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Contents

Focus

Research Productivity of Healthcare Professionals in India

MANUEL RAJ AND A. AMUDAVALLI

There are several opinions concerning the best Health Science programs and their most productive researchers. These opinion studies have originated on several criteria, of which literary productivity—based performance analysis of an individual, institution, and country or world are largely reported. The current article is one such. To review the status of the literary productivity of Healthcare Professionals in India, a case study approach based on the research activity of the faculty and students at Christian Medical College Vellore (CMC) being one of the premier, century old and world-renowned institutions of education and research in Medical Sciences in India was undertaken. This article is the outcome of the research report which attempted to measure the magnitude of the Indian status of the Health Science programs and productivity scaling the literature emanating from the varied Departments/ Disciplines at CMC. The dataset of this analysis scores around of the publications of the CMC faculty during the period from 1976 to 2014. The research data was gathered from the online databases PubMed (National Library of Medicine USA [NLM]); EMBASE&Scopus (Elsevier); and Web of Science (Thomson Reuters). The analysis leads to the major finding that the largest amount of publications over the period in the three disciplines includes: Clinical Haematology, Genito-urinary Surgery and Microbiology. Analysis also indicates a greater growth pattern of productivity in Neurology, Gastroenterology, Microbiology, Paediatrics, General Medicine and General Surgery. It is also confirmed that Indian medical literature is reported largely in Indian medical journals (7/10) and only in three international journals amongst the top-ranked 10 source journals. All these top 10 are ascertained to have high impact factor and also core journals in the discipline. The top-ranked journals are the Lancet, and the International Journal of Leprosy and Blood. To sum up, it can be said that visibility of Indian medical literature is low in the world's map of productivity. It is suggested that an increase in the R&D efforts by the Indian medical research group to reach more of highly ranked international journals is warranted.

Dr. P. Manuel Raj, Lecturer & Head of Library Systems, University of Dammam, Saudi Arabia. Dr. A. Amudavalli, Professor & Head, DLIS, University of Madras, Chennai-5. This study is an outcome of the doctoral research work of the first author under the supervision of the second author.

Introduction

Scientific research is one of the essential missions of any medical institution and medical centres. The quality of research requires faculty members with good research academic records and requires enough research funding. These were available in most of the medical schools and centres in the developed world, and India still comes under the developing countries, and many of the medical faculty do not receive the adequate facility and research funding. Biomedical research productivity ranges from very low in some developing countries to very high in economically developed countries. India tremendously improved its international ranking positions in research productivity during the period 2004–2014, based on the 2015 Scimago Journal and Country Rank (SJR) overall research productivity India ranked 9th and ranked 12th in the Medical research productivity.

High research productivity enhances quality of research and teaching effectiveness. This includes the ability to organize one's thoughts and to communicate well. Scientific productivity has been linked to various factors, such as age and subject specialization, and economic indicators, such as government expenditure on civil research and development. The criteria used for ranking performance of an individual or institution or country range from opinion surveys to measures of research productivity by publication counts in a sample of reputable journals. Several studies have reported the evaluation of research output and scientific publication globally for different regions, particular medical schools, and even for individual scientists (Rahman and Fukui, 249–80; Uthman O.A. and M.B. Uthman, 46). These analyses rely on identifying and then assessing articles published in bibliographic databases, which are principally designed for use by clinicians, academicians and others to search for and retrieve articles. Bibliometric analyses, therefore, represent a secondary use of these databases and are faced by some technical and interpretative issues (Wallin, 261–275). Bibliometric methods provide quantitative measures that serve, as Wallin puts it, 'to transform something intangible into a manageable entity' (Wallin, 261).

Objectives

This paper attempts to project the status of the research productivity of Indian Healthcare professionals through a case study approach of assessing the productivity pattern of the faculty at Christian Medical College (CMC), Vellore, Tamil Nadu. This study results in identifying the major disciplines in the field of health care; and the status (quality) the source journals in which the Indian Healthcare professionals report their research findings.

Methods

All the journal literature carrying the articles published by the faculty of Christian Medical College Vellore, from 1976 to 2014 and reported in *PubMed, EMBASE, Scopus* and *Web of Science* are included for analysis. Since CMC, being one of the premier, century-old and world-renowned institution of education and research in Medical Sciences in India was considered confidently to represent the medical productivity pattern of India.

The data extract used with the structured search query which focused the affiliation fields in all the chosen four databases. For better and quick download of the selected records, *EndNote X5 Reference Manager* using specified *'Z39.50 Connection Files'* was adopted for all the 3 databases, namely *PubMed*, *Web of Science* and *EMBASE*. Since *Scopus* e does not provide the Z39.50 data extraction a separate search was made for the *Scopus* Database through *Sciverse Scopus* Platform provided by *Elsevier*, and the records have been downloaded as a '.RIS' file format and exported the same to *EndNote X5*. These records were compiled and verified for duplication and removed the duplicate records exported *to Microsoft Access* for further analysis. For the purpose of analysis, the working Microsoft Access database was exported to text file or other file format like *Excel*. To identify the discipline; i.e., department publication the all the articles affiliation were collected. To ascertain the impact factor of the top ranked journals *Journal Citation Report (JCR)* Online was employed.

Inferences

The quantum of scholarly output of CMC for the period 1976 to 2014 is found to be 7,742 articles. The research productivity of the disciplines may vary depending on their nature of subject and research programmes. Hence, a study of scientific output is considered to be a prime measure of any scholarly productivity analysis of CMC. The findings are as presented in Table 1.

As per this analysis, Neurological Sciences rank the highest of total research output (10.19). The second in order is recorded by Medical Gastroenterology (582 articles) with 7.52 per cent; and Microbiology contributing 483 articles with 6.24 per cent of total scientific research output holds the 3rd position. Paediatrics scores 4th rank

Table 1: Distributionof Medical Literary Productivity by Discipline

Rank	Sub-Disciplines	Article Count	Percen-tage	Cumulative Percentage
1	Neurology	789	10.19	10.19
2	Medical Gastroenterology	582	7.52	17.71
3	Microbiology	483	6.24	23.95
4	Paediatrics	478	6.17	30.12
5	General Medicine	470	6.07	36.19
6	General Surgery	453	5.85	42.04
7	Clinical Haematology	443	5.72	47.77
8	Psychiatry	337	4.35	52.12
9	Virology	314	4.06	56.17
10	Genito-Urinary Surgery	298	3.85	60.02
11	Pathology	206	2.66	62.68
12	Radio diagnosis	184	2.38	65.06
13	Cardiology	178	2.30	67.36
14	Biochemistry	162	2.09	69.45
15	Ophthalmology	157	2.03	71.48
16	Pharmacology & Clinical Pharmacology	156	2.01	73.50
17	Nephrology	145	1.87	75.37
18	Hand & Leprosy Reconstructive Surgery	135	1.74	77.11
19	Biostatistics	123	1.59	78.70
20	Endocrinology	113	1.46	80.16
21	Obstetrics & Gynaecology	110	1.42	81.58
22	Anaesthesiology	109	1.41	82.99
23	Physiology	105	1.36	84.35
24	Orthopaedic Surgery	94	1.21	85.56
25	Cardio Vascular & Thoracic Surgery	86	1.11	86.67
26	Anatomy	85	1.10	87.77
27	Dermatology, Venereology & Leprosy	79	1.02	88.79
28	Clinical Immunology And Rheumatology	77	0.99	89.78
29	Medical Oncology	68	0.88	90.66
30	Oto-Rhino-Laryngology, Speech And Hearing	58	0.75	91.41
31	Clinical Biochemistry	57	0.74	92.15
32	Pediatric Surgery	51	0.66	92.81
33	Neurosurgery	49	0.63	93.44
34	Plastic Surgery & Reconstructive Surgery	45	0.58	94.02
35	Transfusion Medicine & Immunohaematology	42	0.54	94.56
36	Pulmonary Medicine	40	0.52	95.08
37	Neonatology	34	0.44	95.52
38	Medical Genetics	32	0.41	95.93
39	Physical Medicine & Rehabilitation	30	0.39	96.32
40	Vascular Surgery	27	0.35	96.67
41	Radiation Therapy	25	0.32	96.99
42	Dental Surgery	24	0.31	97.30
43	Occupational Therapy	22	0.28	97.58
44	Accident & Emergency Medicine	21	0.27	97.86
45	Community Medicine	17	0.22	98.08
45	Hepatology	17	0.22	98.30
46	Reproductive Medicine	14	0.18	98.48
47	Pharmacy	13	0.17	98.64
48	Centre For Animal Facility	12	0.15	98.80
48	Palliative Care Unit	12	0.15	98.95
49	Nuclear Medicine	11	0.14	99.10
50	Centre For Stem Cell	10	0.13	99.23
51	Bio Medical Sciences	8	0.10	99.33
51	Forensic Medicine	8	0.10	99.43
51	Geriatrics	8	0.10	99.54
51	Physiotherapy	8	0.10	99.64
52	Family Medicine	7	0.09	99.73
53	Hepato Pancreato Biliary Surgery	5	0.06	99.79
54	Developmental Paediatrics	4	0.06	99.85
55	Dietetics	3	0.05	99.90
56	Endocrine Surgery	2	0.05	99.95
56	Bioengineering	1	0.03	99.98
57	Biomedical Sciences	1	0.02	100.00

Figure 1: Scholarly Productivity of Disciplines

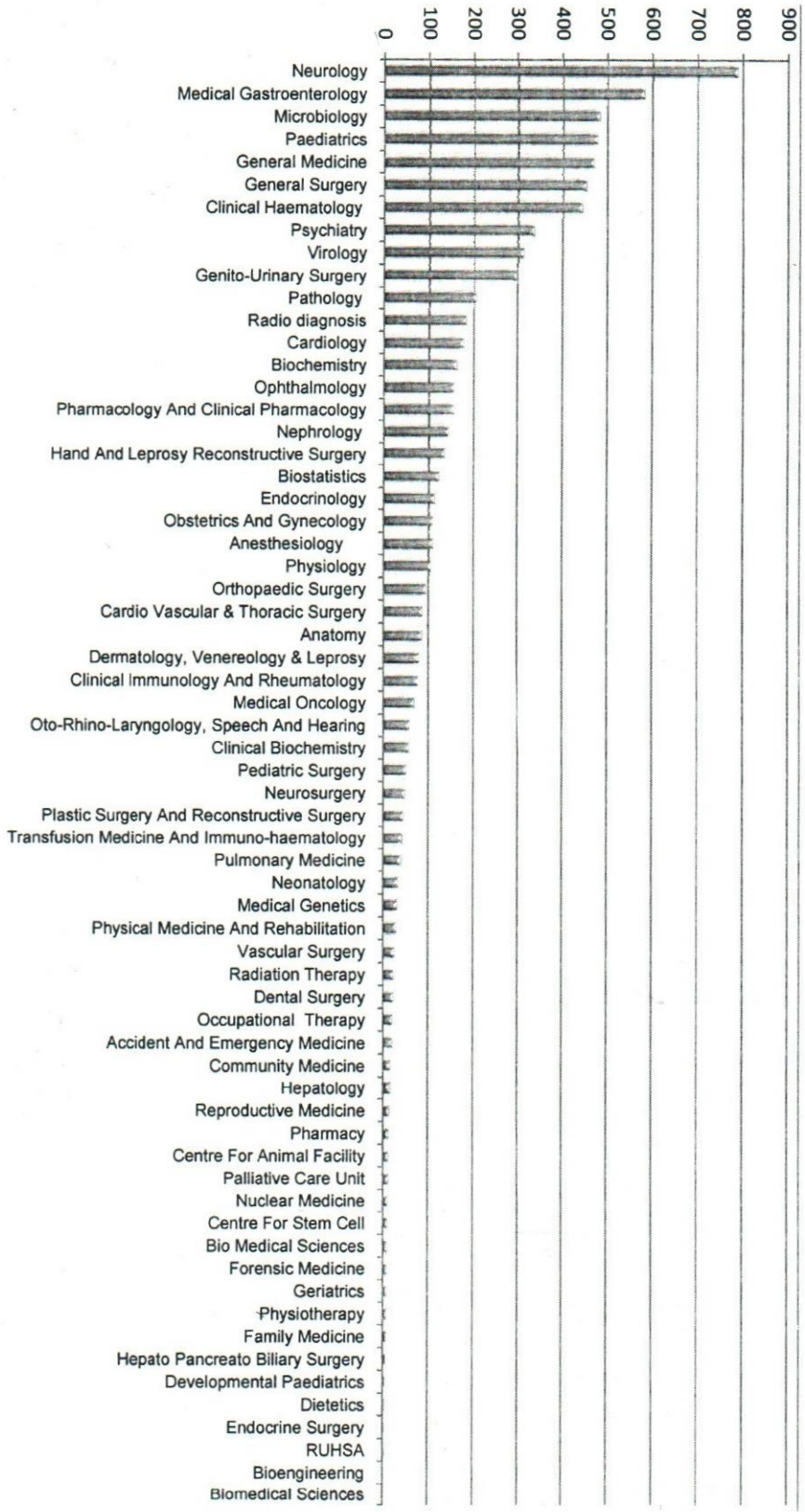

Table 2: Productivity Pattern of the Disciplines by Time Period Scale

Sub-Disciplines	1976–1980	1981–1985	1986–1990	1991–1995	1996–2000	2001–2005	2006–2010	2011–2014	Total
Neurology	65	44	47	78	88	184	137	146	789
Medical Gastroenterology	15	22	29	45	74	94	145	158	582
Microbiology	22	28	45	75	68	64	80	101	483
Pediatrics	25	35	38	19	61	66	102	132	478
General Medicine	35	15	25	36	40	75	119	125	470
General Surgery	25	30	35	42	45	65	101	110	453
Clinical Hematology	0	0	0	32	51	109	125	126	443
Psychiatry	25	32	33	24	24	50	60	89	337
Virology	1	16	24	30	36	64	71	72	314
Genito-Urinary Surgery	0	2	11	15	21	19	110	120	298

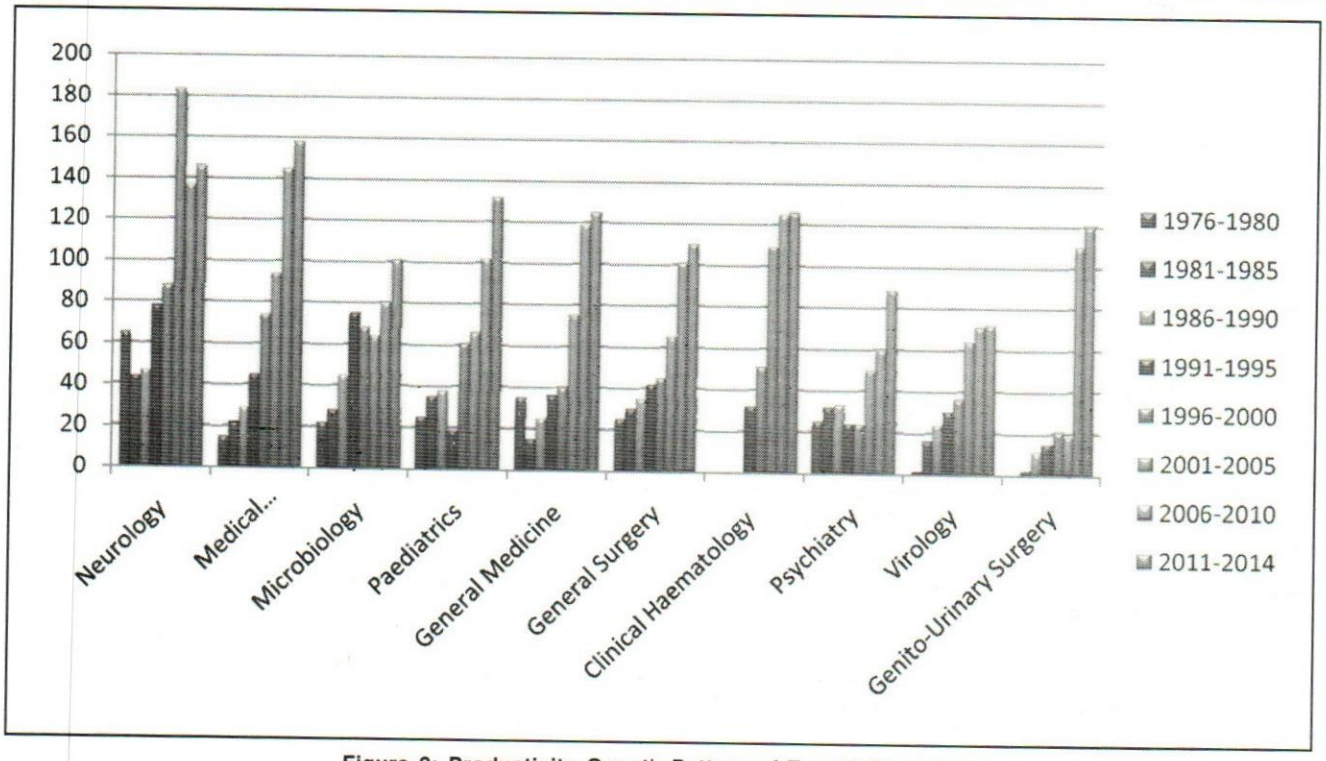

Figure 2: Productivity Growth Pattern of Top 10 Disciplines

followed by General Medicine and General Surgery. The other 61 departments have given a productivity sharing of less than 5 per cent of total research output (Figure 1).

A five-year block period of study was carried out to identify the growth pattern of the scholarly productivity (Table 2).

All the disciplines have shown a steady growth pattern over the study period. Clinical Hematology, Genito-urinary Surgery and Virology are the 3 sub-disciplines among the top 10 to have grown to a higher productivity from that of a zero point (Figure 2).

The source journals (those journals which carry the articles) are ranked as per the quantum of articles published in each of the journals. Since this list is too long, the top 20 journals are listed along with its status, be it national or international (Table 3). The *Indian Journal of Medical Research* ranks first in research output with 4.68 per cent of the total output during the study period.

This is followed by *Indian Pediatrics* which forms 2.98 per cent of the total research output. The next three places are taken over by *National Medical Journal of India* with 2.89 per cent, *Neurology India* with 2.32 per cent and *Indian Journal of Urology* with 1.75 per cent respectively.

Amongst the 24 journals ranked as top 20, only 10 are international journals. The top seven journals being national medical journals, it can be inferred that most of the Indian medical literature is published in native journals.

An Impact Factor analysis was made of the journals for the top 20 ranked journals.

Lancet and *Blood* journals have the highest Impact Factor with 33.63 and 10.56. Interestingly, both these international journals as source journals carrying Indian Medical literature hold only 9th and 8th positions (refer Table 3). It needs to be noted that the top 2 source journals of productivity—*Indian Journal of Medical Research and Indian Paediatrics*—qualify for only 6th and 10th position respectively as per the Impact Factor ranking order.

Table 3: Ranking of Source Journals

SL No.	Journal Title	Number of Articles	Ranking	National / International Journals	Percentage (%)
1	*Indian Journal of Medical Research*	295	1	National	4.68
2	*Indian Paediatrics*	188	2	National	2.98
3	*National Medical Journal of India*	182	3	National	2.89
4	*Neurology India*	146	4	National	2.32
5	*Indian Journal of Urology*	110	5	National	1.75
6	*Journal of Association Physicians of India*	98	6	National	1.55
7	*International Journal of Leprosy*	81	7	International	1.29
8	*Blood*	80	8	International	1.27
9	*Lancet*	79	9	International	1.25
10	*Indian Heart Journal*	75	10	National	1.19
11	*Indian Journal of Psychiatry*	72	11	National	1.14
12	*Indian Journal of Biochemistry & Biophysics*	69	12	National	1.09
13	*Indian Journal of Gastroenterology*	63	13	National	1.00
14	*Journal of Gastroenterology and Hepatology*	62	14	International	0.98
15	*Indian Journal of Medical Microbiology*	60	15	National	0.95
16	*Journal of Postgraduate Medicine*	60	15	National	0.95
17	*Indian Journal of Paediatrics*	53	16	National	0.84
18	*Transactions of the Royal Society of Tropical Medici*	53	16	International	0.84
19	*British Journal of Neurosurgery*	49	17	International	0.78
20	*Tropical Doctor*	49	17	International	0.78
21	*Haemophilia*	47	18	International	0.75
22	*British Journal of Psychiatry*	45	19	International	0.71
23	*Indian Journal of Ophthalmology*	45	19	National	0.71
24	*Indian Journal of Haematology and Blood Transfusion*	44	20	National	0.70

Table 4:Journals with Impact Factor

SL No.	Journal Title	Count	Productivity Rank	Impact Factor
1.	*Lancet*	79	9	33.63
2.	*Blood*	80	8	10.56
3.	*British Journal of Psychiatry*	45	19	5.95
4.	*Journal of Gastroenterology and Hepatology*	62	14	2.41
5.	*Haemophilia*	47	18	2.36
6.	*Indian Journal of Medical Research*	295	1	1.83
7.	*Journal of Postgraduate Medicine*	60	15	1.59
8.	*Indian Journal of Medical Microbiology*	60	15	1.01
9.	*British Journal of Neurosurgery*	49	17	0.97
10.	*Indian Pediatrics*	188	2	0.90
11.	*Neurology India*	146	4	0.83
12.	*Indian Journal of Ophthalmology*	45	19	0.83
13.	*Indian Journal of Biochemistry & Biophysics*	69	12	0.82
14.	*National Medical Journal of India*	182	3	0.54
15.	*Tropical Doctor*	49	17	0.52
16.	*Indian Journal of Pediatrics*	53	16	0.50
17.	*Indian Journal of Urology*	110	5	0.34
18.	*International Journal of Leprosy and Other Mycobacterial Diseases*	81	7	0.22
19.	*Transactions of the Royal Society of Tropical Medicine and Hygiene*	53	16	0.19
20.	*Indian Journal of Gastroenterology*	63	13	0.06
21.	*Journal of Association Physicians of India*	98	6	0.05
22.	*Indian Heart Journal*	75	10	0.04
23.	*Indian Journal of Psychiatry*	72	11	0.04
24.	*Indian Journal of Hematology and Blood Transfusion*	44	20	0.03

Conspectus

This reporting on the status of the research productivity by the Indian Healthcare professionals is only a bird's eye view in the mapping of world's productivity pattern of Medical Literature. The study leads to this interpretation:

1. A gradual Increase in the productivity pattern over the period.
2. Clinical subjects are the sub-disciplines among the top 10 to have a higher productivity.
3. Indian healthcare professionals seem to largely publish more in native journals with quality ranking but comparatively with lower IF than those of the international journals.

It is suggested that to gain better visibility, researchers need to reach to-journals of international repute with higher IF. The Government and other agencies ought to fund more research projects as Health & Hygiene are the most prioritised sectors of any, particularly developing countries like India. Lack of motivation, attitude, incentives, funds, infrastructure, access to world's medical literature, collaboration programs and projects, exchange and interchange of expertise are the barriers sighted in the Indian healthcare research frontier. Perhaps this scenario may change for the better.

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It is health that is real wealth and not pieces of gold and silver.

—Mohandas Gandhi

Efficiency of Health System in Four States of India : A District Level Analysis

NUTAN SHASHI TIGGA AND S. IRUDAYA RAJAN

India has undoubtedly made impressive improvements in the health system since early independence. These can be validated from the impressive results witnessed in reducing mortality and increasing life expectancy rates which are often celebrated about. The national figures though ascertain huge improvements; but the state-level figures are quite disheartening. There exist stark inequalities across states; for instance, states like Kerala and Tamil Nadu have mortality rates lower than the national average in contrast to states like Madhya Pradesh, Bihar and Odisha. Given this scenario, the present study attempts to analyse the health system of four states of India—Kerala, Tamil Nadu, Madhya Pradesh and Odisha. The study uses a non-parametric approach, Data Envelopment Analysis (DEA), to assess and compare the health system across the districts of these four states. This exercise would enable us to identify those districts whose health systems are performing under the mark. The study limits to three outputs and two inputs for 116 districts of India. It was found that of the 116 districts, 13 per cent were technically efficient, having an efficiency score of 1.00, while the remaining 87 per cent districts were technically inefficient. Undoubtedly, Kerala and Tamil Nadu stand to be the most efficient states, with almost all of its districts having an efficiency score of 1.0 or close. Bhopal district has been identified as a peer for many inefficient districts, following which these inefficient districts could move towards the efficiency frontier.

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Introduction

In general, the term health system refers to all amenities and facilities which deliver health care to the people. It has been conceptualized and defined in different ways and varies from country to country. The WHO (2000) defines a 'health system' as comprising of all organizations, people and institutions whose primary intent is to promote, restore or maintain health. Health, being an important determinant of human capital, strongly influences the well-being of the family and the community; hence, an active and efficient health system becomes imperative for any country. According to the WHO, there are three major fundamental objectives or goals which an active health system aims to fulfil, such as improving the health of the population it serves, responding to people's expectations and providing financial protection against the costs of ill-health. The achievement of these three objectives is essential for all countries, irrespective of their income levels or the structure of their health system. To meet these goals, the health systems require carrying out four vital functions—service provision, resource generation, financing and stewardship.

The health system or healthcare system is one of the largest service sectors in India. It follows a three-tier structure—primary, secondary and tertiary level of health care, provided by the public sector, private sector and an informal network of health care providers operating within an unregulated environment. India's health system has had a remarkable evolution since the early independence and can be briefly categorized into three different phases. The First Phase (1947–1983) followed the recommendations of various committees, mainly the 'Bhore Committee', and focused on two principles: (i) universal coverage in the country, free of charge services, run by the state with special focus on the poor, the deprived and those from rural areas and (ii) adoption of the primary health care approach following the 'Alma Ata declaration', focusing

on maternal and child care, immunization, education, sanitation, etc. The Second Phase (1983–2000) marked the documentation of the first National Health Policy of 1983 and the promotion of private sector. The Third Phase (post-2000), which witnessed developments such as the National Rural Health Mission (NRHM), has focused on strengthening the availability of and access to quality of health care, especially for the rural and poor population, women and children.

The two notable reforms in India's health system which made huge differences in the health status of the people are the NRHM, envisioned to strengthen the public sector health; and the initiation of government-sponsored insurance schemes covering hospital care for the poor. Nevertheless, the achievements of these reforms vary across states, depending on how well the health systems responded to or implemented these reforms. Not surprisingly, in most of the states, enormous gaps remain between the actual potential of the health systems and their realized performances. As a result, the levels of achievement are low and disproportionate across states and regions. This is revealed in the disparities seen in the health outcomes across the states. Tamil Nadu has achieved an Infant Mortality Rate (IMR) and Maternal Mortality rate (MMR) of 22 and 97, respectively, against the national average of 44 and 212 (SRS, 2011). The high-focus states such as Odisha, Chhattisgarh, Jharkhand, etc., continue to perform worse than the southern states such as Tamil Nadu and Kerala, despite receiving special attention from the Centre, state machinery and other international organizations in terms of funds, policy formulation, monitoring and evaluation.

Since there are stark inequalities in outcomes, it is imperative to investigate where the health reforms or the policies have failed/are failing. Therefore, this study attempts an evaluation of the health systems across 116 districts of 4 states, to understand the dynamics behind the differential performance of the health systems in states like Kerala and Tamil Nadu vis-à-vis Madhya Pradesh and Odisha. Such a study would enable us to understand the gaps in the functioning of the health system that leads to outcomes below expectations. This, in turn, will help in identifying specific districts, which require special attention in improving their health systems.

Measuring Efficiency of Health System

It is quite surprising to note that the performance of health systems in India is abysmal when compared to the other technological achievements the country has made. Poverty cannot be the sole reason for the poor performance of the states, as India ranks much better than many other poor countries in terms of Gross Domestic Product (GDP). Conversely, in terms of health indicators, India ranks much lower than many other countries—132 in terms of Life Expectancy at Birth; 124 in maternal deaths; 143 in Infant deaths and 145 in child deaths under five years of age. In fact, India's position is worse than many other Asian countries such as Bangladesh, China, Nepal and Sri Lanka (Rao, 2013). The World Health Report (2000) asserts that the primary goal of a health system is to provide better health to the people in a responsive and fairly distributed manner; howsoever, to what extent these goals are achieved is questionable, which is evident from the levels of health outcomes.

Measuring 'efficiency' of health system has become an utmost importance in most of the countries, India being one of them. As evident, schemes such as Universal Health Coverage and Millennium Development Goals have been achieved partially in India when compared to other countries. Since then, many countries have been assessing the scope for improving their health system. A study by Akazili et al. (2008a) found that poor financial inflows and most importantly poor quality of health care has a significant contribution to failure of health reforms undertaken in most of the developing countries.These developing countries have started to realise that increasing financial resources alone might not ascertain efficient delivery system, as many of these countries have reached the upper limit of pumping financial inflows into their health sector (Akazili et al., 2008a).Thus, assessing efficiency of health system has become an important area of research in the ambit of health economics (see, Banker et al. [1986], Fizel and Nunnikhoven [1992], Kooreman [1994], Parkin and Hollingsworth [1997], Burgess and Wilson [1998] and Rollins et al. [2001], Fare et al. [1993], Linna [1998] and Maniadakis and Thanassoulis [2000] as cited in Worthington (2004). While measuring efficiency, we come across two important concepts of efficiency-technical efficiency and allocative efficiency (discussed in the following paragraphs).

Research on health systems has made a significant contribution in improving healthcare performance in most of the developing countries (WHO, 2004). It has enabled us to evaluate the state of a country's health system, realize further scope for improvement and designing guidelines for policy formulation (Bennett et al., 2011; WHO, 2013; Adam et al., 2011). Thus, health systems

have a vital role in controlling emerging and re-emerging diseases in developing countries, depending on their quality, equity and efficiency (WHO, 2000). The *World Development Report* (1993) attributes inappropriate health system structures as the reason for the poor performance of health indicators in low income countries. The health care systems in many countries have been characterized as bureaucratic, centralized, inefficient and non-responsive to the demands of the population (Collins and Green, 2014).

Health systems in most of the developed countries are well researched on; however, it is comparatively a new domain of research in India and many low- and middle-income countries. Studies on health system in India are limited to a few states, covering various domains of its building blocks, such as health policy/governance (36 per cent), health services (27 per cent), health financing (25 per cent), human resources/training (14 per cent), medical technology (4 per cent), and information systems (2 per cent) (Dandona et al., 2009). However, in the recent times, particularly since the early reform period in India, heath system research has gained prominence. But, such studies are biased towards the service of their delivery and have left out other domains such as governance, human resource and health financing (Rao et al., 2014).

Measures of Efficiency

Efficiency measure was introduced by Farrell (1957), following the works of Debreu (1951) and Koopmans (1951). Koopmans (1951) defined efficiency as: *a producer is technically efficient if an increase in any output requires a reduction in at least one other output or an increase in at least one input, and if a reduction in any input requires an increase in at least one other input or a reduction in at least one output. Thus a technically inefficient producer could produce the same outputs with less of at least one input, or could use the same inputs to produce more of at least one output.*

Later Farrell (1957) proposed that efficiency could be decomposed into two components—*technical efficiency (TE)* and *allocative efficiency (AE)*. These together provide a measure of *total economic efficiency (EE)*. Technical efficiency refers to the ability of maximisation of outputs, given the level of inputs and mix of inputs, or the minimisation of input used for a given level of output. TE is defined in relative terms for a given benchmark, often referred to as the 'best practice frontier' representing the actual observed achievements (Fare and Grosskoopf, 1998). Allocative efficiency, means the maximisation of outputs for a given level of input cost, or the minimisation of cost for a given output level. Efficiency scores could be calculated either input or output oriented.

In the case of input-oriented approach to technical efficiency, we measure how many fewer inputs could be used and yet achieve the same level of output. Alternatively, the output-oriented approach measures the additional output that could be achieved while keeping the level of input constant (Forbes et al., 2010).

Various measures of efficiency exist, such as the ratio analysis, linear regression analysis, stochastic frontier analysis (SFA) and data envelopment analysis (DEA). However, DEA is a much preferred measure over the other owing to its simplicity. It has minimal a priori assumption, requires no specific functional form, can accommodate multiple inputs and outputs and problems of multicollinearity and heteroscedasticity are eliminated.

DEA is a non-parametric mathematical programming technique which is based on Linear Programming (LP) and measures the relative performance of a group of organisational units which could be firms, plants, entities, etc. In DEA language it is referred to as Decision Making Units (DMUs) coined by Charnes, Cooper, and Rhodes, such that non-market agencies such as, schools, hospitals, courts, etc., can be included (Ray, 2004). *It helps to estimate the best or maximum performance for each DMU relative to others, which lie on or below the efficient frontier.* There are two basic models of DEA—the CCR model (Charnes, Cooper and Rhodes 1978) and the BCC model (Banker, Charnes and Cooper, 1984). There are other models which have been developed over time. The selection of different models depends of the nature of the production technology, which differ in terms of orientation (input or output), disposability (weak or strong), the type of measures (radial, non-radial or hyperbolic) and returns to scale (constant, diminishing or increasing).

The theoretical framework of DEA was first introduced by Charnes, Cooper, and Rhodes in 1978 in their seminal work in the Operations Research Literature. Their framework known as CCR model (as it was framed by Charnes, Cooper and Rhodes), an extension of the single-output-input technical efficiency measure was introduced by Farrell in 1957, which was extended into a multiple output–input relative efficiency measure. The CCR model assumed constant returns to scales, which was rather restrictive, as CRS would often not exist in many realistic cases. Hence, Banker, Charnes and Cooper (BCC) in 1984 extended the CCR model into a more flexible and refined

one. The BCC model generalised the original model for technologies exhibiting-increasing, constant and decreasing returns to scale (see Ray, 2004). In other words the constant returns to scale (CRS) was relaxed to allow for variable returns to scale (VRS), which was a derivation from Shepherds's distance function (1970).[1]

The DEA was first applied by Nunamaker and Lewin in 1983, to measure nursing service efficiency. Since then many studies have assessed the efficiency of hospitals, health centers and the overall healthcare system, using the DEA method. Most of these have been done in the industrialized countries and middle- and low-income countries (Kirigia et al., 2001; 2004; 2011; Kirigia and Asbu, 2013; Akazili et al., 2008a; Akazili et al., 2008b). A few studies in the Indian context are also found in the DEA literature (Bhat et al., 2001; Dash et al., 2007; Dash, 2009; De et al., 2012; Shetty and Pakkala, 2010). Most of these Indian literatures have primarily focused on a few or all districts of a state. Very few studies including De et al. (2012) and Shetty and Pakkala (2010) have analysed a group of states.

Methodology and Data

Methods

The objective of this study is to evaluate the efficiency of the health system across the districts of four states—Kerala, Tamil Nadu, Madhya Pradesh and Odisha in India. The rationale behind the selection of these four states is to compare the performance of the two better performing states—Kerala and Tamil Nadu versus the worse performing states—Orissa and Madhya Pradesh. These states have been categorized as better or worse performing states based on two health outcomes—infant mortality and maternal mortality rates as given by the latest Sample Registration System (2014). In the present study, of the two orientations—input and output—the input-orientated model has been selected. Further, VRS is assumed as the assumption of CRS fails in a realistic situation. However, to caution, while assuming VRS, higher number of DMU's might be found to be efficient (Ozcan, 2008). Below, the two orientations are discussed in brief along with their linear programming.

Input-oriented Model

The input-oriented model, which is solved for each unit, in this case 116 districts, minimises the inputs, while maintaining the same level of outputs. Presented with notations, district j uses x_{ij} inputs and y_{rj} outputs. Let x_{ij} = input i for district j, where i = 1,2 and j = 1, 2, 3... 116 and y_{rj} = level of output r for district j, where r = 1, 2, 3 and j = 1, 2, 3... 116.

The objective of the model is to minimise the efficiency score denoted by θ, where $0 < \theta < 1$. θ represents the amount by which all the inputs can be reduced for each district while keeping the level of output same. The decision variables λ_j for j = 1, 2,... 116 is the weights used to form a weighted average frontier composite.

Therefore, the input model for district j_0 is

Minimise θ

Subject to:

$$\sum_{j=1}^{27} \lambda_j x_{ij} \leq \theta x_{ij_0} \forall_i = 1,2$$

$$\sum_{j=1}^{27} \lambda_j y_{rj} \geq y_{rj_0} \forall_r = 1,2,3$$

$$\sum \lambda_j = 1$$

$$\lambda_j \geq 0, j = 1,2,3 \ldots j_0.116$$

$$where, \lambda_j \geq 0, j = 1,2,3 \ldots j_0.116$$

Output-oriented Model

The objective of the output oriented model is maximising output at the same level of inputs. Let $Yj = (y_{1j} \ldots y_{rj}) \geq 0$ and $X_j = (x_1 j \ldots x_{ij}) \geq 0$, j = 1, 2,... 116.

As in the input-oriented approach, the output-oriented approach also used the same definition; the efficiency score for district j_0 which is the reciprocal of the inefficiency, θ_j hat is arrived at by solving the following linear programming.

Maximise θ

Subject to:

$$\sum_{j=1}^{27} \lambda_j x_{ij} \leq x_{ij_0} \forall_i = 1,2$$

$$\sum_{j=1}^{27} \lambda_j y_{rj} \geq \theta y_{rj_0} \forall_r = 1,2,3$$

$$\sum \lambda_j = 1$$

$$\lambda_j \geq 0, j = 1, 2, 3 \ldots j_0 . 116$$

$$where, \lambda_j \geq 0, j = 1, 2, 3 \ldots j_0 . 116$$

The two models are similar and must be run individually for all the districts.

DMUs having an efficiency score 1 indicate an efficient unit, while scores below 1 are inefficient units. Once identified as an efficient or inefficient unit, *slacks* indicate the reductions or increments required to be made by the DMUs to reach the frontier and hence become efficient. Further, the inefficient DMUs can follow their *peers* or benchmarks, which are the efficient DMUs to become efficient. In the subsequent section the results and findings are discussed.

Data

The data used in this study is solely from District Level Health Survey (DLHS), 2007–08 (Reproductive and Child Health) for all the inputs and the outputs.

Selection of Inputs and Outputs Variable

For DEA two kinds of data are needed—inputs and outputs. In the present study the inputs and outputs selected are guided by the existing literature and availability of data. The input variables considered for the study are health workers available in health centres (doctors, nurses and paramedical staff) and health centres (PHCs, CHCs and SCs); whereas, the output variables are percentage of women received full antenatal care, percentage of women had safe delivery and percentage of children fully immunized. The number of inputs and outputs has been restricted as too many inputs and outputs for a comparatively small sample (116 DMUs) might lead many DMUs being efficient.

Results and Findings

In Table 1, the descriptive statistics for all input and output variables have been tabulated. It is found that there exists huge variation across districts, as evident from the maximum and minimum values obtained. A district employed 56 health workers on an average in 2008 and had an average of 109 health centres.

Table 1: Outputs and Inputs for Districts

Districts	Full ANC (%)	Full Immunization (%)	Safe delivery	Total number of Health Centres	Total number of Health Workers
Alappuzha	79.6	92.2	99.5	76	148
Ernakulam	65.4	77.4	100	67	145
Idukki	73	85.5	99.5	89	173
Kannur	78.1	81.7	100.00	54	105
Kasaragod	61	87.3	98.6000	71	153
Kollam	72.8	84.5	99.5	85	183
Kottayam	84.4	89.3	100	84	179
Kozhikode	68.9	65	100.00	70	145
Malappuram	55.9	63.9	100	99	188
Palakkad	82	69.6	99.2	95	176
Pathanamthitta	79.8	88.4	100	87	160
Thiruvananthapuram	82.4	91.2	99	78	170
Thrissur	79.2	80.8	100	82	158
Wayanad	68	78.3	95.50	73	151
Coimbatore	57.1	75.8	96.8	45	98

Table 1 to be continued....

Table 1 ...continuation...

Districts	Full ANC (%)	Full Immunization (%)	Safe delivery	Total number of Health Centres	Total number of Health Workers
Cuddalore	34.1	86.9	94.2	63	127
Dharmapuri	59.2	83.3	93.4	61	132
Dindigul	51.5	87.5	94.8	58	118
Erode	54.8	81.6	98.9	50	106
Kancheepuram	46.7	85.9	95.9	45	87
Kanniyakumari	66.2	77.3	100	36	56
Karur	52.6	83.6	92.4	56	118
Krishnagiri	67.3	79.7	90.1	62	128
Madurai	50.1	62.5	96.1	45	73
Nagapattinam	35.9	95	98.8	65	123
Namakkal	62.7	81	96.2	61	130
Pudukottai	43	89.9	98.8	70	132
Ramanathpuram	43.2	88.6	98	71	112
Salem	56.2	67.2	97.6	61	123
Sivganga	59	82.5	98.2	63	97
Thanjavur	66.1	75.4	99.2	67	141
Theni	44.8	72.1	93.3	44	75
Thirunelveli	48.5	66.1	99	59	102
Thiruvallur	54.9	90.1	97.4	48	102
Thiruvarur	52	93.8	97.2	64	112
Thoothukudi	41.3	86.8	98	52	84
Tiruvannamalai	41.8	83.4	78.8	77	150
Trichy	53.1	90.7	95.7	55	108
Vellore	50.5	79.9	97	68	132
Viluppuram	40.8	94.7	94.6	89	179
Virudhunagar	54.4	56.1	94.1	48	81
Balaghat	8.6	70.5	53.5	53	81
Barwani	5.4	21.3	32.7	56	83
Betul	12.5	51.7	44	50	80
Bhind	4	38.5	53.6	49	91
Bhopal	17.9	65.4	60.8	15	31
Chhatarpur	3.7	24.8	53	46	64
Chhindwara	10.3	47.7	42.5	69	103

Table 1 to be continued....

