm that there is a strong relationship between investors' demographics and financial risk tolerance. Therefore, the present study approves the belief that demographic characters remain to affect financial risk tolerance of investors. However, civil status and occupation seem to be insignificant in determine the financial risk tolerance of investors. Investors' investment decision thus depends on their demographic characters. Therefore, it is recommended that in order to motivate saving and investment, demographic characters should be considered as an important factor.
The study provided further evidence to the existing literature on demographic characters of individuals and financial risk tolerance levels in Sri Lanka, which is a developing country. The finding of this study could also assist the practitioners to attract more investment based on the individual's demographics.

10. LIMITATIONS AND DIRECTION FOR FURTHER RESEARCH

This study is limited to only one district in Sri Lanka as its sample selection. Thus, the finding could not be generalized for the entire parts of the country. Further, only seven demographic characters of individuals have been considered for this study and the analysis does not focus on the prediction of association between individual demographic characters and FRT level.

Inclusion of more variables such as investors' attitudes, perceptions, with the coverage of all regional investors of Sri Lanka and utilization of advanced statistical analysis could improve the results. Thus, the extension of future studies could incorporate these suggestions.

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AN ANALYSIS OF HINDI FILM STORIES AND ITS ROI

Saleem Javed

Research Scholar
Maharaj Vinayak Global University, Rajasthan, India

The linguistic narration which turned into pictorial narration, and textual heteronomy whose primary symptom is the absence of an integral narrative structure, produced 'all inclusive film structure'. Indian film industry is as heterogeneous and hybrid as any other Film industry in the world and story too occupies a place with other components like anywhere else, even then why majority of the films are not yielding much desired results.

Much has been debated and glorified about 'dominance of a single ideological master narrative', 'observably pervasive of the Indian cultural environment', 'historical contingency' and 'outside influences' and 'frequent borrowings of elements' etc., the debate has been multi-fold and entering in story writing sphere disguising as 'context free' and 'context sensitive'. Despite the fact that the amount of scholarly research in this area is rapidly growing, its impact on practice has not been as significant as in other components. The ever evident narrative literature, the Indian cinematic convention exhibits 'oral' and 'non-literal' mindset till date. Central to the Indian discourse are notions of extravaganza, tamasha, focus on emotions, ecstasy and despair.

The paramount pressure of RoI (Return on Investment) has jolted the knees of film industry more than before because of the polymorphic prerogative, and, sepulchral predicament does not fulcrum. Our way of storytelling needs revision, the explorative approach of this paper is to give a clear and comprehensive account of story structures, returns in terms of economics, blurred and now restructuring causality, and picking shared similar patterns.

Keywords: *Hindi Film Industry, Bollywood, Oral Tradition, RoI, Film Business, Story, Plot Causality, Restructure*

Introduction

The Indian film industry is the world's largest by volume by releasing more than a thousand films each year. But in terms of revenue it doesn't even stand among the top five highest grossing countries in the world. Indian film industry is as heterogeneous and hybrid as any other Film industry in the world and story too occupies a place with other components like anywhere else, even then why majority of the films are not yielding much desired results.

The Hindi film industry which contributes maximum to the box-office revenue as compared to other language films made in India is subjected to criticism for its exceptionally epigonic or formulaic and stereotypical films. The Indian cinematic convention exhibits 'non-literal' mindset till date. These films, however, have their roots in oral and written scriptures and dramatic genres of traditional Indian culture.

The paramount pressure of good return on investment has jolted the knees of film industry more than ever before. Majority of the films are not even able to break even. In this particular case success means financial break-even or better. What factors cause individual films to succeed or to fail? As has been said that success is multi-factorial while failure can be mono-factorial, but it's a wrong notion. Like success the failure can also be multi-factorial. As it is such a large question because each element requires individual attention, in this paper, I preferred sticking to one of the first and basic elements; story. What is intrinsically wrong with our stories (films)? Does our way of storytelling needs revision?

The Indian cinema is as old as non-Euro-American cinematic tradition, which had its first feature film, *Raja Harishchandra* released in 1913. The historical contingency was deployed as the idea of making the first full length feature film came from *The Life of Christ*. As stories frequently migrate from one medium to another, the tale of Raja Harishchandra, for example, was a traditional narrative that became part of the secular nautanki theatre repertoire during the nineteenth century, and in the early twentieth century moved to the cinema where, as mentioned above, it provided the plot for the first Indian-produced and directed film.