Table 1 ...continuation...

Districts	Full ANC (%)	Full Immunization (%)	Safe delivery	Total number of Health Centres	Total number of Health Workers
Damoh	7.9	17.8	32.9	45	72
Datia	2.6	17.5	50.8	42	79
Dewas	15.8	43.2	68.8	47	69
Dhar	14.5	40.3	45.2	60	89
Dindori	11.9	18.4	15.6	51	77
East Nimar	6.9	42.9	43.4	38	42
Guna	1	25.9	51.9	51	91
Gwalior	5.4	43.8	67	28	59
Harda	11.4	41.8	47.9	32	45
Hoshangabad	6.9	55.7	66.3	45	71
Indore	11.3	70.1	84.7	28	46
Jabalpur	17.9	41.8	64.2	27	57
Jhabua	2.8	17.7	42.5	50	62
Katni	11.9	45.8	52.2	54	94
Mandla	12.7	26.3	29.5	68	104
Mandsaur	12.5	36.8	58.6	49	77
Morena	3.4	38.6	59.9	52	101
Narsimhapur	3	47.1	49.7	51	86
Neemuch	14.5	54.4	61.1	41	81
Panna	6.8	22.2	41.8	47	83
Raisen	4.5	40.7	37.3	50	74
Rajgarh	4.7	25	53.8	52	89
Ratlam	11.5	54.2	63.5	39	59
Rewa	5.4	35.9	47.8	60	112
Sagar	13.2	32.3	48.3	59	84
Satna	5.1	25.6	46.1	55	90
Sehore	11.9	58.5	58.5	51	84
Seoni	22.8	39.2	55.1	50	68
Shahdol	11.3	34.9	47.9	56	92
Shajapur	13.3	51.3	71.8	43	65
Sheopur	2.2	27.1	46	37	48
Shivpuri	3.1	18.2	46.7	40	56
Sidhi	4.6	20.2	24.8	58	86
Tikamgarh	4.2	12.5	54.4	48	75

Table 1 to be continued....

Table 1 *...continuation...*

Districts	Full ANC (%)	Full Immunization (%)	Safe delivery	Total number of Health Centres	Total number of Health Workers
Ujjain	13.9	67.2	69.6	37	60
Umaria	4.5	13	44.2	42	58
Vidisha	4.7	26.4	50.1	37	64
West Nimar	11	49.6	45.4	39	59
Anugul	16	62.8	45.9	51	89
Balangir	29.5	53.3	62.2	45	156
Baleshwar	33.7	82.8	56	68	130
Bargarh	24.9	69.4	65.8	64	99
Baudh	26.6	55.2	37.8	31	96
Bhadrak	29.2	73.6	46.3	68	225
Cuttack	24.5	71.7	71.3	60	136
Debagarh	22.5	56	54.7	50	74
Dhenkanal	15.8	60.9	52.8	66	120
Gajapati	22.7	44.4	26.4	71	175
Ganjam	18.7	47.2	58.7	78	166
Jagatsinghapur	39.4	84.5	83	61	127
Jajapur	28.3	82.4	64.5	75	131
Jharsuguda	32.2	83.3	79.3	33	108
Kalahandi	26.4	43.5	41.7	43	105
Kandhamal	14.6	57.6	26.8	63	126
Kendrapara	24.8	82.7	57.2	59	113
Kendujhar	15.8	58	38.9	65	234
Khordha	23.2	72	76.6	43	95
Koraput	16.1	60.3	20.7	60	207
Malkangiri	13.2	38.3	15.4	57	101
Mayurbhanj	34.1	63.5	45.7	82	226
Nabarangapur	11.7	31.1	18.6	69	117
Nayagarh	14.7	51.8	48.4	67	164
Nuapada	29.6	52.6	45.4	50	95
Puri	19.8	70.9	69.4	62	127
Rayagada	13.7	29.6	21.4	62	210
Sambalpur	33.6	71.3	67.9	49	177
Sonapur	31.4	82.6	54.6	44	73
Sundargarh	26.4	64	52	56	137

Source: DLHS unit level data, 2007–08.

Table 2 shows the efficiency scores for input-oriented DEA, computed using the DEA Programme (DEAP), version 2.1 developed by Tim Coelli. The technical efficiency scores for the 116 districts of 4 states have been shown. Scores of 1.0 is considered to be efficient implying that the DMUs lie on the efficiency frontier, while scores below 1.0 indicate inefficiency which implies the DMUs lie below the frontier. In this respective table we also observe that out of the 116 districts, only 15 districts (13 per cent) have an efficiency score equal to 1; i.e., they lie on the efficiency frontier. While, the other 101 districts (87 per cent) remain inefficient. Of these 15 efficient districts, 5 districts are in Kerala, 6 districts in Tamil Nadu, 2 districts in Orissa and Madhya Pradesh each. Six districts of Odisha—Kandhamal, Rayagada, Gajapati, Kendujhar, Nayagarh and Ganjam—have the lowest efficiency score of 0.2 followed by Madhya Pradesh. Most of the districts of Kerala and Tamil Nadu have better antenatal care, immunization and deliveries rates compared to the Madhya Pradesh and Odisha. Bhopal district of Madhya Pradesh has reported to have the least number of health workers and health centres, yet exhibits better outputs compared to other districts having more than sufficient resources. This implies Bhopal district has efficiently used the available resources. Alternatively, some districts of Odisha have higher number of health workers than the other districts of the mentioned states, yet the outputs are low. This implies these districts have enough resources to cater to the health-related needs of the population but is possibly underutilizing its resources, which is resulting poor outcomes.

Table 2: Summary Statistics

Statistics	Full ANC (%)	Full Immunization (%)	Safe delivery	Total number of Health Centres	Total number of Health Workers
Mean	30.40	59.39	66.95	56.40	109.83
Min	1	12.5	15.4	15	31
Max	84.4	95	100	99	234
SD	24.00	23.33	25.54	15.25	43.33

All the DMUs (districts) exhibit diminishing return to scale. This implies that all the DMUs need to scale down both their inputs and outputs in order to operate at the most productive scale size.

The input and output slacks shown in Table 3 indicate the reductions and increments which if made could make these inefficient DMUs efficient. Slack in general refers to excess input or missing output that exists even after the proportional change in the input or the outputs are made (Shim, 2000). It also indicates the amount of resources which are idle in a particular DMU, and which can be relocated or withdrawn without compromising on the existing output level.

Table 3: Output and Input Slacks

Districts	Full ANC (%)	Full Immunization (%)	Safe delivery	Total number of Health Centres	Total number of Health Workers
Alappuzha	0.0	0.0	0.0	0.0	0.0
Ernakulam	1.0	0.0	0.0	0.0	21.8
Idukki	0.0	0.0	0.0	0.0	2.1
Kannur	0.0	0.0	0.0	0.0	0.0
Kasaragod	0.0	0.0	0.0	0.0	10.8
Kollam	0.0	0.0	0.0	0.0	12.6
Kottayam	0.0	0.0	0.0	0.0	0.0

Table 3 to be continued....

Table 3 ...continuation...

Districts	Full ANC (%)	Full Immunization (%)	Safe delivery	Total number of Health Centres	Total number of Health Workers
Kozhikode	0.0	13.3	0.0	0.0	15.9
Malappuram	10.3	13.4	0.0	0.0	12.4
Palakkad	0.0	16.8	0.8	8.8	0.0
Pathanamthitta	0.0	0.0	0.0	0.0	0.0
Thiruvananthapuram	0.0	0.0	0.0	0.0	0.0
Thrissur	0.0	2.2	0.0	2.0	0.0
Wayanad	0.0	0.0	4.4	0.0	16.0
Coimbatore	5.2	0.5	0.0	0.0	20.7
Cuddalore	23.3	0.0	3.6	0.0	0.0
Dharmapuri	0.0	0.0	4.2	0.0	9.6
Dindigul	5.6	0.0	3.1	0.0	0.0
Erode	7.3	0.0	0.0	0.0	12.8
Kancheepuram	10.5	0.0	2.3	0.0	0.0
Kanniyakumari	0.0	0.0	0.0	0.0	0.0
Karur	0.0	0.0	0.8	0.0	0.0
Krishnagiri	0.0	0.0	9.6	0.0	13.4
Madurai	11.3	13.6	0.0	0.0	1.5
Nagapattinam	0.0	0.0	0.0	0.0	0.0
Namakkal	0.0	0.0	2.9	0.0	14.4
Pudukottai	3.7	0.0	0.0	0.0	0.2
Ramanathpuram	0.0	0.0	0.0	3.4	0.0
Salem	7.0	9.4	0.0	0.0	15.5
Sivganga	0.0	0.0	0.9	2.6	0.0
Thanjavur	0.0	1.9	0.7	0.0	19.7
Theni	13.1	3.2	0.0	0.0	3.5
Thirunelveli	16.5	10.9	0.0	0.0	5.9
Thiruvallur	0.0	0.0	0.0	0.0	0.0
Thiruvarur	0.0	0.0	0.0	0.0	0.0
Thoothukudi	0.0	0.0	0.0	0.0	0.0
Tiruvannamalai	13.7	0.0	16.2	0.0	0.0
Trichy	0.0	0.0	1.7	0.0	0.0
Vellore	9.8	0.0	0.0	0.0	3.3
Viluppuram	0.0	0.0	0.0	0.0	0.0

Table 3 to be continued....

Table 3 *...continuation...*

Districts	Full ANC (%)	Full Immunization (%)	Safe delivery	Total number of Health Centres	Total number of Health Workers
Virudhunagar	4.5	19.4	0.0	0.0	3.2
Balaghat	30.0	0.0	24.1	3.3	0.0
Barwani	12.5	44.1	28.1	5.9	0.0
Betul	5.4	13.7	16.8	4.4	0.0
Bhind	13.9	26.9	7.2	1.7	0.0
Bhopal	0.0	0.0	0.0	0.0	0.0
Chhatarpur	14.2	40.6	7.8	7.3	0.0
Chhindwara	7.6	17.7	18.3	5.8	0.0
Damoh	10.0	47.6	27.9	4.4	0.0
Datia	15.3	47.9	10.0	1.5	0.0
Dewas	0.0	23.8	0.0	5.2	0.0
Dhar	3.4	25.1	15.6	5.9	0.0
Dindori	6.0	47.0	45.2	5.5	0.0
East Nimar	11.0	22.5	17.4	13.0	0.0
Guna	16.9	39.5	8.9	2.4	0.0
Gwalior	20.1	23.5	0.0	0.0	3.7
Harda	6.5	23.6	12.9	7.0	0.0
Hoshangabad	9.5	10.8	0.0	3.8	0.0
Indore	0.0	0.0	0.0	0.0	0.0
Jabalpur	4.2	24.6	0.0	0.0	2.3
Jhabua	15.1	47.7	18.3	10.0	0.0
Katni	6.0	19.6	8.6	2.8	0.0
Mandla	5.2	39.1	31.3	5.3	0.0
Mandsaur	5.4	28.6	2.2	4.7	0.0
Morena	14.5	26.8	0.9	1.0	0.0
Narsimhapur	14.9	18.3	11.1	3.4	0.0
Neemuch	3.3	11.1	0.0	0.6	0.0
Panna	11.1	43.2	19.0	2.6	0.0
Raisen	13.4	24.7	23.5	5.9	0.0
Rajgarh	13.2	40.4	7.0	3.1	0.0
Ratlam	5.7	11.7	0.0	5.1	0.0
Rewa	12.5	29.5	13.0	1.6	0.0
Sagar	4.7	33.1	12.5	6.8	0.0

Table 3 to be continued....

Table 3 *...continuation...*

Districts	Full ANC (%)	Full Immunization (%)	Safe delivery	Total number of Health Centres	Total number of Health Workers
Satna	12.8	39.8	14.7	3.9	0.0
Sehore	6.0	6.9	2.3	3.8	0.0
Seoni	0.0	27.4	9.7	7.5	0.0
Shahdol	6.6	30.5	12.9	3.9	0.0
Shajapur	1.6	16.3	0.0	4.1	0.0
Sheopur	15.7	38.3	14.8	8.9	0.0
Shivpuri	14.8	47.2	14.1	7.1	0.0
Sidhi	13.3	45.2	36.0	5.9	0.0
Tikamgarh	13.7	52.9	6.4	4.8	0.0
Ujjain	2.6	0.0	0.0	2.7	0.0
Umaria	13.4	52.4	16.6	7.4	0.0
Vidisha	13.2	39.0	10.7	2.9	0.0
West Nimar	6.9	15.8	15.4	5.5	0.0
Anugul	1.9	2.6	14.9	2.8	0.0
Balangir	0.0	15.0	8.0	0.0	32.5
Baleshwar	23.0	0.0	39.6	0.0	0.0
Bargarh	9.2	0.0	8.2	3.4	0.0
Baudh	0.0	12.3	30.1	0.0	22.7
Bhadrak	0.0	0.0	26.3	0.0	17.5
Cuttack	4.3	0.0	0.0	0.0	0.0
Debagarh	0.0	10.5	9.8	5.6	0.0
Dhenkanal	2.1	4.5	8.0	2.1	0.0
Gajapati	0.0	22.2	38.3	0.0	8.6
Ganjam	0.0	18.4	2.7	0.0	1.2
Jagatsinghapur	9.5	0.0	7.8	0.0	0.0
Jajapur	30.6	0.0	34.5	0.0	0.0
Jharsuguda	0.0	0.0	0.0	0.0	0.0
Kalahandi	0.0	24.0	26.0	0.0	10.3
Kandhamal	3.3	7.8	34.0	0.5	0.0
Kendrapara	31.4	0.0	38.0	0.0	0.0
Kendujhar	2.1	7.4	21.9	0.0	23.0
Khordha	12.9	0.0	0.0	0.0	3.8
Koraput	1.8	5.1	40.1	0.0	20.8

Table 3 to be continued....

Table 3 ...continuation...

Districts	Full ANC (%)	Full Immunization (%)	Safe delivery	Total number of Health Centres	Total number of Health Workers
Malkangiri	4.7	27.1	45.4	2.5	0.0
Mayurbhanj	0.0	5.9	28.2	0.0	21.4
Nabarangapur	6.2	34.3	42.2	3.3	0.0
Nayagarh	3.2	13.6	12.4	0.0	5.7
Nuapada	0.0	15.7	24.9	0.0	1.1
Puri	7.9	0.0	0.7	0.0	0.0
Rayagada	4.2	35.8	39.4	0.0	19.8
Sambalpur	0.0	0.0	6.6	0.0	35.9
Sonapur	23.6	0.0	44.3	0.0	0.0
Sundargarh	0.0	3.5	15.7	0.0	10.3

Focusing on the district having the lowest efficiency score, it is found that Kendujhar district of Odisha has one input slack (total number of health workers). In order to become efficient this district needs to reduce the number of health workers by 23, while keeping its output level constant. Alternatively, it can also improve its output levels as can be seen from the output slacks. In order to move to the frontier, this district could also increase its antenatal care services, immunization and delivery rates by 2 per cent, 7 per cent and 22 per cent respectively.

Benchmarking process or identifying 'peer' groups of the different inefficient units is the final step in DEA. Peers are a set of potential role models that a unit can emulate to become efficient. Each inefficient DMU moves either horizontally or vertically; i.e., increasing its outputs or reducing its inputs by following the closest DMU such that it becomes efficient and lies on the frontier. For each inefficient DMUs, a single or a set of efficient DMU's are identified which acts as peers. These inefficient DMUs are therefore required to follow the efficient peers to become

Table 4: Peers of Few Inefficient Districts

Ernakulam	Kottayam	Kanniyakumari	
Idukki	Kanniyakumari	Thiruvallur	Alappuzha
Kasaragod	Kanniyakumari	Nagapattinam	Alappuzha
Dindigul	Thiruvallur	Kanniyakumari	Bhopal
Erode	Thiruvallur	Kanniyakumari	Jharsuguda
Kancheepuram	Thoothukudi	Thiruvallur	Kanniyakumari
Salem	Bhopal	Kanniyakumari	Kanniyakumari
Sivganga	Kanniyakumari	Kanniyakumari	Thiruvarur
Chhindwara	Kanniyakumari		
Dindori	Bhopal		
Bhadrak	Kanniyakumari	Jharsuguda	Bhopal
Cuttack	Kanniyakumari	Kanniyakumari	Jharsuguda
Debagarh	Bhopal	Kanniyakumari	
Dhenkanal	Bhopal		
Gajapati	Bhopal	Kanniyakumari	

efficient. Table 4 summarises the peers for all the inefficient states. Kendujhar district has Bhopal as its peer. It could learn from its peer the production process and hence become an efficient unit. For most of the inefficient units, Bhopal district is the peer whom they need to emulate to become efficient.

Conclusion

This paper attempted to measure the health systems of 116 districts in 4 states of India by using Data Envelopment Analysis, a non-parametric method. This is one of the most widely used methods of measuring performance. With the help of this method we showed that many districts have been using excess of resources to achieve the existing output. The slacks obtained from the analysis indicate the amount by which reductions or increments are to be made to make the inefficient units efficient.

In the above analysis we found that of the 116 districts, only 15 districts were efficient, with Kerala and Tamil Nadu topping the list, implying they have the efficient level of input and output mix. This is clearly evident from the health indicators of the Tamil Nadu and Kerala. For the two southern states, all the health outputs considered are better than the two northern states except for number of health workers. Few of the districts in Odisha have better inputs, yet poor outputs. This indicates that there exists scope for improvement in these inefficient districts. Bhopal district has emerged as a peer for many of the districts, implying their health system has made efficient use of the available resources, despite having lesser inputs compared to other districts. Thus, it can be said, Kerala and Tamil Nadu have an efficient health system, while few districts of Madhya Pradesh and Odisha have also been successful in efficiently utilizing their resources. It is important to note that all the districts which lie on the frontier; i.e., are efficient, but it does not imply that there is no further scope for improvement by either reducing the input used or increasing the output level; however, due to lack of data such an analysis would be difficult. Thus, these are often considered as the best achievable and the remaining states which are inefficient are ranked relative to those which are efficient. Most of the districts in Odisha and Madhya Pradesh require special attention, either in terms of monitoring the functioning of the health system or providing additional resources to cater to the needs of the population.

Data Envelopment Analysis as a measurement of efficiency although has been well appreciated, has several limitations. To start with, the selection of inputs and outputs is what requires the special attention. Considering too many inputs and outputs in a relatively small sample often causes more number of DMUs to turn efficient. Also, DEA being a non-parametric method fails to provide any statistical inferences as no statistical tests can be performed.

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The secret of health for both mind and body is not to mourn for the past, not to worry about the future, or not to anticipate troubles, but to live the present moment wisely and earnestly.

—Siddhartha Gautama Buddha

Focus

Research Productivity of Lung Cancer by Indian Scientists during 1984–2013

DR. R. JEYSHANKAR AND A. VELLAICHAMY

This study mainly focuses on Indian research output in Lung Cancer, one of the leading causes of carcinogens and tumor promoters ingested via smoking. The data for this study was obtained from Scopus database for the period of 1984–2013. The analysis shows that majority (94 per cent) of the scientists preferred to publish research papers in joint authorship. In depth, this study analysed that USA is the major collaborating partner of India with a share of 24.66 per cent publications. Tata Memorial Hospital, Mumbai is the most productive institution in India on Lung Cancer research. It has contributed 16.90 per cent of the total research output. Indian Journal of Cancer is the most productive journal of Lung Cancer research and it has contributed 8.65 per cent of publications.

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Introduction

Lung cancer is the leading cause of cancer deaths for men in developing countries. Lung cancer history shows that about a century and a half ago, lung cancer was an extremely rare disease. Lung cancer has been known in industrial workers from the late 19th century. It came into prominence as a public health problem in the Western world in 1930s—at first in men, and later (in 1960s) among women. The causes of increase in lung cancer incidence were thought to have included increased air pollution, cigarette smoking, asphalting of roads, increase in automobile traffic, exposure to gas in World War I, the influenza pandemic of 1918 and working with benzene or gasoline. According to WHO reports, between 1960 and 1980, the death rate due to lung cancer increased by 76 per cent in men and by 135 per cent in women (Park, 2013). It accounts for more cancer deaths every year than breast, colon and prostate cancer combined (Munjal, 2012).

In the past, there were no specific studies on the research productivity of lung cancer in Indian contribution. However, only few studies have been undertaken in the past on the contribution, citation impact and evaluation of various diseases.

Literature Review

In the recent years, many researchers have conducted research productivity analysis in different medical fields. The following studies related to the objectives of this study have been reviewed for the identification of research gap.

Jeyshankar and Rameshbabu (2013) analysed the Leukemia research output carried out during the year 1960–2011. The study indicates that the overall growth rate of literature output is found to be positive with an increasing trend in leukemia research throughout the study

period. Two and more authored papers constitute majority of the contribution and degree of collaboration had a maximum value of 0.96. The result shows that research development activities are on increasing trend in leukemia research in India.

Gupta and Adarsh Bala (2013) studied research output of India in Alzheimer's disease research during 2002–11. The study indicates that India ranks at 16th position (with 900 papers) among top 20 top countries with a global publication share of 1.33 per cent (rising from 0.39 per cent in 2002 to 2.36 per cent during 2011) and an annual average publication growth rate of 31.92 per cent during 2002–11.

Vellaichamy and Jeyshankar (2014) investigated anemia research in India. The study analysed highest number of papers (739) is published in the year 2013 but it received 178 citations only. The minimum number (47) of papers is published in the year of 1996, but they have received 3,245 citations. The study also reveals that lowest number (0.56 per cent) of citations received in the year 2013. USA is found India's major collaborative partner in anemia research which has 4.98 per cent share of total research output.

Omwoyo et al.(2004) conducted a study on HIV/AIDS research output in Uganda and Kenya. The study covered 1,045 documents, out of which 369 (35.3 percent) were on HIV/AIDS in Kenya and 676 (64.7 percent) were on Uganda. Seven (0.7 percent) documents were shared by the two countries. The study revealed most publications were co-authored and focused on women, and a large proportion of HIV/AIDS documents were published outside Africa.

Singh, Ahmad and Nazim (2008) studied a bibliometric study of Embeliaribes. They were analysed growth of literature, authorship pattern, most prolific authors, core journals of the subject, most productive institutes and countries. It has been found that most articles involved collaboration between two or three authors Author productivity was not found exactly fit to Lotka's law with a value of n = 2.

Swapan Kumar and Bhattacharya (2005) studied bibliometric study of cancer research in India. The study analysed 58.59 per cent of Indian authors have single publication, 14.97 per cent publish two articles, 7.72 per cent publish three articles; 19 most productive authors are identified who had published more than 50 articles. The Institution analysis showed that All India Institute of Medical Science (AIIMS), Delhi has produced maximum papers on cancer research followed by Tata Memorial Hospital, Mumbai.

Mohan Gupta and Ritu Gupta (2015) analysed 1,368 publications on prostate cancer in India, as covered in Scopus database during 2004–13, experiencing an annual average growth rate of 18.77 per cent and citation impact of 5.23. The study also analysed world prostate cancer output (89,994 publications) came from several countries, of which the top 15 (United States, United Kingdom, Germany, Canada, Italy, Japan, and China) accounts for 94.80 per cent share of the global output during 2004–13. India's global publication share was 1.52 per cent and hold 14th rank in global publication output during 2004–13.

Objectives of the Study

The main objectives of the present study, research productivity on lung cancer literature in India during 1984–2013, based on publications output, as indexed in Scopus database. In particular, the study focuses on the following objectives are;

1. To examine the research productivity of lung cancer during 1984–2013;
2. To measure and calculate the Relative Growth Rate (RGR) and Doubling time (Dt) and degree of collaboration;
3. To identify the authorship pattern and most prolific authors;
4. To identify major international collaborative countries in India; and
5. To identify the active Indian institutions on lung cancer research.

Methods and Tools for Data Collection

The data for the present study were retrieved from Scopus multidisciplinary database which contains abstracts and citations for academic journal articles. The following terms were identified to retrieve the records in title, abstract and keywords fields (i.e.,TITLE-ABS-KEY ['lung cancer' or 'lung metastasis' or 'lung malignancy' or 'lung carcinoma' or 'bronchogenic carcinoma' or 'adenocarcinoma of lung' or 'small cell carcinoma' or 'large cell carcinoma') or TITLE-ABS-KEY ('squamous cell carcinoma' or 'bronchoalveolar carcinoma' or 'bronchial gland carcinoma' or 'adenosquamous carcinoma' or 'neoplasm of lung') and PUBYEAR > 1983 and PUBYEAR < 2014. A total of 3684 records were downloaded for the period of thirty

years 1984–2013. The collected data were transferred into Microsoft Excel 2007, and data were analysed and tabulated based on the objectives.

Data Analysis and Discussion

Compound Annual Growth Rate (CAGR)

These 3,684 publications are further grouped year-wise and the same is shown in Table 1. Further Compound Annual Growth Rate (CAGR), the year-over-year growth rate of articles published over a specified period of time, Rate of Growth with base year 1999 has been calculated and the same is shown in Table1 using the formula;

$$CAGR = \left(\frac{Ending\ Value}{Begining\ Value} \right)^{\frac{1}{n-1}} - 1$$

Table 1: Year-wise Distribution of Indian Lung Cancer Literature

S. No.	Year	TP	ΣTP	%	Σ%	RoG	RoG (Base Year 1999)
1	1984	7	0.2	7	0.2	1.00	0.11
2	1985	16	0.4	23	0.6	2.29	0.26
3	1986	8	0.2	31	0.8	0.50	0.13
4	1987	13	0.4	44	1.2	1.63	0.21
5	1988	15	0.4	59	1.6	1.15	0.25
6	1989	10	0.3	69	1.9	0.67	0.16
7	1990	13	0.4	82	2.2	1.30	0.21
8	1991	14	0.4	96	2.6	1.08	0.23
9	1992	18	0.5	114	3.1	1.29	0.30
10	1993	14	0.4	128	3.5	0.78	0.23
11	1994	17	0.5	145	3.9	1.21	0.28
12	1995	19	0.5	164	4.5	1.12	0.31
13	1996	31	0.8	195	5.3	1.63	0.51
14	1997	35	1	230	6.2	1.13	0.57
15	1998	30	0.8	260	7.1	0.86	0.49
16	1999	61	1.7	321	8.7	2.03	1.00
17	2000	37	1	358	9.7	0.61	0.61
18	2001	60	1.6	418	11.3	1.62	0.98
19	2002	67	1.8	485	13.2	1.12	1.10
20	2003	93	2.5	578	15.7	1.39	1.52
21	2004	114	3.1	692	18.8	1.23	1.87
22	2005	141	3.8	833	22.6	1.24	2.31
23	2006	145	3.9	978	26.5	1.03	2.38
24	2007	179	4.9	1157	31.4	1.23	2.93
25	2008	211	5.7	1368	37.1	1.18	3.46
26	2009	255	6.9	1623	44.1	1.21	4.18
27	2010	345	9.4	1968	53.4	1.35	5.66
28	2011	490	13.3	2458	66.7	1.42	8.03
29	2012	593	16.1	3051	82.8	1.21	9.72
30	2013	633	17.2	3684	100	1.07	10.38
Total		**3684**	**100**				
CAGR		**0.16**					**CAGR Percentage 16%**

During 1984–2013, about 3,684 papers were published on lung cancer by Indian scientists. It is also observed the Indian scientists during the periods 1984–2000 are published very less number of research productivity are fluctuation. The table shows that from year 2003 research productivity lung cancer research literature was increased (86.83 per cent). The average number of papers produced per year was 12.8. The highest numbers of papers (633) were published in the years 2013. Figures 1 and 2 show that growth of the literature on lung cancer research.

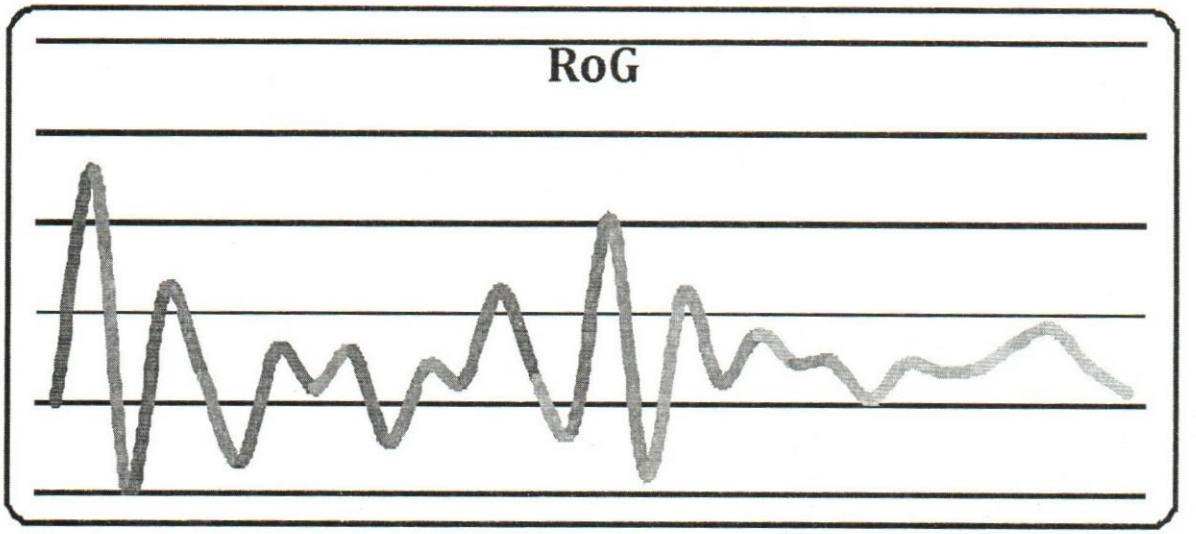

Figure 1: Ratio of Growth of Indian Lung Cancer Literature

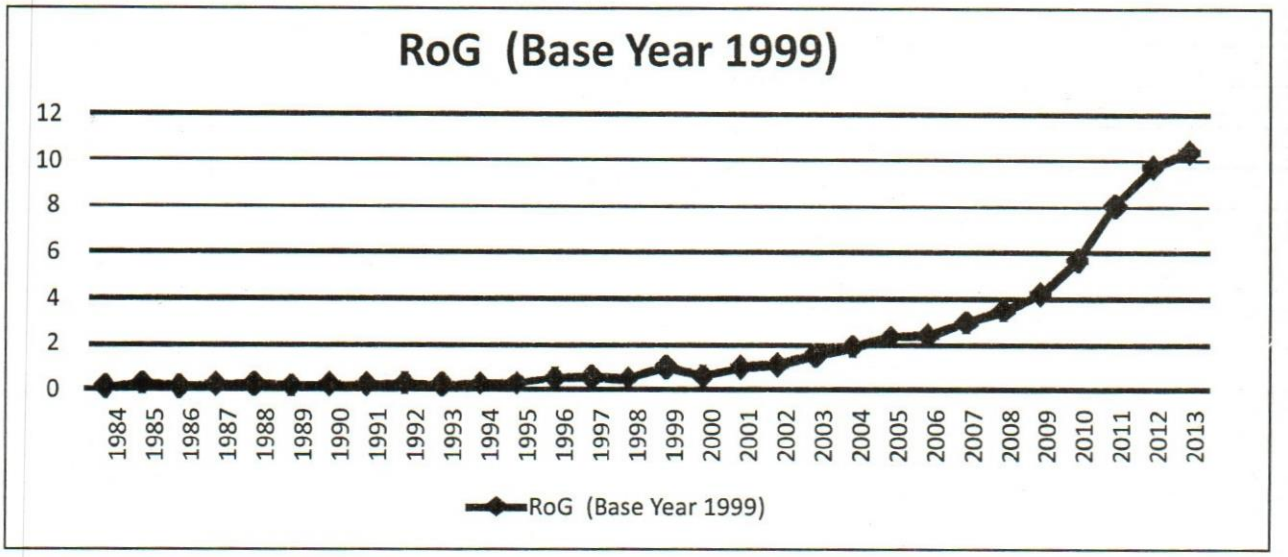

Figure 2: Ratio of Growth of Indian Lung Cancer Literature with base year 1999

It can be seen from the table that the Indian publication on lung cancer research seems to be in parabolic trend. During the last 10 years there is a substantial increase in the publications. This indicates that the awareness and importance of lung cancer has been in increasing trend. The CAGR indicates 16 per cent of growth in lung cancer research.

Literature Growth on Lung Cancer in India

The growth of publications was analyzed by using two parameters: Relative Growth Rate and Doubling time (Mahapatra, 1985). The Relative growth rate (RGR) and doubling time has been calculated and the same is shown in Table 2.

Table 2: RGR and Dt of Indian Lung Cancer Literature

Year	No. of records	Cumulative	W1	W2	RGR	Dt
1984	7	7	0	1.95	0	0
1985	16	23	1.95	3.14	1.19	0.58
1986	8	31	3.14	3.43	0.30	2.32
1987	13	44	3.43	3.78	0.35	1.98
1988	15	59	3.78	4.08	0.29	2.36
1989	10	69	4.08	4.23	0.16	4.43
1990	13	82	4.23	4.41	0.17	4.01
1991	14	96	4.41	4.56	0.16	4.40
1992	18	114	4.56	4.74	0.17	4.03
1993	14	128	4.74	4.85	0.12	5.98
1994	17	145	4.85	4.98	0.12	5.56
1995	19	164	4.98	5.10	0.12	5.63
1996	31	195	5.10	5.27	0.17	4.00
1997	35	230	5.27	5.44	0.17	4.20
1998	30	260	5.44	5.56	0.12	5.65
1999	61	321	5.56	5.77	0.21	3.29
2000	37	358	5.77	5.88	0.11	6.35
2001	60	418	5.88	6.04	0.15	4.47
2002	67	485	6.04	6.18	0.15	4.66
2003	93	578	6.18	6.36	0.18	3.95
2004	114	692	6.36	6.54	0.18	3.85
2005	141	833	6.54	6.73	0.19	3.74
2006	145	978	6.73	6.89	0.16	4.32
2007	179	1157	6.89	7.05	0.17	4.12
2008	211	1368	7.05	7.22	0.17	4.14
2009	255	1623	7.22	7.39	0.17	4.05
2010	345	1968	7.39	7.58	0.19	3.60
2011	490	2458	7.58	7.81	0.22	3.12
2012	593	3051	7.81	8.02	0.22	3.21
2013	633	3684	8.02	8.21	0.19	3.68

$$\text{Relative Growth Rate (RGR)} = \frac{Log_{e2}W - Log_{e1}W}{2^T - 1^T}$$

$$\text{Doubling time (DT)} = \frac{0.963}{R}$$

Major Collaborative Partners of India

The collaborative nature of Indian lung cancer research is predominantly has been analysed. The total number of Indian papers involving international collaboration during 1984–2013 is 1253, accounting for 34.01 per cent share in the cumulative publications output of India in lung cancer research. United States was the major collaborating partner of India during 1984–2013 accounting 24.66 per cent of collaborative publications, followed by France (5.19 per cent share), Germany (5.03 per cent share) and United Kingdom (4.95 per cent share), Australia and Japan (3.51 per cent share) of collaboration of Indian Publications.

Figure 3: RGR and DT of Indian Lung Cancer Literature

Table 3: Collaborated Countries

S. No.	Collaborating Country	Number of Papers	Percentage
1	USA	309	24.66
2	France	65	5.19
3	Germany	63	5.03
4	United Kingdom	62	4.95
5	Australia	44	3.51
6	Japan	44	3.51
7	Italy	43	3.43
8	Canada	41	3.27
9	China	30	2.39
10	South Korea	26	2.08
11	Switzerland	24	1.92
12	Netherlands	24	1.92
13	Singapore	24	1.92
14	Poland	23	1.84
15	Spain	22	1.76
16	Belgium	22	1.76
17	Taiwan	22	1.76
18	Saudi Arabia	22	1.76
19	Brazil	18	1.44
20	Israel	15	1.20
21	Russian Federation	14	1.12
22	Austria	12	0.96
23	Argentina	12	0.96
24	Malaysia	11	0.88
25	Denmark	11	0.88
26	Egypt	11	0.88
27	Sweden	10	0.80
28	Turkey	10	0.80
29	Nepal	10	0.80
30	Portugal	10	0.80
31	Other Countries	199	15.02
	Total	**1253**	**100**

Most Productive Indian Institutions

The Indian Institutions that contributed more than 25 publications for Lung cancer research during the study period have been shown in Table 4. Tata Memorial Hospital, Mumbai has contributed more than 294 (16.90 per cent) publications and seems to be the major contributors. It is followed by All India Institute of Medical Sciences, New Delhi 228 (13.10 per cent), Postgraduate Institute of Medical Education and Research Chandigarh 196 (11.26 per cent) and University of Madras, Chennai 77 (4.43 per cent).

Table 4: Most Productive Indian Institutions on Lung Cancer

S. No.	Indian Institution/University/R&D	Number of Papers	Percentage	Rank
1	Tata Memorial Hospital, Mumbai	294	16.90	1
2	All India Institute of Medical Sciences, New Delhi	228	13.10	2
3	Postgraduate Institute of Medical Education and Research, Chandigarh	196	11.26	3
4	University of Madras, Chennai	77	4.43	4
5	Indian Institute of Chemical Technology, Mumbai	60	3.45	5
6	Institute Rotary Cancer Hospital, New Delhi	56	3.22	6
7	Chhatrapati Shahuji Maharaj Medical University, Lucknow	52	2.99	7
8	Regional Cancer Centre, Thiruvananthapuram	49	2.82	8
9	Indian Institute of Integrative Medicine, Srinagar	45	2.59	9
10	Christian Medical College, Vellore	43	2.47	10
11	Panjab University, Chandigarh	43	2.47	10
12	Amala Cancer Hospital and Research Centre, Kerala	43	2.47	10
13	Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow	42	2.41	11
14	Kidwai Memorial Institute of Oncology, Bangalore	41	2.36	12
15	Bhabha Atomic Research Centre, Mumbai	39	2.24	13
16	Medical College and Hospital, Kolkata	38	2.18	14
17	Chittaranjan National Cancer Institute, Kolkata	36	2.07	15
18	Cancer Institute, Chennai	36	2.07	15
19	Sher-I-Kashmir Institute of Medical Sciences, Jammu and Kashmir	35	2.01	16
20	Indian Institute of Toxicology Research, Lucknow	35	2.01	16
21	Rajiv Gandhi Cancer Institute and Research Centre, New Delhi	33	1.90	17
22	Aligarh Muslim University, Uttar Pradesh	31	1.78	18
23	National Institute of Pharmaceutical Education and Research, Hyderabad	30	1.72	19
24	Government Medical College & Hospital, Chandigarh	28	1.61	20
25	Jawaharlal Nehru Medical College, Karnataka	28	1.61	20
26	Kasturba Medical College, Manipal	27	1.55	21
27	Indian Institute of Science, Bangalore	25	1.44	22
28	University of Delhi, New Delhi	25	1.44	22
29	Nil RatanSircar Medical College, Kolkata	25	1.44	22
	Total	**1740**	**100**	

Preferred Journals by Indian Scientists

Table 5 discussed that preferred journals to publish their research articles by Indian scientists. The top 25 journals contribute 25.11 per cent of Indian contributions. Majority of the lung cancer research appeared in Indian Journal of Cancer (80) followed by Asian Pacific Journal of Cancer Prevention (73), Journal of Cancer Research and Therapeutics (68), Indian Journal of Pathology and Microbiology (67) and Lung India (55); 10 per cent of the Indian contributions were appearing in these five journals.

Authorship Pattern

The publications of lung cancer are further analysed on 'single author', 'two authors', 'three authors', 'four

Table 5: PreferredJournals by Indian Scientists on Lung Cancer

S. No.	Indian Scientists contribution in the Journals	Number of Papers	Percentage	Rank
1	Indian Journal of Cancer	80	8.65	1
2	Asian Pacific Journal of Cancer Prevention	73	7.89	2
3	Journal of Cancer Research and Therapeutics	68	7.35	3
4	Indian Journal of Pathology and Microbiology	67	7.24	4
5	Lung India	55	5.95	5
6	Journal of Association of Physicians of India	50	5.41	6
7	Indian Journal of Radiology and Imaging	49	5.30	7
8	European Journal of Medicinal Chemistry	46	4.97	8
9	Journal of the Indian Medical Association	43	4.65	9
10	BMJ Case Reports	34	3.68	10
11	Medicinal Chemistry Research	33	3.57	11
12	Bioorganic and Medicinal Chemistry Letters	29	3.14	12
13	Indian Journal of Medical and Paediatric Oncology	28	3.03	13
14	National Medical Journal of India	27	2.92	14
15	Plos One	26	2.81	15
16	Indian Journal of Medical Research	24	2.59	16
17	Acta Cytologica	24	2.59	16
18	Indian Journal of Surgical Oncology	24	2.59	16
19	Journal Indian Academy of Clinical Medicine	22	2.38	17
20	International Journal of Pharma and Bio Sciences	21	2.27	18
21	Journal of Clinical and Diagnostic Research	21	2.27	18
22	International Journal of Pharmaceutical Sciences Review and Research	21	2.27	18
23	Journal of Anaesthesiology Clinical Pharmacology	20	2.16	19
24	Indian Journal of Nuclear Medicine	20	2.16	19
25	Molecular and Cellular Biochemistry	20	2.16	19
	Total	**925**	**100**	

Table 6: Authorship Pattern of Indian Lung Cancer Literature

S.No.	Authorship Pattern	Frequency	Percent	Cumulative Percent
1	Single Author	201	5.5	5.5
2	Two Author	585	15.9	21.3
3	Three Author	698	18.9	40.3
4	Four Author	712	19.3	59.6
5	5 and above	1488	40.4	100.0
	Total	**3684**	**100.0**	

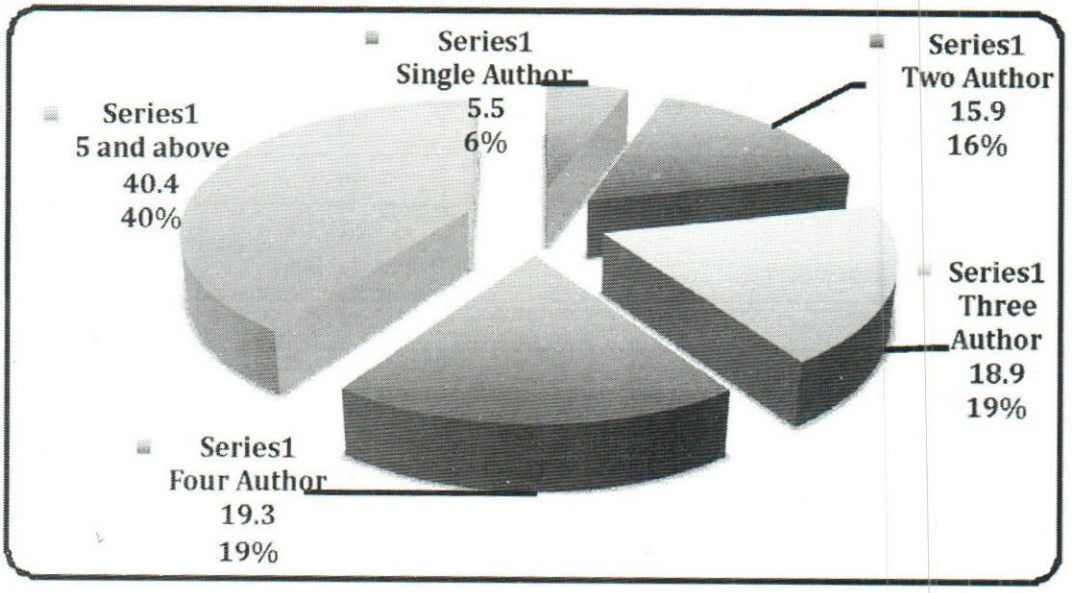

Figure 4: Authorship Pattern of Indian Lung Cancer Literature

author', and 'five and above authors', and the same is shown in Table 6. It is evident from the Table 6 and Figure 4, that nearly 94 per cent were collaborative research either by two authors or more than two authors in the case of Indian publications. Nearly 6.0 per cent of publications have single authors.

Table 7 shows that G. Kuttan has contributed 37 publications that fetch 937 citations which includes 109 self-citations. The average citations of his publications were 25.32, followed by C.S. Pramesh with 35 publications that fetch 69 citations, which includes 34 self-citations. The average citations of his publication were 1.97. D. Sakthisekaran has contributed 32 publications that fetch 458 citations which includes 40 self-citations. The average citation of his publication was 14.31. The impact of the number of publications was measured based on their average citation among the top authors after excluding the self-citation. The ranks were assigned based on average citation. Based on the above top three authors were G. Kuttan, D. Sakthisekaran and R. Guleria, C.S. Pramesh who have contributed more papers (35) obtained only 17th rank, because of low average citation, which indicates the majority of the papers are may not be qualitative or over cite of missing his paper.

Table 7: Top Indian Authors on Lung Cancer Research

S. No.	Author	Total Papers	Total Citation	Self - Citation	Average Citation	Average Self Citation	Rank
1	Kuttan, G.	37	937	109	25.32	2.95	1
2	Pramesh, C.S.	35	69	34	1.97	0.97	17
3	Sakthisekaran, D.	32	458	40	14.31	1.25	2
4	Singh, N.	32	71	38	2.22	1.19	16
5	Behera, D.	30	234	47	7.80	1.57	8
6	Mohan, A.	28	303	11	10.82	0.39	4
7	Saxena, A.K.	27	224	79	8.30	2.93	6
8	Aggarwal, A.N.	26	87	46	3.35	1.77	13
9	Guleria, R.	25	321	18	12.84	0.72	3
10	Jambhekar, N.A.	25	195	10	7.80	0.40	7
11	Mistry, R.C.	24	79	3	3.29	0.13	14
12	Thulkar, S.	23	98	11	4.26	0.48	11
13	Kumar, R.	21	135	18	6.43	0.86	9
14	Prabhash, K.	21	49	5	2.33	0.24	15
15	Rangarajan, V.	20	76	6	3.80	0.30	12
16	Devaki, T.	20	208	57	10.40	2.85	5
17	Basu, S.	20	112	25	5.60	1.25	10

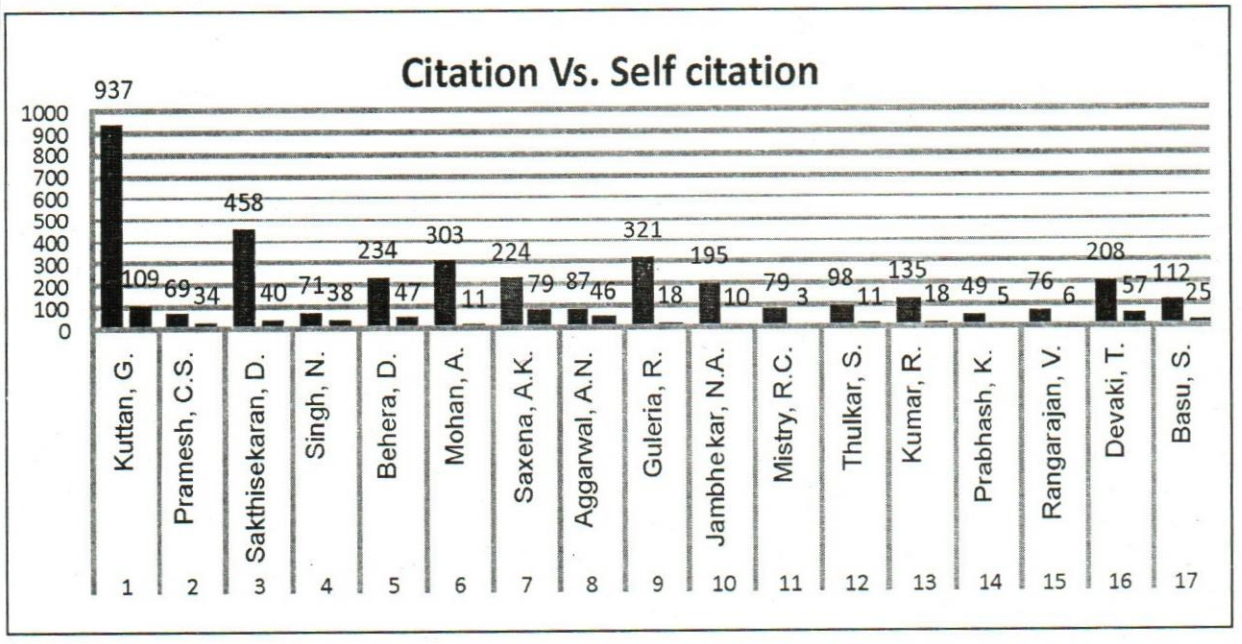

Figure 5: Citation and Self Citations of Top Indian Authors

Top Indian Authors and Their *h-index*

The top authors were identified and their contributions were listed. The details such as name of the author, total number of publications, total citation, without self-citation, h-index and the rank were assigned based on the h-index shown in Table 8.

Table 8: Top Indian Authors and Their *h-Index*

S. No.	Author	TP	TC	Without Self-citation	*h-Index*	Rank
1	Kuttan, G.	37	937	828	16	1
2	Pramesh, C.S.	35	69	35	5	11
3	Sakthisekaran, D.	32	458	418	12	2
4	Singh, N.	32	71	33	5	12
5	Behera, D.	30	234	187	9	5
6	Mohan, A.	28	303	292	10	3
7	Saxena, A.K.	27	224	145	9	6
8	Aggarwal, A.N.	26	87	41	5	13
9	Guleria, R.	25	321	303	10	4
10	Jambhekar, N.A.	25	195	185	9	7
11	Mistry, R.C.	24	79	76	5	14
12	Thulkar, S.	23	98	87	5	15
13	Kumar, R.	21	135	117	6	9
14	Prabhash, K.	21	49	44	4	16
15	Rangarajan, V.	20	76	70	4	17
16	Devaki, T.	20	208	151	8	8
17	Basu, S.	20	112	87	6	10

G. Kuttan has contributed 37 publications that fetch 937 citations which include 828 without self-citations with his h-index 16. It is followed by C.S. Pramesh with 35 publications that fetch 69 citations which include 35 without self-citations with his h-index 5 and D. Sakthisekaran has contributed 32 publications that fetch 458 citations which includes 418 without self-citations with his h-index 12. Based on h-index the top three authors were G. Kuttan, D. Sakthisekaran, and A. Mohan, C.S. Pramesh who have contributed more papers (35) obtained only 11th rank with h-index of 5. Even though he is the second-highest contributed author, gets 11th position based on h-index and 17th position based on average citation.

Conclusion

Indian scientists together have published 3,684 papers in lung cancer ancer research during 1984–2013. USA is India's major collaborative partner during 1984–2013 with a share of 52.31 per cent, followed by France (with 5.19 per cent share), Germany (with 5.03 per cent share), etc. The topmost productive three institutions, namely Tata Memorial Hospital (16.90 per cent) followed by All India Institute of Medical Sciences (13.10 per cent), Postgraduate Institute of Medical Education and Research (11.26 per cent) and these institutions contributed 718 publications with 19.49 per cent share of total research output. Among various journals publishing Indian Lung Cancer research papers, majority of the lung cancer research appeared in Indian Journal of Cancer (8.65 per cent) followed by Asian Pacific Journal of Cancer Prevention (7.89 per cent), Journal of Cancer Research and Therapeutics (7.35 per cent).

Lung cancer still remains the leading cause of cancer deaths claiming more lives each year than breast, colon and prostate cancer combined. There is also need to increase funding support for research and development (R&D) and create awareness and conduct the training programmes by Indian government. The government takes precaution steps to educate the society, lung cancer causes, risk, symptoms, abolished tobacco oriented products, advertisement through mobile phone message

and Social Networking Sites, etc. It is also important to initiate a systematic screening programme for identification and diagnosis of lung cancer. The Indian government should create the agenda of health care all type cancers like Breast Cancer, Colon and Rectal Cancer, Endometrial Cancer, Kidney Cancer, Melanoma Cancer, Non-Hodgkin Lymphoma, Pancreatic Cancer, Prostate Cancer and Thyroid Cancer.

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A Nation that destorys its soils destroys itself. Forests are the lungs of our land, purifying the air and giving fresh strength to our people.

—Franklin D. Roosevelt

Focus

Health Workforce in the Rural Public Health Sector in Assam : Current Status and Way Forward

DILIP SAIKIA AND HEMANTA BARMAN

The purpose of this paper is to examine the adequacy of health workforce in the rural public health sector in Assam. The findings reveal that Assam faces an acute shortage workforce in the rural health sector. Although the position of the state is better than the national average in terms of health workforce density and population coverage by health workforce, the national and global norms that exist in this regard are yet to be satisfied. The findings also suggest that both demand and supply side factors are responsiblefor the shortages of health workforce in the state. The paper emphasizes the urgent need to create the required number of posts and fill up the vacancies;attractive incentive packages to attract doctors and specialists to the rural areas;training to existing workforce to keep them up-to-date; and suitable human resource management system in recruitment, distribution and management of health workforce in order to resolve the problem of health workforce shortages in the state.

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Introduction

Public health, defined as 'all organized measures to prevent disease, promote health and prolong life among the population as a whole' (WHO-WTO, 2002), plays a key role in providing universal access to healthcare services to the people of a nation. The role of public health sector is even more vital in populous developing countries like India, where more than two-thirds of the population lives in rural areas[1] and one-fifth of the population are below the poverty line,[2] whereas the presence of private sector in the rural areas is very negligible.

The health workforce, defined as 'all people engaged in actions whose primary intent is to enhance health' (WHO, 2006), is at the heart of the healthcare system (Joint Learning Initiative, 2004). The *World Health Report 2000* remarks that human resources are 'the most important of the health system's inputs. The performance of healthcare systems depends ultimately on the knowledge, skills and motivation of persons responsible for delivering services' (WHO, 2000). WHO (2014) further reiterates the importance of health workforce in promoting health and well-being of the people and asserts that there is 'no health without a workforce'. Emphasizing the critical role of the health workforce, Anand and Bärnighausen (2012) describe the health workers as the foundation of the health system and note that every function of the health system is either undertaken by or mediated through the health workers.[3] There is no doubt that health workers are

[1]As per Census 2011 about 68.8 percent population of India live in the rural areas.

[2]As per the Planning Commission estimates, the percentage of population below the poverty line in 2011–12 was 21.9 percent; the figure for the rural area was 25.7 percent (Government of India, 2013).

[3]The activities performed by the health workers include providing curative and preventive services to patients, and information about symptoms, diagnoses and treatment options along with selection of treatment technologies and medical equipment (Anand and Bärnighausen, 2012).

responsible for delivering healthcare services, and hence, the numerical adequacy, appropriate skill mix and geographical spread of the health workforce are all crucial for efficient functioning of the healthcare system. There is ample evidence to support that greater availability of health workers leads to better service utilization and health outcomes (Anand and Bärnighausen, 2004; WHO, 2006; Rao et al., 2012).

Although the Joint Learning Initiative (2004) highlighted the health workforce crisis across the globe and alerted the world, a decade ago, to the necessity of responding to health workforce needs, the problem of scarcity of health workforce is widespread even today. A recent WHO report observes that out of 186 countries with available data 83 countries don't currently meet the threshold of 22.8 skilled health professionals (midwives, nurses and physicians) per 10000 population (WHO, 2014).

The report also brings out the widespread variation in accessibility and availability of health workforce within countries and the challenge in replacement of the ageing health workers.

Similar to other countries, there has been severe shortage of skilled health workforce in India (WHO, 2006). The *World Health Report 2006* placed India among the 57 countries which have been facing a crisis in health workforce. As per the report, in 2003 India had 6 doctors, 8 nurses, 4.7 midwives, 0.6 dentists and 5.6 pharmacists per 10000 population. Based on Census 2001 data Rao et al. (2011) and Rao et al. (2012) estimated that India has approximately 20 health workers per 10000 population and when adjusted the estimates for health worker qualification the health worker density reduced to a little over 8 per 10000 population. Rao et al. (2012) also pointed out that the combined density of doctors, nurses and midwives (11.9) is about half of the WHO benchmark of 25.4 workers per 10000 population and when adjusted for qualification, the density falls to around one-fourth of the WHO benchmark. Several other studies also report the severe shortages of health workforce in India and the barrier it has created in achieving universal health coverage in the country (for example, Satpathy and Venkatesh, 2006; Baru et al., 2010; Hazarika, 2013; Government of India, 2011a).

An important aspect of health workforce in India is uneven distribution of the health workers across the states and between rural and urban areas. Hazarika (2013) observes that economically backward states have lower density of health workers and lesseducated workforce. Rao et al. (2012) find that the states in northern and central India have low density of doctors, whereas the southern states tend to have a higher density of doctors. Rao et al. (2012) further note that across states health workers are concentrated in the urban areas and the density of health workers per 10000 population in urban areas (42) is nearly four times than that of rural areas (10.8), even though more than two-thirds of Indians live in the rural areas.

Like other states, the healthcare sector of Assam has suffered severe shortages of workforce, especially in the rural areas. Available data from the National Family Health Survey-III (2005–06) reveals that only 35 per cent PHCs in Assam have adequate staff (reported in Dash, 2012). The report of the National Commission on Macroeconomics and Health (NCMH) finds that in 2004 the density of health workers (doctors, nurses and midwives) per 10000 population was 13.7 in Assam, compared to all-India average of 22.1 (Government of India, 2005). Based on National Sample Survey data (61st round [2004–05]; on Employment and Unemployment Survey) Motkuri (2011) shows that only 22.9 per cent of the total health workforce in Assam were employed in the rural areas and the density of health workforce per 10000 population in rural area was only 4.2, compared to 88.7 in the urban areas. The study also reveals that the share of health workforce engaged in the public sector in Assam was 59.3 per cent (compared to the national average of 28.2 per cent) and density of health workers in public sector per 10000 population was 9.3 (compared to the national average of 8.6). Although Assam is one of the 18 states which have assigned special focus under the National Rural Health Mission (NRHM) launched by the Government of India in 2005 in order to strengthen the rural healthcare infrastructure in the country, the problem of numerical shortages of skilled workforce in the rural healthcare sector in the state has not resolved even today. In a recent study Goswami and Dutta (2012) find that in 2010 about 27.5 per cent PHCs in Assam runs with only one doctor, 59.5 per cent PCHs don't have a lady doctor, and there are severe shortages of specialists and radiographers in CHCs.

In this context, the present study aims to make an assessment of the current status of health workforce in the rural public healthcare system in Assam. The rest of the paper is organized in the following sections. The next section provides an overview of the socioeconomic profile and health status of Assam vis-à-vis India. Then we examine the availability and shortages of health workforce in the rural health institutions in Assam. In the next section, we discuss the production capacity of health workforce in the state. The last section summarizes the findings of the study.

Socioeconomic and Health Status: Assam vis-à-vis India

Assam is one of the economically backward states of the Indian Union. The level of living standard of the people, as expressed by per capita income, in the state is almost half of the all India average (Table 1). As per the 2011 Census, Assam accommodated 31.17 million population (about 2.58 per cent) of Indian Union, of which 26.78 million lived in the rural areas, which is about 3.21 per cent of total rural population of India. In terms of demographic

Table 1: Selected Socioeconomic and Health Indicators: Assam and India

Indicators	Area	Year	Assam	India
Per capita net domestic product (Rs. at 2004–05 prices)		2011–12	21406	37851
Population (in millions)	Total	2011	31.17	1210.19
	Rural	2011	26.78	833.09
Sex ratio (females per 1000 males)	Total	2011	954	940
	Rural	2011	956	947
Literacy rate	Total	2011	73.18	74.04
	Rural	2011	70.44	68.91
Female literacy rate	Total	2011	67.27	65.46
	Rural	2011	64.09	58.75
Infant mortality rate	Total	2011	55	44
	Rural	2011	58	48
Under-five mortality rate	Total	2011	78	55
	Rural	2011	83	61
Maternal mortality rate	Total	2007-09	390	212
Life expectancy at birth (years)	Total	2011	61.9	65.5
Human Development Index	Total	2007-08	0.444 (16)	0.467
Health Index	Total	2007-08	0.407 (23)	0.563
Number of Sub Centres	Rural	2011	4604	148124
Number of PHCs	Rural	2011	938	23887
Number of CHCs	Rural	2011	108	4809
Population covered by a Sub Centre	Rural	2011	5817	5624
Population covered by a PHC	Rural	2011	28551	34876
Population covered by a CHC	Rural	2011	247968	173235
Population served per government hospital	Total	2010	203721	100908
	Rural	2010	247968	113392
Population served per government hospital bed	Total	2010	4089	1542
	Rural	2010	8266	5179
% of villages having access to a Sub Centre within three km	Rural	2007-08	83.2	71.4
% of villages having access to a PHC within ten km	Rural	2007-08	68.3	71.2
% deliveries attended by health personnel	Rural	2007-08	37.6	43.6
% children 12-23 months fully immunized	Rural	2007-08	50.9	54.1

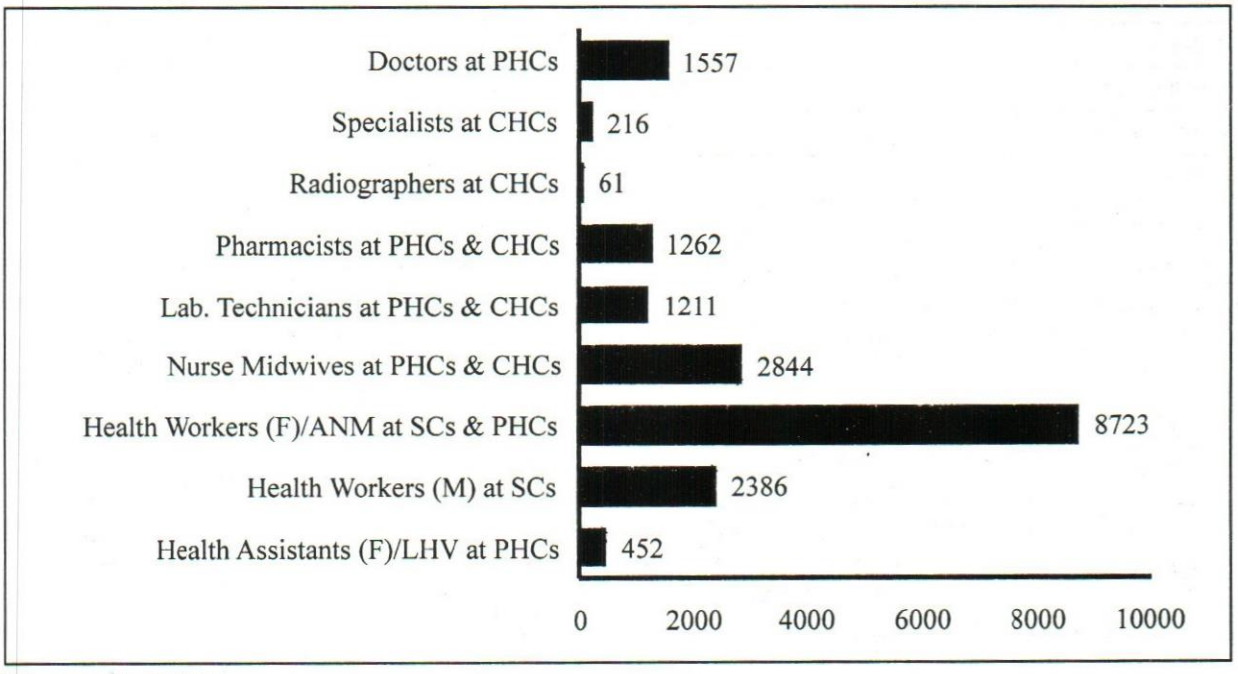
Source: (a) Handbook of Statistics on Indian Economy; (b) Population Census 2011; (c) Bulletin on Rural Health Statistics in India 2011; (d) National Health Profile 2011; (e) District Level Household and Facility Survey (DLHS-3), 2007–08.

characteristics such as sex ration, literacy rate, female literacy rate, etc., Assam is ahead of the national average. However, the health status of the state is comparatively poor than the national average (Table 1). The mortality rates – be it infant mortality, under-five mortality, or maternal mortality – in the state are higher than the national average and the life expectancy at birth is lower than the national average. The poor health status is reflected in the low human development. Although the human development index (HDI) of Assam is slightly below the national average, but in terms of rank of the state compared to other states, it stood at 16th position. The position of the state in terms of health index, which is a sub-index of HDI, is even awful and Assam ranked at 23rd. The health status is even pitiable in the rural areas of the state and the same is the case for the country as a whole, which is visible from the data presented in Table 1.

Looking at the healthcare infrastructure, there are about 4604 Sub-centres, 938 PHCs and 108 CHCs in Assam as on march 2011, which accounted for about 3.11 per cent, 3.93 per cent and 2.25 per cent respectively of all India total. In terms of population covered by these health institutions and government hospital bed, the situation in the state is below the all India average (except population covered by a PHC). For instance, a government hospital in Assam has to serve more than two times population than a government hospital served at the national level and a government hospital bed in Assam has to serve more than two-and-a-half times population than a government hospital bed served at the national level. The population covered by a government hospital and a government hospital bed in the rural areas is even worse. The disappointing picture of healthcare facilities in the rural areas of the state compared to the national average is also visible in terms of accessibility to these facilities. Take the percentage of villages having access to a PHC within 10 km, or the percentage of deliveries attended by health personnel, or the percentage of children (between 12–23 months) fully immunized; in all the cases the situation in the state is below the national average.

Health Workforce Availability

Figure 1 shows the availability of workforce in the rural health centres in Assam. As on March 2011 there are 1557 doctors, 216 specialists, 14405 nurses (including ANMs, male health workers and female health assistants), 1262 pharmacists and 61 radiographers in rural centres of Assam. Table 2 depicts the density and population coverage of different cadres of health workforce in Assam vis-à-vis India. The density of total doctors, nurse and paramedical staff in Assam (0.07, 0.55 and 0.65 per 1000 population respectively) is better than the national average (0.04, 0.43 and 0.48 per 1000 population respectively). Looking at the different types of health workers separately,



Note: Data as on March 2011.
Source: Bulletin on Rural Health Statistics in India 2011.

Figure 1: Availability of Workforce in Rural Health Institutions in Assam

it is apparent that except for radiographers and health assistant (female) the density of other cadres in the state is higher than the national average. Overall, the density of aggregate workforce is slightly higher at 0.72 per 1000 population as compared to all India average at 0.52 per 1000 population. Although there are no norms for density of health workforce in India, but if we consider a threshold level of 2.5 workforce (including doctors, nurses and midwives) per 1000 population, as suggested by the Joint Learning Initiative (2004) or the World Health Organization's critical shortage threshold level of 2.28 per 1000 population (WHO, 2006), then the current status of health workforce in the state as well as the country as a whole is far below the critical threshold level. The Joint Learning Initiative (2004) asserts that failing to achieve the suggested threshold of density of aggregate workforce, it becomes difficult to achieve an 80 per cent coverage rate for deliveries by skilled birth attendants or for measles immunization, which is clearly understood from the low rate of safe delivery and full immunization in the rural Assam as well as India (Table 1).

In terms of population coverage by a manpower, Assam's position is better than that of all India average for each category of health workforce, except radiographers and female health assistants (Table 2). Take a doctor at PHCs, who has to serve 16,697 people in Assam compared to the national average of 31,697 people, and a nurse midwife, who has to serve 9,141 people in rural Assam compared to the national average of 12,772 people. As per the NRHM norms, there must be a health worker (female) and a health worker (male) per 5000 population in the plain areas and 3000 population in the hilly/tribal/ desert areas, whereas there are no such population norms for other cadres of health workforce (Government of India, 2011c). From Tables 2 and 3 it is evident that Assam has fulfilled the norm only in case of health workers (female), while the country as a whole has failed to fulfill the norms in both the cases. The NRHM further recommended that

Table 2: Density and Population Coverage of Health Workforce in Rural Health Centres

(as on March 2011)

Health Workforce	Workforce density per 1000 population		Population coverd by a workforce	
	Assam	India	Assam	India
Doctors at PHCs	0.0599	0.0315	16697	31697
Specialists at CHCs *	0.0083	0.0083	120356	120340
Radiographers at CHCs	0.0023	0.0027	426180	375758
Pharmacists at PHCs and CHCs	0.0485	0.0296	20600	33827
Laboratory Technicians at PHCs and CHCs	0.0466	0.0194	21467	51490
Nurse Midwives at PHCs and CHCs	0.1094	0.0783	9141	12772
Health Workers (F)/ANM at Sub Centres and PHCs	0.3355	0.2491	2980	4008
Health Workers (M) at Sub Centres	0.0918	0.0626	10896	15955
Health Assistants (F)/LHV at PHCs	0.0174	0.0191	57515	52462
Health Assistants (M) at PHCs	NA	0.0187	NA	53422
All Doctors #	0.0682	0.0399	14663	25089
All Nurse $	0.5541	0.4277	1805	2338
All Paramedical Staff %	0.6516	0.4794	1535	2086
All Manpower	0.7198	0.5192	1389	1926

Notes:
* Specialists include Surgeons, Obstetricians & Gynecologists, Physicians and Paediatricians.
# All Doctors include allopathic doctors and specialists.
$ All Nurses includes nurse midwife, health workers (F & M) and health assistants (F & M).
%All Paramedical Staffs include radiographers, pharmacists, laboratory technicians, nurse midwife, health workers (F & M) and health assistants (F & M). NA – Data not available.

Source: Bulletin on Rural Health Statistics in India 2011.

Table 3: Health Workforce: Norms and Level of Achievements

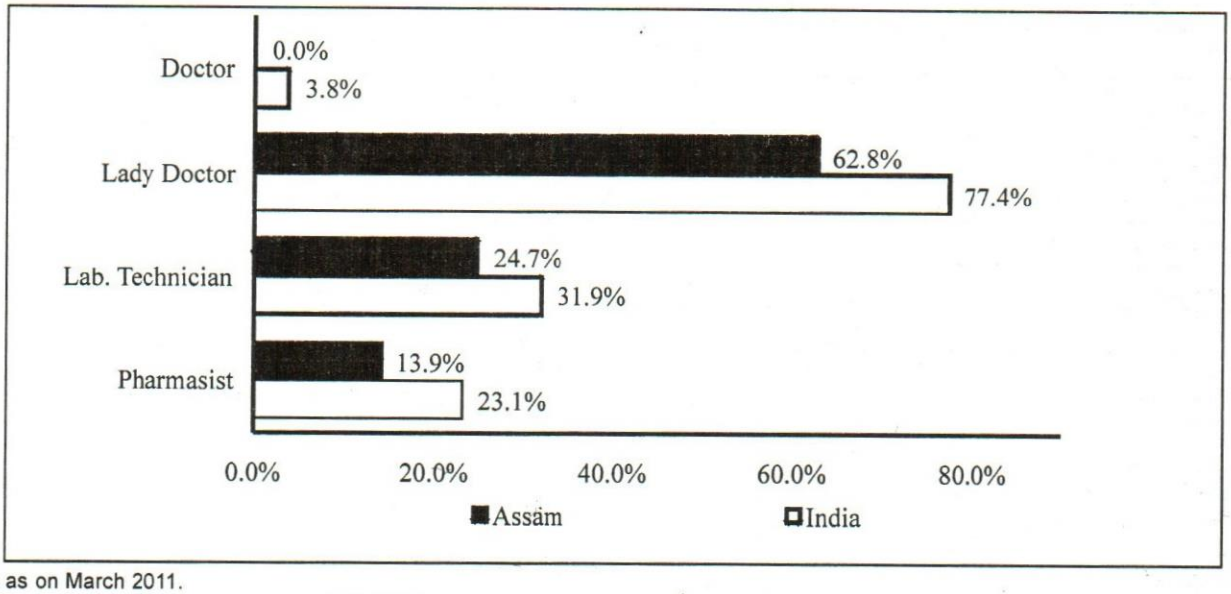
Indicators	Norms		Achievements	
	General	Tribal/Hilly/Desert	Assam	India
Population covered by a HW (F) at Sub Centresand PHCs	5000	3000	2980	4008
Population covered by a HW (M) at Sub Centres	5000	3000	10896	15955
Ratio of HA (M) at PHCs to HW (M) at Sub Centres	1 : 6	1 : 6	#	1 : 3
Ratio of HA (F) at PHCs to HW (F) at Sub Centresand PHCs	1 : 6	1 : 6	1 : 19	1 : 13

Note:
HW- Health worker, HA- Health Assistant;
Data on Health Assistant (M) at PHCs is not available for India.
Source: Bulletin on Rural Health Statistics in India 2011.

the ratio health assistant (female) at PHCs to health worker (female) at Sub-centres and PHCs and the ratio of health assistant (male) at PHCs to health worker (male) at Sub-centres should be 1:6, both in plain and hilly/tribal/desert areas (Government of India, 2011c). The data reported in Table 3 shows that both Assam and the national average have fulfilled the norm in the first case, whereas data is not available for Assam to comment on the second one and the national average (1:3) is below the norm. Additionally, if we consider the recommendation of the World Development Report 1993 that the ratio of nurses to doctors should exceed 2:1 as a minimum and a ratio of 4:1 or higher is regarded as best for cost effective quality care (World Bank, 1993); the minimum norm has not been fulfilled by the state. In 2011, the ratio of nurses to doctors was 1.6:1 in Assam and 2:1 in India, and including midwives the ratio improves to 6.5:1 and 8.2:1 respectively. In view of this, it is necessary to simultaneously augment the number of doctors and improve the ratio of nurse/midwife to doctor in the state.

Shortfall in Health Workforce

The review of available data in the preceding section reveals that the availability of workforce in the rural health institutions in Assam as well as the country as a whole is inadequate and there is scarcity of different cadres of health workforce. In 2011 about 32 per cent PHCs in Assam have been functioning with only one doctor and 74 per cent CHCs don't have all the specialists, even though as per NRHM norms CHCs must have four specialists – a physician, a surgeon, a paediatrician and an obstetrician and gynaecologist. The corresponding figures for India were 62 per cent and 87 per cent respectively. Figure 2 shows some even more serious concerns. In 2011 about



Note: Data as on March 2011.
Source: Bulletin on Rural Health Statistics in India 2011.

Figure 2: Percentage of PHCs Functioning without Workforce

62.8 per cent PHCs don't have a lady doctor, 24.7 per cent PHCs don't have a laboratory technician and 13.9 per cent PHCs are without a pharmacist in Assam. Although these figures are better than the corresponding all India figures (77.4 per cent, 31.9 per cent and 23.1 per cent respectively), the lack of these health workforce hinders the efficient functioning of the health centres.

Table 4 depicts the shortfall of different types of health workforce in the rural health centresas on March 2011. The shortfall of workforce is calculated as the difference between the required workforce (which is calculated using the prescribed population norms on the basis of rural population from 2011Census) and workforce in-position. It is evident from the table that while for the country as a whole there is acute shortfall of all the categories of health workforce, in Assam there are surplus of some cadres of health workforce, whereas some other cadres are in short. The number of doctors, pharmacists, nurse midwives, laboratory technicians and health workers (female) in Assam are more than the required numbers; whereas for the country as a whole there are 12 per cent fewer doctors, 22.5 per cent fewer pharmacists, 23 per cent fewer nurse midwives, 47.4 per cent fewer laboratory technicians and about 4 per cent fewer health workers (female). There is deficit of about 216 (50 per cent) specialists in the CHCs in Assam, the requirement being 432. Of the specialists, surgeons are short by 61 per cent, physicians are short by 75 per cent, paediatricians are short by 57.4 per cent and obstetricians and gynecologists are short by 6.5 per cent. The shortfall of radiographers at CHCs is 43.5 per cent. At the PHCs level, there is shortfall of 486 (51.8 per cent) female health assistants, whereas data on in-position male health assistants is not available, the requirement being 938 for both. At the Sub Centres level, there is deficit of about 2218 (48.2 per cent) male health workers; the requirement being 4604. The situation is even more serious in the tribal areas. The Bulletin on Rural Health Statistics in India 2011 reveals that in the tribal areas in Assam

Table 4: Requirement and Shortfall of Health Workforce in Rural Health Centres

(as on March 2011)

Health Workforce	Assam		India	
	Required	In Position	Shortfall	Shortfall
Doctors at PHCs	938	1557	+	2866 *(12.0)*
Specialists at CHCs	432	216	216 *(50.0)*	12301 *(63.9)*
Surgeons	*108*	*42*	*66 (61.1)*	*3052 (63.5)*
Obstetricians & gynecologists	*108*	*101*	*7 (6.5)*	*2682 (55.8)*
Physicians	*108*	*27*	*81 (75.0)*	*3252 (67.6)*
Paediatricians	*108*	*46*	*62 (57.4)*	*3029 (63.0)*
Radiographers at CHCs	108	61	47 *(43.5)*	2593 *(53.9)*
Pharmacists at PHCs and CHCs	1046	1262	+	6444 *(22.5)*
Nurse Midwives at PHCs and CHCs	1694	2844	+	13262 *(23.0)*
Laboratory Technicians at PHCs and CHCs	1046	1211	+	13611 *(47.4)*
Health Workers (F)/ANM at Sub Centres and PHCs	5542	8723	+	6555 *(3.8)*
Health Workers (M) at Sub Centres	4604	2386	2218 *(48.2)*	95909 *(64.8)*
Health Assistants (F)/LHV at PHCs	938	452	486 *(51.8)*	9036 *(37.8)*
Health Assistants (M) at PHCs	938	NA	NA	9935 *(41.6)*

Note:
+ indicates surplus;
NA - Data not available.
Figures in the parentheses represent percentage shortfall of the requirement.
Source: Bulletin on Rural Health Statistics in India 2011.

specialists are short by 40.6 per cent, radiographer are short by 37.5 per cent, pharmacists are short by 36.8 per cent, laboratory technicians are short by 45.3 per cent, male health workers are short by 74 per cent and female health assistants are short by 55 per cent (Government of India, 2011c). As such, there is serious shortfall in the number health workforce in the state as compared to the global as well national norms, which have resulted in suboptimal performance of the rural health systems, such that the vulnerable section of population in rural, tribal and hilly areas continue to be extremely un-served or underserved.

Although the shortfall of health workforce in Assam is less severe than the national average, this shortfall shows the sorry state of affairs of the rural healthcare system in the state. The shortage of workforce implies that even physical infrastructure is present in the health centres the deficiency of workforce makes the whole existing facility meaningless. The lack of adequate workforce not only affects the service delivery to the patients but also results in underutilization/non-utilization of the existing physical infrastructure and facilities in the health centres, leading to closure of those facilities. Consider the lack of surgeons, obstetricians and gynecologists, physicians and paediatricians in the CHCs, which deprives the patients from specialists' treatment. Besides, the lack of particular types of workforce creates problem in delivery of certain healthcare services. Take the lack of lady doctors in 591 (62.8 per cent) PHCs in the state. The lack of lady doctors severely affects access to healthcare services for female patients as they might not feel comfortable to discuss their certain health issues with male doctors. Similarly, the shortfall in male health workers in the Sub Centres results in poor male participation in family welfare and other health programmes, and also creates overburdening of the existing male health workers leading to underperformance of these workers.

In addition to the shortfall of health workforce, there are reports about large-scale absenteeism and low level of participation in providing healthcare services among the existing health workers (Choudhury et al., 2006; Hammer et al., 2007; Bhandari and Dutta, 2007). Based on a nationally representative all-India survey (conducted between December 2002 and March 2003, as a part of the World Development Report 2004 – 'Making Services Work for Poor People') of 1,436 PHCs and CHCs in 19 states, Choudhury et al. (2006) estimated that the absence rate among the primary health providers was 40 per cent in India, whereas absenteeism in Assam was 58 per cent, which was highest among the surveyed states. Their findings also reveal that absenteeism was highest among the high-ranked medical providers, such as doctors compared to the lower-ranking ones and among the men than the women.

The shortfall of health workers and large scale absenteeism among the existing health workers implies that there are too few healthcare providers at the health centres when patients demand healthcare, which creates overburdening of the staff that are present at that time and also long waiting time for the patients as they have to be in long queue for their numbers to come. The limited workforce, further, implies that not every patient can be attended by the available health workers. Besides, in many instances the health centres never open in due time and in other occasions they remained closed, which is more often at the Sub-centre level, leading to inconvenience of timing for the patients. Because of these problems, patients are reluctant to use public healthcare facilities. The available data from the National Family Health and Facility Survey – III (2005–06) reveals that of the households who don't use government medical facilities (34.8 per cent) in Assam, about 11.2 per centof households cited that the waiting time is too long as reason for not using it (government facilities), another 6.6 per cent households cited the reason as facility timing is not convenient and 6.1 per cent households cited it as health personnel often absent (IIPS, 2007).

Meeting the Demand for Health Workforce

With the growing population size, notably ageing population[4] and the increasing diseases burden, both communicable and non-communicable,[5] the demand for healthcare services has been on the rise over the years. Howevergiven the current status of health workforce in the state, as observed in the previous section, there is urgent need for strengthening the stock of different cadres of health workforce in the coming years. To meet the increasing demand for health workforce it is necessary to

[4]As per Census data, between 2001 and 2011 the elderly population (age 60 and above) in India has increased from 76.62 million (7.45 per cent) to 96.82 million (8.0 per cent) and that in Assam increased from 1.56 million (5.85 per cent) to 1.90 million (6.10 per cent). It is estimated that by 2026 the elderly population of India will increase to 173.18 million (12.37 per cent) and that of Assam to 3.92 million (11.01 per cent).

[5]It is estimated that India accounts for about 21 per cent of the world's global burden of disease and is home to the greatest burden of maternal, newborn and child deaths in the world (Tripathy, 2014).

scale up the training capacities of health workforce in the state.

The review of available literature suggest that the distribution of medical colleges and training institutions is quite uneven among the states in India,with the poorest states having a lesser number of them (Government of India, 2005; Hazarika, 2013) and there is wide disparity in the quality of education across the states (Government of India, 2007). Hazarika (2013) finds that the eight Empowered Action Group (EAG) states, which account for half of the India's population, have only one-fifth of the medical colleges and a quarter of the dental and nursing institutes. Similarly, the eight northern states, with about 3.8 per cent of India's population, have less than 3 per cent of medical colleges and less than 2per cent of the dental and nursing institutes.The problem of uneven distribution of medical colleges and training institutions across the states has been highlighted by both the National Commission on Macroeconomics and Health (NCMH) and the High Level Expert Group (HLEG) on Universal Health Coverage for India, and remarked that it has led to 'severe health system imbalances across the states, both in production capacity and in quality of education and training, eventually leading to poor healthcare outcomes' (Government of India, 2005; 2011b).