When we talk about Indian film as being formulaic, it's not an escapist root but was a necessity during

the times when sound creeps into silent era. As compared to silent era, the transition to sound was not very smooth. The problem was at three levels:

a) It was an economic burden,
b) It was a technological burden and,
c) A new breed of trained actors and writers and other manpower was needed.

As it was already an obvious economic, intellectual and technological suicidal mission and because of sound, therefore the language, the global market shrank to a country or region specific market. Again the traditional model of singing and dancing and having two stars with time tested story comes to rescue. This formula was perfected by Dalsukh M Pancholi – a tycoon from Lahore who produced *Khazanchi* (1941) and its songs were an instant hit. Film songs are often charged to break continuity in space and time. They are not just for the sole purpose of spectacle, but prove to be absolutely functional in terms of narration. It is not only an artful conceived alternation of Hindi, Urdu and English but also offers a way which story is not able to supply.

As India films are charged to be too emotional, one need to understand that esthetical sensibility of a place may differ from another. The emotional content in Indian art or Indian cinema is like a banquet or feast in which there is one overall flavour but in which varieties of feelings and emotions provide the needed texture. The Western sensibility does not appreciate the sudden shifts of *Bhava* – from hasa to shoka or rati – but they provide the much needed emotional diversity which is in sync with traditional Indian narrative style.

Another element that confounds Western critics is what they call the lack of a story in Hindi films or there is no narrative coherence or fragmentary structure. The answer to this question lies with the aesthetic theory of *rāsā* (flavour) on which classical Indian theatre is based. According to this theory what counts for the audience are the emotion, and not so much "what" and "how" it happens, the emotional element can only be accentuated when there is a predictable narrative development. If plot is only a conventional succession of events then Hindi films are all about emotional, aesthetical and spiritual revelation. It is about the characters – the complexity of people and their contradictory or paradoxical nature, the way they love each other and hurt one another and suddenly come face to face with themselves. Westerners criticise the stereotypical characters of Hindi cinema like if the actor's name is Ram so he has to be '*maryadapurshotam*' but here is where they miss the point that it had never been about the maryadapurshotam, but was about the '*purushartha*', it's about the *Karma* not the *bhagya*.

If you really want to highlight your hero, you need to have a powerful villain. In Hindi films the villain is frequently supported by accomplices but there is less interaction among these characters as compared to heroic clan. It tends to lend the tendency of making the villain a two-dimensional character where as he/she needs to be three-dimensional. There is no story of the villain and as he/she has his/her first entry, they are at the peak of their career. As the film progresses and the villain comes in full force after the intermission, he/she only moves a notch or two up in their character graph and towards the end of the beat sheet, they are bound to be either dead or captured, in most of the cases they die. Supporting villains have a number of categories like vamps, comic villains and strong-arm or the one who a minor character and for some petty reason betrayed the hero or his father. In most of the cases the comic villains are reformed and the fate of the vamp depends on what kind of a relation she shares with the protagonist. They too are round character and a small back story will enhance the subplot of the film.

The relative lack of organic form or the plot to be considered of secondary importance does not have to do with the classical structure of narration, but the production style adopted in the Indian film industry where there is no coordination among various authors. Part of it is also shared by the government, for its apathy towards the industry. Westerners love to tell short stories and therefore it becomes necessary for them to get into the nitty-gritty of human emotion and we as Indian love to tell epic stories therefore it become episodic in nature.

Not only in India, but Egyptians, Greeks, Romans, Jews and Chinese have had a culture of storytelling which passed on from generation to generation, with addition and subtraction as per the geographical need. Stories always moved liberally. As Shenghuan Xu put in his article "On the transmutation of texts": "The sense of time is one of the earliest concepts formed in human minds... Therefore, temporal order has been the primitive sequence for the texts human beings to perceive and describe the world." The typical integrity of a story lies in the balance between opposite elements, and help to reconcile the opposite elements like the balance between good and bad in Indian tradition, the harmony between yin and yang in Chinese culture, the equilibrium of forces in Egyptian, Greeks and Roman stories etc. Christianity and Islam did not have their own set of stories and therefore the initial stories have references from Jewish and other geographically nearby countries.