Table 5 shows the number of institutions and the production capacity of different cadres of healthcare professionals in Assam vis-à-vis India. As per the recommendation of the Mudaliar Committee of 1961 there must have one medical college for a population of 50 lakh, and as per this norm, the required number of medical colleges in Assam is six. In 2012 there are five medical colleges in Assam with a total of 626 MBBS seats, compared to three medical colleges with 391 seats in 2004

Table 5: Production Capacity of Health Workforce

(as on March 2012)

Health Work force	Type of Institute	Number of Institutes		Admission Capacity	
		Assam	India	Assam	India
Doctor	Government	5 *(2.98)*	168	626 *(3.04)*	20574
	Private	0 *(0.00)*	194	0 *(0.00)*	25055
	Total	5 *(1.38)*	362	626 *(1.37)*	45629
GNM	Government	4 *(2.01)*	199	54 *(0.75)*	7234
	Private	20 *(0.85)*	2351	554 *(0.59)*	94386
	Total	24 *(0.94)*	2550	608 *(0.60)*	101620
ANM	Government	5 *(1.90)*	263	80 *(1.14)*	7044
	Private	11 *(0.93)*	1179	304 *(0.94)*	32281
	Total	16 *(1.11)*	1442	384 *(0.98)*	39325
B.Sc (N)	Government	2 *(2.41)*	83	60 *(1.32)*	4555
	Private	5 *(0.35)*	1433	240 *(0.34)*	71193
	Total	7 *(0.46)*	1516	300 *(0.40)*	75748
M.Sc(N)	Government	2 *(6.67)*	30	37 *(6.57)*	563
	Private	1 *(0.22)*	453	10 *(0.12)*	8637
	Total	3 *(0.62)*	483	47 *(0.51)*	9200

Notes:
Figures in the parentheses represent percentage share of Assam to all-India.
GNM - General Nurse Midwives;
ANM – Auxiliary Nurse Midwives.

Source: Medical Council of India; Indian Nursing Council.

(Government of India, 2005). There are 24 General Nursing and Midwifery (GNM) training institutes and 16 Auxiliary Nurse Midwifery (ANM) training institutes. The annual admission capacities in these institutes are 608 and 384 respectively. Besides the state has seven recognized institutes offering Bachelor of Science in Nursing (B.Sc.[N]) degree and another three recognized institutes offering Master of Science in Nursing (M.Sc.[N]) degree; in which the admission capacity are 300 and 47 respectively.This implies that Assam, which accommodates 2.6 per cent of India's population (Table 1), has fewer medical colleges (1.38 per cent) and MBBS seats (1.37 per cent) and fewer nursing institutes and seats (1 per cent and 0.7 per cent respectively); reflecting the poor medical education infrastructure in the state.

One striking feature of medical education in Assam is that the presence of private sector in medical education is limited to the nursing institutes, whereas at the national level the private sector has a notable involvement in medical education. The poor presence of private sector in medical education in the state reflects couple of things: the process of privatization of medical education in the state is very slow, which to a large extent depends on willingness of the state government; and lack of motivated educational entrepreneurs willing to invest in medical education in the state.

Available data from the Central Bureau of Health Intelligence, Government of India shows that the production and stock of health workforce in the state has increased in recent years. Between 2006 and 2012 the stock of registered doctors in Assam has increased from 16,980 to 20,195 (19 per cent), AYUSH doctors has increased from 874 to 1,174 (34.3 per cent), nurse/midwife has increased from 26,495 to 39,036 (47.3 per cent) (Government of India, 2006; 2011d). Despite this increase,the posts of health workers in the rural public health centres remain vacant.These shortages are mainly attributed to a combination of factors: reluctance of the government for creation of new posts, delayin sanction of the required posts, poor retention rate, and undue delayin the recruitment process. Although posts of health workers at various levels are sanctioned, many of them are lying vacant because most of the health workers, especially doctors and specialists, donot want to work in the rural areas. Even though in many cases doctors are there, they hardly visit their designated centres; rather they engage in private practices.This suggests that increase in the production and supply of health workforce alone will not necessarily address the shortages of health workforce in the public health sector in Assam.

Conclusion

While India strives to achieve universal health coverage by 2020, the public health sector of the country has been suffering from severe shortages of one or the other typehealth workforce, especially in the rural areas and the backward states; even though the NRHM has prescribed the minimum norms. In this context, this paper examines the current statusof health workforce in the rural public health sector in Assam. The findings reveal the poor health status in the state, particularly in the rural areas. One of the reasons for this, as we argued in this paper, is the lack of adequate healthcare infrastructure, especially lack of skilled health workforce. Although the health workforce density in the state is better than the all-India level, it is below the WHO's critical threshold level. Similarly, Assam's position is better than the national average in case of population covered by a health workforce, but the population norms set by the NRHM in this regard are yet to be satisfied. The findings suggest serious shortfall of different cadres of health workforce in Assam as compared to the national and global norms, though these shortfall in the state are less severe than the all-India level.

These observed shortages in workforce in the state cannot be attributed to supply side factors (e.g., production capacity of health workers) alone; rather a combination of supply side factors, demand side factors (e.g., motivation to work in the rural areas, incentives to recruit and retain, institutional factors, etc.) and political factors are responsible for this. But whatever the reasons are, the shortfall of workforce hinders the efficient functioning of the rural healthcare system and affects the healthcare service delivery mechanism, and, thereby, stands asserious barrier to universal health coverage in the state. Therefore, it needs to be addressed with urgency if universal health coverage is to be achieved by 2020. Although, there is no single solution this complex problem, but ways forward do exist.There is urgent need to create the required number of posts and fill up the vacancies by simplifying the recruitment procedures. There is also need to introduce attractive incentive packages to encourage the doctors and specialists to serve in the rural areas. Efforts also need to be made to provide training to the existing workforce to keep them up-to-date. Further, suitable human resource management system should be introduced in recruitment, distribution and management of the health workforce. Besides, developing new courses and new cadres for the rural health sector is a way forward.The decision of the Central Government to

introduce a new four-year course in Bachelor of Rural Health Care, as against the current five and a half year MBBS course, is a right move in the direction towards overcoming the shortage of doctors in the rural areas.

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There's nothing more important than our good health—that's our principal capital asset.

—Arlen Specter

Focus

Impact of Healthcare Services on the Health Status of People: A Case Study of Barak Valley of Assam

SUCHITRA DAS

In the present era, economic development has shifted to human development paradigm where human beings are considered as the means and end of development. Health is considered as one of the important means of human development. Health has direct relation with increasing productive capacity of a person, reducing poverty of a person and enhancing economic growth of a country. Considering health as a right the WHO committed to provide health for all by 2000 and India being a signatory member launched the primary healthcare services for the improvement of health for all. In this paper attempt is made to study the changes in the health scenario of the people after the launching the healthcare services like National Rural Health Mission. Thus, Barak Valley, the remotest part of the country situated in the southern most part of Assam with a very weak socioeconomic infrastructure is considered as the study area. The study is mainly based on primary and secondary data. Primary data is collected on the basis of random sampling. A health index is prepared to look upon the health status of the people. It is found that launching of the healthcare delivery services has lead to the reduction of morbidity occurred by the diseases known as public health problem. Moreover, changes with regard to maternal and infant mortality are also found

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Introduction

Formation of human capabilities with improved health, education and skill is one of the strong requirements of human development and has been attached with the process of economic development. It is a widely accepted view that healthy, educated and skilled labour force is the most important productive asset. Health is inseparable from human development as well as economic development. Health has direct relation with increasing productive capacity of a person, reducing poverty of a person and enhancing economic growth of a country.

Health status of an individual depends on a number of factors like existing medical facilities, environment, individual's lifestyle, genetic factor, economic factor, social factor and political factor. To ensure health these factors play a very crucial role. Dreze and Sen (1998) and Koivusalo (2001) argued among the different forms of intervention that can contribute to the provision of social security, the role of healthcare deserves forceful emphasis. The Lalonde report (1981) in Canada identified two main health-related objectives: first, the healthcare system and second, prevention of health problems and promotion of good health. It emphasized government participation and argued that biomedical healthcare system is wrong, and the need is to look beyond the traditional healthcare (sick care) system if we wish to improve the health of the public.

In India nearly 70 percent of the population belongs to rural areas and they are suffering and dying from preventable diseases, problems related to mother and child, malnutrition and also the burden of non-communicable diseases like cancer, diseases or illness due to the use of tobacco, cardio-vascular diseases, and HIV-AIDS. These populations are trapped in poverty, malnutrition, low

level of literacy, and are facing high rate of infant and maternal mortality rate with low expectancy of life at birth, etc. Taking together rural and urban areas, India's position on health status is very low compared to the developed countries and also very low even compared to the other Asian countries. For instance, as per the *World Bank* (2010) the maternal mortality rate (MMR) per lakh live births is 230 in India, whereas it is only 37 in China, even in Sri Lanka it is 35 and 5 in Japan in the year 2010. Infant mortality rate (IMR) per thousand live births, for the year 2010 is 47.1 in India, 13.7 in China, 8.9 in Sri Lanka, 2.4 in Japan, and in Bangladesh the IMR is also low compared to India as it is 37.5. Taking another health indicator of life expectancy at birth, in India it is 66.1 years which is even low compared to some of the Asian countries like Bangladesh (69.49 years), China (74.89 years), Sri Lanka (73.76 years) and even Nepal (67.10 years). Comparing the three health indicators of MMR, IMR and life expectancy at birth, it can be seen that the health scenario of India is not quite satisfactory. If we consider the picture of rural areas of India, the condition is even more acute. Launching of National Rural Health Mission (NRHM) in the year 2005 is a landmark in providing primary healthcare services in the rural areas of the country.

It is seen that the rural healthcare services are assumed to have an impact on the health condition of the people. These are first, through providing the measures to control diseases, second by building the basic infrastructures and different health extension activities and involvement of health attendants or workers apart from the physicians and third, by making efforts to change the health habits of people.

In this respect it *necessitates* in the present paper to study impact of healthcare services on the health status of the people of Barak Valley.

Background of the Study Area

The Barak Valley region is situated in the southernmost part of Assam and comprises of three districts - Cachar, Karimganj and Hailakandi. Of the three districts of the valley, Hailakandi is the smallest district with total geographical area of 1,327 sq. km and Cachar is the largest district with 3,786 sq. km. The second largest district Karimganj covers 1809 sq. km of the total geographical area of the Valley. As per 2011 census of the total population 86.87 per cent of population comes from rural areas. Thus, it can be said that the rural area dominates the Barak Valley. The sex ratio of the valley is 957 females per thousand of males. The literacy rate of Cachar district is 80.36 per cent, of Karimganj district is 79.72 per cent and of Hailakandi district is 75.26 per cent, while for the state of Assam the literacy rate is 73.18 per cent in 2011.

Compared to the other parts of the state, the three districts of the Valley have a poor health status. As per the statistics it is revealed that, rural infant mortality rate (per thousand of live births) is 60 in Cachar, 71 in Karimganj 56 in Hailakandi and in the state it is 64. Maternal mortality rate (per lakh of live births) of the Barak valley is 342, that of the state is 381 and of India is 230. The doctor–population ratio (per lakh of population) is only 0.78 in Barak Valley, in national level it is 6. The number of bed available per lakh population is only 1.91 in Barak Valley, whereas in the state level and national level it is 3.24 and 7 respectively (Joint Director of Health Services, 2010). The poor health indicators of Barak Valley are due to the poor health infrastructure.

Objectives of the Study

In this paper attempt is made to study the impact of healthcare delivery services in the health status of people of Barak Valley. Thus the specific objectives of the study are as follows:

1. To study the available healthcare delivery services in Barak Valley.
2. To study the impact of healthcare delivery services on health status of the people of Barak Valley.

Data Source

The data sources are both primary and secondary. The main sources of secondary data are the official publications of government agencies of both State and Central Governments, like Directorate of Economics and Statistics — Government of Assam and Government of India, Directorate of Health Services- Government of Assam, Ministry of Health and Family Welfare-Government of India.

Primary data is collected on basis of multistage sampling. There are 27 community development blocks in Barak Valley (Cachar — 15, Karimganj — 7 and Hailakandi— 5). In the first stage of sample selection 6 Community Blocks (Cachar — 3, Karimganj — 2, and Hailakandi — 1) has been selected at random. From the selected 6 (six) Community Blocks 1 Gaon Panchayat from each Blocks is selected on the basis of simple random sampling. From each of 6 selected Gaon Panchayat 2

villages have been selected by using simple random sampling. From each village 20 per cent of total household is surveyed.

Methodology

The available healthcare services leading to changes in the health status of the people are studied under general health condition of the rural masses and maternal and child mortality. Under general health condition, incidence of morbidity is considered as the main aspect to look for. The morbidity of people is considered for those diseases which are considered as the public health problem. Based on this public health problem a health index is prepared to have a look on the health status of the rural masses. Reduction in maternal and child mortality reflects the better health status. The most threatening problem is the high rate of maternal and child death. The rural healthcare services by launching different schemes has made the improvement of maternal and child health as its focal point. In this respect the occurrence of maternal and child death is also looked for realizing the health status.

Findings

To Study the Available Healthcare Delivery Services in Barak Valley

The healthcare delivery services in the rural areas of Barak Valley are mainly based on public health sector. The rural people are mostly dependent on public sector delivery of healthcare services other than traditional health practices. The network of private health services is not satisfactory in Barak Valley. The delivery of public healthcare services in the rural area is provided by the three tier system of healthcare services. As per the norms of NRHM, there must be one CHC for every 1 lakh 20 thousand population, one PHC for every 30,000 of population and for 5,000 of population one SC. But the existing health centres in Barak Valley is lagging behind these norms. There are only 9 CHCs, 61 PHCs and 591 SCs in Barak Valley covering the total population of 3,138,041 of the Valley. However, the required number of CHCs, PHCs and SCs are 26, 104 and 627 respectively. All these are shown in Table 1.

Table 1: Public Health Infrastructure in the rural areas of Barak Valley

Health Institutions	Cachar	Karimganj	Hailakandi	Total No.
a. B P H C	08	05	04	17
b. CHC	04(12)	01(09)	04(5)	09(26)
c. MPC	14	07	05	26
d. SHC	3	3	01	7
e. SD	2	7	2	11
f. PHC (a+c+d+e)	27(47)	22(37)	12(20)	61(104)
g. SC	269(284)	217(221)	105(122)	591(627)
h. Total Rural Population	14,20,309	11,06,745	6,11,087	3138041

Note: *Figure in the bracket implies required number of health centres as per norms.Source: Joint Director of Health Services: 2010

The private healthcare mechanism of the Valley is revealed in Table 2, where it is seen that the total number of registered private clinic and nursing home is 2 and 14, respectively, and these are concentrated in the urban areas. Compared to private health institutions, the network of public health institutions are large. The entire health promotion of the valley thus rests on the public health sector. Since, establishment of private health sector is very much profit oriented, the Barak Valley with large rural area provide very less scope for the private health sector. The delivery of both curative and preventive healthcare services is vested on the public health sector in the Valley.

Table 2: Private Health Delivery Institutions of Barak Valley

District/State	Clinic/Poly Clinic	Nursing Home	Total	Diagnostic Centre
Karimganj	0	2	2	3
Cachar	2	12	14	15
Hailakandi	0	0	0	0
Barak Valley	2	14	16	18

Source: NER Data Bank.

The delivery of healthcare services becomes smooth when the basic infrastructure of health is very strong. The above analysis has led to conclude that the availability of health centres though widely organized on the basis of three-tier systems, but more health centres are required to make the services more reachable to the rural population, reducing the burden of population on the health centres.

The delivery of healthcare services, apart from the health centres, are also vested upon the availability of manpower and other health infrastructure like availability of bed per population. From Table 3 it is seen that in Barak Valley total number beds in civil hospital (CH) is 250, in the rural health centres that is BPHC, MPHC and CHC is 440. For the people with illness the total 690 beds are

Table 3: Number of Beds in Public Health Institutions of Barak Valley

District / State	No. of Beds					Total	Available 10000 beds per populaion
	CH	BPH C	MP HC	CHC	SDCH		
Cachar	50	48	72	90	0	260	1.50
Karimganj	100	30	32	60	0	222	1.82
Hailakandi	100	24	24	60	0	208	3.16
Barak Valley	250	102	128	210	0	690	1.91
Assam	3030	894	2104	3330	735	10099	3.24
India							07

Source: Joint Director of Health Services: 2010, World Health Statistics 2012.

available in the hospital and other health institutions in the entire Barak Valley. Taking per ten thousand of population these available beds covers only 1.91 per cent of the total population. This implies that per 10,000 population of the Valley only one bed is available in the public hospitals and health centres, whereas for the state the bed population ratio is 3.24. To provide smooth service for the patients in such a condition becomes very difficult.

The doctor population ratio is another significant indicator of smooth health delivery services to the people. The availability of doctors per 10,000 of population in Barak Valley is 0.78 while in all India level it is 6. According to WHO, availability of at least 23 health workforce taking together physicians, nurses, other health attendant per 10,000 of population is required to cover health services to the people.

Having an Accredited Social Health Activist (ASHA) for every village with a population of 1,000 is one of the key strategies under the National Rural Health Mission (NRHM). The available ASHA workers per ten thousand of population in the Barak Valley are 9.18. This implies that in Barak Valley the number of available ASHA workers-population ratio have almost arrived its norms.

Table 4: Public Sector Health Workforce- Population Ratio of Barak Valley

Work Force	Per 10000 Population			Barak. Valley
	Cachar	Karimganj	Hailakandi	
1. Doctor	0.75	0.80	0.82	0.78
2. Nurses	3.57	3.92	3.93	3.75
3. Other health attendant	2.02	2.22	2.12	2.10
4. ASHA	9.1	9.3	9.3	9.18
5. Total (1+2+3+4)	15.42	16.22	16.12	15.82
6. Total (1+2+3)	6.34	6.94	6.87	6.63

Source: Joint Director of Health Services, 2010.

To Study the Impact of Healthcare Delivery Services on Health Status of the People of Barak Valley

There exists a relationship between improved health status and delivery of healthcare services. The existing healthcare services in the rural areas have to give some health outcomes. Healthcare services can be said to be efficient when the existing healthcare services can lead to better health conditions of the targeted population. Health conditions of a family is said to be better when the disease intensity in a family is less and recovery from disease is high. To measure the health condition of a family a mean health index is prepared ranging from 0 to 1, 0 indicates worst health condition and 1 indicates better health condition.

Mean Health Index of a family (HI) = $\frac{(1-DI)+RD}{2}$,

Where DI=Disease intensity of a family and

RD= Recovery rate of family from diseases.

Disease intensity (DI) of a family is measured as,

$$DI = \frac{\text{Total number of family members suffering from diseseas}}{\text{Total family size}}$$

DI ranges from 0 to 1. Where, 0 = no one in the family members are disease prone,

1= all family members are disease prone

And thus, (1-DI) = A family free from disease. Recovery rate of family from diseases is calculated as,

$$RD = \frac{\text{Total number of family members recovered}}{\text{Total number of family members suffered}}$$

RD ranges from 0 to 1, where 1 = fully cured and 0 = still uncured.

To measure disease intensity in a family some specific diseases are taken into consideration which are water borne, air borne, vector borne and due to unhygienic living condition of the family and the treatment of these selected diseases are available in the public health centres within the range of rural households. The reason for selecting these diseases (malaria, typhoid, tuberculosis, pneumonia, diarrhea, dysentery, jaundice, measles, mumps, chickenpox, worm infestations, and cataract) is because large masses were suffering from these diseases and becoming a public health problem and leading to poor health scenario and also loss of life in some cases. The different health schemes are taken to reduce these diseases and the treatments of these diseases are available for the rural people through public health systems. The time period taken for the purpose is the diseases suffered for last one year from the period of interview. The recovery rate is also calculated during the same period. However, the uncured diseases suffered for the last 15 days from the date of interview is not taken into consideration.

The average Disease intensity (DI) of the sample households is found to be 0.09 which shows that the intensity of diseases in a family is low. The average of suffering from diseases in a family is found to be very less. That is the average number of family members free from disease (1-DI) is large that is 0.91. The average disease intensity in Cachar, Karimganj and Hailakandi districts is 0.08, 0.10 and 0.11 respectively. Compared to three districts of Barak Valley the disease intensity of Cachar district is less and Hailakandi has that of the highest.

The average recovery rate of Cachar district is 0.65 while that of Karimganj and Hailakandi districts is 0.50 and 0.52 respectively. The recovery rate from diseases is better in Cachar compared to that of Karimganj and Hailakandi district. The average recovery rate of the sample household is 0.57 which implies that there is a moderate degree of recovery rate from diseases suffered.

Considering the disease intensity (DI) and recovery rate of diseases (RD), the average health index of sample households is found to be 0.87 which shows that health scenario of the people of sample households is in a quite better condition. The health index of the districts of Karimganj, Cachar and Hailakandi is 0.85, 0.83 and 0.91 respectively. The health index of the people of Cachar district is found to be better compared to the other two districts of Barak Valley (as in Table 5).

Table 5: Health Index of the Rural People of Sample Households

Heads / Blocks	Disease Intensity (DI)	Recovery Rate (RD)	Health Index (HI)
Lowairpua	0.13	0.48	0.80
North Karimganj	0.03	0.59	0.95
Karimganj	**0.10**	**0.50**	**0.85**
Hailakandi	**0.11**	**0.52**	**0.83**
Kalain	0.12	0.59	0.84
Udharbond	0.05	0.63	0.94
Borjalenga	0.08	0.70	0.92
Cachar	**0.08**	**0.65**	**0.91**
Barak Valley	**0.09**	**0.57**	**0.87**

Source: Sample Survey 2010–11.

The low disease intensity of the rural masses of Barak Valley implies that the occurrence of diseases which is considered as the public health problem has declined. People are now less suffering from these diseases. The reasons for such findings are discussed in the following paragraphs.

First, the different health schemes to control these diseases like malaria control programme, tuberculosis control programme, vector borne disease control programme, blindness control programme, increasing effort for providing sanitation and safe drinking water have been successful in reducing the occurrence of some of these diseases.

Second, these disease control schemes have much positive externalities. When a particular person is cured from the disease which is very much commutative, it reduces the degree of occurrence for another person. The different health programme along with its extension activities like that of providing mosquito nets and screening of malaria (if any) through ASHA workers and other health attendants, etc. has improved the scenario of people suffering from malaria and availability of free medicine has also reduced tuberculosis.

Third, the relative coverage of safe drinking water and sanitation facilities and the growing awareness of the rural masses about the significance of using proper sanitation, safe drinking water have also reduced the incidence of the diseases due to water borne and airborne causes.

However, the recovery rate of the family who are found to be disease prone is slow. The recovery rate from diseases for the sample households is 0.57, which implies that the recovery rate is moderate for a family who is attacked by these diseases. It is seen that, the disease intensity of a family is very less, but compared to that the recovery rate is poor. The reason behind such slow recovery or absence of full recovery from these diseases is because of the lack of full coverage of health infrastructures with respect to doctor population ratio, health institutions population ratio, discontinuation of complete course by the affected people. Sometimes some medicine (e.g., antibiotic) is not found in the public institutions and the patients due to their low income cannot afford to purchase the full course of the medicine and thus the disease is not cured fully. Apart from income constraint literacy or educational level also works as a hindering factor to interrupt in taking the doses of medicine in right proportion and right time. Most of the rural people were found to forget or could not understand how and when to take the medicine and also have less knowledge on completion of courses of the medicine.

Taking the average disease intensity and recovery rate from disease, the health index which has shown a quite high level of 0.87 implies that the morbidity due to public health problem diseases has been lowered. However, complete remedy from these diseases yet to be achieved.

However, during the visit of the sample areas and interviewing the respondents it is found that some other types of health problem due to different other types of diseases were also faced by the people. Thus apart from calculating health index of the rural people based on the sufferings from public health problem diseases, the percentages of population suffering from other diseases in all age groups are taken into consideration. The average number of days suffered from diseases for the last 100 days and the average expenditures incurred for the treatment of the diseases per family is taken into consideration. Expenditure on treatment above the calculated monthly per capita income of the sample households is considered as the maximum expenditure and the minimum range of expenditure is considered on the basis of the lowest expenditure incurred on medical treatment. Based on these two levels, the impact of suffering from disease is divided into severe, moderate and mild. The range of average number of days suffered and the average expenditure incurred for considering the degree of impact of suffering as severe, moderate or mild is considered as shown in Table 6.

Table 6: Impact of Suffering from Diseases

Impact of Disease	Average number of Days Suffered	Expenditure incurred(in ')
1. Severe	More than thirty days	Above 1907.27
2. Moderate	Fifteen days to thirty days	500 to 1907
3. Mild	Less than fifteen days	Less than 500

Source: Calculated by Author based on Sample Survey 2010–11.

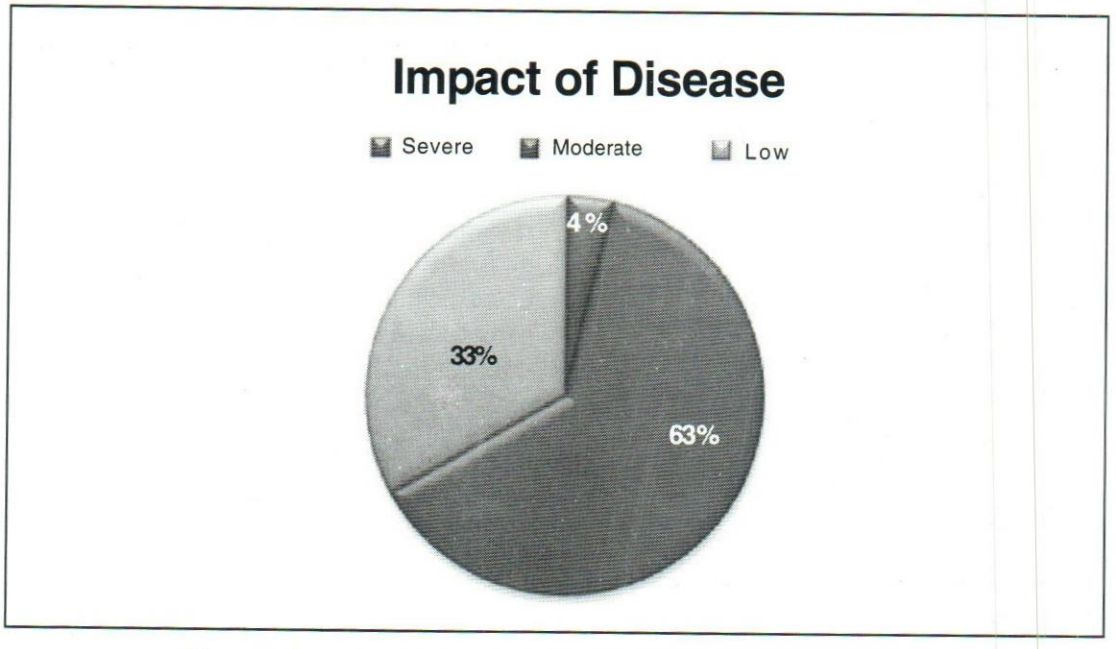

Figure 1: Impact of Disease on the Rural Households of Barak Valley

Taking in descending order of occurrence of diseases most of the respondents reported the problem of gastritis, dermatological diseases, cancer, hypertension, diabetics, and cardiovascular diseases, stroke, gall bladder and kidney stone diseases. Impact of diseases are considered as severe when the average suffering of a family is for thirty days or more and for the treatment expenditure incurred is more than the calculated average per capita income of sample households that is ' 1907.27 and still the disease is not recovered. Moderate impact of diseases are considered as those the average suffering from which is for more than fifteen days to less than thirty days and expenditure incurred is less than the average per capita income (' 1907.27). Mild impact diseases are considered as those the average suffering is for less than fifteen days and the expenditure incurred for treatment is less than ' 500.

The moderate impact of diseases on population is found to be the highest of about 63 per cent. This implies that 63 per cent of the households spend a major part of their income on healing of diseases. On an average large amount of expenditures is spent on curing diseases in this group. In this group the number of households remains ill for more than 15 days to one month, which is a great economic loss. Of the total households, 4 per cent and 33 per cent have severe and mild impact of diseases respectively on them. This is shown in Figure 1.

Maternal and Child Health Status

The existing rural healthçare services have given much space for the improvement of health of mother and child. These two classes are more vulnerable as they are more prone to mortality. Rate of child death and rate of maternal death are taken to assess maternal and child health status. The time period taken is 2005–2010. Rate of infant death is calculated for the consecutive five years using the following method:

$$\text{Rate of child birth: } = \frac{\text{Number of death of child below the age of 5 years in a given area given year}}{\text{Number of live birthe in the same year}} \times 100.$$

Death of female is considered during period of pregnancy, while delivery of child and within the period of one month after delivery. Rate of maternal death is calculated using the following method:

$$\text{Rate of Maternal death: } = \frac{\text{Total number of female death in an given area in a given year}}{\text{Total number of live births in the same area and year}} \times 100.$$

Table 7: Child and Maternal Death (2005-10) in the Sample Areas of Barak Valley

Child Death (inper centage)	
Still Birth	7.14
Below age one	69.05
Age one to five	23.81
Female child	52.38
Male child	47.62
Maternal Death (inper centage)	
While Delivery	47.05
After Delivery (within the one month)	40.41
While Pregnancy	12.54

Source: Sample Survey 2010–11.

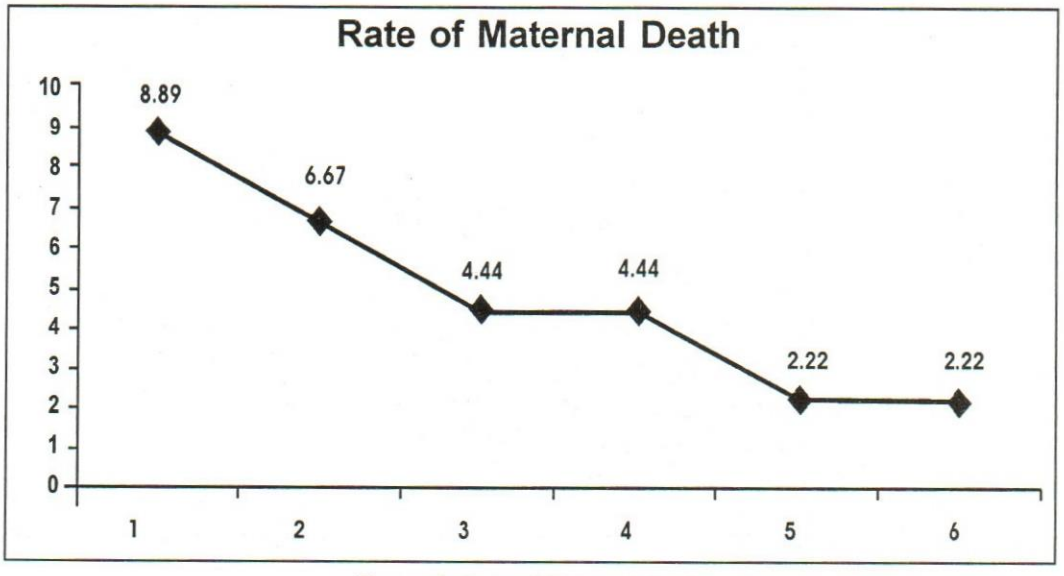

Figure 2: Rate of Maternal Death

In the sample areas of Barak Valley of the total child death in the last five years, 7.14 per cent are still birth, 69.05 per cent are under one year of age and 23.81 per cent are within 1 to 5 years of age. It is also found that of the total death female child death was 52.38 per cent, a little higher compared to that of male child of 47.62 as shown in table VI.26.

Of the total maternal death in the study area in the last five years 47.05 per cent died while delivery and 40.41 per cent died within one month due to complications arising after delivery of the child and 12.54 during the period of pregnancy (refer Table 7).

The calculated rate of child and maternal death however showed a decline from 2005 to 2010. The rate of maternal death was 8.89 per cent in 2005, which declined to 2.22 per cent in 2010. Similarly, the rate of child death which was very high of 13.33 per cent in 2005 declined to 2.22 per cent in 2010 as shown in the following Figures 2 and 3.

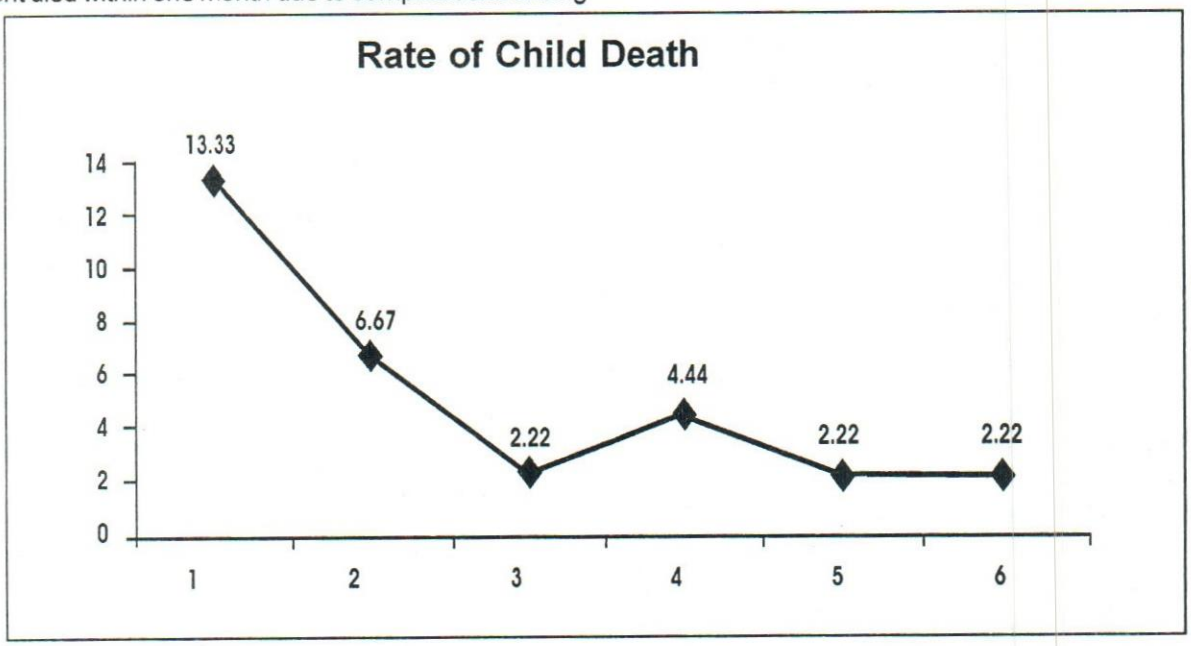

Figure 3: Rate of Child Death

Factors Influencing Health Index

The factors influencing the health index of the rural people of Barak Valley has been considered on the two following grounds:

1. Utilisation of public health institutions: As it is found that nearly 45.39 per cent of the rural population depend on public health institutions it is quite obvious to look on the relation between utilization of public health institutions and health index of the rural masses of the Barak Valley.
2. Visit of health workers to the rural households: it is found that in the rural areas ASHA (Accredited Social Health Activist) are vested with the role of monitoring the health of the rural masses. In this regard it is found that in 49.6 per cent of the rural households are visited by the ASHA workers and other health attendants.

The correlation coefficient between health index and utilization of public health institutions is found to be 0.010 which implies that public health institutions have not lead to much better health conditions of the rural masses of the Barak Valley. At the same time there exist a very poor degree of relation between visit of health personal and better health index as the correlation is found to be 0.007. This result reflects the fact that the health personnel makes fewer visits to the houses and still does not play active role in promoting overall health of the rural masses. It was found in the field survey that mainly ASHA and ANM makes visit to the rural households and looked for child and maternal care only. The correlation between visit of health personal and maternal death and child death is found to be –0.030 and –0.047, respectively, implies that visit of health personal to the rural households have improved a little bit the condition of maternal death and child death (refer Tables 8, 9 and 10).

Table 8: Visit of Health Personal to the Households

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	No	214	50.4	50.4	50.4
	Yes	210	49.6	49.6	100.0
	Total	424	100.0	100.0	

Source: Sample Survey 2010–11.

Table 9: Correlation between Utilisation of Public Health Institutions and Health Index

		Health index of the Household
Utilization of Public health Institutions	Pearson Correlation	0.010
	Sig. (2-tailed)	0.816
N=424		

Table 10: Correlation between Visit of Health Personal and Health Index, Child Death and Maternal Death

		Health Index	Child Death	Maternal Death
Visit of Health Personal	Pearson Correlation	0.007	-0.047	-0.030
	Sig. (2-tailed)	0.872	0.279	0.480
	N=424			

Conclusion and Suggestions

With very less coverage of private sector health services in the rural areas, the dependency on the public sector for health services has been more in the rural areas irrespective of the different income group. The existence of sub centres, primary health centres and community health centres though has led to the promotion of both preventive and curative health services, but still these health institutions are functioning at less than the norms, leading to heavy burden of population per health institutions. Moreover the absence of man power in these health institutions and other basic amenities like number of beds, medicine has limited the functioning of proper delivery of health services from the public sector.

However, the existing healthcare services are found to have made some sort of changes in the health status of the people. The entire process of the mechanism of health delivery system at least has some positive impact.

The network of rural health services should be made more efficient regarding the allocation of health services and must be assured that the health services reach to the target group. The presence of doctor, nurses and other health attendant must be made for 24 hours. Medicine should be made available to the village health centres at either subsidized rate or in free of cost.

The number of health personnel should be increased and other health infrastructure have to be strengthened to lessen the burden of population on the existing health delivery mechanism and at same time smoothen the service.

The health activists and other extension health workers should be made more efficient and must make the rural masses aware about the different health services available for them and assure the utilization of those services.

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A healthy attitude is contagious but don't wait to catch it from others. Be a carrier.

—Tom Stoppard

Focus

Social Support and Its Relationship to Work-life Balance — A Study of Medical Professionals in Government Hospitals of Himachal Pradesh

SAKSHI SHARMA AND JAI SINGH PARMAR

Social support is the extent to which an individual perceives that his or her needs for support, information, and feedback are fulfilled. In fact, social support is closely related to the concept of a social network, or the ties to family, friends, neighbours, colleagues, and others which have some significance to the person. Support is a crucial component of job resource. Several research studies in the past have proposed that individuals can cope with work and family demands if they were well supported by the people around them. Keeping this in view, the present study was designed to investigate the relationship between the various sources of support and work–life balance (and its dimensions). The study sought to determine whether work support (supervisor and co-worker) and spouse support had any relationship with work–life balance and its dimensions. The study was conducted among medical professionals employed in various government hospitals of Himachal Pradesh. A sample of 216 nurses and 141 doctors were selected in the study. The data thus collected have been analyzed with the help of SPSS 17. In order to analyze the data the statistical tools, viz. Pearson correlation coefficient and One-way ANOVA were used. The findings of the study demonstrated significant correlation between various sources of support and work–life balance (and its dimensions).

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Introduction

Social support at the workplace can come from many sources; the most commonly explored sources are supervisors and co-workers. Both of these sources of social support are important because they indicate the potential aid that is available to an individual. With regard to the content of workplace social support, a distinction is usually made between four types (House, 1981): emotional support (e.g., through empathy, caring, love, trust and concern), instrumental support (e.g., direct help provided by others), informational support (e.g., advice, information, suggestions or directions) and appraisal support (e.g., feedback or social comparison relevant to a person's self evaluation).

Social support has been identified as a resource that helps individuals cope with job stress through supportive relationships with others. Family cohesion, or the emotional bonding among family members, is sometimes used as an indicator of family support. Social support comes from sources like spouse, children, and friends. If a person gets the moral and social support from spouse and parents, it becomes easy to maintain a balance in their life. Low balance may result into employee attrition, high absenteeism and sometimes may lead to health problems.

Greenhaus and Beutell (1985) expressed the 'work–family conflict' as 'a form of inter-role conflict in which the role pressures from the work and family domains are mutually incompatible in some respect'. There are two directions of interference; namely, work-to-family conflict (WFC) and family-to-work conflict (FWC). Work family conflict occurs when work role expectations interfere with family role expectations, while family work conflict occurs when family role expectations interfere with work role

expectations. Although, researchers have predominantly focused on the conflict perspective of the work–family interface, yet many researchers have also examined the positive aspects of work–family interface. Positive work–family interface have been described by constructs such as positive spill over, work–family facilitation, work–family enhancement, and work–family enrichment. Voydanoff (2002) defined work family enhancement as 'the extent to which aspects of work or family role provide resources that facilitate performance of the other role.' Like, work–family conflict, work–family enhancement have two directions, namely, work-to-family enhancement and family-to-work enhancement.

Several writers (Kahn and Antonucci, 1980; Cobb, 1976; Payne, 1980) have proposed that individuals cope with work and family demands if they are well supported by the people around them. Social support was conceptualized by Kahn and Antonucci (1980) as interpersonal transactions that include one or more of the following key elements: affect, affirmation and aid. They define affect as the expression of liking, admiration, respect or love; affirmation as an expression of agreement or acknowledgement that another person was right in what he or she said or did; an aid was the giving of assistance such as money, time, labor and information. Procidano and Heller (1983) define social support as 'the extent to which an individual perceives that his or her needs for support, information, and feedback are fulfilled'. Social support is closely related to the concept of a social network, or the ties to family, friends, neighbors, colleagues, and other of significance to the person. Support is a crucial component of job resource. Receiving support either at work or in the family is a resource that generates positive affect in one domain that enhances the quality of life in the other (Grzywacz and Marks, 2000) and facilitates individuals to their goals. Psychologists have conducted considerable research on social support and have found that an increase in social support can alleviate many of the harmful effects on employees.

Literature Review

During the past decades a large number of studies have been conducted to examine the work–life balance of employees of various organizations. These studies have demonstrated the relationship between social support and work–life balance. Walsh (2012) investigated the gender differences in hospital doctors' perceptions of burnout and their intentions to leave, particularly with respect to factors relating to work–life balance. The study found that work to life interference was related to job burnout and management support attenuated job burnout. Further, the study reported that support from co-workers had beneficial effects in reducing job burnout.

Bhargava and Baral (2009) while examining the antecedents and consequents of work–family enrichment in Indian managers from four organizations in manufacturing and information technology sector in India found that family support and supervisor support were positively related to family-to-work enrichment, whereas job characteristics and supervisor support were positively related to work-to-family enrichment.

Major, Fletcher, Davis and Germano (2008) through their study tested a multilevel model examining the influence of work–family culture and supportive workplace relationships on work interference with family and demonstrated that the supportive workplace relationships and co-worker support were closely linked to decreased work interference with family.

Mesmer-Magnus and Viswesvaran (2006) examined the value of facets of work family environment; i.e., work/family policies and programmes, including flexibility and dependent care, and family-friendly culture, including work/family culture, supervisor support, and co-worker support in reducing reports of work/family conflict. The study found that the spousal support was strongly related to family-work conflict. In addition, it was found that work/family culture and supervisor support influences workers' feelings of work/family conflict.

Wadsworth and Owens (2007) investigated the effects of social support on work–family enhancement and work–family conflict on employees of two public sector organizations of United States and concluded that supervisor support and organizational social support were negatively related to work interference with family. The study further indicated that social support received from a supervisor, co-worker, and organizational source were positively related to work enhancement of family.

Voydanoff (2004) examined the effects of work demands and resources on work-to-family conflict and facilitation. The study revealed that work–family organizational support (supportive organizational culture and supervisor work–family support) is negatively associated with work-to-family conflict and positively associated with work-to-family facilitation

Batt and Valcour (2003) in their study explored the relationship between human resource practices and three

outcomes of interest to firms and employees: work–family conflict, employees' control over managing work and family demands and employees' turnover intentions. The study found that supportive supervision was associated with lower work–family conflict.

Kim and Ling (2001) studied the sources and types of work–family conflict among married Singapore women entrepreneurs and reported significant negative relation between emotional and attitudinal support from spouse and work–family conflict.

Burke and Greenglass (1999) examined the work–family conflict, spouse support and nursing staff wellbeing during a time of hospital restructuring and downsizing. The data was collected from Canadian hospital-based nurses. The study found that the nurses reported greater work–family conflict than family-work conflict. Also, it was found that spouse support reduced family-to-work conflict.

Thomas and Ganster (1995) through their study investigated the relationship between family-supportive components of the work environment and employee indicators of strain and found that supportive practices, in terms of flexible schedules and supervisor social support, contributed towards the employees' perception of control over family and work which in turn was associated with lower levels of work–family conflict.

Grzywacz and Marks (1999) in their study indicated that more resources that facilitate development in work or family settings (e.g., more decision latitude at work, support at work from co-workers and superiors, emotionally close spouse and family relations) were associated with less negative and more positive spillover between work and family. By contrast, more barriers arising from person-environment interactions at work and in the family (e.g., more pressure at work, spouse disagreement, and perception of family burden) were associated with more negative spillover and less positive spillover between work and family.

The Study

The existing literature review on work–life balance reveals that a lot of research has been conducted on work–life balance of employees in various organizations, yet there is a dearth of research conducted on the work–life balance of medical professionals. Medical professionals are the backbone of hospital organization andtheir job is full of stress and strain, viz. dealing with stressful situations, administrative burdens, emotionally demanding contact with patients etc. constitute an environment which is quite different from other organizations and consequently create unique problems for them. Working in an environment where one has to take care of human lives with no mistakes can be very stressful for medical professionals. It is important for medical professionals to be in a healthy state of mind, free from worries and anxieties. Psychologists have conducted considerable research on social support and have found that an increase in social support can alleviate many of the harmful effects on employees. Support (e.g., emotional, instrumental and informational) from work and family can help medical professionals to deal with the conflicting demands of work and family. In this backdrop, the present study examines the relationship between social support and work–life balance of medical professionals working in government hospitals of H.P. In the present study an attempt has been made to investigate the relationship between the various sources of support and work–life balance. Through this study an effort has been made to understand whether the work support and spouse support had any relationship with work–life balance and its dimensions.

Objectives of the Study

Keeping in mind the review of past studies, the present study was conducted with the following objectives:

1. To study the relationship between work support and work–life balance (and its dimensions) of medical professionals of government hospitals in Himachal Pradesh.
2. To study the relationship between spouse support and work–life balance (and its dimensions) of medical professionals of government hospitals in Himachal Pradesh.

Hypothesis

H_{01}: There is no significant relationship between work support and work–life balance (and its dimensions) of medical professionals in government hospitals of Himachal Pradesh.

H_{02}: There is no significant relationship between spouse support and work–life balance (and its dimensions) of medical professionals in government hospitals of Himachal Pradesh.

H_{03}: There is no significant difference in work–life balance (and its dimensions) among medical professionals at varied levels of work support (i.e. low, average and high work support).

H_{04}: There is no significant difference in work–life balance (and its dimensions) among medical professionals at varied levels of spouse support (i.e. low, average and high spouse support).

Research Methodology

The study is mainly based on primary data which was collected through the respondents consisting of 141 doctors and 216 nurses employed in government hospitals of Himachal Pradesh. In order to get the required information a well-designed questionnaire was prepared and administered among respondents. Data was collected from six government hospitals of four districts of Himachal Pradesh, namely Kangra, Mandi, Shimla and Solan. There are 12 districts in the state of Himachal Pradesh and for the present study 4 districts were selected on the basis of random sampling. The total number of government hospitals in the four districts is 26. However, we selected six hospitals on the basis of convenience and judgement sampling.There were 812 nursing staff and 503 doctors working in the six hospitals. Questionnaires were distributed to 300 nurses and 215 doctors on the basis of judgement sampling and out of which 225 questionnaires of nurses and 141 questionnaires of doctors were returned, yielding a response rate of 75 per cent and 65 per cent respectively. Out of 225 questionnaires of nurses 216 were considered for the analysis purpose owing to the treatment of missing data values. Total 9 questionnaires were omitted due to reasons of incompleteness and irrelevance. The final sample consisted of 216 nurses and 141 doctors. The data thus collected have been analyzed with the help of SPSS 17. The various statistical tools,viz. Pearson correlation coefficient and One-way ANOVA were used to analyse the data.

Reliability

Work–Life Balance: In the present study, the WIPL scale had a reliability of α = .92 for doctors and α = .73 for nurses, the PLIW subscale had a reliability of α = .83 for doctors and α = .87 for nurses, and the WPLE subscale had a reliability of α = .89 for doctors and α = .83 for nurses. Work life balance was assessed with 15-item scale adapted from an instrument developed and reported by Fisher-McAuley, Stanton, Jolton and Gavin (2003).Their original scale consisted of 19 items designed to assess three dimensions of work–life balance: work interference with personal life (WIPL), personal life interference with work (PLIW), and work/personal life enhancement (WPLE). The scale used in the present study is the scale reported by Hyman (2005), where the original 19 items have been reduced to 15 items, but retains all three dimensions. The respondents were asked to indicate the frequency with which they have felt in a particular way during the past three months using a seven point time related scale (e.g., 1 = Not at all, 4 = Sometimes, and 7 = All the time). Scoring was done as 7,6,5,4,3,2,1 (7 = Not at all, 4 = Sometimes, and 1 = All the time) for the dimensions of work interference with personal life (except item 7, which was reverse coded) and personal life interference with work. Higher scores indicated low interference, and lower levels of interference were interpreted as higher levels of work–life balance. For the dimension work/personal life enhancement scoring was 1,2,3,4,5,6,7 (1 = Not at all, 4 = Sometimes, and 7 = All the time) as the items were positively worded. The overall work–life balance score was computed by adding the score on three dimensions.

Social Support:The reliability coefficient (alpha) for the three social support subscales were .87 (doctors and nurses) for supervisor support, .93 (doctors) and .92 (nurses) for co-worker support, .77 (doctors) and .87 (nurses) for spouse support. The scores on work support were obtained by adding the scores of supervisor support and co-worker support. Perceptions of support from supervisors, co-workers and spouse were measured. Items developed by Caplan et al. (1975) were used for all three sources of support. Unlike some procedures which measure social support indirectly, these sub-scales were chosen because they directly assess the respondent's perception regarding the level of social support. Each respondent was requested to state the extent of social support received from each source using five-point Likert scaled response options.

Results and Discussion

Demographic Profile of the Respondents

The demographic profile of the respondents is shown in Table 1.The average age for the nurses included in the study was 39.5 years (SD = 10.59). In terms of marital status, 75 per cent were married and 24.5 per cent were single, widowed or divorced. All the nurses were female. The average age for the doctors included in the study was 31.5 years (SD = 6.33). Sixty-four percent were male. In terms of marital status, 44 per cent were married and 56 per cent were single, widowed or divorced.

Table 1: Demographic Profile of Respondents

Medical Professionals	Gender		Marital Status		Age		
	Male	Female	Married	Single/Widowed/ Divorced	Min.	Max.	Mean
Doctors	90 (63.8)	51 (36.2)	62 (44)	79 (56)	25	54	31.54
Nurses	–	216 (100)	163 (75.5)	53 (24.5)	25	57	39.56

Note: Figures in parenthesis shows percentages.

Relationship between Work Support and Work–Life Balance

In order to find the relationship between work support (supervisor and co-worker) and work–life balance and its dimensions of medical professionals Pearson correlation coefficient was employed and the results are shown in Table 2.

Table 2: Correlation Coefficient between Work Support and Work–Life Balance and Its Dimensions for Doctors and Nurses

Work Life Balance	Correlation	
	Doctors	Nurses
WIPL***	.51**	.35**
PLIW***	.20*	.14*
WPLE***	.60**	.38**
WLBT***	.59**	.40**

Notes: *Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)
*** WIPL-Work interference with personal life, PLIW- Personal life interference with work, WPLE- Work personal life enhancement, WLBT- Work life balance total

In case of doctors work support was found to be significantly and positively correlated with work interference with personal life (WIPL, r = .51**, p<.01), work/personal life enhancement (WPLE, r = .60**, p<.01), overall work–life balance (WLBT, r = .59**, p<.01) and personal life interference with work (PLIW, r = .20*, p<.05), although the relationship with PLIW was generally weaker.

In case of nurses work support was found to be significantly and positively correlated with work interference with personal life (WIPL, r = .35**, p<.01), work personal life enhancement (WPLE, r = .38**, p<.01), overall work–life balance (WLBT, r = .40**, p<.01) and personal life interference with work (PLIW, r = .14*, p<.05), although the relationship with PLIW was generally weaker.

From the statistical results it can be inferred that higher the work support, lesser is the work interference with personal life, lesser is the personal life interference with work, higher is the work personal life enhancement and higher is the overall work–life balance.

Hence, the hypothesis H_{01}; i.e.,*there is no significant relationship between work support and work–life balance (and its dimensions) of medical professionals in government hospitals of Himachal Pradesh* is rejected and alternate hypothesis is accepted for all the dimensions of work–life balance and for overall work–life balance, in case of doctors and nurses both.

Relationship between Spouse Support and Work–Life Balance

In order to find the relationship between spouse support and work–life balance and its dimensions of medical professionals Pearson correlation coefficient was employed and the results are shown in Table 3.

Table 3: Correlation Coefficient between Spouse Support and Work–Life Balance and Its Dimensions for Doctors and Nurses

Work Life Balance	Correlation	
	Doctors	Nurses
WIPL***	.25*	.31**
PLIW***	.33**	.26**
WPLE***	.21	.38**
WLBT***	.32**	.42**

Notes: *Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

In case of doctors, spouse support was found to be significantly and positively correlated with personal life interference with work (PLIW, r = .33**, p<.01), overall work–life balance (WLBT, r = .32**, p<.01), and work interference with personal life (WIPL, r = .25*, p<.05), although the relationship was weaker. No significant correlation was found between spouse support and work personal life enhancement (WPLE, r = .21).

In case of nurses, spouse support was found to be significantly and positively correlated with work interference with personal life (WIPL, r = .31**, p<.01), personal life interference with work (PLIW, r = .26, p<.01), work/personal life enhancement (WPLE, r = .38**, p<.01) and overall work–life balance (WLBT, r = .42**, p<.01).

The results shows that higher the spouse support, lesser is the work interference with personal life, lesser is the personal life interference with work, higher is the work/ personal life enhancement (in case of nurses) and higher is the overall work–life balance.

Hence, in case of doctors, the hypothesis H_{02} i.e. *there is no significant relationship between spouse support and work–life balance (and its dimensions) of medical professionals in government hospitals of Himachal Pradesh* is rejected and alternate hypothesis is accepted for the dimensions work interference with personal life, personal life interference with work and for overall work–life balance. However, the hypothesis H_{02} is accepted for the dimension work/personal life enhancement whereas in case of nurses thehypothesis H_{02} is rejected and alternate hypothesis is accepted for all the dimensions of work–life balance and for overall work–lifebalance.

Work–Life Balance of Medical Professionals at Varied Levels of Work and Spouse Support

To test the hypothesis H_{03} and H_{04}, the medical professionals were classified into three groups (see Table 4), based on the scores obtained in the questionnaire as those with:

a) Low work support and Low spouse support < (Mean-0.5 S.D.)

b) Average work support and Average spouse support Score between (Mean-0.5 S. D.) and (Mean + 0.5 S.D.)

c) High work support and High spouse support Score > support (Mean + 0.5 S.D.)

Table 4: Classification of Medical Professionals on the Basis of Scores on the Variables Work Support and Spouse Support

Variables	Medical Professionals	Classification								
		Low			Average			High		
		N	%	Mean	N	%	Mean	N	%	Mean
Work support	Doctors	45	31.91	17.17	50	35.46	24.76	46	32.62	32.21
	Nurses	69	31.94	16.27	79	36.57	26.06	68	31.48	33.35
Spouse support	Doctors	19	30.64	10.89	21	33.87	16.33	22	35.48	19.63
	Nurses	41	25.00	9.12	65	39.63	14.15	58	35.36	18.55

Work–life balance at varied levels of work support

One-way ANOVA was employed to find whether there is any significant difference in work–life balance and its dimensions among medical professionals at low, average and high level of work support. The results are discussed in the following paragraphs.

One of the assumptions of the one-way ANOVA is that variances of the groups should be similar. Table 5 shows the results of Levene's Test of Homogeneity of Variances, which tests for similar values. In case of doctors, the sig. value is greater than 0.05 for the dimensions WIPL, WPLE and for WLBT. Therefore, the assumption of homogeneity of variances is met on these dimensions. However, the sig. value is less than 0.05 for the dimension PLIW, which means the assumption of homogeneity of variance is not met and therefore two robust tests (Brown-Forsythe and Welch) were conducted.

Also from the details of the Table 5 it is clear that, in case of nurses, the sig. value is greater than 0.05 for all the dimensions of work–life balance and for overall work–

Table 5: Test of Homogeneity of Variances: Work Support

Work Life Balance	Medical Professionals	Levene Statistic	df1	df2	Sig.
WIPL	Doctors	.090	2	138	.914
	Nurses	1.816	2	213	.165
PLIW	Doctors	4.962	2	138	.008
	Nurses	.139	2	213	.870
WPLE	Doctors	.040	2	138	.961
	Nurses	3.118	2	213	.046
WLBT	Doctors	1.667	2	138	.193
	Nurses	1.283	2	213	.279

life balance, therefore meeting the assumption of homogeneity of variance.

Since for the dimension personal life interference the assumption of homogeneity of variance was not supported in case of doctors, therefore Welch and Brown-Forsy the tests were conducted. Table 6 shows the results of the two tests. Form the details of the Table 6, F value was not found to be significant for the dimension PLIW ($F = 2.127$, $p>0.05$). The results imply that there is no significant difference in personal life interference with work among doctors with low, average and high level of work support.

Table 6: Robust Test of Equality of Means – Work Support (Doctors)

		Statistic	df1	df2	Sig.
PLIW	Welch	2.127	2	90.343	.125
	Brown-Forsythe	1.847	2	131.087	.162

Table 7 shows the output of ANOVA analysis. F values were found to be significant for the dimensions WIPL ($F = 16.43$, $p<0.05$), WPLE ($F = 23.38$, $p<0.05$) and for WLBT ($F = 22.27$, $p<0.05$). This suggested that work interference with personal life, work/personal life enhancement and overall work–life balance differed significantly among doctors at varied levels of work support.

Table 7: Work–Life Balance of Doctors at Varied Levels of Work Support

Work Life Balance	Sources of variance	Sum of Squares	df	Mean Square	F	Sig.
WIPL	Between Groups	2302.950	2	1151.475	16.43	.000
	Within Groups	9667.603	138	70.055		
	Total	11970.553	140			
WPLE	Between Groups	1236.764	2	618.382	23.38	.000
	Within Groups	3648.513	138	26.438		
	Total	4885.277	140			
WLBT	Between Groups	8601.490	2	4300.745	22.27	.000
	Within Groups	26644.170	138	193.074		
	Total	35245.660	140			

Table 8: Work–Life Balance of Nurses at Varied Levels of Work Support

Work Life Balance	Sources of variance	Sum of Squares	df	Mean Square	F	Sig.
WIPL	Between Groups	1326.768	2	663.384	12.52	.000
	Within Groups	11284.047	213	52.977		
	Total	12610.815	215			
PLIW	Between Groups	134.392	2	67.196	2.68	.070
	Within Groups	5327.367	213	25.011		
	Total	5461.759	215			
WPLE	Between Groups	998.513	2	499.257	14.08	.000
	Within Groups	7551.816	213	35.455		
	Total	8550.329	215			
WLBT	Between Groups	6115.442	2	3057.721	16.82	.000
	Within Groups	38721.887	213	181.793		
	Total	44837.329	215			

As evidenced in Table 8, F values were significant for the dimensions WIPL (F = 12.52, p<0.05), WPLE (F = 14.08, p<0.05) and for WLBT (F = 16.82, p<0.05). However, F value was found to be insignificant for the dimension PLIW (F = 2.68, p>0.05). The results suggested that work interference with personal life, work personal life enhancement and overall work–life balance differed significant among nurses at varied levels of work support.

Hence, in both the cases, the hypothesis H_{03}; i.e., *there is no significant difference in work–life balance (and its dimensions) among medical professionals at varied levels of work support (i.e., low, average and high work support)* is rejected and alternate hypothesis is accepted for the dimensions of WIPL, WPLE and for WLBT. However, this hypothesis is accepted for the dimension PLIW. The results imply that work interference with personal life, work personal life enhancement and overall work–life balance differ significantly among medical professionals depending upon the level of work support received. However no significant difference was observed in personal life interference with work.

Work–life balance at varied levels of spouse support

One-way ANOVA was employed to find whether there is any significant difference in work–life balance and its dimensions among medical professionals at low, average and high level of spouse support. The results are discussed in the following paragraphs.

Table 9 shows the results of Levene's Test of Homogeneity of Variances. In case of doctors and nurses, the sig. value is greater than 0.05 for the dimensions WIPL, PLIW, WPLE and for WLBT. Therefore, the assumption of homogeneity of variances is met.

Table 9: Test of Homogeneity of Variances– Spouse Support

Work Life Balance	Medical Professionals	Levene Statistic	df1	df2	Sig.
WIPL	Doctors	2.338	2	59	.105
	Nurses	.169	2	161	.844
PLIW	Doctors	1.570	2	59	.217
	Nurses	.270	2	161	.764
WPLE	Doctors	2.387	2	59	.101
	Nurses	1.083	2	161	.341
WLBT	Doctors	1.452	2	59	.242
	Nurses	.117	2	161	.890

Table 10 shows the output of one-way ANOVA analysis. F value was found to be significant for the dimension of PLIW (F = 3.30, p<0.05). This suggested that there is significant difference in personal life interference with work among doctors at various levels of spouse support. F values were found to be insignificant for WIPL (F = 1.66, p>0.05), WPLE (F = 1.93, p>0.05) and WLBT (F = 2.89, p>0.05). This suggested that there is no

Table 10: Work–Life Balance of Doctors at Varied Levels of Spouse Support

Work Life Balance	Sources of variance	Sum of Squares	df	Mean Square	F	Sig.
WIPL	Between Groups	276.648	2	138.324	1.66	198
	Within Groups	4898.594	59	83.027		
	Total	5175.242	61			
PLIW	Between Groups	174.802	2	87.401	3.30	.043
	Within Groups	1558.376	59	26.413		
	Total	1733.177	61			
WPLE	Between Groups	125.635	2	62.817	1.93	.154
	Within Groups	1920.365	59	32.549		
	Total	2046.000	61			
WLBT	Between Groups	1458.806	2	729.403	2.89	.063
	Within Groups	14874.161	59	252.104		
	Total	16332.968	61			

Table 11: Work–Life Balance of Nurses at Varied Levels of Spouse Support

Work Life Balance	Sources of variance	Sum of Squares	df	Mean Square	F	Sig.
WIPL	Between Groups	980.057	2	490.029	8.97	.000
	Within Groups	8790.991	161	54.602		
	Total	9771.049	163			
PLIW	Between Groups	235.148	2	117.574	4.19	.017
	Within Groups	4507.993	161	28.000		
	Total	4743.140	163			
WPLE	Between Groups	805.028	2	402.514	10.12	.000
	Within Groups	6402.485	161	39.767		
	Total	7207.512	163			
WLBT	Between Groups	5487.398	2	2743.699	13.84	.000
	Within Groups	31896.913	161	198.117		
	Total	37384.311	163			

significant difference in work interference with personal life, work personal life enhancement, and overall work–life balance between doctors with low, average, and high spouse support.

As presented in Table 11, F values were significant for the dimensions WIPL ($F = 8.97$, $p<0.05$), PLIW ($F = 4.19$, $p<0.05$), WPLE ($F = 10.12$, $p<0.05$) and for WLBT ($F = 13.84$, $p<0.05$). The results imply significant differences in work interference with personal life, personal life interference with work, work personal life enhancement and overall work–life balance between nurses with low, average and high spouse support.

Hence, in case of doctors, the hypothesis H_{04}; i.e., *there is no significant difference in work–life balance (and its dimensions) among medical professionals at varied levels of spouse support (i.e. low, average and high spouse support)* is rejected and alternate hypothesis is accepted for the dimension of PLIW. However, this hypothesis is accepted for the dimensions WIPL, WPLE and WLBT. The results imply that personal life interference with work differ significantly among doctors depending upon the level of spouse support received. However, no significant difference was observed in work interference with personal life, work personal life enhancement and overall work–life balance.

In case of nurses, the hypothesis H_{04}; i.e., *there is no significant difference in work–life balance (and its dimensions) among medical professionals at varied levels of spouse support (i.e., low, average and high spouse support* is rejected and alternated hypothesis is acceptedfor the dimensions WIPL, PLIW, WPLE and WLBT. The results imply that there is significant difference in work interference with personal life, personal life interference with work, work personal life enhancement and overall work–life balance of nurses depending upon the spouse support received.

Conclusion and Implications

The study was undertaken to determine whether work support and spouse support had any relationship with work–life balance and its dimensions. The findings of the present study align with the past research that demonstrates positive correlation between various sources of support and work–life balance and is dimensions (Walia, 2011). The present study further demonstrated that higher is the support from supervisor, co-worker and spouse, lesser is the work interference with personal life, lesser is the personal life interference with work, higher is the work/ personal life enhancement and higher is the overall work–life balance. The findings of the study also revealed that work interference with personal life, work personal life enhancement and overall work–life balance differed significantly among doctors and nurses depending upon the level of work support they received. In addition to this, study also reported significant differences in personal life interference with work of doctors depending upon the level of spouse support they received. In case of nurses, work

interference with personal life, personal life interference with work, work personal life enhancement and overall work–life balance differed significantly depending upon the level of spouse support received.

Through the present study it has been established that support from supervisor, co-worker and spouse act as important predictors of work/family conflict and work–family enhancement. Substantial social support from supervisors through behaviour that shows care and willingness to listen to the problems can reduce the conflict that employees experience in balancing the demands of various domains of life. The willingness from co-workers to provide adequate moral support in job can reduce the intrusion work problems in employees' family lives. Sergerstrom et al. (2011) stated that it is the quality of relationships (e.g., war, friendly, caring and supportive) that is determining factor, and support from managers, supervisors, and colleagues is important for buffering the negative effects of work-related stressors. Therefore, the organizations can create family friendly culture by training the supervisors to be more work family supportive. In addition, emotional support from spouse can help reduce family intrusion into the work–life of employees. Thus, individuals should foster social support from various sources so as to reduce work–life conflict and increase positive spillover from work to family and family to work.In addition, various work–family supportive programmes such as flexi-time, compressed workweek and job sharing can be administered by the organizations to their employees. Such programmes would facilitate greater support to individuals who strive to balance work and other family responsibilities and consequently reduce work–family conflict.

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Healthy citizens are the greatest asset any country can have.

—Winston S. Churchill

Feature

Impact of Climate Change and Policy Initiatives

DINESH SINGH AND MITTER SAIN

This is an ***abridged updated edition*** *of the article of 7th November 2014, which was delivered by Mr. Dinesh Singh in the Asia Environment and Economic Forum organised by Asian Productivity Organisation (APO) at Tokyo during 10th to 12th December 2014. The article attempts to explain the* ***Impact of Climate Change and Policy Initiatives*** *in an objective and simple manner.* ***Part I*** *gives an* ***Overview,*** *including the meanings of the terms related to the subject.* ***Part II*** *enunciates salient details of the* ***Major International Initiatives****. Of the continuum: UNFCC Convention →Kyoto Protocol →Bali Road Map → Cancun Agreements →Durban Outcomes →Doha Climate Gateway →Warsaw Outcomes → Lima Call for Climate Action, it focuses on the critical and important milestones of:* ***UNFCCC; Kyoto Protocol; Doha Climate Gateway; Warsaw Outcomes; and Lima Call for Climate Action****.* ***Part III*** *sums up the* ***Crux****, makes a brief* ***Analysis*** *and offers a few* ***Suggestions****.*

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Part I : Overview

1.1 **Climate Change** is a measurable and perceptibly felt long-term change in climate[1] and associated phenomena[2] in a contiguous geographical region, reflecting a significant variation in timeliness and intensity of the general weather[3] conditions vis-a-vis the earlier patterns.

1.2 In addition to **natural factors** like changes in solar radiations received by the earth, tectonic and volcanic activities and biotic processes, certain recent **human activities** are attributed to be mainly responsible for climate change.

1.3 Industrialisation during the last one and a half centuries, with concomitant growth in mining and manufacturing activities; rapid growth in population during the last century, along with its increasing needs and changing consumption patterns; increased pressures on and over-exploitation of natural resources of water and land, including soil, forests, minerals and fossil fuels; excessive dependence on fossil fuels (coal, oil, natural gas) for energy requirements; have mainly contributed to the problem.

1.4 Presently the concerns are centred around the anthropogenic [4] activities which cause **global warming** that leads to **climate change.**

Disclaimer:

Parts I, II and Crux in Part III are an objective narration of the facts related to the subject. The Analysis and Suggestions in Part III are of the authors.

The views expressed in this article are those of the authors and are not the official views of Government of India or Ministry of Statistics and Programme Implementation

[1]**Climate:** the general weather conditions prevailing in an area over a long period of time.

[2]**Climate Change and Impacts** include the slow and gradual: increase in surface temperature; melting of polar ice; melting of glaciers, along with long-term lean-season effects on perennial rivers; rise in sea level, along with erosion and submergence of soil and intrusion of salt water into fresh water sources in coastal regions; irregular and erratic weather patterns, including shifting of seasons and increasing / decreasing seasonal rainfall; extreme weather events, including floods and droughts and changes in frequency and intensity of cyclones; effects on forests, including shift in forest coverage and types and effects on associated biodiversity; effects on agriculture and food production, due to changes in temperature, humidity and precipitation (rainfall, snow); changes in flora and fauna; etc.

[3]**Weather:** the state of the atmosphere at a place and time as regards temperature, wind, humidity and precipitation (rain, snow, dew).

[4]**Anthropogenic:** effects on the natural world relating to or resulting from human activities.

1.5 **Global warming** is the gradual increase in the average temperature of the earth's surface[5] on a century scale.

1.6 **Enhanced greenhouse effect** is generally accepted to be the main cause of **global warming.**

1.7 **Greenhouse effect** is the natural phenomenon that keeps the earth warm due to the physical property of atmospheric gases to trap and re-radiate the sun's energy to the earth rather than allow it back into space. Certain gases like carbon dioxide, methane and nitrous oxide and some chemicals such as chlorofluorocarbons (CFCs), commonly called the **greenhouse gases** (GHGs), have greater propensity to trap and re-radiate the sun's energy, and retard its return back into space. Increase in the concentration of the greenhouse gases in the atmosphere causes **enhanced greenhouse effect.** (Water vapour also acts as a greenhouse gas; it increases due to global warming, and thereby further enhances global warming.)

1.8 In the 1980s the international community became increasingly serious towards the problem, with the growing scientific evidence of the adverse effects of human interference on the earth's climate system[6] and the rising concerns about the environment. Climate change is a global phenomenon that requires internationally co-ordinated and universally implemented efforts.

1.9 In 1988 the **Intergovernmental Panel on Climate Change (IPCC)** [a] was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organisation (WMO) **to provide** the world with **a clear scientific view on the current knowledge on climate change and its potential environmental and socio-economic impacts.** The IPCC reviews and assesses the most recent scientific, technical and socio-economic information, to ensure an objective and complete assessment of the current information on climate change related issues. (It does not conduct any research, nor does it monitor climate related data or parameters.) Currently 195 countries are its members.

1.10 **IPCC** in its **First Report** in **1990** [b] *inter alia* observed that:

(i) emissions from human activities are substantially increasing the atmospheric concentration of greenhouse gases, which enhances the greenhouse effect and results in additional warming of the earth's surface [7];

(ii) carbon dioxide was responsible for over half the enhanced greenhouse effect in the past, and was projected to remain so in the future;

(iii) atmospheric concentrations of long-lived gases[8] (carbon dioxide, nitrous oxide and CFCs) adjust slowly to changes in emissions. Continued emissions of these gases at present rates would cause increased concentrations for centuries ahead. The longer the emissions continue to increase at present rates, the greater the reductions that would be needed for the concentrations to stabilise at a given level. It was estimated that the long-lived gases would require immediate reduction in emissions from human activities of over 60 percent to stabilise their concentrations at today's levels, while methane would require a 15-20 percent reduction;

(iv) if 'business-as-usual' in emissions of greenhouse gases continues, a rate of increase of global mean temperature during the next century (21st century) of about 0.3° C per decade (which is greater than that seen over the past 10,000 years) will result in a likely increase in global mean temperature of about 1°C above the present value by 2025 and 3° C before the end of the next century [this rise will not be steady because of the cross-influence of other factors]; and

[5]**Earth's surface:** land and water (lakes, rivers, seas).

[6]**Climate System:** interactive system consisting of the atmosphere, land, water (lakes, rivers, seas), snow and ice, and marine and terrestrial living organisms; including influence of external forces (principally the Sun).

[7]Concentrations of carbon dioxide and methane after remaining relatively constant up to the 18th century have risen sharply since then due to human activities. Concentrations of nitrous oxide have increased since the mid 18th century, especially in the last few decades. CFCs were not present in the atmosphere before the 1930s.

[8]**Atmospheric lifetime of greenhouse gases:**

Carbon dioxide	: 50-200 years (the absorption of carbon dioxide by the oceans and the biosphere is dependent on a number of dynamic factors, and hence a single value cannot be given)
Nitrous oxide	: 150 years
CFC-12	: 130 years
CFC-11	: 65 years
Methane	: 10 years

an average rate of global mean sea level rise of about 6 cm per decade over the next century (mainly due to thermal expansion of the oceans and the melting of some land ice mass) will result in rise of about 20 cm in global mean sea level by 2030 and 65 cm by the end of the next century (21st century).

1.11 **IPCC** in its **Fifth Report** (released on **1st November 2014**) has *inter alia* observed that [b ii; b iii]:

(i) human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems;

(ii) continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems. Limiting climate change would require substantial and sustained reductions in greenhouse gas emissions which, together with adaptation, can limit climate change risks;

(iii) adaptation and mitigation are complementary strategies for reducing and managing the risks of climate change. Substantial emissions reductions over the next few decades can reduce climate risks in the 21st century and beyond, increase prospects for effective adaptation, reduce the costs and challenges of mitigation in the longer term, and contribute to climate-resilient pathways for sustainable development;

(iv) many adaptation and mitigation options can help address climate change, but no single option is sufficient by itself. Effective implementation depends on policies and cooperation at all scales, and can be enhanced through integrated responses that link adaptation and mitigation with other societal objectives.

1.12 **Policy responses / initiatives** to global warming and climate change include:

(i) mitigation / alleviation by reducing the levels of emissions of greenhouse gases to control global warming;

(ii) adaptation / adjustment to the effects of climate change;

(iii) creating / building systems resilient to the effects of climate change;

(iv) steps for scientific and technological advancements in climate engineering.

1.13 The present international thrust, however, is on preventing the human-induced climate change through a range of concerted policy initiatives and interventions designed to:

(i) reduce greenhouse gas emissions by source and protect and enhance greenhouse gas sinks[9] **(mitigation);**

(ii) assist in **adaptation** to the effects of global warming.

Part II : Major International Initiatives

2.1 **The United Nations Framework Convention on Climate Change (UNFCCC; Earth Summit; June 1992; Rio de Janeiro)** [c i; c ii; d]: Negotiations to build a global consensus began in December 1990 under the aegis of the UN General Assembly through an Inter-governmental Negotiating Committee (INC). The Convention was adopted in May 1992. It was opened for signatures in June 1992 at the UN Conference on Environment and Development at Rio de Janeiro. It entered into force in March 1994. The Convention has almost universal acceptance [196 ratifiers (195 countries, 1 regional economic integration organisation (EEC))].

2.2 The **objective** of the Convention is to stabilise greenhouse gas concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

2.3 It was one of three conventions adopted at the Rio Earth Summit in 1992. The sister Rio Conventions were the UN Convention on Biological Diversity and the Convention to Combat Desertification. The three are intrinsically linked. A Joint Liaison Group has been set up

[9]**greenhouse gas sinks:** natural or artificial bodies or processes that absorb or remove greenhouse gases from the atmosphere (examples: oceans, forests, landfills, photolysis in stratosphere, etc.).
['sink' is the opposite of 'source'.]

to increase cooperation among the three conventions, with the aim of developing synergies in their activities on issues of mutual concern. The Group now also incorporates the Ramsar Convention on Wetlands.

2.4 The UNFCCC shows the **commitment** of the country parties towards controlling greenhouse gas emissions, but is **not binding** as it contains no enforceable obligations. The Convention established a **framework** for the further action in the arena, including negotiation of specific international protocols that may set binding stipulations.

2.5 The Convention:

(i) considered **the common but differentiated responsibilities** and **respective capabilities** of the country parties, and their specific national and regional development priorities, objectives and circumstances, and **categorised** them in different groups, developed country parties and economies in transition (**Annex I**) [10], developed country parties (**Annex II**) [11] and developing country parties (**Non Annex I**) [12];

(ii) recognized the specific needs and special circumstances of the developing country parties, especially those which are particularly vulnerable to the adverse effects of climate change and those which would have to bear a disproportionate or abnormal burden under the Convention;

(iii) sought a commitment from **all country parties** (Annex I and Non Annex I) to make available national inventories of anthropogenic emissions by sources and removal by sinks of all greenhouse gases not controlled by the **Montreal Protocol** [13] using comparable methodologies; to formulate and implement national and regional programmes to mitigate climate change by addressing anthropogenic emissions by sources and removal by sinks; to the extent feasible take climate change into consideration in their relevant social, economic and environmental policies and actions; and to promote and cooperate in all areas, scientific, technological, socio-economic, educational, training, public awareness, etc., related to climate change;

(iv) laid down that the **developed country parties and economies in transition** (Annex I), shall adopt national policies and take corresponding measures on the mitigation of climate change by limiting anthropogenic emissions of greenhouse gases and protecting and enhancing greenhouse gas sinks and reservoirs, to demonstrate that these countries are taking the lead;

(v) laid down that the **developed country parties** (Annex II) shall provide new and additional financial resources including for technology transfer to meet the agreed full cost incurred by developing country parties (Non Annex I) in complying with their obligations and in adapting to the adverse effects of climate change; and shall take all practicable steps to promote, facilitate and finance as appropriate the transfer or access to environmentally sound

[10]**Annex I: 43** developed country parties and economies in transition [**28** developed countries (originally 26; Malta was added in 1994 and Cyprus in 1997), **14** economies in transition, **1** regional economic integration organisation (European Economic Community)].

[11]**Annex II: 24** developed country parties excluding economies in transition [**23** developed countries of Annex I, excluding Liechtenstein, Monaco, Turkey (deleted in June 2002), Malta and Cyprus, **1** regional economic integration organisation of Annex I (European Economic Community)].

[Annex II is a sub-set of Annex I.]

[12]**Non Annex I:** parties not listed in Annex I, mostly developing countries.

[13] • **The Vienna Convention for the Protection of the Ozone Layer** was adopted in 1985 and entered into force in September 1988. It is the **framework** Convention for efforts to protect the globe's ozone layer, with the objective to promote cooperation by means of systematic observations, research and information exchange on the effects of human activities on the ozone layer and to adopt legislative or administrative measures against activities likely to have adverse effects on the ozone layer. It has been ratified by **197** countries.

[The **Convention** did not require the countries to take concrete action to control ozone depleting substances; in accordance with the provisions of the Convention, the countries agreed the Montreal **Protocol** on Substances that Deplete the Ozone Layer to advance that goal.]

The Montreal Protocol on Substances that Deplete the Ozone Layer was agreed in September 1987 and entered into force in January 1989. It aims **to reduce the production and consumption of ozone depleting substances** in order to reduce their abundance in the atmosphere, and thereby protect the earth's ozone layer. It has been ratified by **197** countries. Around **96** ozone depleting chemicals are listed in the Protocol, for immediate control and time-bound phasing-out.

The Montreal Protocol includes a unique **adjustment provision** that enables the Parties to the Protocol to respond quickly to new scientific information and agree to accelerate the reductions required on chemicals covered by the Protocol. These adjustments are then automatically applicable to all countries that have ratified the Protocol. The Parties to the Protocol have amended the Protocol to enable, among other things, the control of new chemicals and the creation of a financial mechanism to enable developing countries to comply.

technologies and know-how to other country parties, particularly the developing country parties (Non Annex I), to enable them to implement the provisions of the Convention.

2.6 In a nutshell, the Convention:

(i) **created a global consensus** and **set a specific goal** to prevent "dangerous" human interference with the climate system;

(ii) **put the onus on developed countries and economies in transition to take the lead** in limiting greenhouse gas emissions and protecting and enhancing greenhouse gas sinks (primarily on home ground);

(iii) **directed new funds** (above and beyond any financial assistance that they may already be providing) **and sharing of technology from developed countries for climate change action in developing countries.**

2.7 The country parties continued further negotiations in order to agree on decisions that will advance the objectives, commitments and implementation of the Convention, through the Conference of the Parties (COP) and its subsidiary bodies, the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Subsidiary Body for Implementation (SBI).

2.8 **The Kyoto Protocol to the United Nations Framework Convention on Climate Change (Kyoto Protocol; December 1997; Kyoto)** [c iii; c iv; f]**:** The Kyoto Protocol was concluded in the Conference of the Parties (COP) to the UNFCCC at Kyoto in 1997. It was adopted in December 1997. It **commits its parties to** the internationally set **binding emission limitation / reduction targets.** Recognising that developed countries are principally responsible for the current high level of greenhouse gas emissions as a result of more than 150 years of industrial activity, it places a heavier burden on the developed countries on the **principle of common but differentiated responsibilities.**

2.9 The detailed rules for the implementation of the Protocol were adopted at the COP in Marrakesh, Morocco in 2001 **(Marrakesh Accords).** It entered into force in February 2005. Its first commitment period started in 2008 and ended in 2012.

2.10 The Protocol:

(i) **listed the greenhouse gases** [carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6)] not controlled by the Montreal Protocol [14] and identified the main sectors / source categories of anthropogenic activities of greenhouse gas emissions (**Annex A** to the Protocol);

(ii) **laid-down the emission limitation or reduction commitment targets** as a percentage over the base year (1990)[15] for each Annex I[16] party (except Belarus, Turkey, Malta and Cyprus) (**Annex B**[17] to the Protocol). Overall these targets seek atleast an average five per cent emission reduction compared to the 1990 level over the five year period 2008 to 2012 (first commitment period);

(iii) stipulated that each Annex I party will provide data to establish its level of Carbon stock in 1990, for estimating the changes in the subsequent years against the base year;

(iv) adopted the methodologies accepted by IPCC on the calculation of the carbon dioxide equivalent of anthropogenic emissions of the other greenhouse gases by sources and their removal by sinks;

(v) stipulated that the Annex I parties will ensure individually or jointly that their aggregate anthropogenic carbon dioxide equivalent emissions of greenhouse gases listed in Annex A does not exceed the assigned amounts of emission limitation and reduction commitment inscribed in Annex B;

(vi) allowed any Annex I party to transfer to or acquire from any other such party emission reduction units (ERU) resulting from projects aimed at reducing

[14] **Around 96 fluorocarbons**, including **Chlorofluorocarbons (CFCs)**, are listed in the **Montreal Protocol**.

[15] **5 Annex I countries**, Bulgaria, Hungary, Poland, Romania and Slovenia, have different base year/s.

[16] **Annex I to the UNFCCC** (developed country parties and economies in transition).

[17] **Annex B:** Lists emission limitation or reduction commitment for **39** developed country parties and economies in transition of Annex I (excluding **3** developed countries, Turkey, Malta and Cyprus, and **1** economy in transition, Belarus).