But what was the need to borrow the stories, the answer lies in the fact that human beings have always told stories. It is the most important thing which makes us who we are and distinguishes us from other creatures on the planet.

Though film making is a modern enterprise in terms of aesthetical, technological and economical aspects, in case of Hindi films there is a direct connection with the large body of epic stories that exist in oral and written form, and the continued use of these traditional elements greatly contributes in the ongoing popularity of Hindi films. The elements of *nautanki*, *Khyal*, *manch*, *bhavai* are liberally used in conveying a story. Even these forms have gathered their material from many sources: the *Mahābhārata*, *Rāmāyaṇa, Pañcatantra*, *Purnas* and other Indian legends, Arabic and Persian tales, historic incidents and characters. Aesop fables, Arabian Nights, Sindbad and more than half of the western nursery rhymes and Ballads have their origin in *Pañcatantra* and *Jatak* stories (Dudes 1995).

One of the unique features of the old India literature that has dominated the narrative text is the frame story. It is a narrative method whereby a main narrative framework is composed so as to organize a set of stories within. Each of these stores is a story within a story. In terms of psychology it is to say that there is conscious, subconscious and unconscious, but it is about mind at the same time about one's personality, identity and memories. If one wants to collect several narrative structures within one, the solution has always been the frame.

Pañcatantra, narrated by Pandit Vishnusharma, is a group of seventy two stories divided in five chapters and each chapter has a basic frame story containing other stories within. All these short stories in a basic frame story have a purpose. Though they arise from a common centre but they are different from each other. So these stories can be told as independent different stories but if looked into the context they have some other meaning to offer. The trick of open ended ending is used and the end of one story becomes the starting point of the next story. In the story of monkey and crocodile while finishing the story if one says – people who are hungry stoop to any level like Priyadarsana. The croc asked him to tell the story of priyadarsana (close ended and yet open ended).

Now, in a way the Jataka, the Mahabharata and the Panchatantra initiated a kind of frame-narrative tradition, with authors throughout the world, till today, emulating this method. It spread and became popular throughout the world because of its inherent structure and flexibility. These different imitations in the distant cultures truly suggest the universality of the Indian frame narrative form, which was meant to be used originally for the fables.

Many films tends to achieve the effect of originality and individuality by using the devices like flashback, flash-forward, homodiegetic or hetrodiegetic or direct opening to the climax as the film starts or surprise ending. This originality and individuality has long been explored and perfected to the core in many epics, puranas and pan-Indian tales. Vyāsa (the author) in *Mahābhārata* operates on several narrative levels and the beauty is that even "the author" is not able to change the course of the plot with his interventions as a character.

Review of Literature

Virpi Hameen-Anttila (2018) in her extensive paper 'To Make the Short Story Long: The Development of the Frame-Story Structure in Sanskrit Narrative' not only investigates the first frame in Vedic literature and follows the development but also offers a comprehensive study material of the history of frame in India. What is interesting and very much informative aspect of the paper is that it offers a structural solution of some of the problems which has not been addressed for a long period of time. It rightfully brings out the empirical structures for narrator and narrative levels and offers some of structures in an insightful manner. She restructures the frames as per her understanding and geographic sensibility. What is unique about this paper is towards the end, the master model, which offers an alternative version for already existing known frame technique. But it fails to capture the recent development of other narrative styles which are very much in use by the time this paper was published. It does not talk about one of the most prominent structure that being the cyclical stories: be it Mahabharata or Ramayana, if you look closely they all are, at the deep level, cyclical in nature. It ends where it started but the characters or even the narrator who is at three levels (as it talks about Vyāsa) is not the same. Though the balance is restored but it's not the same as it was in the beginning or in the opening image. It is the equilibrium which is balanced but not the same counterpoise.

Yujun Liu (2017) in the paper titled *'Similarities and Differences of the Narrative Structure of Western and Chinese Short Narratives'* tried to analyze the narrative structure by choosing twelve Chinese and ten English short narrative from ancient to modern times and trying to establish the similarities thus the validation of the West. Though I have consulted this paper briefly, the major problem that I found out with this paper was that the paper tried very hard to prove that the Chinese stories, from a specific date onwards – as

mentioned in the paper, are on the similar lines as of its western counterpart. As it is one the questions that I have raised in my paper, why do we need to have the approval? Different countries can have different sensibilities and ways of saying the similar stories. Why not to stick to our own style of storytelling?