[18] **Joint Implementation (JI)** [c v]**:** allows a country with an emission reduction or limitation commitment under the Kyoto Protocol (Annex B Party) to earn emission reduction units (**ERUs**) from an emission-reduction or emission-removal project in another Annex B Party, each equivalent to 1 tonne of CO_2, which can be counted towards meeting its Kyoto target. Joint implementation offers Parties a flexible and cost-efficient means of fulfilling a part of their Kyoto commitments, while the host Party benefits from foreign investment and technology transfer.

anthropogenic emissions by sources or enhancing anthropogenic removal by sinks of greenhouse gases in any sector of the economy [**joint implementation** (JI)] [18];

(vii) taking into account the common but differentiated responsibilities and the specific national and regional development priorities, objectives and circumstances, without introducing any new commitments for parties not included in Annex I, but re-affirming existing commitments under the Convention, and continuing to advance the implementation of these commitments in order to achieve sustainable development, stipulated that the parties shall:

(a) formulate where relevant and to the extent possible cost-effective national and where appropriate regional programmes to improve the quality of local emission factors, activity data and models which reflect the socio-economic conditions of each party for the preparation and periodic updating of national inventories of anthropogenic emissions by sources and removal by sinks of all greenhouse gases not controlled by the Montreal Protocol;

(b) formulate and implement national and where appropriate regional programmes containing measures to mitigate climate change and measures to facilitate adequate adaptation to climate change.

(viii) stipulated that the developed parties included in Annex II to the Convention shall provide:

(a) new and additional financial resources to meet the agreed full cost incurred by developing country parties (Non Annex I) in advancing the implementation of the commitments at (vii) (a);

(b) such financial resources, including for transfer of technology, needed by developing country parties to meet the agreed full incremental cost of advancing the implementation of the commitments at (vii) (a) and (b).

(ix) defined **clean development mechanism** (CDM)[19] to assist the parties not included in Annex I to achieve sustainable development and to contribute to the ultimate objective of the Convention and to assist parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitment under the Protocol. It allowed the Annex I parties to use certified emission reductions (CER) accruing from project activities in developing countries (Non Annex I) to contribute towards compliance with their quantified emission limitation and reduction commitment;

(x) introduced **international emissions trading** (IET)[20] by allowing Annex B parties to participate in emission trading for the purpose of fulfilling their commitments under the protocol provided that such trading is supplemental to their domestic action required to meet their commitments;

(xi) allowed a party to withdraw from the Protocol any time after three year from the date on which the Protocol entered into force.

2.11 In a nutshell, the Protocol:

(i) **operationalised the UNFCC Convention** by committing developed country parties and economies in transition to take the lead to stabilize greenhouse gas emissions (the Convention in itself only encouraged countries to do so);

[19]**Clean Development Mechanism (CDM)** [c vi]: allows a country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol (Annex B Party) **to implement an emission-reduction project in developing countries**. Such projects can earn saleable certified emission reduction (**CER**) credits, each equivalent to 1 tonne of CO_2, which can be counted towards meeting Kyoto targets. A CDM project activity might involve, for example, a rural electrification project using solar panels or the installation of more energy-efficient boilers. The mechanism stimulates sustainable development and emission reductions, while giving industrialized countries some flexibility in how they meet their emission reduction or limitation targets.

[20]**International Emissions Trading (IET)** [c vii]: Parties with commitments under the Kyoto Protocol (Annex B Parties) have accepted targets for limiting or reducing emissions. These targets are expressed as levels of allowed emissions, or 'assigned amounts', over the 2008-2012 commitment period. The allowed emissions are divided into 'assigned amount units' (**AAUs**). Emissions trading allows countries that have emission units to spare – emissions permitted them but not "used" – to sell this excess capacity to countries that are over their targets. Since carbon dioxide is the principal greenhouse gas, people speak simply of trading in carbon (**'carbon market'**). Apart from AAUs, the other units which may be transferred under the scheme, **each equal to 1 tonne of CO_2**, may be in the form of: a removal unit (**RMU**) on the basis of land use, land-use change and forestry (**LULUCF**) activities such as reforestation; an emission reduction unit (**ERU**) generated by a joint implementation project; and a certified emission reduction (**CER**) generated from a clean development mechanism project activity.

(ii) **set binding emission limitation / reduction targets** for **38** developed countries and economies in transition and the European Community (**1**) in its first commitment period (2008 to 2012), aiming at atleast an average five per cent emission reduction compared to the base year (1990).

(iii) **bound only the developed countries** (and not the economies in transition) **for providing support to the developing countries;**

(iv) **set up a strong and effective reporting and compliance mechanism.**

(v) **provided flexible market mechanisms** of Joint Implementation, Clean Development Mechanism and International Emissions Trading (supplemental to domestic action);

(vi) **prompted governments to put in place legislation and policies** to meet their commitments, **businesses to make climate-friendly investment decisions,** and the **formation of a carbon market.**

2.12 The parties to the Kyoto Protocol adopted an amendment to the Protocol in the COP in Doha in December 2012 **(Doha Amendment)** [c iii ; c viii ; c ix ; g] . The Amendment:

(i) **laid down the second commitment period,** from 2013 to 2020;

(ii) ensured that the Protocol's important legal and accounting models remain in place and underlined the principle that developed countries lead the mandated action to cut greenhouse gas emissions;

(iii) **ensured that the Protocol's market mechanisms,** Joint Implementation (JI), Clean Development Mechanism (CDM) and International Emissions Trading (IET), will continue (access to the mechanisms will remain uninterrupted for all developed countries and economies in transition that have accepted targets for the second commitment period);

(iv) **added** nitrogen trifluoride (NF_3) **to the list of greenhouse gases in Annex A;**

(v) **revised the list of countries and fixed the quantified emission limitation or reduction commitment targets for the second commitment period in Annex B**[21], seeking atleast an average eighteen per cent emission reduction compared to the 1990 level over the eight year period 2013 to 2020;

(vi) provided that surplus assigned amount units (AAUs) can be carried over without limit from the first to the second commitment period by parties included in Annex I that have a target for the second commitment period, but with restrictions on the use of these carried-over AAUs for the second commitment period and quantitative limits on how many of these units may be acquired from other parties [22];

(vii) allowed the parties to adjust the calculation of the assigned amount or cancel assigned amount units (AAUs) equivalent to the decrease in its quantified emission limitation or reduction commitment through transferring these units to a **cancellation account** (so as to ensure that an **increase in ambition** for emission limitations and reduction commitments is effective);

(viii) provided that where units from approved activities under market-based mechanisms are used by parties included in Annex I to assist them in achieving compliance with their quantified emission limitations or reduction commitments, a share of the units will be used to cover administrative expenses and to assist developing country parties that are particularly vulnerable to the adverse effect of climate change to meet the cost of adaptation if these units are acquired under emissions trading.

2.13 The amendment is subject to acceptance by the parties to the Kyoto Protocol and will enter into force (for those parties having accepted it) after acceptance by atleast 3/4th of the parties to the Protocol. The parties are

[21] **39** developed country parties and economies in transition were listed in **Annex B** for the first commitment period. **1** country, USA, did not accept the Protocol.

In the **revised Annex B**, **4** countries, Canada, Japan, New Zealand and Russian Federation, **do not have** emission limitation / reduction targets for the second commitment period. [**1**, Canada, later withdrew from the Protocol (in 2012).] **4 new** countries, Belarus, Cyprus, Kazakhstan and Malta, **have been included** and **have** quantified emission limitation or reduction commitment targets for the second commitment period.

Accordingly **38** country parties [**37** countries and the European Union (**1**)] have emission limitation / reduction targets for the second commitment period in **revised Annex B**.

[22] **carry-over adjustment**

allowed to provisionally apply the amendment pending its entry into force.

2.14 **The United Nations Climate Change Conference (Doha Climate Gateway; November – December 2012; Doha)** [cix]**:** The seven inter-related conferences conducted simultaneously under the aegis of UNFCCC:

(i) **adopted the amendment to the Kyoto Protocol;**

(ii) set out a timetable to adopt a universal climate change agreement by 2015, which will come into effect in 2020;

(iii) emphasised the need to increase ambition to reduce the emissions of greenhouse gases and to help the vulnerable countries to adjust;

(iv) made further progress towards establishing the financial and technological support and new institutions to enable clean energy investments and sustainable growth in developing countries;

(v) endorsed the selection of Republic of Korea to host the **Green Climate Fund** [23] ;

(vi) recommended to establish an international mechanism to address loss and damage[24] of the adverse effects of climate change, which complements the existing arrangements for adaptation by developing country parties (Non Annex I) [h]; and requested developed country parties (Annex II) to provide developing country parties (Non Annex I) with finance, technology and capacity building [i] .

2.15 **Warsaw Outcomes** [cx]**:** In the meeting of the Conference of the Parties (19th COP) at Warsaw in November 2013 the governments:

(i) took further essential decisions towards securing a universal climate change agreement [25] in 2015, and advanced the timeline for the development of the 2015 agreement (the initial draft text to be tabled by December 2014, and the formal draft text by May 2015, with a view to successfully conclude the negotiations in December 2015);

(ii) agreed on a mechanism to address loss and damage caused by long-term climate change impacts **(Warsaw International Mechanism for Loss and Damage);**

(iii) agreed on the rulebook for reducing emissions from deforestation and forest degradation, together with measures to bolster forest preservation;

(iv) agreed that the Green Climate Fund will be ready for capitalisation in the second half of 2014.

2.16 **Lima Call for Climate Action** [ui; uii]**:** In the last COP (20th) at Lima in December 2014 the governments:

(i) elaborated the elements of the **universal 2015 agreement** and agreed the ground-rules on how all countries can submit their **intended nationally determined contributions (INDCs)** [26] that will form the foundation for climate action **post 2020;**

(ii) agreed that each party's intended nationally determined contribution (INDC) towards achieving the objective of

[23]**Green Climate Fund** is envisaged as a mechanism to transfer funds from the developed countries to the developing countries to assist them in mitigation and adaptation measures in dealing with the effects of climate change.

[24]The deliberations in the COP at Doha 2012 ultimately led to establishment of the **Warsaw International Mechanism for Loss and Damage** to address loss and damage associated with impacts of climate change, including extreme events and slow onset events, in developing countries that are particularly vulnerable to the adverse effects of climate change (adopted in the COP at Warsaw in November 2013) [cxi; cxii].

[25]**Universal climate change agreement in 2015:** The objectives of the envisaged 2015 agreement are to bind **all** nations together into an effective global effort to reduce emissions rapidly enough to chart humanity's longer-term path out of the danger zone of climate change, while building adaptation capacity; and to stimulate faster and broader action now. The proposed 2015 agreement is envisaged to come into effect in 2020 (when the second commitment period of the Kyoto Protocol comes to an end). It is envisaged to be finalised in the 21st COP in Paris in Nov. – Dec. 2015.

[26]**US – China Bilateral Climate Deal of 11th November 2014** [viw]**:** US (14 %) and China (28%) account for about 42% of global greenhouse gas emissions [2013]. US has not ratified the Kyoto Protocol. China, being a Non Annex I country has no binding targets. As part of their bilateral agreement, US has indicated its intent to reduce its emissions by 26-28% below its 2005 level in 2025 and make its best efforts to reduce its emissions by 28%. China indicated its intent to achieve peaking of CO_2 emissions around 2030 and make its best efforts to peak early and to increase the share of non-fossil fuel in primary energy consumption to around 20% by 2030. **Evidently, these targets will form part of their respective INDCs.**

Both countries agreed to create a US-China Clean Energy Research Centre, to facilitate collaborative work in carbon capture and storage technologies, energy efficiency in buildings, and clean vehicles. They agreed on a joint peer review of inefficient fossil fuel subsidies under the G-20. They also agreed on action to expand joint clean energy research and development; advance major carbon capture, utilisation and storage demonstrations; enhance cooperation on HFCs; launch a climate-smart / low-carbon cities initiative; promote trade in green goods; and demonstrate clean energy on the ground. [US' target of reduction of 28% by 2025 against the 2005 level (UNFCCC data) amounts to about 9 % reduction against the 1990 level (UNFCCC data) (which is the uniform base level for all countries under the Kyoto Protocol).]

the Convention will represent a progression beyond the current undertaking of that party;

(iii) invited **all** parties to consider communicating their undertakings and adaptation planning or consider including an adaptation component in their intended nationally determined contributions (INDCs);

(iv) recognising that **national adaptation plans (NAPs)** offer an important way of resilience, made significant progress in elevating adaptation on to the same level as action to cut and curb emissions (mitigation);

(v) agreed that the **least developed countries and small island developing states** may communicate on strategies, plans and actions for low greenhouse gas emission development reflecting their special circumstances in the context of intended nationally determined contributions (INDCs);

(vi) agreed that all parties ready to do so will communicate their INDCs by the first quarter of 2015 (well in advance of the 21st COP in Paris); and the UNFCCC Secretariat will prepare a synthesis report by 1st November 2015 on the aggregate effect of all INDCs communicated by 1st October 2015.

(vii) formalised the concept of **national appropriate mitigation action (NAMA)** - plans of developing countries to reduce emissions and to develop sustainably, which can be supported by developed countries;

(viii) brought the total amount pledged to the Green Climate Fund close to US $ 10.2 billion;

(ix) urged developed country parties to provide and mobilize enhanced financial support to developing country parties for ambitious mitigation and adaptation actions, and set the goal of mobilizing jointly US $ 100 billion per year by 2020 to address the needs of developing countries;

(x) announced the **Lima Ministerial Declaration on Education and Awareness**-raising aimed at developing education strategies that incorporate the issue of climate change in curricula, while also raising awareness on climate change in the design and implementation of national development and climate change strategies.

Part III : Crux, brief Analysis and few Suggestions

3.1 **Crux:** The present attention is centred on human-induced emissions of greenhouse gases which cause enhanced greenhouse effect that leads to global warming and consequent climate change:

- anthropogenic activities →greenhouse gas emissions → enhanced greenhouse effect → global warming → climate change

3.2 **IPCC**

- provides objective and comprehensive assessment of the up-to-date information and scientific and technological inputs on climate change and related issues

3.3 **Montreal Protocol**

- committed the countries to reduce the production and consumption of ozone depleting substances

3.4 **UNFCCC**

- laid down the framework for the coordinated and concerted global efforts to prevent dangerous human interference with the climate system
- considered the common but differentiated responsibilities and respective capabilities of the developed and the developing countries
- sought a commitment from all countries (Annex I and Non Annex I) to mitigate climate change by addressing anthropogenic emissions by sources and their removal by sinks
- required the developed countries and economies in transition (Annex I) to take the lead
- required the developed countries (Annex II) to provide financial and technological support to the developing countries (Non Annex I) for mitigation and adaptation
- was not binding and contained no enforceable obligations

3.5 **Kyoto Protocol**

- operationalised the UNFCC Convention
- listed the greenhouse gases not controlled by the Montreal Protocol
- set binding emission limitation and reduction commitment targets for developed countries and economies in transition in its first commitment period (2008 – 2012)
- established market mechanisms of Joint Implementation, Clean Development Mechanism and International Emissions Trading

3.6 **Doha Amendment** to the Kyoto Protocol

- laid down the second commitment period (2013 – 2020)
- extended the list of greenhouse gases
- revised the list of countries and fixed their emission limitation or reduction commitment targets for the second commitment period
- provided for carry-over adjustment from first to second commitment period
- has as yet not entered into force

3.7 **Warsaw Outcomes**

- established an International Mechanism for Loss and Damage
- set the timeline of second half of 2014 for capitalisation of the Green Climate Fund
- set the timeline of December 2015 for a Universal Climate Change Agreement beyond 2020

3.8 **Lima Call for Climate Action**

- agreed the ground-rules on how all countries can submit their intended nationally determined contributions (INDCs)
- recognised that national adaptation plans (NAPs) offer an important way of resilience, and invited all parties to consider communicating their undertakings and adaptation planning or consider including an adaptation component in their INDCs
- agreed that the least developed countries and small island developing states may communicate on strategies, plans and actions for low GHG emission development reflecting their special circumstances in the context of INDCs
- formalised concept of national appropriate mitigation action (NAMA) – plans of developing countries to reduce emissions and develop sustainably, which can be supported by developed countries
- agreed that all parties ready to do so will communicate their INDCs by the first quarter of 2015 (well in advance of the 21st COP in Paris); and the UNFCCC Secretariat will prepare a synthesis report by 1st November 2015 on the aggregate effect of all INDCs communicated by 1st October 2015

3.9 **Brief analysis:** The market-mechanisms of **Joint Implementation** (JI), **Clean Development Mechanism** (CDM) and International Emissions Trading (IET) have been operationalised. But the **Green Climate Fund,** envisaged as a mechanism to transfer funds from the developed to the developing countries, has as yet **not been capitalised** and operationalised (the total pledge by December 2014 stands at only US $ 10.2 billion, against the envisaged US $ 100 billion).

Table 1

S. No.	Country Party	Base Year 1990 level of GHG(Gg CO_2 equivalent)[27] [c xiii]	Emission Limitation/ Reduction Target (% change against the base level) [f]	2012 level of GHG (Gg CO_2 equivalent)[c xiii]	Achievement (% change against the base level)[c xiii]
	Annex I Annex B				Target Achieved
1	Australia	545495.2	8	558809.3	2.4
2. *	Belgium	142117.7	(-) 8	115139.1	(-) 19.0
3. ^	Bulgaria	108092.6	(-) 8	52838.1	(-) 51.1
4. ^	Croatia	25169.5	(-) 5	20494.4	(-) 18.6
5. ^	Czech Republic	192708.2	(-) 8	124214.1	(-) 35.5
6. *	Denmark	75303.3	(-) 8	52280.9	(-) 30.6
7. ^	Estonia	31794.4	(-) 8	17237.2	(-) 45.8
8. *	Finland	56653.9	(-) 8	35113.1	(-) 38.0
9. *	France	531764.1	(-) 8	451967.4	(-) 15.0

[27] 1 Gigagram (Gg) = 1000 metric tonnes (t)

Table 1 to be continued.....

...Continuation...

S. No.	Country Party	Base Year 1990 level of GHG(Gg CO_2 equivalent)[27] c xiii	Emission Limitation/ Reduction Target (% change against the base level) f	2012 level of GHG (Gg CO_2 equivalent)c xiii	Achievement (% change against the base level)c xiii
10. *	Germany	1223530.7	(-) 8	935595.5	(-) 23.5
11. ^	Hungary	111891.7	(-) 6	57573.5	(-) 48.5
12.	Iceland	4713.1	10	5173.9	9.8
13. *	Italy	515446.3	(-) 8	441527.2	(-) 14.3
14. ^	Latvia	6346.2	(-) 8	(-) 1322.1	(-) 120.8
15. ^	Lithuania	44427.2	(-) 8	13545.7	(-) 69.5
16. *	Luxembourg	13248.8	(-) 8	11404.6	(-) 13.9
17.	Monaco	109.5	(-) 8	93.4	(-) 14.7
18. *	Netherlands	214862.6	(-) 8	195204.9	(-) 9.1
19.	Norway	40262.4	1	26055.6	(-) 35.3
20. ^	Poland	556906.7	(-) 6	367413.3	(-) 34.0
21. ^	Romania	269755.7	(-) 8	98219.9	(-) 63.6
22. ^	Russian Federation	3527913.5	0	1753028.6	(-) 50.3
23. ^	Slovakia	64219.0	(-) 8	34607.4	(-) 46.1
24. ^	Slovenia	18669.1	(-) 8	14555.2	(-) 22.0
25. *	Sweden	34010.7	(-) 8	22185.9	(-) 34.8
26. ^	Ukraine	870437.8	0	373809.3	(-) 57.1
27. *	United Kingdom of Great Britain and Northern Ireland	780684.3	(-) 8	577325.9	(-) 26.0
27.	**Total**	**10006534.2**		**6354091.3**	**(-) 36.5**
1.	European Union (15)[28]	4122611.1	(-) 8	3428887.8	(-) 16.8
	Annex I Annex B				Target Not Achieved
1. *	Austria	68209.1	(-) 8	76220.8	11.7
2.	Canada	519888.1	(-) 6	739486.7	42.2
3. *	Greece	102643.0	(-) 8	108041.1	5.3
4. *	Ireland	52933.7	(-) 8	55386.4	4.6
5.	Japan	1167502.2	(-) 6	1268052.4	8.6
6.	Liechtenstein	218.7	(-) 8	218.5	(-) 0.1
7.	New Zealand	23391.1	0	49449.7	111.4

[28]The 15 countries in the European Union (EU) re-fixed their emission reduction targets amongst themselves under a burden sharing agreement, keeping the overall EU Kyoto target of (-) 8 % intact. The country-wise targets as originally specified in Annex B (and not as re-fixed under the burden sharing agreement) and the country-wise achievements as reported under Kyoto Protocol have been taken. The individual country-wise information of the 15 EU members will not add-up as the aggregate of the EU as a whole (because of subsequent internal adjustments due to different base years for non-CO_2 greenhouse gases and use of market mechanism within the group and as a group).

Table 1 to be continued.....

...Continuation...

S. No.	Country Party	Base Year 1990 level of GHG(Gg CO_2 equivalent)[27] [c xiii]	Emission Limitation/ Reduction Target (% change against the base level) [f]	2012 level of GHG (Gg CO_2 equivalent)[c xiii]	Achievement (% change against the base level)[c xiii]
8. *	Portugal	58477.9	(-) 8	55302.2	(-) 5.4
9. *	Spain	260444.4	(-) 8	307280.0	18
10	Switzerland	50968.6	(-) 8	50320.1	(-) 1.3
11	United States of America (Not Ratified)	5402124.4	(-) 7	5546303.9	2.7
11	**Total**	**7706801.2**		**8256061.8**	**7.1**
38	**Grand Total (27+11)**	**17713335.4**		**14610153.1**	**(-) 17.5**
	Annex I Not in Annex B				**No Target**
1. ^	Belarus	110576.8	None	63782.6	(-) 42.3
2	Cyprus	5948.9	None	9240.1	55.3
3	Malta	1986.6	None	3132.9	57.7
4	Turkey	144364.1	None	380058.7	163.3
4	**Total**	**262876.4**		**456214.3**	**73.5**
42	**Grand Total (27+11+4)**	**17976211.8**		**15066367.4**	**(-) 16.2**

*** 15 members of European Union (EU)**

^ 14 economies in transition

3.10 (i) The performance of **Annex I** country parties in the first commitment period (2008 to 2012) has been tabulated below.

(ii) (a) Kyoto targets for **Annex B** countries in the first commitment period (2008 – 2012) aimed at atleast an average 5 percent emission reduction in aggregate emissions of CO_2 equivalent against the 1990 level.

(b) **27** of the **38** countries in **Annex B** met their emission limitation / reduction targets (average 36.5 percent reduction). **11** countries [including USA, which had an emission reduction target, but did not ratify the Protocol (and accordingly the target was not binding)] could not achieve their targets (average 7.1 percent increase). Taken together, the 38 countries in Annex B achieved an overall reduction of 17.5 percent, which is more than 3 times the envisaged minimum 5 percent reduction against the 1990 base.

(c) Only **1** of the **4 Annex I** countries which are not in **Annex B** had a reduction in emissions against the 1990 base. The other **3** countries had an increase in emissions. Together these 4 countries had an increase of 73.5 percent.

(d) All **42** countries of **Annex I** together (including USA, which did not ratify the Protocol, and the 4 countries which are not part of Annex B) achieved a reduction of 16.2 percent.

(e) **European Union** (**15** member countries) achieved an overall reduction of 16.8 percent, which is more than 2 times its combined target of **8** percent reduction. **5** of its members did not individually meet their original Kyoto targets (of them, **3,** Greece, Ireland and Portugal, however, met their revised targets as re-fixed under the burden sharing agreement). **3** members, Luxembourg, Austria and Spain, did not meet their revised targets (of them, **1,** Luxembourg, however, met its original Kyoto target).

Table 2

Annex I	Base Year 1990 level of GHG (Gg CO_2 equivalent) [c xiii]	2012 level of GHG (Gg CO_2 equivalent) [c xiii]	Achievement (% change against the base level)
14 economies in transition	5938908.4	2989997.2	(-) 49.7
28 developed countries	12037303.4	12076370.2	0.33

(f) The performance of the **14 economies in transition** vis-a-vis that of the 28 developed countries in **Annex I** has been compared below.

All the **13** economies in transition in **Annex B** exceeded their limitation / reduction targets, and the **14th**, Belarus, which is **not in Annex B**, also showed a significant decrease in emissions. The developed countries, taken together, did not show reduction in emissions, but remained static (with a marginal increase of 0.33 percent).

Table 3

Annex I	Base Year 1990 level of GHG (Gg CO_2 equivalent) [c xiii]	2012 level of GHG (Gg CO_2 equivalent) [c xiii]	Achievement (% change against the base level)
With LULUCF	17976211.8	15066367.4	(-) 16.2
Without LULUCF	19064633.6	17038743.0	(-) 10.6

(iii) The **Annex I** countries, taken together, achieved more success in emission reduction through Land Use, Land Use Change and Forestry (LULUCF).

(iv)(a) The position of 6 major developing countries which, not being part of **Annex B** (or of **Annex I**), do not have binding emission limitation / reduction targets has been shown below.

Table 4

S. No.	Country Party	Base Year 1990 level of GHG (Gg CO_2 equivalent) [c xiii]	Emission Limitation/ Reduction Target (% change against the base level)	2012 level of GHG (Gg CO_2 equivalent)[c xiii]	Achievement (% change against the base level)
	Non Annex I Not in Annex B				
1.	**India**	1228540.1 (1994 level)	None	1301204.3 [29] (2000 level)	5.9
2.	**China**	3650138.0 (1994 level)	None	7045044.7 (2005 level)	93.0
3.	**Brazil**	1389137.7 (1990 level)	None	2191858.9 (2005 level)	57.8
4.	**South Korea**	263223.0 (1990 level)	None	508251.9 (2001 level)	93.1
5.	**Indonesia**	464553.0 (1990 level)	None	1375587.9 (2000 level)	196.1
6.	**Malaysia**	75602.8 (1994 level)	None	(-) 26797.6 (2000 level)	(-) 135.5

(b) Since the base years and periods are different, percentage change (achievement) is **not *inter se* comparable.** However, it can be said that except 1, Malaysia, the other 5 countries showed a significant increase in emissions.

(v) **Overall, the Kyoto targets have been met.** But there has been **wide disparity in** the **individual country achievements. Some** have **over-achieved,** and **some** have **under-achieved [including industrial giants** like **Canada, Japan, USA, Spain** (which also have

[29]Indian Network for Climate Change Assessment has estimated the total greenhouse gas emissions of India in 2007 to be 1727706.1 Gg of CO_2 equivalent, which is an increase of 40.6 % in the 13 year period 1994 to 2007

comparatively high per capita emissions of greenhouse gases)]. **The developed countries, together, have not shown a decrease** in emissions (**the European Union, however, has exceeded its collective reduction target**). **The economies in transition have performed well,** all of them having exceeded their individual targets (this has been one major reason for the over 3 times achievement of the Kyoto targets by the Annex B countries taken together). There has been **significant increase in the emission levels of developing countries like India, China, Brazil, South Korea, Indonesia** (but these countries largely have **comparatively low per capita emissions)**..[para 3.12 (ii) (d) may also be seen.]

3.11 (i) The position of ratification / acceptance of **IPCC, UNFCCC, Kyoto Protocol and Doha Amendment to Annex B** has been summarised below.

Table 5

	No. of Parties [30]	Remarks
IPCC	**195** (all members of WMO/ UN are members)	IPCC is an inter-governmental scientific body, whose membership is automatic for members of WMO / UN. It has almost universal membership.
UNFCCC	**196** (195 countries and 1 EEC)	UNFCCC lays down the framework, seeks commitments, but is not binding and contains no enforceable obligations. It has almost universal ratification. **Annex I** developed country parties and economies in transition are required to take the lead. **Annex II** developed country parties are required in addition to provide financial and technological support to **Non Annex I** developing country parties. Of the **28** developed countries listed in **Annex I**, **5**, Liechtenstein, Monaco, Turkey (deleted in 2002), Malta and Cyprus, are **not listed in Annex II**.
Kyoto Protocol 1st commitment period 2008 to 2012[c xiv]	**192**	Kyoto Protocol operationalises the UNFCC Convention. **Annex B** lays down binding emission limitation or reduction commitment targets for **Annex I** countries. Of the **43** developed country parties and economies in transition in **Annex I**, **3** developed countries, Turkey, Malta and Cyprus, and **1** economy in transition, Belarus, are **not** included in **Annex B**. Accordingly **39** country parties [**38** countries and European Union (**1**)] have emission limitation / reduction targets. **1**, USA, listed in Annex B, signed the Protocol but did not ratify it. **1**, Canada, listed in Annex B, ratified the Protocol, but later withdrew from it (in 2012).
Doha Amendment to Annex B 2nd commitment period 2013 to 2020[c xv]	**29** (earlier 30; France later Withdrew its Acceptance to the Amendment to Annex B in 2009) Will come into force after acceptance by 3/4th of the parties to the Protocol (note: 23 parties have accepted the Doha Amendment *per se*)	Doha Amendment **revised** the list of countries and **fixed** the quantified emission limitation or reduction commitment targets in **revised Annex B** for the **second commitment period** of the Protocol. **4** countries, Canada, Russian Federation, Japan and New Zealand, do not have emission limitation / reduction targets for the second commitment period. [Of them, **1**, Canada, has withdrawn from the Protocol, **1**, Russian Federation, has accepted the amendment to Annex B, and **2**, Japan and New Zealand, have not accepted the amendment as yet.] **4 new** countries, Belarus, Cyprus, Kazakhstan[31] and Malta, which were **not in Annex B**, have been **included** in **revised Annex B** and have emission limitation / reduction targets for the second commitment period. Accordingly in **revised Annex B 38** country parties [**37** countries (including France) and European Union (**1**)] have quantified emission limitation / reduction targets for the second commitment period. The Amendment to Annex B has **not come into force** since only **29** parties have accepted it, against the requirement of 192 x 3/4 = **144**.

[30]Signature → Ratification → Acceptance → Accession - - Approval

[31]Kazakhstan is a Non Annex I and Non Annex B country that has been included in revised Annex B.

(ii) (a) **35** country parties of **Annex B** have **not accepted** the **amendment to Annex B** as yet, though they had committed targets in the first commitment period of the Protocol.

(b) Only **4** countries from **Annex B**, Australia, Czech Republic, Norway and Russian Federation, and **2** included in **revised Annex B**, Belarus and Kazakhstan, have accepted the **amendment to Annex B** till now.

(iii) The position of the following **23** countries in respect of Kyoto Protocol and Doha Amendment to Annex B has been analysed below (**Table 6**): **4** countries from Annex B (and 1, France, which later withdrew its acceptance) and **2** from revised Annex B which have accepted the amendment to Annex B till now; **8** countries in Annex B which did not achieve their Kyoto targets and also had an increase in emissions over the 1990 base (Table 1); 3 countries of Annex I which are not in Annex B and had an increase over the 1990 base (Table 1); and 5 developing countries (Table 4) which though not having binding emission limitation / reduction targets had an increase in emission levels.

Table 6

S. No.	Country	Emission Limitation/ Reduction Target (% change against the base level)[c xiii]	Achievement (% change against the base level)[c xiii]	Position regarding Kyoto Protocol 1st commitment period 2008 to 2012 [c xiv]	Position regarding Doha Amendment to Annex B 2nd commitment period 2013 to 2020 [c xv]
	Annex B				**Accepted**
1.	**Australia** (developed country)	8	2.4	Ratified **Not met** the emission limitation / reduction target	**Accepted** Emission limitation/reduction target **fixed** for the second commitment period
2.	**Czech Republic** (economy in transition)	(-) 8	(-) 35.5	Ratified **Met** the emission limitation / reduction target	**Accepted** Emission limitation/reduction target **fixed** for the second commitment period
3.	**France** (developed country)	(-) 8	(-) 15.0	Ratified **Met** the emission limitation / reduction target	Initially Accepted; later **Withdrew** its acceptance to the amendment to Annex B in 2009 Emission limitation/reduction target **fixed** for the second commitment period
4.	**Norway** (developed country)	1	(-) 35.3	Ratified **Met** the emission limitation / reduction target	**Accepted** Emission limitation/reduction target **fixed** for the second commitment period
5.	**Russian Federation** (economy in transition)	0	(-) 50.3	Ratified **Met** the emission limitation / reduction target	**Accepted** Emission limitation/reduction target **not fixed** for the second commitment period
	Revised Annex B				**Accepted**
1.	**Belarus** (economy in transition)	None	(-) 42. 3	Ratified In Annex I Not in Annex B **Decrease** in emissions	**Accepted** Emission limitation/reduction target **fixed** for the second commitment period
2.	**Kazakhstan** (economy in transition)	None	(-) 25.8	Ratified Not in Annex I Not in Annex B **Decrease** in emissions	**Accepted** Emission limitation/reduction target **fixed** for the second commitment period
	Annex I Annex B		**Increase over 1990 base**		

Table 6 to be continued.....

...Continuation...

S. No.	Country	Emission Limitation/ Reduction Target (% change against thebase level)[c xiii]	Achievement (% change against the base level)[c xiii]	Position regarding Kyoto Protocol 1st commitment period 2008 to 2012 [c xiv]	Position regarding Doha Amendment to Annex B 2nd commitment period 2013 to 2020 [c xv]
1.	**Austria** (developed country)	(-) 8	11.7	Ratified **Not met** the emission limitation / reduction target	**Not Accepted** Emission limitation/reduction target **fixed** for the second commitment period
2.	**Canada** (developed country)	(-) 6	42.2	Ratified **Withdrew** from the Protocol in 2012 **Not met** the emission limitation / reduction target	**Not a Party anymore**
3.	**Greece** (developed country)	(-) 8	5.3	Ratified **Not met** the emission limitation / reduction target	**Not Accepted** Emission limitation/reduction target **fixed** for the second commitment period
4.	**Ireland** (developed country)	(-) 8	4.6	Ratified **Not met** the emission limitation / reduction target	**Not Accepted** Emission limitation/reduction target **fixed** for the second commitment period
5.	**Japan** (developed country)	(-) 6	8.6	Ratified **Not met** the emission limitation / reductio target	**Not Accepted** Emission limitation/ reduction target **not fixed** for the second commitment period
6.	**New Zealand** (developed country)	0	111.4	Ratified **Not met** the emission limitation / reduction target	**Not Accepted** Emission limitation/reduction target **not fixed** for the second commitment period
7.	**Spain** (developed country)	(-) 8	18.0	Ratified **Not met** the emission limitation / reduction target	**Not Accepted** Emission limitation/ reduction target **fixed** for the second commitment period
8.	**United States of America** (developed country)	(-) 7	2.7	Not Ratified Signatory to the Kyoto Protocol, but **did not ratify** it. Emission limitation / reduction target not applicable **Increase** in emissions	**Not a Party**
	Annex I Not in Annex B		**Increase over 1990 base**		
1.	**Cyprus** (developed country)	None	55.3	Ratified **Increase** in emissions	**Not Accepted** Emission limitation/reduction target **fixed** for the second commitment period
2.	**Malta** (developed country)	None	57.7	Ratified **Increase** in emissions	**Not Accepted** Emission limitation/reduction target **fixed** for the second commitment period
3.	**Turkey** (developed country)	None	163.3	Ratified **Increase** in emissions	**Not Accepted** Emission limitation/reduction target **not fixed** for the second commitment period

Table 6 to be continued.....

...Continuation...

S. No.	Country	Emission Limitation/ Reduction Target (% change against thebase level)[c xiii]	Achievement (% change against the base level)[c xiii]	Position regarding Kyoto Protocol 1st commitment period 2008 to 2012 [c xiv]	Position regarding Doha Amendment to Annex B 2nd commitment period2013 to 2020 [c xv]
	Non Annex I Non Annex B		**Increase in emissions** (different base years and periods)		
1.	**India** (developing country)	None	5.9	Ratified Provisions not binding **Increase** in emissions	**Accepted** Provisions **not binding**
2.	**China** (developing country)	None	93.0	Ratified Provisions not binding **Increase** in emissions	**Accepted** Provisions **not binding**
3.	**Brazil** (developing country)	None	57.8	Ratified Provisions not binding **Increase** in emissions	**Not Accepted** Provisions **not binding**
4.	**South Korea** (developing country)	None	93.1	Ratified Provisions not binding **Increase** in emissions	**Accepted** Provisions **not binding**
5.	**Indonesia** (developing country)	None	196.1	Ratified Provisions not binding **Increase** in emissions	**Not Accepted** Provisions **not binding**

(iv) It can be inferred that by and large the **under-achievers have stronger reservations on the second commitment period,** while the **over-achievers and those on whom the emission limitation / reduction targets are not binding are more forthcoming.**

(v) It is also seen that the **diverse and shifting stands** of the various countries were **not visible till the time of the non-binding provisions** of the **Convention**, but **became evident when the binding commitments** of the **Protocol's first commitment period** came in place, and **became more pronounced when the** Protocol's **second commitment period was negotiated.**

3.12 Few suggestions:

(i) **Clean energy:** (a) Fossil fuel accounts for 82 percent of the energy produced in the world.[32] Carbon dioxide from fossil fuel use is the largest contributor (57 percent) to global greenhouse gas emissions. And energy supply (26 percent), industry (19 percent), transport (13 percent) and residential & commercial buildings (8 percent), which are pre-dominantly based on fossil fuel use, are together the largest source of global greenhouse gas emissions[33]. Among the fossil fuels, coal contributes the most to greenhouse gas emissions per unit of energy produced, followed by oil and natural gas (in that order).

[32]**Total Primary Energy Supply by Resources (2011) [n]:**

Fossil	:	82%
Hydro (> 10 MW)	:	11%
Nuclear	:	5%
Renewables (other than large hydro)	:	2%

[33]**Global Greenhouse Gas Emissions by Gas (2004) [o i]:**

Carbon Dioxide (fossil fuel use)	:	57%
Carbon Dioxide (deforestation, decay of biomass, etc)	:	17%
Carbon Dioxide (other)	:	3%
Methane	:	14%
Nitrous Oxide	:	8%
F-gases	:	1%

Global Greenhouse Gas Emissions by Source (2004) [o i]:

Energy supply	:	26%
Industry	:	19%
Forestry	:	17%
Agriculture	:	14%
Transport	:	13%
Residential & Commercial buildings	:	8%
Waste and wastewater	:	3%

(b) The prime focus has to be on replacement of fossil fuel with alternative clean sources of energy. But fossil fuel cannot be wished away as of now. Thus the parallel focus has to be on reducing the emission intensity of greenhouse gases in fossil fuel.

(c) Nuclear energy and renewable energy (including hydro) being the cleanest are the alternatives to fossil fuel. The potential for enhancing renewable energy[34] is fairly limited [due to high and variable (cost-dependent) opportunity], but the potential for enhancing nuclear energy[35] is enormous at present (due to steady-cost opportunity).

(d) Enhancing renewable energy to the maximum and in particular enhancing nuclear energy exponentially[36] is a core direction ahead. Concurrently reducing the emission intensity of greenhouse gases in fossil fuel is equally important.[37]

(e) This needs to be the principal area for action, including for channelizing of financial resources and technological support.

(ii) **Categorisation of country parties in respect of binding obligations and commitments:** (a) UNFCC Convention considered the common but differentiated responsibilities and respective capabilities of the country parties, and put them in three categories (Annex I, Annex II and Non Annex I). Recognising that the increase in concentration of greenhouse gases in the atmosphere is largely due to industrialisation in the developed countries, the Convention put the onus on developed country parties and economies in transition (Annex I) to take lead and on the developed country parties (Annex II) to provide financial and technological support to the developing country parties (Non Annex I). The Kyoto Protocol, while operationalising the Convention, adopted the Annex I country parties into the Annex B of the Protocol for the purpose of setting binding quantified emission limitation or reduction commitment targets. There is no binding condition on developing countries (Non Annex I, Non Annex B), unless they voluntarily wish to abide or take steps in consonance.

(b) This is a very broad thumb-rule[38] categorisation, based essentially on the generalised conventional classification of developing - - - - developed, and with countries moving to open economies being broadly classified as - - in transition - - . It is ridden in contradictions. It is beyond the capacity of countries like Greece, Portugal, Finland, Ireland, Iceland in Annex II, which have comparatively low GDP, to provide significant financial support to the Non Annex I developing countries. The categorisation does not take into consideration the major and fast shifts in the economic conditions of the various countries across the globe. Countries like China, India, Brazil, South Korea (Non Annex I) have become relatively economically strong, while countries like Greece, Portugal, (Annex II) have become relatively economically weak. The oil exporting countries like Saudi Arabia, UAE, which, though not in Annex II, have reasonably high GDP, and can afford to finance mitigation and adaptation activities in other countries for the purpose of common good, and especially so as they are the beneficiaries of oil export (after coal, oil contributes the most to greenhouse gas emissions). The premises on which the countries were categorised in Annex I and Annex II of UNFCCC and in Annex B of Kyoto Protocol might not be the most appropriate at present.

(c) Developed countries like USA, Australia, Canada are seeking mandatory conditions on developing countries like India, China on the basis of their aggregate greenhouse emissions, whereas the developing countries like India, China, Brazil advocate to continue to be out of the binding purview of the Protocol. India wants per capita greenhouse

[34]**Renewable energy** includes: hydropower, solar, wind, biomass, geothermal and ocean.