Sabrina Ciolfi (2012) in her paper *'Popular Hindi Cinema: Narrative Structures and Points of Continuity with the Tradition'* investigates how the long history of Hindi cinema has kept its pace with all the new styles of storytelling and remained true to its essential characteristics and in many ways resisted the cultural imperialism. She did raise some of the common questions with which Indian cinema has always been attacked and tried to explain that otherwise considered as the shortcomings for a non-European film industry is actually the strength of Indian film industry style of storytelling. She did explore the different verities of cultural forms and other traditions of storytelling still existing in some form or the other but it become hard to find out the practical examples for some of the claims she has offered through this paper. Her claim that traditional happy ending in popular Hindi cinema provides the opportunity to extol the traditional value may have been true for most of the films a decade ago but in current scenario the protagonist may end up what he/she wished for but now they pay the price for it (one of the latest development in Hindi film story writing style).

Research Methodology

The paper evaluates the long lost traditional of Indian story telling practices and structure which lasted for centuries on its merit. Though contemporary Hindi cinema swears to use it but has lost its original track in following the core of it. To differentiate between the two prefixed sets of Hindi film periods, content analysis has been opted. The first set exhibits the tradition story sets of golden age of Hindi cinema while the second set comprised of the postmodern cinema. The paper tried to explore and compare the difference between these two sets and tried to bring out the elements that need to be addressed on the argent basis. The tradition elements which were very much evident till the end of golden year of Hindi film lost its sheen during the following decades and it jolted the knees of Hindi film industry and it kept on losing in the world market. Had these traditional elements been clutched upon, we could have been in better position in terms of revenue too.

Conclusion

As this paper tries to establish the point that if we reinvestigate our pre-established perfected story structure, we may convert this understanding into better box office collection for Indian film industry. Would you not notice the point that the story structure of feature film Hatim Tai (1956 and 1990) had seven questions to be answered to bring back Gulnar Pari and as each question is answered, a part of Gulnar Pari comes back to life? Now compare this story structure with Harry Potter franchise films where seven horcruxes need to be destroyed in order to kill Voldemort. I am not at all suggesting that J K Rowling borrowed this structure for her books but not only this but many more and also different story structures exist in oral and written documents from the past which are now known worldwide. As long as the stories remain true to the soil or indigenous, they will be unique. One may make *Million Dollar Baby* (2004) in any part of the world, but to make *Dangal* (2016) you will have to come to India. Baahubali 2 (2017) opened on more than 7,000 screens in China only and the success story of Andhadhun (2018) needs no proof. The RoI against its investment is a testimony. To name a few, the mega story structures like Sinhasan Battisi, Vikram Aur Betaal, Sindbad, Arabian Nights, *Mahābhārata*, *Rāmāyaṇa, Pañcatantra,* and stories from *Purnas* are to be told again but with a difference.

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NARRATING LOCAL MEDICINE IN COLONIAL ODISHA: SOME ASPECTS OF TRIBAL HEALTH & EPIDEMIC DISEASES

Dr. Susanta Barik

Assistant Professor in History, Department of History & Archaeology
Fakir Mohan University

Abstract: Odisha was a tribal dominated state. The most of people are tribals which inhabited in hill areas. Important tribes were Kandhas, Santals, Mundas, Gadbas, Hos, Bhuyans, Koyas, Juangas, Parajas, Sauras, Kols, Bhumijs, and the Bondas. The tribes of Orissa, their economy and colonial organization as well as belief and practice bear great similarity in the area. The changes and shifts of tribal life reflected in the indigenous disease, health and medicine in the state. The indigenous communities had the vision to develop health relating to disease and medicine. The aspect of health was considered vital and gave more importance to the medicine men and women. The tribal aspects of disease were specifically based on magic, spirits and ghosts. It found that God sent diseases because the Earth was getting over crowded by human beings. The Didayis felt that *Mapru* (God) sent epidemics to earth in order to prevent it from over population. In this paper I have focused to analyze various diseases and their methods of eradication. The tribals of Odisha attacked by various disease like Small Pox, Cholera, Kalazar and Malaria during colonial period. But their practices basically depended on god and goddess for removal of diseases. So in this article I focused on what the colonial government intervened in tribal health and what are the responses of tribal people.

Keywords: *Tribal Disease, Medicine, Colonial Government, Epidemics Diseases*

'In English it calls Hospital
In Hindi *Hospatal*
In Odia it called *daktarkhana*
But whatever its name it really means disease and death'

Introduction

The emergence of social history of medicine as a field of historical inquiry can be traced back to the founding of the Society for the Social History of Medicine in 1970s[1] in Great Britain. Today, with the development of Preventive and Social Medicine as a new branch of medicine and new social history as an important field of social science research, the social history of medicine has attained new dimensions. No wonder research in the social history of medicine covers a wide range of subjects which include not only aspects of health disease and medical care but also attitudes to illness, medical thought and treatment, systems of medical care, the cultural roots of medicine, epidemic diseases and mortality, public health policy, etc. The concept of public health evolved in Great Britain in the eighteenth century as a consequence of the impact of the industrial revolution and its attendant problems − slums, accumulation of refuse and human excreta, overcrowding and a variety of social problems. Frequent outbreaks of cholera, Chadwick's 1842 Report, which highlighted the pitiable sanitary conditions of the labouring population, the realization that filth and garbage are the greatest enemies of humankind. When Public Health Act introduced in England in 1848, the technique of sanitary awakening treatment developed. By the time the more comprehensive Public Health Act 1875 came to be passed it was an acceptance of the principle that the state is responsible for the health of the people.[2]

Public health in the nineteenth century was primarily concerned with sanitary Regulations and organisation of medical relief during outbreak of epidemic diseases. However, during the early decades of the twentieth century it included a lot more than mere sanitary measures.The British government introduced various measures to consolidate its base in India. The reaction was seen in every aspect of life from the Indian people. This study tries to locate this contradiction between the British state and the Indian people. Tribal Medicines are medicinal system followed by various tribes of different regions of countries. It is accepted fact that the tribes all over the world owning their own culture based on that they developed their own system of medical practices, which are being addressed as folk and ethno-medicines. There are numerous herbs available in their surroundings and that herbs are being used by tribal community as food and medicine for curing their diseases. They have been continued to live in forest environment since from many generations and developed their own knowledge on flora and fauna of the forest that are known as folk or

indigenous knowledge. At the same time they have also developed their own folk beliefs based on their traditional practices which would help them in curing various forms of diseases. The beliefs and practices related to curing disease which are based on unwritten knowledge are carried from generation to generation through the practitioners. The common belief, customs, practices related to health and disease in turn influences the health seeking behavior of the community. Tribal groups are homogeneous culturally and developed strong magico-religious health care systems and they wish to survive in this own way.[3]

In India the tribal population constitute 8 percent. The largest number of tribal communities inhabited in Odisha i.e. 62 tribal groups were living in remote areas and out of which 13 were identified as primitive tribal groups (PTGs). According to 2001 Census Report this group constitute 8.15 million (22.3% of the total population of the state). Important tribes were Kandhas, Gond, Santals, Mundas, Gadbas, Hos, Bhuyans, Koyas, Juangas, Parajas, Sauras, Kols, Bhumijs, and the Bondas. All the tribal communities were mostly inhabited in North Western and South Western district of Odisha. Out of 62 tribal communities, the largest number of tribal was Kondha/ Khond which constituted 17.1 per cent of the total Schedule Tribe (ST) population.[4]

How did the tribal population locate disease? Colonial discourse

Biswamoy Pati(1998) narrated an important perspective to understand the indigenous communities/tribal conception of health relating to disease and medicine. He collected variety of sources including the rich oral tradition of the tribal communities and their views relating issues of health, disease and medicine. He had interpreted disease and illness in the context of Colonization and the role of tribal and non-tribal communities to relating to illness.[5] His work draws a dynamic framework how tribal people invented new gods and goddesses to deals with diseases. The tribes of Orissa, their economy and colonial organization as well as belief and practice bear great similarity in the area. The changes and shifts of tribal life reflected in the indigenous disease, health and medicine in the state. The aspect of health was considered vital and gave more importance to the medicine men and women. The tribal aspects of disease were specifically based on magic, spirits and ghosts. He documented in his work how Souras invented new God called *Sahibosum.* To deal with cholera, wooden images of this God were carved and sacrifices were offered to her for removal of diseases. Another belief was that God sent diseases because the Earth was getting over crowded by human beings. The Didayis felt that *Mapru* (God) sent epidemics to earth in order to prevent it from over population. Some tribals believe that disease was caused by the ghost. The Godbas, linked leprosy to the *duma* (ghost) of a god. If a man or woman died, the people accepted the negative (evil) aspect of the ghost of the gods. In all of these good and evil aspects that ghosts were the ultimate source of disease. The Santal tribes believe that if a *bonga*(evil spirit) fell in love with human being madness was being caused. The Mundas believed that madness was caused by one's own *bhoot*(spirit) when it attacked. The Hos connected it to the bonga which struck when it injured. In the same way, insanity was also seen as a hereditary disease. The Kandhas saw it as an excess of bile in the head and child inherited from his/her parents. It would be cured by the cooling of the head.[6]