[35]**Matter and Energy:** Matter on being destroyed gets converted into energy ($e = mc^2$). Solar energy is released on destruction of matter, by atomic fusion. That process is external to the planet. The two broad sources of energy on the planet are solar energy, past or present, and nuclear energy (from man-induced destruction of matter, by atomic fusion or fission). Energy in fossil fuels (coal, oil, natural gas) originates from solar energy of the yesteryears, which was absorbed by plants through photosynthesis and retained or transferred to herbivores and further to carnivores. Hydro-electricity is based on the energy provided by the sun, for the water vapour to rise and precipitate as rain and snow. Wind energy is based on the energy provided by the sun, in changing the air pressures. Solar energy (as commonly called) is the direct trapping of the energy of the sun.

[36]**Nuclear energy:** In respect of nuclear energy, the integral aspects of safety and security as well as non-proliferation, have to be simultaneously ensured. Therefore, without diluting the strict controls, and without allowing proliferation, it could be considered to house giant reactors in safe and secure, isolated and unpopulated areas, and creating a global transmission grid to feed the countries across the world.

[37]Emphasis on clean energy, articulated by the authors in their earlier article of November 7th 2014, has been prominently included in the US – China Bilateral Climate Deal of 11th November 2014 (footnote [26] refers).

[38]Countries belonging to the Organisation for Economic Cooperation and Development (**OECD**) and countries with **economies in transition** from Central and Eastern Europe were initially taken into **Annex I**.

emissions and right to sustainable development to be the prime consideration; similarly, China, Brazil want right to sustainable development to be the prime consideration. While the first argument is based on the principle of equity among the countries, the second argument is based on a more logical and convincing principle of equity among the population[39].

(d) It may be seen that there are very wide disparities between the developed and the developing countries in respect of the country-wise aggregate greenhouse gas emissions and the country-wise per capita greenhouse gas emissions.

(e) These contradictions and differences in opinion are one basic reason for the present conflict and dissent, and are not letting the amendment to Annex B of the Protocol to be ratified, and may well lead to the collapse of the Kyoto Protocol and may even affect the negotiations for the Universal Climate Agreement beyond 2020.

Table 7[v]
Category / country-wise per capita and total emissions [2013]

Category / Country	Per capita emissions t CO_2 per person	Total emissions	
		Gt CO_2[40]	%
Global (with bunkers[41])	**5.0**	**36.13**	**100**
Annex B	**7.5**	**13.05**	**36.1**
USA	16.4	5.23	14.5
Russian Federation	12.7	1.81	5.0
Japan	9.8	1.25	3.4
Canada	14.3	0.50	1.4
Non Annex B	**3.5**	**21.04**	**58.2**
China	7.2	9.98	27.6
India	1.9	2.41	6.7
South Korea	12.5	0.62	1.7
Iran	7.9	0.61	1.7
Saudi Arabia	18.0	0.52	1.4

(f) While the existing direction and conditions of the Convention and the Protocol in respect of developed countries and economies in transition should stay, Annex II and revised Annex B need to be rationalised. The onus of financial support requires to be removed from the developed countries having comparatively low GDP, and some of the oil exporting countries ought to be included in the list of financial support-givers (on the basis of GDP and quantum of oil exports). A cess on exports of fossil fuels (coal, oil, natural gas) could also be imposed, with the proceeds going towards an international climate fund. Certain conditions also need to be imposed on the Non Annex I developing countries. Considering that the emission of greenhouse gases is intricately and directly related to the source of energy as well as to the high emission intensity of greenhouse gas in fossil fuel, the logical stipulations for developing countries can be: (i) optimising the use of alternative energy to fossil fuel[42] and (ii) decreasing the emission intensity of greenhouse gases in fossil fuel. These conditions would be dependent on the country-specific base level and potential for each country. This would also necessitate focussed channelizing of finance and technology in these areas by the support-givers in rationalised Annex B in consonance with the country-specific external assistance requirement of each country.

(g) The basis for negotiating the Universal Climate Change Agreement beyond 2020 also needs to include the above as fundamental considerations.

(iii) **Formal education system:** (a) Though development and implementation of educational and public awareness programmes on climate change and its effects is included in the UNFCC Convention, the concerted global efforts in this arena are not visible.

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[39]Rise in per capita income and rise in human resource development index have direct co-relation with rise in per capita energy consumption. Therefore, restricting increase in energy consumption in developing countries would be unfair, considering that the damage has been principally done by the indiscriminate use of fossil fuel with high intensity of emission of greenhouse gases by developed countries in their industrialisation process.

It is projected by some developing countries like India that even with the rise in per capita income and concomitant increase in per capita energy consumption in developing countries, their per capita greenhouse gas emissions will not reach the present or projected levels of developed countries.

[40]**1 metric tonne** (t) = **1,000,000 gram** (g) ; **1 Gigatonne**(Gt) = **1,000,000,000 metric tonnes** (t)

[41]'bunker' connotes international aviation and shipping fuel.

[42]As part of the US–China Bilateral Climate Deal, China has committed to increase its share of non-fossil fuel in primary energy consumption to around 20 % by 2030 (footnote [26] refers).

(b) Behavioural and value changes are long drawn processes, best achieved through the formal curricula. In addition to the financial and technological efforts, the educational efforts should be simultaneously intensified, to include the issues of environment protection, global warming and climate change at the primary stage of formal education itself, as well as to have specialised disciplines on these subjects at the graduate, post–graduate and research level, in all countries of the world. A specialised cell in a UN organisation or in the UNFCCC secretariat should evolve standardised course material, especially for the primary and secondary school level, which should be added to the regular curricula across the globe. In a span of 20 to 30 years, aware generations will be produced, who are conscious of their responsibilities as citizens of the planet. This will be relatively without much conflict or dissent and be much less resource-dependent, and more in the nature of a managerial systemic intervention.[43]

(iv) **Legislative and policy expertise:** (a) The process of compliance with and implementation of international Protocols requires the governments to enact the necessary legislation, form the requisite policies and make their legal and administrative systems compliant. However, the issues related to global warming and climate change are complex and difficult, and cut across multiple sectors and multiple ministries / departments in government. Most countries (developed and developing, both) do not have the requisite expertise in this domain.

(b) A specialised cell within a UN organisation or in the UNFCCC secretariat should provide the country-specific assistance and expertise in the framing of policies and the enactment / amendment of laws (without compromising or infringing on the sovereign status of the countries). Such dedicated cell to help frame apt policies and laws will accelerate the whole process. This too is comparatively less resource-dependent and more of a managerial input.

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Feature

Performance Enhancement of a Manufacturing Unit of Northern India Using Continuous Improvement Strategies—A Case Study

JAGDEEP SINGH AND HARWINDER SINGH

Continuous Improvement (CI) is one important lean manufacturing tool to reduce waste and improve flexibility in manufacturing processes allowing lot size reduction and manufacturing flow improvements. Manufacturing organizations are implementing such strategies to enhance the performances of manufacturing process through waste elimination and reducing setup times. The purpose of this case study to improve the performance of manufacturing unit using Continuous strategies, viz. Single Minute Exchange of Die (SMED), 5S, Standardization, Redesign and Poka-Yoke by significant improvement in overall equipment effectiveness of their manufacturing equipments. Results indicated that these strategies significantly aimed at improvement of 3.01 per cent in OEE which leads to improve the performance of manufacturing system processes.

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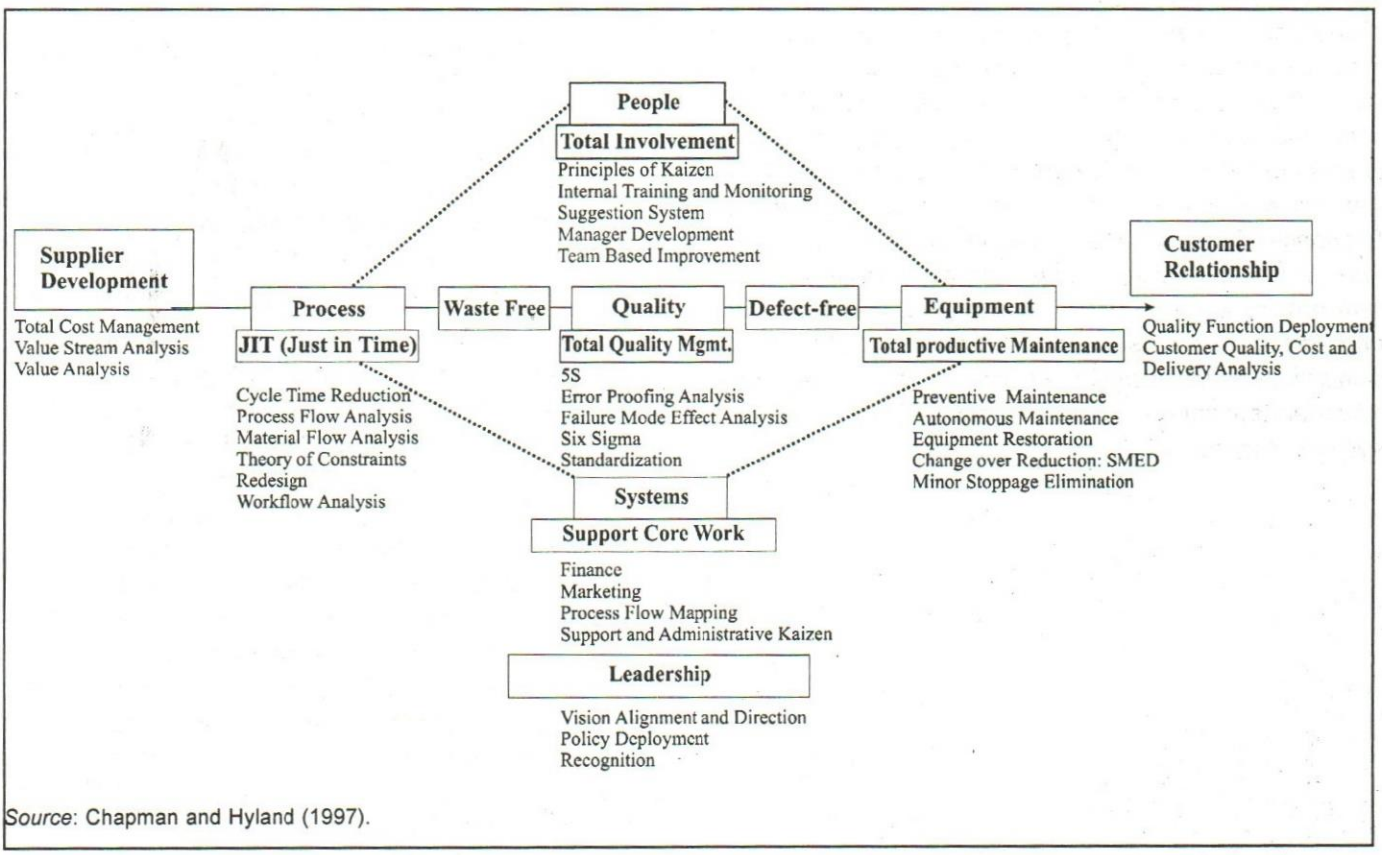
Introduction

Today's competitive market, in almost every category of products and services, is characterised by accelerating changes, innovation and massive amounts of new information. Simply stated, competitiveness of a firm refers to firstly management of capabilities to exploit its resources, competencies and knowledge, and secondly to manage change with the overall objectives of adapting better and faster than competition. Superior manufacturing performance of a firm leads to competitiveness. Business environment in the last decade has changed radically in India.

With the advent of World Trade Organisation regime of globalisation and liberalised trade, the heavily protected Indian industry has had to face competition both from within as well as established companies practicing world-class techniques (Sardana and Sinha, 2011). In today's highly dynamic and rapidly changing environment, the global competition among organizations has lead to higher demands on the manufacturing organizations. The manufacturing industry has experienced an unprecedented degree of change in the last three decades, involving drastic changes in management approaches, product and process technologies, customer expectations, supplier attitudes as well as competitive behavior. These challenges are forcing the manufacturing organizations globally to foster high reliability, availability and maintainability in the manufacturing systems by implementation of various strategic and proactive market driven strategies to remain competitive in a highly dynamic environment (Ahuja et al., 2006). Improving customer service, making operation faster, more operation and reduction in costs are challenges faced by manufacturers today. To meet these challenges many companies in India searching to improve their ability to

compete globally. Wastage during production process is rapidly growing day by day in industries. This is because of change in taste of the customer, which will lead to increase in production costs. There are different techniques of waste reduction and performance enhancement like Just in Time (JIT), Total Quality Management (TQM), Total Productive Maintenance (TPM), Kaizen or Continuous Improvement, etc. Working in any kind of manufacturing environment one of the unfortunate characteristics is waste. Waste can extend from unused raw material to damaged products, and it can carry quite of a financial loss for the company if not treated in an efficient manner. In order to reduce waste, there are several numbers of methods and strategies that companies can use depending on the desired results. Therefore, organisations in today's highly challenging scenario have moved to reduce costs and improve quality and responsiveness, the reduction in inventory using improvement techniques like continuous improvement or Kaizen (Wu and Chen, 2006).

Kaizen approach involves different strategies for its successful implementation in manufacturing organization. Figure 1 shows different strategies of CI approach or eight organizational strategies and sub-strategies of CI approach. The advantage of designating and using OEE as a measure is that it clearly identifies causes of losses in effectiveness, and allows the continuous monitoring of the most important factors which influence system performance. The purpose of this paper is to reduce the setup time and significant improvement in OEE by using CI methodology; i.e., SMED technique in a systematic manner which leads to improvement in overall equipment effectiveness of their manufacturing equipments. This improvement in OEE is validated through paired sample *t* test for its significance level.



Source: Chapman and Hyland (1997).

Figure 1: A Total System Approach to Continuous Improvement (Strategies and Sub-strategies of CI Approach)

Introduction to the Company and OEE

ABC Company is one of the premier units of Hero Group of Companies. The company's office is situated in Punjab. The setup was established in the year 1971. The company is engaged in manufacturing and supply of auto parts to M/S Hero Moto Corporation Ltd. The wide range of products consists of crankshafts and kick lever for different range of motorcycles. The company is managed by a team of professionals with focus on the following:

- Customer Satisfaction
- Continual Improvement
- Prevention of pollution, hazards and accident
- Compliance with legal and other applicable requirements

Beginning 1971, the four decades of its eventful journey have established ABC Company a name to reckon with as reputed suppliers of hot forged components and sub-assemblies to a number of industries vertical in two wheeler segments in India and abroad. With the vision of its founder – Umesh Munjal, new dimensions have been added to the operations keeping excellence and quality as the benchmarks. Innovation, futuristic R&D, zero error, precision work, culture and more have added to elite performance of Highway. The different departments include Forging shop, Ultrasonic section, machine shop and standard room. OEE as a result can be expressed as the ration of the actual output of the equipment divided by the maximum output of the equipment under the best performance condition. The Overall Equipment Effectiveness was originated from the Total Productive Maintenance practices, developed by Nakajima at the Japan Institute of Plant Maintenance, the aims of TPM is to achieve the ideal performance and achieve the Zero loss which means no production scrap or defect, no breakdown, no accident, no waste in the process running or changeover. The quantification of these accumulations of waste in time and its comparison to the total available time can give the production and the maintenance management a general view of the actual performance of the plant, and it can help them to focus the improvement on the bigger loss (Sharma et al., 2006).

OEE is equal to the multiplication of the three main bases for the main six big losses:

- Availability indicates the problem which caused by downtime losses.
- Performance indicates the losses caused by speed losses and
- Quality indicates the scrap and rework losses.

TPM can be defined in terms of overall equipment effectiveness (OEE) which, in turn, is a function of availability (A), performance efficiency (PE), and quality rate (QR):

$$\text{Availability} = \frac{\text{Loading time} - \text{Down time}}{\text{Loading time}}$$

Performance efficiency (PE) = Operating speed rate * Net operating rate

$$\text{Operating speed rate} = \frac{\text{Theoretical cycle time}}{\text{Actual cycle time}}$$

$$\text{Net operating rate} = \frac{(\text{Processed amount})^* (\text{Actual cycle time})}{\text{Operating time}}$$

$$\text{Quality rate (Q)} = \frac{\text{Processed amount} - \text{Defect amount}}{\text{Processed Amount}}$$

OEE = (Availability)* (Performance Efficiency)*(Quality Rate) {Dal et al., 2000}

SMED — a Basic Technique for Setup Reduction

Shingo, a Japanese Industrial Engineer, developed the sophisticated technique of SMED in 1987 when he applied this technique to large body moulding presses at Mazda Automobile Industry and successfully achieved 57 per cent of setup time reduction. Now, SMED is becoming a universal approach, which can be made compatible to any type of industry with the use of some additional industrial engineering tools (Hurley, 2000). Shingo (1985) defined that Single-Minute Exchange of Die (SMED) refers to the theory and techniques used for the reduction of equipment setup times. SMED has as its objective to accomplish setup times in less than 10 minutes, i.e. a number of minutes expressed by a single digit. Although not all setups can be literally reduced to this time, between one and nine minutes, this is the goal of the SMED methodology. SMED, also known as Quick Changeover of Tools, was developed by Shingo who characterized it as a scientific approach for the reduction of setup times, and which can be applied in any industrial unit and for any machine. SMED is defined as the minimum amount of time necessary to change the type of production activity taking into consideration the moment in which the last piece of a previous lot was produced vis-à-vis the first piece produced by the subsequent lot.

Setup time is one of the vital parameters used in any manufacturing industry and is a form of necessary input to every machine or workstation. Because setups are a collection of sequence dependent changeover activities which are carried out before starting the production of any product, productive time for a machine can be increased by reducing its setup time. Manufacturers

need to be more responsive to the dynamic customer demands to maintain their competitive edge over others (Burman and Gershwin, 1996). According to Pannesi (1995), shorter setups bring the following impacts to any type of production system:

- make feasible the production of smaller lots;
- reduce set-up scrap;
- decrease set-up labour cost;
- make production system flexible;
- reduce product lead time;
- enhance productivity and utilization of assets; and
- reduce manufacturing cost

Quantitatively, setup time for every machine can be defined as the function of three major elements: method, organization and production constraints. 'Method' refers to the way in which the setup is performed and should be suggested by the designer. Standardization and simplification are the characteristics of an ideal set-up procedure. To reduce setup time, non-value adding activities should be avoided and online activities should be externalized to off line. For effective and efficient set-ups, clear organization of manpower is needed so that every body involved in these crucial activities knows about their respective jobs and authorities.

Methodology Adopted and Case Study Setting

The time associated with setup of forging press has been calculated and OEE associated with the forging press have been analyzed before and after implementing CI strategies. Based on results, conclusions are drawn. Single-Minute Exchange of Die (SMED) is one of the many lean production methods for reducing waste in a manufacturing process. It provides a rapid and efficient way of converting a manufacturing process from running the current product to running the next product. Different members of TPM departments of a manufacturing unit used stopwatch technique to measure setup time of various activities associated with the progressive dies setup (Bottom and Top Blocker; Bottom and Top finisher) used in forging shop of the manufacturing unit. The setup time of internal activities (internal setup is that setup operation that can be done only when the machine is shut down) and external activities (external setup is that setup operation that can be done when the machine is still running. These operations can be performed either before or after the machine is shut down) associated with setup of different dies used on the forging press has been calculated and OEE associated with this setup activities have been analyzed before and after implementing SMED in systematic manner. The improvement in overall equipment effectiveness is tested for its significance by using statistical techniques to validate the data collection before and after implementing CI strategy, viz. SMED in the shop floor of the manufacturing industry under study. The total setup time associated with SMED is 262 minutes. Table 1 shows all the activities associated with setup and time associated with these activities in setup of progressive dies.

Table 1: Activities Associated with Setup and Time Taken to Perform These Activities

Activities	Time taken (Minutes)
Bolt loosened Bottom Die	1 min
Bolt loosened Top Die	3 min
Bottom Die taken out	1 min
Top die taken out	1 min
Cleaning	1 min
Top finisher inserted	1 min
Top blocker inserted	1 min
Top Die bolts tightened	3 min
Bottom finisher inserted	110 min
Bottom blocker inserted	90 min
Bottom bolt tightened	3 min
Die clamping bolt checked	1min
Gap checked	1min
Top die temperature	45 min
Bottom die temperature	
Total time	262 min

The objective of SMED is to reduce the setup time. Setup time is the time elapsed at a work centre from when the last good part of the current run is completed until the work centre starts running the first good part of the next run. Long setup time resulted in a reduced number of setups, larger batch sizes and larger buffering work-in-process inventories and poor process flow and performance. In order to reduce the setup time associated with setup of progressive dies, the primary responsibility have been assigned to Air man, Die-fitter, Forger and Loader. It results in reduction of setup time and is helpful in fluctuation of demand for different range of product. Table 2 shows the activities associated with setup of progressive dies and responsible persons for these activities.

Table 2: Responsibility for SMED Activities

Activities	Quantity	Responsibility
Arrange rods	4	Air man
Ensure dies are properly heated in die heating furnace	–	Die-fitter Supervisor
Arrange spanner	02	Forger
Arrange Allen key	02	forger
Pneumatic wrench	01	Forger
Remove bins from backside of forge press	–	Loader
Place billet bin of component to be forged near loader	–	Loader
Clamps for top die	01	Airman
Check all dimensions of top dies and bottom dies as mentioned in SMED check sheet		Die fitter
Cleaning of bottom holder grounded surface		Die fitter
Outside diameter of bottom and top die (bulging effect)		Die fitter
Check temperature Of top and bottom dies: Top Die = 175°C; Bottom Die = 220°C		Die fitter
Verify ejector pin length and diameter		Die fitter
Check tightness of bottom die and clamping bolts after heating		Die fitter

OEE Improvement Using SMED

With the application of SMED technique, average setup time has been reduced or faster changeovers mean less equipment down time.

Down Time = Electrical Breakdown + Die heating + Die change

Average set up time = Die heating +Die change = 262 min

$$\text{Availability} = \frac{\text{Loading time} - \text{Down time}}{\text{Loading time}}$$

As the average setup time decreases, downtime also decreases and as a result availability of production equipments increases as suggested by formula. Hence OEE increases considerably.

Table 3: OEE Before Implementing SMED

Day	Total Time Available (min)	Down Time (min)	Operating Time (min)	Processed Amount	Rejection	Availability	Performance Efficiency	Quality Rate	OEE (per cent)
2 march 2013	1320	490	830	6140	7	0.5	0.924	0.99	45.73
4 march	1320	545	775	5868	9	0.58	0.946	0.998	54.78
5 march	1320	435	895	5605	5	0.67	0.782	0.99	52.34
6 march	1320	530	990	8045	7	0.598	1.01	0.99	59.79
7 march	1320	375	965	7025	11	0.715	0.91	0.998	64.9
8 march	1320	325	915	6250	9	0.753	0.85	0.998	63.8
8 march	1320	304	925	6850	8	0.769	0.906	0.99	68.9
9 march	1320	345	920	6420	8	0.738	0.872	0.998	64.27
11 march	1320	405	890	6540	12	0.693	0.918	0.998	63.49
12 march	1320	275	910	7020	10	0.79	0.964	0.998	76.04

OEE Improvement and Validation of Increase in OEE

Average OEE before implementing CI strategies = 61.41%

OEE after implementing CI strategies = 64.42%

Increase in OEE = 3.01%

This increase on OEE is validated by using paired sample t test.

Null Hypothesis:

HO: There is no significant difference in the percentage improvement of OEE before and after SMED.

Alternate Hypothesis:

Ha: There is a significant difference in the percentage improvement of OEE before and after SMED

Average of deviation = 64.404

Standard Deviation = 0.639

t value = 5.010902

p value (two tailed) = 0.007

The table value for 8 degree of freedom at 5 per cent*** significance is 2.311, which is less than 5.010902 and p value is less than 0.05. Hence the null hypothesis is rejected. The result signifies that there is a significance difference in the percentage increase of OEE before and after implementing SMED. Hence, it is concluded that SMED implementation brings significant positive change to OEE improvement.

Various Shortcomings in the Die Readjustments and SAP–LAP Analysis on Case Study

Various internal and external activities, which give contribution to the setup process while doing die-readjustment activities, are also analyzed with a root-cause study, tools used to overcome these activities, and approximate time saved are summarized in Table 4.

Table 4: Shortcomings in Die Readjustments and Time Saved by Using CI Strategies

Shortcomings in die readjustment system	Estimated time taken (min)	Approx. time saved (min)	Tool/technique used
Lack of 5S activities	120	85	5S/Housekeeping
Scarcity of fool proof ness in system	160	90	Poka-Yoke
Use of sub-standard dierepair-activity	150	85	Standardization/small stoppage elimination
Absence of particular tool kit	170	100	Re-Design of toolkit

Note: Average time taken = 150 min

Percentage time saved = 60 per cent

Average time saved = 90 min

The flexible system methodology tries to resolve the end of continuum paradoxes, as it is based on a spectral paradigm, treating all of the systems-based methodologies and techniques as lying on a continuum ranging from hard to soft and all problem situations also on a continuum ranging from unstructured to well structure. Hard and soft system based techniques can be integrated in number of ways. SAP–LAP (Situation, Actor, Process-Learning Issues, Actions Suggested, Performance Expected) is a holistic framework that blends hard systems and soft systems paradigms (Sushil, 1999).

Situation:

- Technology brought from different countries. Strategic alliance with M/S Hero Moto Corp Limited.
- Manufacturing crankshafts of different models of different motorcycles.
- Enhanced manufacturing capabilities because of innovative efforts by everybody.
- Handsome increase in turnover and profits.
- A special coining machine for improving the flatness of the crankshafts.
- Special purpose machines (SPMs), CNCs and VMCs at various locations for machining of heavy forging, components and subassemblies.
- The organization has facilities available for the testing of incoming raw material and finished product.
- Low OEE and high setup time

Actors

- Managing director of the company as the motivating force.
- M/S Aarti Steels of India is providing the technological solutions.
- Top and middle management is dedicated a lot. Proper hierarchy is followed.
- Innovative engineers to utilize the available strategies of CI approach by modifying the same to suit the local requirements.
- High configuration workstations are used for improving activities continuously.
- Reputed auto parts manufacturing organization.

Process

- Keep upgradation of technology to enhance the production rates.
- Flexible workforce to tackle different types of CNC, VMC and conventional machines.
- Enhanced manufacturing flexibility by launching new type of kick lever.
- Making use of local facilities, skills and raw materials.
- Generating employment for a large number of persons.
- Significant reduction in setup and operation time through CI strategies viz. SMED, 5S, Poka-Yoke, Standardization and redesign.

Learning Issues

- Strong technical support from M/S Vardhman Steels helps in grabbing the large market share.
- Higher production rates are the main objective of the organization.
- Company is investing regularly in machinery and equipment to keep it updated with improvements.
- Advanced tools like continuous improvement are used in most of the critical processes.
- Organization need to change its policies and procedures to effectively monitor small incremental changes.

Actions Suggested

- Employees need to be updated with sophisticated CI tools.
- On Job and off Job training is needed to improve operator effectiveness.
- Faculty from respective department should be involved in the training program.
- Considerable support is required from managers, supervisors and workers for strategic implementation of CI tools.
- Make the technology utilization more flexible by introducing volume flexibility, product flexibility and process flexibility.
- Flexible staff hierarchy.
- Formation of cross functional teams leads to improvement in processes.

Performance Expected

- Leading manufacturer of auto parts
- Enhancement of market share.
- Strategic alliance resulting in increased export to other countries.
- Launch of new crankshaft in Indian market.

Conclusion and limitations

CI approach is a management approach to identifying and eliminating waste (all non-value-added activities) through continuous improvement by reducing time-associated setup in pursuit of perfection. The result of investigation demonstrated that CI strategies play a significant role in improving the performance through system simplification, organization potential and incremental improvements. The improvement of 3.01 per cent in OEE and reduction of 60 per cent setup time has been achieved by strategic implementation of CI approach. Implementing principles or strategies of CI approach in any process will bring huge results to organizations for improving processes. Strategic implementation of CI approach systematically aims at improving the OEE using setup time reduction. The successful implementation of SMED and other CI strategies are the key to a competitive advantage for any manufacturer that produces, prepares, processes or packages a variety of products. The present study is limited to a very few CI strategies and the other remaining strategies can also be implemented to produce desired

results. Second, case study is limited to mechanical manufacturing industry of Northern India.

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Soil is leaving eco system, and is a farmer's most precious assets. A farmer's productive capacity is directly related to the health of his/her soil.

—Howard Warner Buffett

Feature

Problems and Prospects of Home-Based Women Workers in Tamil Nadu

S. CHANDRAKUMARMANGALAM AND D. ARUN KUMAR

The entire economy of India is a combination of formal and informal economies in general. The share of informal economy compared to formal economy is much higher at the national as well as global level. According to International Labour Organization (ILO) 2002, the informal economy comprises informal categories of product and services and it has rapid growth globally which includes agriculture and non agriculture employment categories, non-standard or a typical work-self employed, part-time work and causal work. Informal economy is dualistic by nature, which is separated from the formal sector and complements the formal economy, though they are both interdependent. The general characteristics of informal economy are unregulated, unrecognized, unstructured and also subordinate and dependent feature of capitalist economy and globalization.

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What Is Home-Based Work?

Home-based work (also known as teleworking or telecommunicating) is an employment arrangement in which employee work from home on a full time, part time, temporary or permanent basis. Employees working at home usually rely on technology to enable them to perform their work; however, that is not an essential element. The provision of home-based work is not a legislative requirement in Western Australia and the decision generally rests with the employer.

Statement of the Problem

The workers in the informal sectors are generally paid less and work in very poor and vulnerable condition though their number is growing significantly and they are contributing to the market needs. Due to lack of professional quality, education and skills for quality production, they operate mostly outside the formal economy and are exposed to various serious problems. However, the sector has been contributing significantly in economics, social as well as human development of the countries concerned. Basically, home-based women workers engage in small production activities and employment relations existing in causal, kinship or personal and social relations rather than contractual arrangements with formal guarantees. The world economy has been shifting from formal to informal and it is more flexible and the current global trend has also been fully affected by liberalization and globalization process of global economy. Therefore, the informal economy is a strong part of the national economy as well as labour market which has been creating significant employment opportunities and reducing the poverty gap and social injustice. The dynamism of the informal economy and its effect on the livelihood of the poor are equally important to create opportunity and upward mobility for the poor and their families.

Home-based women workers with in the border framework of informal sector are often an invisible, neglected and ignored sector in Tamil Nadu, though their number is estimated to be around 3 million, out of which 78 per cent are women at present.

Rationale of Study

The home-based work is taken as outsourcing, subcontracting and family-based work with the linkages of formal and informal market setup. Many production firms are not recorded particularly those related to survival activities whereas multinational and bi-lateral companies with the highest economic power are recognized in the labour market. Home-based work in urban areas is more fragile and home-based women workers are engaging in various types of works to maintain and increase their earning sources. For instances, home-based women workers do marketing through street vending as well as sometime other labour work in the afternoon, then work as a home-based worker during night also. Insecure employment forces them to engage in different types of work simultaneously. Globalization is also a cause for increasing diversified home-based works and unorganized and unplanned urbanization.

Since home-based work is one of the neglected sectors of informal economy from the national economy and national recognition by the government; therefore, it is not surprising to observe that there is a severe lack of data and information on this subject with concerned agencies of the government in Tamil Nadu. There are sporadic or very few or limited studies being carried out by some NGOs like Home Net Tamil Nadu focusing on the problems and issues and the status of home-based women workers in Tamil Nadu; however, these studies are general in nature and lack comprehensiveness or in-depth in their contents. In this regard, it is a matter of great satisfaction for the people working in this field that for the first time the census of Tamil Nadu commencing in near future has realized the need to collect information about home-based women workers in Tamil Nadu and accordingly incorporates the necessary questions in the census questionnaire. Undoubtedly, with this inclusion of question on home-base workers, the country will have for the first time at least the complete and reliable data on home-based women workers in Tamil Nadu.

It is neither desirable nor possible to formulate appropriate policy and intervention measures by the central government in the absence of basic information pertaining to home-based women workers in Tamil Nadu. It is expected that the present study will furnish necessary information about different aspects of home-based women workers so as to enable the concerned authorities of government of Tamil Nadu to initiate the process of the formulation of appropriate policies for the secure livelihood of home-based women workers including urban working poor home-based women workers. Moreover, this document will also serve in pressurizing and in lobbying with government to expedite the process of policy formulation and intervention measures in future.

Importantly, the study has given a special focus on poor home-based working women and their livelihood aspects. So the study has analyzed the relationship and dimension of urban poor home-based women workers urban in terms of urban poverty, its dynamism keeping home-based work in mind as an occupation

Objectives of the Study

1. To study the socio-economic condition of the home-based women workers in Tamil Nadu.
2. To analyze the factors influencing to involve in home-based work.
3. To identify the common problem faced by the home-based women workers.
4. To suggest remedial measures to enhance the standard of living.

Research Methodology

The present study uses both primary and secondary data. The primary data were collected from 1,000 respondents with the help of a well-structured questionnaire; the data thus collected were subdue in to suitable tabular form; appropriate statistical tools were employed to analyze the data, secondary data were also used from the standard libraries in Coimbatore, Chennai and Bangalore; in addition, Web resources also used.

Data Analysis and Interpretation

Age and Income Earned by the Respondents

Age is an important factor in deciding home-based work. For the purpose of this study, age of the respondents has been classified in to three states, viz. Young (below 30 years), Middle age (31–50 years) and Old category (above 50 years). The distribution of sample respondents according to age of the respondents and the income earned by the home-based women workers are shown in Table 1.

Table 1: Frequency Table of Age of the Respondents

Age	No. of Respondents	Per cent
Up to 30 years	271	27.1
31 to 50 years	511	51.1
Above 50 years	218	21.8
Total	1000	100
Average	40.84	
Min-Max	14-85	
SD	13.12	

It could be seen from Table 1 that 271 (27.1 per cent) respondents belong to young category, 511 (51.1 per cent) respondents belongs to middle-aged category and 218 (21.8 per cent) belong to above 50 years age category. With a view to find the degree of association between age of the respondents and income earned a two-way table was prepared and is shown in Table 2.

It is highlighted from Table 2 that the percentage of high amount of income earned was the highest (57.0 per cent) among the middle-aged category and the same was the lowest (17.6 per cent) among the old aged category of the respondents. The percentage of medium amount of income earned was the highest (56.4 per cent) among the middle-aged respondents and the same was lowest (15.1 per cent) among the old aged respondents. On the other hand, the percentage of low amount of income earned was the highest (41.3 per cent) among the middle-aged category and the same was lowest (25.8 per cent) among the young category of the respondents.

Table 2: Age and Annual Family Income Cross Tabulation

Age Group	Annual Family Income			Total
	Low (up to Rs 36000)	Medium (Rs 36001 to Rs 72000)	High (above Rs 72000)	
Young	92 (25.8)	143 (28.5)	36 (25.4)	271 (27.1)
Middle	147 (41.3)	283 (56.4)	81 (57.0)	511 (51.1)
Old	117 (32.9)	76 (15.1)	25 (17.6)	218 (21.8)
Total	356 (100.0)	502 (100.0)	142 (100.0)	1000 (100.0)

In order to find the relationship between age of the respondents and annual income earned, a chi-square test was employed and results of the test shown in Table 3.

Table 3: Age and Annual Income Earned (Chi-Square Test)

Factor	Calculated chi-square value	Table value	D.F.	Remarks
Age of the Respondent	42.496	13.28	4	Significant at 1% level

Hypothesis

Null hypothesis (H_0): There is no close relationship between age of the respondents and the income earned.

Alternative hypothesis (H_1): There is a close relationship between age of the respondents and the income earned.

It is divulged from Table 3 that the calculated chi-square value is greater the table value and the result is significant at 1 percent level. Hence the Null hypothesis (H_0) is rejected and Alternative hypothesis (H_1) is accepted. From the analysis, it is concluded that there is a close relationship between age of the respondent and amount of income earned by home-based women workers.

Educational Qualification and Income Earned by the Respondents

Education gives knowledge and motivates the individual with confidence to start home-based work, even when they are unable to get an employment either in government (or) private sector organizations. For the purpose of this study, educational qualification has been classified into

six categories; viz., Illiterate, Primary level, Middle school, High school, Higher secondary school and Graduates. The frequency distribution of sample respondents is shown in the Table 4.

Table 4: Frequency Table of Educational Qualification

	No. of Respondents	Percent
Illiterate	553	55.3
Primary	151	15.1
Middle	135	13.5
High school	82	8.2
Higher secondary school	61	6.1
Graduate and above	18	1.8
Total	1000	100

It is learned from the Table 4 that 55.3 per cent of the respondents were illiterate, 15.1 per cent them having primary level education, 13.5 per cent of the respondents having middle school education, 8.2 per cent of them were studied up to high school level and 6.1 per cent of the respondents studied higher secondary school level. On the other hand, a meager 1.8 per cent percentage was witnessed with graduate level. With a view to find the degree of association between educational qualification of the respondents and income earned, a two-way table was prepared and is shown in Table 5.

It is highlighted in Table 5 that the percentage of high amount of income earned was the highest (42.3 per cent) among the illiterate category and the same was the lowest (0.7 per cent) among the graduate and above category of the respondents. The percentage of medium amount of income earned was the highest (52 per cent) among the illiterate respondents and the same was lowest (2 per cent) among the graduate and above respondents. On the other hand, the percentage of low amount of income earned was the highest (65.2 per cent) among the illiterate category and the same was lowest (2 per cent) among the graduate and above respondents.

Table 5: Educational Qualification and Annual Family Income Cross Tabulation

Educational Qualification	Annual Family Income			Total
	Low (up to Rs 36000)	Medium (Rs 36001 to Rs 72000)	High (above Rs 72000)	
Illiterate	232 (65.2)	261 (52.0)	60 (42.3)	553 (55.3)
Primary	46 (12.9)	82 (16.3)	23 (16.2)	151 (15.1)
Middle	30 (8.4)	76 (15.1)	29 (20.4)	135 (13.5)
High School	23 (6.5)	42 (8.4)	17 (12.0)	82 (8.2)
Higher Secondary School	18 (5.1)	31 (6.2)	12 (8.5)	61 (6.1)
Graduate and above	7 (2.0)	10 (2.0)	1 (0.7)	18 (1.8)
Total	356 (100.0)	502 (100.0)	142 (100.0)	1000 (100.0)

In order to find the relationship between educational qualification of the respondents and annual income earned, a chi-square test was employed and results of the test shown in Table 6.

Table 6: Educational Qualification and Annual Income Earned (Chi-Square Test)

Factor	Calculated chi-square value	Table value	D.F.	Remarks
Education qualification of the Respondent	33.025	23.21	10	Significant at 1% level

Hypothesis

Null hypothesis (H_0): There is no close relationship between educational qualification of the respondents and the annual income earned.

Alternative hypothesis (H_1): There is a close relationship between educational qualification of the respondents and the annual income earned.

It is divulged from Table 6 that the calculated chi-square value is greater the table value and the result is significant at 1 per cent level. Hence, the Null hypothesis (H_0) is rejected and Alternative hypothesis (H_1) is accepted. From the analysis, it is concluded that there is a close relationship between Educational qualification of the respondent and amount of income earned by home-based women workers.

Marital Status and Income Earned by the Respondents

Marriage is an unforgettable event in every human life. Married people are getting support from the in-laws side both financially and morally. Hence, they are extending a good social network. For the purpose of this study, marital status has been classified under three strata, viz. married, unmarried and divorced/widowed. The frequency distributions of sample respondents are shown in Table 7.

Table 7: Frequency Table of Marital Status

	No. of Respondents	Percent
Unmarried	42	4.2
Married	840	84.0
Divorced/Widowed	118	11.8
Total	1000	1000

It is learned from Table 7 that 4.2 per cent of the respondents were unmarried, 84 per cent of the respondents are married and 11.8 per cent of the respondents are divorced/widowed. With a view to find the degree of association between educational qualification of the respondents and income earned, a two-way table was prepared and is shown in Table 8.

Table 8: Marital Status and Annual Family Income Cross Tabulation

Marital status	Annual Family Income			Total
	Up to Rs 36000	Rs 36001 to Rs 72000	Above Rs 72000	
Unmarried	18 (5.1)	16 (3.2)	8 (5.6)	42 (4.2)
Married	271 (76.1)	449 (89.4)	120 (84.5)	840 (84.0)
Divorced/Widowed	67 (18.8)	37 (7.4)	14 (9.9)	118 (11.8)
Total	356 (100.0)	502 (100.0)	142 (100.0)	1000 (100.0)

It is highlighted from Table 8 that the percentage of high amount of income earned was the highest (84.5 per cent) among the married category and the same was the lowest (5.6 per cent) among the unmarried category of the respondents. The percentage of medium amount of income earned was the highest (89.4 per cent) among the married respondents and the same was lowest (3.2 per cent) among the unmarried respondents. On the other hand, the percentage of low amount of income earned was the highest (76.1 per cent) among the married category and the same was lowest (5.1 per cent) among the unmarried respondents.

In order to find the relationship between marital status of the respondents and annual income earned, a chi-square test was employed and results of the test shown in Table 9.

Table 9: Marital Status and Annual Income Earned (Chi-Square Test)

Factor	Calculated chi-square value	Table value	D.F.	Remarks
Marital Status of the Respondent	30.615	13.28	4	Significant at 1% level

Hypothesis

Null hypothesis (H_0): There is no close relationship between Marital Status of the respondents and the income earned.

Alternative hypothesis (H_1): There is a close relationship between Marital Status of the respondents and the income earned.