Among the Kuttia Kandha tribes, Pijjumunda was the name of the water place in Saphaganna .JaonraPinnu lived there. Whenever the people of that area suffered from headache, cold, cough, fever and gonorrhea Jaonra Pinnu gave them medicine and they recovered. One day a man attacked by small pox on her forehead , A Vaidya said there is no need for medicine but eat salt and chilli, fish and meat every day and soon there will be a discharge from your swelling and will recover. When a man had wound, he eats plenty of meat and fish and he recovered. The following folk tale of the Kuttia Kandhas illustrated below:

> "*When the Sun god began to go round the earth he was disgusted to see men relieving themselves in the early mornings. One day he decided to punish them since they insulted him by pointing their organs at his face, although he gave the light. The next day he climbed into the sky with a flower. When he saw jagat Kandha relieving himself he threw the flower on him and said, Go and became syphilis, the scorpion disease. Fifteen days later Jagat fell ill and the sun god was very pleased. He said to the disease, 'Became a fly and go in to the rebels of many men.'*"[7]

In this Folk tale, we have found that the angry/insulted god striking to the disease Syphilis. This conceptualized that the notion of uncleanness that suggest the degree of Hinduisation. It also stated that there was a connection between Syphilis and man.

Thus, some areas illness and disease related to the process of colonialism. In fact, the Saura tribal's invented a new god called *Sahibosum*. Their sahib god was forest guard and policeman carrying cholera with him. The Sauras carved wooden

images in his honor and placed them outside of their villages. It was called as a 'Aeroplane god of the Sauras" who was responsible for disease constipation. The practices were mostly found in Ganjam District. Not only was he worshiped but also offered sacrifices. In the Saura tribals, one day a *pana* had no children by her many years, then together went to the Maskan Mountain. They begged the god for a gift and God gave the women a flower of seven colours, when she ate she conceived and got a son.[8]

Pati's works also reflected how disease was attributed to plural factors and it dealt with plurality of healing practices. The Kandhas identified smallpox around the early decades of the nineteenth century as a disease caused by *Joogah Pennoo*, the god of smallpox. *Joogah Pennoo* sowed small pox as men sowed seeds upon earth. The Kandhas offered buffaloes, hogs, and sheep to appease the small pox god. Kandhas of Orissa started process to prevent Joogah Pennoo from reaching their villages. The Kandhas also resorted to meriah sacrifice. This sacrifice was made to protect them from diseases. In November 1860, the worship of Kandhas goddess made by Jagooah Pojaree at Karanjia. Here they have realized that the problem of small pox was due to the presence of Piakas (martial caste which involved in agriculture).[9]

Several of the Kandhas were reduced to poverty and some had to mortgage their children in order to meet the demands of the inoculators to get themselves and their families inoculated. The state also witnessed the invention of Dharma Pinnu-their small pox goddess by the Kuttia Kandhas to cope with the disease. *Dharma Pinnu* was seen as the source of small pox and worshiped in all agricultural forests. What is interesting in that she was worshiped as an Oriya Goddess and lived in luxurious? Ceremonies were performed in her honor just before the sowing in the hill clearings. The invocations at her special ceremony were made in Oriya and the offerings that were made were not only of rice, beer but also milk, ghee, rice and mohwa (guava). When the small pox was virulent, saffron-stained rice representing every soul in the village was placed. After numerous offerings it was dragged with the necessary ceremonies to the boundary of the village. Through this influence the small pox deity was not crossed the village limits.[10]

David Hardiman also observed that when small pox deities reached in the particular region, A large basket was filled with cooked rice and red powder. This was thrown the border of the village and passed village to village for preventing small pox goddess. Besides of this another method also applied to please small pox goddess and offering sweet drink called *pana.* Through this it was optimistic that goddess will leave the village without attacking to people. The same method also applicable in case of goddess of chicken pox, cholera, measles and the plague epidemic. However, we get a reference from Gangpur(a princely state) in 1870 that when a small pox broke out the king sent a official named Gajendra Babu to look into the matter of small pox.[11]

Another believes among the tribal's that God sent epidemics disease in earth for overcrowding by human beings. The Didayis also believed that *Mapru* (god) sent epidemics to earth to prevent from being overpopulated. It also believed that hungry gods came down to earth to obtain offerings from devotee because human beings were the source of disease.[12]

It was identified that some tribal's believed diseases were occurred by ghosts of Gods. The Gadbas also strongly believed that the disease Leprosy was caused by *Duma* (ghost) of a god. The Santals also invented a new God bonga (evil spirit) related to insanity. They had a perception that if a man affected by insanity because of *bonga* fell in love with human being.[13] The Mundas and Hos tribes also believed that insanity was caused by its owns *bhoot* (ghost). Some places of Odisha also reported that insanity was hereditary disease.

Picture No.1

A so called witch was being cured of evil possession during a ceremony in Odisha.

Source: www.govermentofodisha.com

A similar traditional ceremony has been performed in Gujarat region that most villagers believe that the disease was caused by the small pox goddess Sitala Devi. The goddess was worshiped in public places such as cross roads outside the village or in the house of the person who was suffering from the disease. She was represented by a metal (lota) drinking pot on the neck of which was placed a coconut. A woman also represented the goddess and she was worshiped. A common practice was to persuade her through offerings of food and sacrificial victims to leave the village. A large basket of cooked rice and red powder was placed in border of the village where she buried. In some cases the basket immersed in the sea. Another method was that the offering to the small pox goddess was sweet drink called *pana*. Through this, the goddess would leave the village without any attack of disease. In fact, this method has been adopted to leave the goddess of small pox, cholera, measles and the plague epidemic. However, the way small pox polarized gender tensions in indigenous societies are rather striking. A report was collected in 1870s from Gangpur, (a princely state) when small pox broke out in *Kurumke*l village. When small pox broke out in *kurumkeli* it was attributed to witches and the village head man sent four "witch finders" who located four women. The village headman sent a report to the Raja (king) that sent officials like Gajendra Babu to investigate the problem and ordered all witches to restrain from any mischief and restore peace in the village. Later a small amount of hair was cut from their head of each of the four women who had been identified as witches and ghosts. Then the four women were tied to posts and after being questioned and they were ritually tortured. One woman denied that she was a witch and she was beaten with the green stalk of a castor plant. After about half dozen blows, she confessed to being a witch and fainted on being released. Another woman had to go through the same ordeal and both of them died - one the next day and the other a few days later. Of the other two, one admitted that she was a witch and gave the names of the spirits responsible for the outbreak of small pox, whereas the other denied any knowledge of witchcraft.[14]

Picture. No.2.
Members of the Dongria Kondh tribe perform rituals on a woman believed to be a witch. Women remain worst-affected by the act of witch-hunting across the state:

Source: www.govermentofodisha.com

Table No. 1

The herbs used by the indigenous people in the Koraput district

Herbs	Scientific name	Disease
Kochila	-------	Kalazar
Chadoigudi	Hemidesmus	Black-water fever
Kochila seed	---------	Malaria
Patalagaruda root	Rauwolfia Serpentina	Snake-bite
Range Charo	Sesalania Pemicea	Inflammation due to food poisoning, eye/ear diseases, dysentery, gonorrhoea and erysipelas
Bela	----------	Dysentery
Buin	Nimba Gentiana	Constipation

Source: Nilamani Senapati and N.K.Sahu, Orissa District Gazetteers; Koraput, Cuttack, 1966, p.114

Disease and female body

Another serious problem was that associated with the female body. A female was always feared of trauma and child birth. Bonda woman was very normal when she was pregnant. But given the uncertainties of child bearing, they depended on a host of charms and magic spells to get the child out of the mother's womb. The impact of colonialism seems the invention of some gods. Thereafter and Pana a (ritualistic drink) were offered to small pox deity not to cross the village limits. The indigenous tribal society was consolidated its patriarchal position with the outbreak of small pox, popular tribal cosmology has been identified in colonial period. People closely associated these gods with a wide variety of things and consequently they had to be feared, admired, revered, appeased and say sweet words to leave them in place. Some of the Goddess had emerged in the state with the process of Hinduisation. The emergence of small pox goddess in the state is first and foremost. Mohwa (liquor) illustrates its inner tensions and contradictions. The question of ritually torturing witches and symbolically cutting of their hair, it was selective targeting of female identity.[15]

Colonial Intervention & Vaccination

After colonization of Odisha after 1803, they have firstly intervened health and disease in colonial Odisha. Puri emerged as a metaphor for disease and death. They have regarded as Puri was "valley of death" where dead bodies of cholera victims are lying and vultures feasting to them. However, British looking to unhealthy condition of Puri they established the Puri Pilgrim Hospital in 1836. Another development occurred that the census operation started which identified categories of people birth and dead viz, insane, idiots, deaf and dumb, blind, and lepers.[16] They have identified the time when epidemic struck (small pox- from January to mid-April; Cholera – from June to August; dysentery, Malaria and elephantiasis-from beginning to the end of the rains).[17]

By the intervention of colonial administration in state, there was shifts and changes in the second half the nineteenth century. The Kandhas of Panigooda and Guddapoor practised to prevent small pox through inoculation. Some of the Kandhas also mortgaged their children in order to meet the the demands of Inoculators for their family inculcation. Subsequently Government official like Captain Mcneill send 'sircar' for vaccination process. When a child got fever, it confirmed that the goddess *sitala* had possess in his/her body. For the removal of diseases a ritual also arranged for the appease to goddess by offerings of coconuts, curd cheese, plantain rice and vermilion. The child was treated very gently and fed rice, dal and fried plantain to pleasing goddess. There were hereditary outcaste's *panas* who performed this role for the inoculations. The system of inoculation work performed by the hereditary *tikadars (inoculators*)[18] and it was also compulsory to follow the same occupation in particular family. The vaccination drive was also taken by Cuttack Mission Press. In this vaccination drive only sahib were supported, whereas the Murkhas (uneducated) and the agyani (ignorant) people did not like the vaccination. It also reported that it was the duty of all to convince to people for the usefulness of vaccination. Women were mostly hesitated to get the vaccination. Leprosy was also another area which colonial government directly interfered.[19] They established various centres at Puri, Sambalpur,[20] Deogarh and Princly states of Mayurbhanja in the early years of the twentieth century. The colonial health administration identified that leprosy being communicated by the bacillus which badly consumption of cured fish as source.[21]

Table.2.
This table shows vaccination programme in princely states.

Year	Number of Vaccinations	Number of Re-vaccinations
1906-07	165,967	43,498
1912-13	387,190	215,438
1917-18	526,410	330,938

Source: Based on S. N. Tiwary, Annual Statistical returns and short notes in vaccination in Bihar and Orissa for the year 1918-19, Patna.

Response of Tribal People

The response of tribal people from the very beginning was pessimistic, neutral, protective and negative towards colonial administration. Gradually they have changed their practices towards colonial power and knowledge and science and technology. The dislocations affecting the indigenous societies got reflected in the perceptions that we have sought to highlight. The symbols of colonialism seem fairly obvious in the invention of certain gods. Furthermore, popular tribal cosmology also identified colonial agencies and officials with the world of these gods. They belonged to the order associated with a wide variety of things and consequently they had to be

feared, admired, revered, appeased and also coaxed to leave them in peace.

Discussion or Summary

The indigenous tribal society consolidated its patriarchal position with the outbreak of small pox. The question of ritually torturing witches and symbolically cutting off some of their hair in order to deprive them of their power a selective targeting of female identity. The issue of witchcraft seems to have enjoyed a fairly wide acceptance. We have sought to highlight the processes and the complexities generated by the interactions between colonialism, the adivasi and the non-tribal population and the bearing they had on the issues of health and medicine. After colonial intervention, the custom, belief practices declined in tribal areas and moreover, one has to also keep in mind the attempt to resist vaccination by the colonial authorities and first try out the alternatives available from the plains, as in the case of the Kandhas of Subarnaghurry. A virtually similar picture emerges when it comes to the tribal approach to the non-tribal people from the plains, some of whom were distinctly associated with their exploitation. A lot needs to be learnt indigenous experience from them.

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