It is divulged from Table 9 that the calculated chi-square value is greater the table value and the result is significant at 1 per cent level. Hence, the Null hypothesis (H_0) is rejected and Alternative hypothesis (H_1) is accepted. From the analysis, it is concluded that there is a close relationship between Marital Status of the respondent and amount of income earned by home-based women workers.

Number of Days Work Available in a Month and Income Earned by the Respondents

To earn sizeable income, more number of employment days to the job order is essential. For the purpose of the study, number of days work available in a month was studied under three strata up to 10 days in a month, 11 to 20 days in a month and more than 20 days in a month. The frequency distribution of the sample respondents is shown in Table 10.

It could be seen from Table 10 that 70 (7 per cent) respondents work up to 10 days in a month, 575 (57.5 per cent) respondents work 11 to 20 days in a month and 355 (35.5 per cent) respondents work more than 20 days in a month. With a view to find the degree of association between number of days work available in a month of the respondents and income earned, a two-way table was prepared and is shown in Table 11.

Table 10: Frequency Table of Number of Days' Work Available in a Month

	No. of Respondents	Percent
Up to 10 days in a Month	70	7.0
11 to 20 days in a Month	575	57.5
More than 20 days in a Month	355	35.5
Total	1000	100.0
Average	20.03	
Min-Max	1–30	
SD	5.578	

It is highlighted in Table 11 that the percentage of high amount of income earned was the highest (61.3 per cent) among respondent who work 11 to 20 days in a month and the same was the lowest (5.6 per cent) among respondents who work up to 10 days in a month. The percentage of medium amount of income earned was the highest (62.9 per cent) among respondent who work 11 to 20 days in a month and the same was lowest (5.2 per cent) among respondents who work up to 10 days in a month. On the other hand, the percentage of low amount of income earned was the highest (48.3 per cent) among respondent who work 11 to 20 days in a month and the same was lowest (10.1 per cent) among respondents who work up to 10 days in a month. In order to find the relationship between the number of days' work available in a month of the respondents and annual income earned, a chi-square test was employed and results of the test are shown in Table 12.

Table 11: Number of Days' Work Available in a Month of the Respondents and Annual Family Income Cross Tabulation

No. of Days work available in a Month	Annual Family Income			Total
	Low (up to Rs 36000)	Medium (Rs 36001 to Rs 72000)	High (above Rs 72000)	
Up to 10 days in a Month	36 (10.1)	26 (5.2)	8 (5.6)	70 (7 0)
11 to 20 days in a Month	172 (48.3)	316 (62.9)	87 (61.3)	575 (57.5)
More than 20 days in a Month	148 (41.6)	160 (31.9)	47 (33.1)	355 (35.5)
Total	356 (100.0)	502 (100.0)	142 (100.0)	1000 (100.0)

Table 12: Number of Days' Work Available in a Month and Annual Income Earned (Chi-Square Test)

Factor	Calculated chi-square value	Table value	D.F.	Remarks
No. of days work available in a month	21.638	13.28	4	Significant at 1% level

Hypothesis

Null hypothesis (H_0): There is no close relationship between Number of days work available in a month of the respondents and the annual income earned.

Alternative hypothesis (H_1): There is a close relationship between the number of days work available in a month of the respondents and the annual income earned.

It is divulged from Table 12 that the calculated chi-square value is greater the table value and the result is significant at 1 per cent level. Hence, the Null hypothesis (H_0) is rejected and Alternative hypothesis (H_1) is accepted. From the analysis it is concluded that there is a close relationship between Number of days work available in a month of the respondents and amount of income earned by home-based women workers.

Working Hours and Income Earned by the Respondents

The number of working hours per day has been studied under two strata, namely up to 8 hours per day and more than 8 hours per day. The frequency distribution of the sample respondents according to number of hours worked is shown in Table 13.

It could be seen from Table 13 that 837 (83.7 per cent) respondents work up to 8 hours a day and 163 (16.3 per cent) respondents work more than 8 hours a day. With a view to find the degree of association between working hours of the respondents and income earned a two way table was prepared and is shown in Table 14.

Table 13: Frequency Table of Working Hours

	No. of Respondents	Percent
Up to 8 hours a day	837	83.7
More than 8 hours a day	163	16.3
Total	1000	1000
Average	6.38	
Min-Max	2-15	
SD	2.541	

Table 14: Working Hours and Annual Family Income Cross Tabulation

Working Hours	Annual Family Income			Total
	Up to Rs 36000	Rs 36001 to Rs 72000	Above Rs 72000	
Up to 8 Hours a Day	293 (82.3)	422 (84.1)	122 (85.9)	837 (83.7)
More than 8 hours a Day	63 (17.7)	80 (15.9)	20 (14.1)	163 (16.3)
Total	356 (100.0)	502 (100.0)	142 (100.0)	1000 (100.0)

It is highlighted from Table 14 that the percentage of high amount of income earned was the highest (85.9 per cent) among the respondent work up to 8 hours a day and the same was the lowest (14.1 per cent) among the respondents work more than 8 hours a day. The percentage of medium amount of income earned was the highest (84.1 per cent) among the respondent work up to 8 hours a day and the same was lowest (15.9 per cent) among the respondents work more than 8 hours a day. On the other hand, the percentage of low amount of income earned was the highest (82.3 per cent) among the respondent work up to 8 hours a day and the same was lowest (17.7 per cent) among the respondents work more than 8 hours a day.

In order to find the relationship between working hours of the respondents and annual income earned, a chi-square test was employed and results of the test shown in Table 15.

Table 15: Working Hours and Annual Income Earned (Chi-Square Test)

Factor	Calculated chi-square value	Table value	D.F.	Remarks
Working Hours	1.069	5.991	2	Significant at 1% level

Hypothesis

Null hypothesis (H_0): There is no close relationship between working hours of the respondents and the income earned.

Alternative hypothesis (H_1): There is a close relationship between working hours of the respondents and the income earned.

It is surmised from Table 15 that the calculated Chi-Square value is less than the Table value and the result is Not Significant at 1 per cent level and 5 per cent level. Hence, the Null hypothesis (H_0) is accepted and Alternative hypothesis (H_1) is rejected. From the analysis, it is inferred that there is no close relationship between number of working hours and amount of income earned by home-based women workers.

Community and Income Earned by the Respondents

Community plays a predominant role in getting home-based work. For the purpose of the study, the communal status of the respondents has been studied in to four categories namely Schedule Caste/Scheduled Tribe (SC/ST), Most Backward Caste (MBC), Backward Caste (BC) and Forward Caste (FC) the frequency distribution of sample respondents is shown in Table 16.

It could be seen from the Table 16 that 345 (34.5 per cent) respondents belong to Schedule Caste/Scheduled Tribe (SC/ST), 138 (13.8 per cent) respondents belongs to Most Backward Caste (MBC), 478 (47.8 per cent) respondents belongs to Backward Caste (BC) and 39 (3.9 per cent) belongs to Forward Caste (FC). With a view to find the degree of association between community of the respondents and income earned, a two-way table was prepared and is shown in Table 17.

Table 16: Frequency Table of Community of the Respondent

	No. of Respondents	Percent
SC/ST	345	34.5
MBC	138	13.8
BC	478	47.8
FC	39	3.9
Total	1000	1000

Table 17: Community and Annual Family Income Cross Tabulation

Community	Annual Family Income			Total
	Up to Rs 36000	Rs 36001 to Rs 72000	Above Rs 72000	
SC/ST	159 (44.7)	147 (29.3)	39 (27.5)	345 (34.5)
MBC	37 (10.4)	81 (16.1)	20 (14.1)	138 (13.8)
BC	144 (40.4)	256 (51.0)	78 (54.9)	478 (47.8)
FC	16 (4.5)	18 (3.6)	5 (3.5)	39 (3.9)
Total	356 (100.0)	502 (100.0)	142 (100.0)	1000 (100.0)

It is highlighted from Table 17 that the percentage of high amount of income earned was the highest (54.9 per cent) among the backward caste category and the same was the lowest (3.9 per cent) among the forward caste category of the respondents. The percentage of medium amount of income earned was the highest (51 per cent) among the backward caste respondents and the same was lowest (3.6 per cent) among the forward caste respondents. On the other hand, the percentage of low amount of income earned was the highest (44.7 per cent)

among the Schedule Caste/Scheduled Tribe category and the same was lowest (4.5 per cent) among the forward caste respondents.

In order to find the relationship between Community of the respondents and annual income earned, a chi-square test was employed and results of the test shown in Table 18.

Table 18: Number of Days Work Available in a Month and Annual Income Earned (Chi-Square Test)

Factor	Calculated chi-square value	Table value	D.F.	Remarks
Community	28.751	16.81	6	Significant at 1% level

Hypothesis

Null hypothesis (H_0): There is no close relationship between Community of the respondents and the income earned.

Alternative hypothesis (H_1): There is a close relationship between Community of the respondents and the income earned.

It is divulged from Table 18 that the calculated chi-square value is greater the table value and the result is significant at 1 per cent level. Hence, the Null hypothesis (H_0) is rejected and Alternative hypothesis (H_1) is accepted. From the analysis, it is concluded that there is a close relationship between community of the respondents and amount of income earned by home-based women workers.

Problem Faced by the Home-Based Women Workers

The problem faced by the home-based women workers are studied by selecting 8 major issues. They are income is not enough, affect daily household works, specific health problems, no frequent orders, shortage of raw materials, not enough space to work, no proper machinery/tool/ equipment, no proper recognition from household members. Henry Garrett Ranking method was employed to ascertain the magnitude of the problem. The result of the Henry Garrett Ranking is shown in Table 19.

It is found from Table 19 that among the eight problems, the problem 'Income earned by the home-based women workers is not enough' was ranked first with a Garrett score of 70570 points. It is followed by 'Specific health problem' with a Garrett score of 59760 points. The problems such as 'Affect daily household works', 'No frequent job orders', 'Shortage of raw materials' and 'Not enough space in the work environment' were ranked in the

Table 19: Henry Garrett Ranking

	Total Score	Mean Score	Rank
Income is not Enough	70570	70.57	1
Affect daily household works	57771	57.771	3
Specific health problems	59760	59.76	2
No frequent orders	54375	54.375	4
Shortage of raw materials	47334	47.334	5
Not enough space to work	41755	41.755	6
No proper machinery/tool/ equipment	38443	38.443	7
No proper recognition from household members	25992	25.992	8

third, fourth, fifth, sixth positions with the Garrett score of 57771, 54375, 47334, 41755 points respectively. On the other hand, 'No proper machinery/tool/equipment in the workplace' was ranked in the seventh position with the Garrett score of 38443 points. On lastly, the problem 'No proper recognition from the members of the family' was ranked in the eighth position with the Garrett score of 25992 points.

Results and Discussion

1. Age

While analyzing the age of the home-based women workers and their income-earning capacity, young category of the respondents are earning better income than the middle- and old-age category it is due to more dynamism, active participation and high level of job involvement.

2. Education

Education-wise analysis pinpointed that the respondents having school level education are earning better than the high school level and college-level educated respondents.

3. Marital Status

While analyzing the analysis of marital status it is found that the married category of the respondents are earning more from the in-laws than the unmarried and divorced/ widowed category.

4. Number of Days Work Available in a Month

Number of days work available in a month was studied and found that the home-based women workers got job orders only 11 to 20 days. Hence, it is suggested that they may have wide network directly to the factory owners and try to get the work for 26 days and above per month.

5. Working Hours

Working hours were studied and found that the respondents working up to 8 hours per day are earning better salary than the respondents working more than 8 hours per day.

6. Communal Status

Community-wise analysis of home-based women workers and their incoming earning capacity reveals the respondents belong to Backward Caste (BC) are earning better than the other category of respondents.

7. Income Earning Capacity

While analyzing Income earning capacity of the home-based women workers reveals that most of the home-based women workers earning very low income from their existing occupation which does not meet their domestic expense the biggest challenge faced by the home-based women workers is how to increase the present low-level incomes in order to change the economic condition of home-based women workers has independent and stand on their own feet. The empowerment of women is only when they are economically sound to meet the critical issues and solve it through financial support.

8. Recognition in the Family

It was learnt from the analysis that women workers are not given due respect by the family members. They are simply collecting the money and not recognize them properly.

9. Working Environment

The respondents were asked about the working environment they had revealed that the day-to-day work place is not conducing and lack with minimum facility such as light, ventilation, air, etc., most of the home-based women workers are living in congested environment due to poverty. Normally they live in one or two room house which serve has their living room, kitchen and study room for their children there is no privacy in the home and home-based production materials are kept one side and the other living items are on the other side.

10. Wage Rate

The home-based women workers are not paid evenly for the same job. The providers are agents practicing discrimination against home-based women workers will be highly exploited, thereby making them further economically weak it is discouraging to observe that almost 50 per cent of the home-based women workers have expressed that they have been paid less wage for the same amount and value of goods

11. Housing Condition

Most of the home-based women workers are living in the rented houses in a cramped condition the rented accommodation is often one room and mostly two rooms as the cost of the pucca rooms is very high and they cannot afford to have more than one or two even it is extremely crowded and congested to work and live.

12. Legal Protection Security

Fast pace of haphazard urbanization in the country has resulted in to several problems and one of them is the security of life this is the general problems being faced by all. A majority of the home-based women workers have felt that they have not been protected by law in the country there is utmost necessity of protecting the home-based women workers by some-how in the country which is still lacking.

13. Machinery, Tools and Equipment

In the present year of globalization, a stiff competition is prevailing in the business regarding the size and scale and it is proved in the case of home-based women workers as well in order to win in the global competition the home-based women workers needs to update the knowledge and upgrade in terms of technology to survive in the market to reduce the cost to increase the profit. The analysis reveals that most of the home-based women workers not having latest machines or tools or equipment they have realized the technology and they are adopting is obsolete though somehow they are managing it.

14. Poor Networking and Organization

The home-based women workers tendency and to some extent preference for working has made them weak, vulnerable and unorganized to fight against the contractors, raw materials dealers, etc., this shows that they need to be more organized and united to fight against discriminatory wage rates and to make their voice heard properly at different levels starting right from their own home to local government and to the policy-making body of the government as well as to employers and sub-contractors from whom they get works. This shows that the organization and networking part needs to be further strengthened.

15. Poor Public Services and Facilities

Safe drinking water is necessary in order to minimize the water-borne diseases particularly to the poor urban dwellers including home-based women workers. However, the problem lies in situation like there is tap but there is hardly

any supply of water and similarly there electricity connection but there are longer hours of load shedding. Those who can afford to buy water are buying water in jars from the market as well as from private tankers while those who are not in this position are compelled to depend on wells and tube wells, boring waters, etc., though they are not very much suitable for drinking there is no choice in the absence of other better alternatives. The issue of severe lack of drinking water and prolonged hours of load shedding are the major problems directly affecting lives of the urban poor including the home-based women workers.

16. Low Proportion of Literacy

As mentioned above in order to be well-informed and be aware of the new technology and demand in market for different types of products, it requires certain level of education beyond mere literacy. Majority of the home-based women workers are at least literate with few having complete even graduate level of education. And the number of home-based women workers with SLC is relatively not small. Therefore, what is needed is not only to increase the proportion of literates but also their education level.

Conclusion

The centrality of information structure of employment is one of the key themes in the literature on the structure of labour markets (Shapiro and Stiglitz, 1984). The analysis of home-based women workers provides in this regard precious insights, because the investigation of the organization of this form of labour reveals significant dynamics of the dissemination of information in the labour market. In this context, this paper investigated the problems faced by the home-based women workers and the prosperity gained having activity involved in home-based women workers.

First, most of the home-based women workers are suffering from the social limitations on their physical mobility: home-based women workers signifies the group of workers with the limited physical mobility within an informal form of employment. Thus, their attempts to bypass their disadvantages in this sense characterize the organization of the home-based women workers. Second, home-based women workers are complements or substitutes for the factory system.

Characteristics of the information dissemination for the home-based women workers reflect the diverse interests of the home workers and factory managements. Thus, they constantly develop strategies in order to turn their disadvantages into bargaining chips: the cooperation among home workers within informal networks of home-based women workers is the primary means to have a stronger position vis-à-vis the middlepersons and ultimately vis-à-vis the firms using the home-based women workers as a satellite form of industrial labour.

It is suggested that a good networking is essential between home-based women workers and the job provider as well as fellow employees. These networks either finish the assembly of semi-finished products or reprocess the completed products for the sake of product differentiation. The former kind of tasks is usually low-skilled in comparison to the latter.

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If by gaining knowledge we destroy our health we labour for a thing that will be useless in our hands.

—John Locke

Feature

Customer Feedback–based Product Improvement: A Case Study

MUKESH BULSARA AND HEMANT THAKKAR

Product improvement is a continuous process for survival and growth of all industries. But developing newer products frequently is very challenging and difficult task. So, continuous improvement in existing product is important for quality improvement, refreshment of product and customer satisfaction. In fact, product improvement is also necessary for improvement of attitude of employees (internal customers) of the organization. Updating the existing product by making good changes is as good as product development. This is because revised products attract the customer and results like marketing refreshment. The product development leads to newer and improved products which satisfy customers' requirements. Theoretically, product development is a very expensive and time-consuming process; many organizations are not able to develop newer products at regular intervals. Hence, continuous product improvement is desirable for the manufacturing organization.

Customer feedbacks about the performance of the product are very important as they lead to direction of research. Industry collects the feedback while selling the product to the customers; however, they fail to implement the suggestions given by the customers. Many times feedback opinions are not correct because they are not taken from the actual users of the product. This paper discusses the implementation of customer feedback to improve the existing product. The customer feedback data can be utilized for product improvement process.

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Introduction

An industry would be interested in developing new products because of the obvious reason of expansion of business and ultimately generation of more profit. Most of the industries tend to develop a product which is closely related to the industry's existing product. The product that an industry would like to develop may be one which is already available in the market meaning thereby that the competitors are already available. There are some industries which tend to develop existing products with new technology. There are yet other kinds of organizations which study the changing needs of customer and launch a product which has never been launched before. This is the case with every new product launched for the first time. There are certain factors which influx product development, like changing needs of customers, technological enhancement, economic development of country, competition in the market, changes in the government polices, etc.

Literature Survey

V. Kumar, Lerzan Aksoy, et al. (2010) suggest that customers can generate value to the firm through more ways than only their purchase behavior and a more comprehensive assessment is needed. In this article, it is mentioned that the customers provide value to the firm through their own transactions, behavior of referring prospects, encouragement on other customers and individuals to make (or not make) initial or additional purchases, and feedback to the firm on ideas for innovation/ improvements. The four dimensions together constitute a Customer's Engagement Value (CEV). The four dimensions of CEV are Customer Lifetime Value (CLV), Customer Referral Value (CRV), Customer Influencer Value (CIV) and Customer Knowledge Value (CKV): (1) Customer purchasing behavior, whether it is repeat purchases or

additional purchases through up-selling and cross-selling (corresponding to customer lifetime value [CLV]). (2) Customer referral behavior as it relates to the acquisition of new customers through a firm initiated and incentives formal referral programs (extrinsically motivated; corresponding to customer referral value [CRV]). (3) Customer influencer behavior through customers' influence on other acquired customers as well as on prospects (e.g., WOM activity that persuades and converts prospects to customers, minimizes buyer remorse to reduce defections, encourages increased share-of-wallet of existing customers; usually intrinsically motivated; corresponding to customer influencer value [CIV]). (4) Customer knowledge behavior via feedback provided to the firm for ideas for innovations and improvements, and contributing to knowledge development (extrinsically or intrinsically motivated; corresponding to customer knowledge value [CKV]).

Hongchul Lee and Jaemyung Lee (2011) have discussed the concepts of design for manufacturability and concurrent engineering. They have mentioned significant advances in integrating the design function with other areas in companies; major gaps remain in the timely and accurate provision of costing information to designers. Inappropriate designs increase the redesign cost and delay the product realization. They have suggested customer-integrated design of the product, which aims to reduce the design cost of the product.

Nadia Bhuiyan (2011) has mentioned in his study that the degree of design effort on real customer needs is a qualitative in-process metric which ensures as much as possible that the final design meets customer requirements. This requires seeking customer input and feedback throughout the entire development stage and thus the customer becomes an integral part of the design team to overcome technical problems that arise and that necessitate product design changes during the development stage. Customer needs and wants assessment must be a vital and ongoing activity throughout development, both to ensure that the product is designed right and also to speed development toward a correctly defined target.

Barak Libai, Ruth Bolton, et al. (2010) have explored the consequences of customer-to-customer (C2C) interactions as an essential development of customer management in recent years. This interest is driven much by new online environments that enable customers to be connected in numerous new ways and also supply researchers' access to rich C2C data. The aim here is to take a broad view of C2C interactions and their effects and to highlight areas of significant research interest in this domain. The authors look at four main areas: the different dimensions of C2C interactions; social system issues related to individuals and to online communities; C2C context issues including product, channel, relational and market characteristics; and the identification, modeling, and assessment of business outcomes of C2C interactions.

Joan L. Giese and Joseph A. Cote (2000) have explorative researched on customer satisfaction. Customer satisfaction consists of three general components: (1) consumer satisfaction is a response (emotional or cognitive); (2) the response pertains to a particular focus (expectations, product, consumption experience, etc.); and (3) the response occurs at a particular time (after consumption, after choice, based on accumulated experience, etc). Consumer satisfaction has been typically conceptualized as either an emotional or cognitive response. More recent satisfaction definitions concede an emotional response. Response intensity refers to the strength of the satisfaction response, ranging from strong to weak. Terms such as, 'like love,' 'excited,' 'euphoria,' 'thrilled,' 'very satisfied,' 'pleasantly surprised,' 'relieved,' 'helpless,' 'frustrated,' 'cheated,' 'indifferent,' 'relieved,' 'apathy,' and 'neutral' reveal the range of intensity. These details can be used as drive for product improvement.

Overall summary of literature survey indicates that the consumer feedbacks are key elements for product improvement process.

Product Improvement

Product improvement is a continuous and never-ending process. It is an ongoing effort to improve the product features, product services and production methodology or processes. These efforts should be incremental over a period of time. The product performance, product services and production processes are continuously evaluated and improved in the light of their performance, efficiency, effectiveness and flexibility. The quality improvement in the products and production processes are known as Kaizen. Following are the important features of Kaizen:

- Improvements are based on many small changes rather than the radical changes that might arise from Research and Development.
- As the ideas come from the workers and customers, they are less likely to be radically different, and therefore easier to implement.

- Small improvements are less likely to require major capital investment than major process changes.
- The ideas come from the talents of the existing workforce, as opposed to using research, consultants or equipment – any of which could be very expensive.
- All employees should continually be seeking ways to improve their own performance.
- It helps encourage workers to take ownership for their work, and can help reinforce team working, thereby improving worker motivation.

Product Improvement Sources

Product improvement/modification ideas can be derived from several sources:

1. Customers can give ideas from the feedbacks. If they have made any complaint about the performance of the product, it should be taken seriously, and improvement can be thought of as feasible.
2. Workers can suggest their ideas in manufacturing process through Quality Circle. Management should put faith and involve them in the development of the product.
3. Product can be compared with similar product available in the market and the improvement can be made for the betterment of the products.
4. New features or secondary functions can be added in the products as per the development of the technology. Customers are always pleased to use latest technological features in the product.

Continuous Improvement

Old organizations in the past have been concerned with doing more of the same with disregard of the customer feedback and market demand. When performance of the product deteriorates, organizations tend to double their efforts in doing more of the same. This traditional approach towards improvement lacked in will and determination in measurement of effort made by which are all necessary if superior performance is to be achieved in modern business environment. Modern management suggests Kaizen for survival and better performance of the product in the market.

Kaizen is a Japanese concept, which means continuous improvement. This is a continuous process, making small changes in the product for achieving better performance of the products. Improvement in quality can be achieved by the application of some simple steps for the purpose of identifying and correcting causes of troubles in manufacturing process and reasons of customer complaints. These steps include:

1. Determine the rate of defective, rejection, rework, customer complaints, etc.
2. Separate the breakdown data (exceptional cases) on the basis of characteristics by comparing existing process or performance.
3. Identify the causes for the defective, rejections, rework, customer complaints, etc.
4. Critically analyze the alternative solutions to minimize the defective, rejections, rework, customer complaints, etc.
5. Implement the better solution for control of defectives, rejections, rework or customer complaints.
6. Compare the results with earlier results.

Continuous improvements are preferable to large or breakthrough changes in the products. The benefits of the continuous improvement are involvement of everyone, group effort (team work), state of art, less investment, and long-lasting changes.

This process is also known as Deming cycle or P-D-C-A cycle. This is a generalized strategy to solve any problem related to manufacturing process and performance of product. Figure 1 shows P-D-C-A cycle.

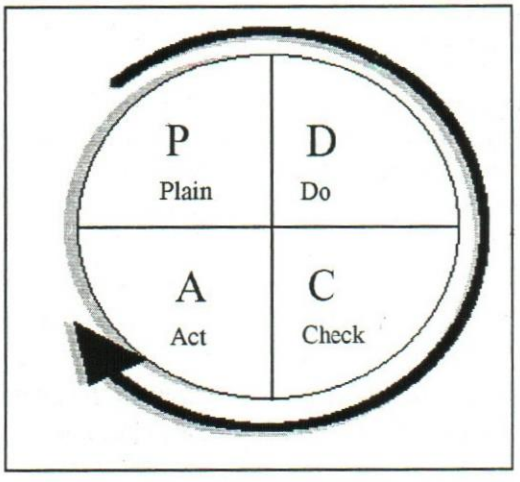

Figure 1: PDCA cycle

Manufacturing process difficulties, under-rating performance of the product and major customer complaints are considered as problems of the product. Solving these problems is a central in quality improvement programme. The problems can be solved by using P-D-C-A cycle. Each phase of the sequence involves one or more steps, which are scientific tools to ensure that analysis and changes are based on sound reasoning. P-D-C-A cycle is a cyclic process for planning and testing improvement activities prior to full-scale implementation. When an improvement idea is identified, it is often advisable to test it on a small scale prior to full-scale implementation to validate its benefit. Additionally, by introducing a change on a small scale, employees have time to accept it and are more likely to support it. Step-wise P-D-C-A cycle is as follows:

1. Plan a change for improvement (or to solve a problem)
2. Make change in the product at small scale (trial base)
3. Check / observe the effects of the change in the product
4. Act if the improvement is observed

Repeat the cycle on continual basis.

Customer Feedback

Customer feedback is a very old concept, in which customers are asked to fill certain information about the product. This information is filled very casually by customers, and the data generated out of the feedback is only used for preparing formal record. Sometimes the customer feedbacks are taken from the dealers of the product, who may not be the end users of the product. Customer feedbacks are generally taken after the sales up to very short period during warranty or guarantee period till free services are given.

There are very few industries that conduct field survey after long period of sales of the product. They have experienced that the direct contact with end users of the product gives correct feedback about the functioning of the product. Also many times initially trained users of the products are changed or transferred, so further training of new operator for correct use and maintenance of the product is required.

The customer feedbacks are collected to measure customer experience and to improve their satisfaction. The customer feedback may be complaint about the performance of the product. Feedback data should be collected and analyzed carefully for any similar repetitive observations. This may lead to any improvement in the design, manufacturing or material aspects of the products.

Many researchers have developed a different strategy to handle customer feedback. The generalized steps to follow in the customer complaints are as follows:

1. Always listen to customers' complaint and understand their view carefully.
2. Empathize on the problem of the product.
3. Offer a reasonable solution to the problem.
4. Execute the solution in the product as per the strategy.
5. Do some follow up about the revised performance of the product.

In general observation, people always avoid facing the problems. Hence, customer service person should have an attitude to face and solve the problem instead of avoiding them. There are checkpoints which can be helpful to service person in solving customer complaints:

1. Priority should be given to each customer. Emergency cases should be given priority. There should be multiple service engineers and workstation for the solution. Waiting time should be kept at minimum level.
2. Complaint contains insight. Many times problem lies in a specific area / component / assembly and it creates problems in different area.
3. Important and technical complaints should be recorded to understand long term observations. Such complaint leads to key factors for product modification opportunity.
4. The complaintner may be honest, chronic, aggressive, or with positive or negative attitude; the judgment should be made about him.
5. Always passive role in solution of complaint discourages the customers. So, active involvement to solve complaint is required.
6. If customer demands, logical causes of occurrence of problem; than they should be explained to complaintner.
7. If problem is not clarified, then supportive questionnaire should be asked for proper understanding of the complaint.

8. The customer complaint should be attended in very short time. Unnecessary delay should be avoided.

9. Unnecessary formalities should be avoided and individual problem should be attended.

10. Small problems should be solved and occurrence of such problems should be controlled by making permanent changes in the design, drawing, manufacturing of the product. Prevention is always better than cure.

11. Customers are more interested in solution of the problem instead of reasons of difficulties in solution of the problem.

12. Product complaints and performance problems should not be taken as personal eligation of customers.

Product Improvement through Customer Feedback

The feedbacks of customers can be of three types; viz, positive: in terms of appreciation, neutral as neither appreciation nor criticism, and negative: in terms of complaints due to trouble in operation or functioning of the product. Out of these negative feedbacks are most useful for the industries. Since negative feedbacks are indicative of potential area that can be the scope for the further development of the product. If this process is carried out systematically, many improvements are possible in the product, which can be incorporated in the future.

Case Study

A case study is presented for a domestic flour mill. The flour mills are manufactured by a small-scale industry and market targeted was local district domestic customers. The primary function of domestic flour mill is to grind wheat and other food grains for domestic use. The size of the flour mill is small (5 kg/hr) considering the domestic customers. The product is technically designed, manufactured and marketed by the same industry. The after-sales service is very important for such kind of domestic appliances. The company provided after-sales services to all customers and cumulatively collected customer feedbacks. The generalized complaints made by customers are mentioned as follows:

1. The domestic flour mill is very noisy.

2. There are many vibrations coming during grinding of grains.

3. The grinded flour quality is not consistent.

4. Small jerks are observed during operation of flourmill. But they were variable in different domestic flour mills.

5. Grain grinding is not a smooth and silent operation.

The major complaint raised by customers was about the noisy operation of flour mill. All major customers were satisfied with the primary function of flour mill; i.e., grinding of grain, but major complaint was noisy operation. The industry made several experiments for reduction of noise, but they could not reduce noise level by significant amount.

Analysis of Customer Feedback

The industry owner thought for solving this complaint by consulting an external expert/engineer. The customer feedbacks were referred for the product improvement and causes of noise were analyzed as follows:

1. Noise due to grinding action of grains.

Noise cannot be totally eliminated, since it is the basic function of the flourmill.

Still there is a scope of further noise reduction, but it requires major change in design of flour-mill, and which is not desirable. The manufacturing industry does not wanted to make major changes in the design of domestic flour mill.

2. Noise due to looseness of body parts, components, etc.

All body parts were checked for enough number of screws and fasteners, and was found sufficient. It is observed that the noise is not due to transmission components of the flour mill. The body parts were also sufficient strong in dimension, so, it was observed that noise is not due to weak cross section of the components.

3. Noise due to defective bearing and its assembly.

It was observed that the grinding operation is noisy even if the flour mill is newly manufactured. Hence, a defective bearing as cause of noise was ruled out. It was also observed that the noise was coming in all flour mills, hence the problem is not in any specific flour mill, but more or less noise is coming in all products. The problem may be due to any weak design of component or faulty assembling operation. The industry desired the solution of noise from any manufacturing process–related problem.

4. Noise due to vibrations in rotating parts of domestic flour mill.

This is the key parameter for generation of noise, but it requires in-depth analysis of many aspects. The causes

of vibrations may be unbalanced pulverizing rotor, which is used for grinding operation, misalignment of shaft, or bent shaft. The route cause of vibration may be any one or combination of these three reasons.

For locating root cause each probable causes were observed and checked. The rotor is checked for balancing, but it was found that the rotors were balanced to correct grade of balancing. The pulverizing rotor and grinding chamber are mounted on extended motor shaft, so scope of misalignment between rotor and motor does not exist. The design, manufacturing and assembly of motor does not permit any change in misalignment of two end caps of the motor. Here it was observed that the vibrations were found in axial direction apart from radial direction.

The third probable cause is bent shaft. Five shafts were randomly selected for checking the bentness. To locate the root cause of bent in shafts, they should be checked before assembly and after assembly. The schematic diagram of set-up for checking bent in shaft is shown in Figure 2.

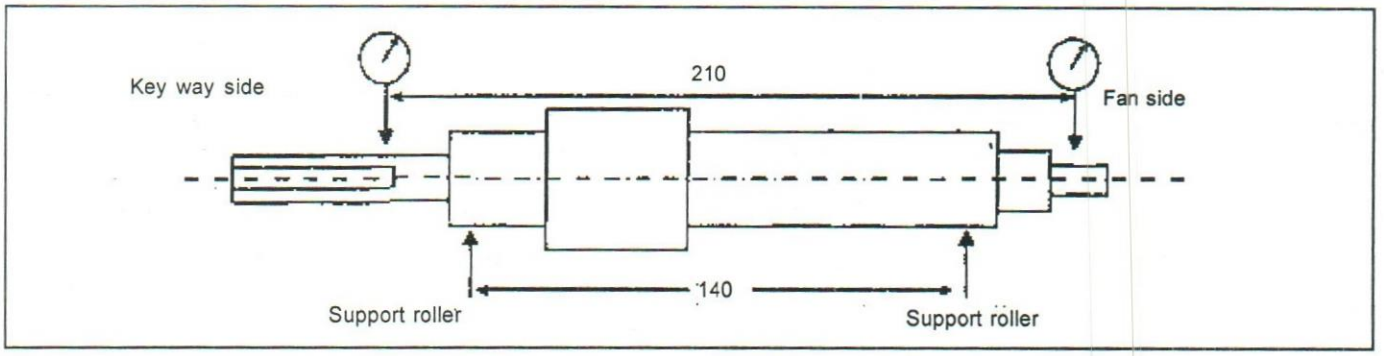

Figure 2: Set-up diagram for checking run-out of shafts

The shafts are supported on rollers for checking the run out at both ends. The reading observed for these shafts are indicated in Table 1. The readings are plotted and shown in Figures 3a and 3b.

Table 1: Shafts with before assembly of rotor were checked for Run out

Shaft No.	Key way side			Fan side		
	Before grinding	After grinding	After motor assembly	Before grinding	After grinding	After motor assembly
1	0.04	0.04	0.13	0.05	0.12	0.04
2	0.05	0.08	0.32	0.06	0.23	0.13
3	0.06	0.06	0.12	0.06	0.17	0.05
4	0.02	0.03	0.18	0.04	0.03	0.04
5	0.04	0.02	0.20	0.03	0.02	0.07

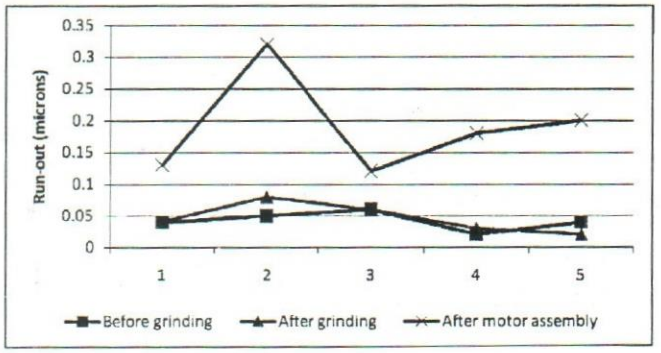

Figure 3a Run-out Keyway side

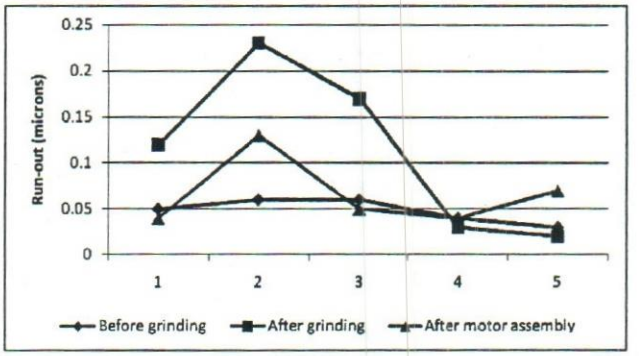

Figure 3b Run-out Fan side

The shafts run-out are checked after the assembly of covers. The readings observed for this condition are mentioned in Table 2. The readings are plotted and shown in Figures 4a and 4b.

Table 2: Shafts with assembly of rotor were checked for Run out

Shaft No.	Key way side				Fan side			
	Without rotor	After rotor fitting	After grinding	After motor Assembly	Without rotor	After rotor fitting	After grinding	After motor Assembly
1	0.03	0.04	0.03	0.09	0.03	0.04	0.15	0.07
2	0.05	0.06	0.08	0.23	0.05	0.04	0.13	0.09
3	0.03	0.05	0.06	0.15	0.02	0.05	0.17	0.10
4	0.06	0.06	0.07	0.23	0.05	0.03	0.12	0.08
5	0.02	0.02	0.03	0.14	0.02	0.02	0.08	0.04

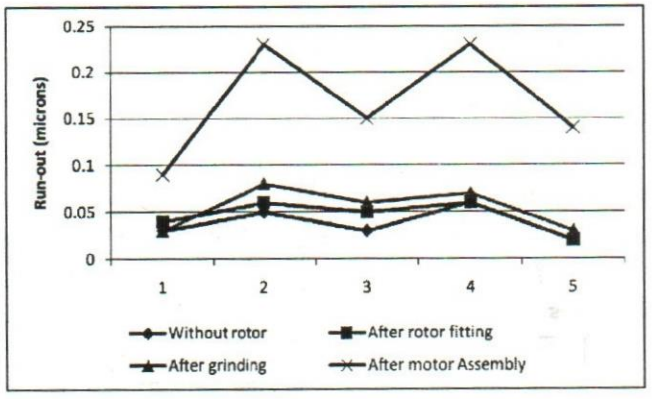

Figure 4a Run-out Keyway side

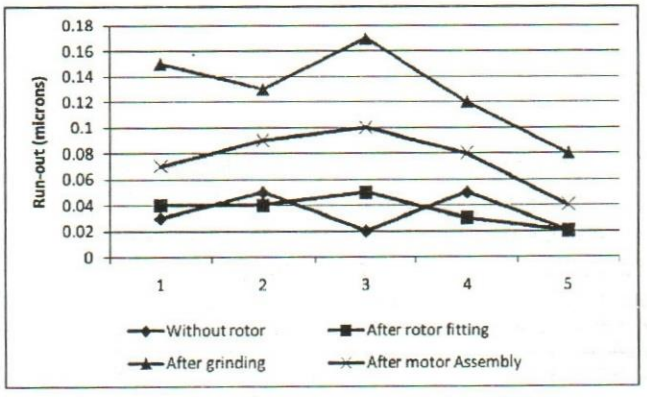

Figure 4b Run-out Fan side

It was observed that the major reason for vibration in domestic flour mill is bent shafts. The shafts are bent during machining process as well as assembly process. The complete PDCA analysis is shown in Figure 5.

1. Plan

- Performance measure (grinding of grains) observed and found perfect.
- Major customer complaints observed and that was noise during grinding.
- It was planned to reduce noise level.

2. Do

- Various causes of noise analyzed (like looseness of compone nts, bearing noise, vibrations etc.).
- Shafts were found bent.

3. Check

- Shaft bent-ness found after grinding process.
- Shaft assembly found with high run-out.
- Spigot cover length (6 mm) found insufficient for maintaining concentricity.

4. Act

- Shafts were bent during grinding process due to higher depth of cut. So, it was recommended to reduce the depth of cut.
- Higher grinding allowances were provided in the shafts. Grindin g allowance reduced to 0.25 mm only.

Figure 5: P-D-C-A analysis

Suggestions for Product/Process Improvement

1. The shafts were bent during grinding process due to higher depth of cut. Hence, it was recommended that the grinding allowance should be reduced to 0.25 mm from 1 mm. The grinding depth of cut should be reduced to 0.01 to 0.02 mm to prevent deflection during grinding process.
2. The rotors are also found to bent and non-concentric due to haphazard turning and grinding process. It was recommended that since the rotor possess hollow cross section, the turning operation should be carried out in multiple steps with smaller depth of cut. The grinding allowance should be reduced to 0.25 mm from 1 mm and also the depth of cut should be reduced from 0.01 to 0.02 mm to prevent deflection and bending.
3. Cover spigot length was 6 mm, which will be further reduced due to chamfer operation. This must be around 10 mm to maintain the axis alignment during assembly operation.
4. The stacks are being welded in present assembly, which leads to distortion and deflection. This should to be avoided by changing the fixing with two fastners from outside.
5. The strength of shaft needs to increase to avoid bending during manufacturing process. The minimum diameter of the shaft is 19 mm, which may be sufficient for grinding of grains operation, but the diameter should be increased by at least 6 mm for rigidity purpose. This will solve the major troubles of bending and deflection of shafts. Alternatively use of higher grade steel is also option available for change in design. However, both the alternative involves cost implications.

Results of Product Improvement

Since the root cause of noisy operation is identified, manufacturer adopted all suggestions as mentioned above except the last due to cost implication. The shafts are analyzed after the implementation of the suggestions. The observation results are mentioned as indicated in Table 3. The readings are plotted and shown in Figures 6a and 6b.

Table 3: Run out observations after grinding process as per suggestions

Shaft No.	Key way side				Fan side			
	Without rotor	After rotor fitting	After grinding	After motor Assembly	Without rotor	After rotor fitting	After grinding	After motor Assembly
1	0.03	0.04	0.03	0.03	0.03	0.04	0.06	0.07
2	0.05	0.06	0.08	0.04	0.05	0.04	0.07	0.06
3	0.03	0.05	0.06	0.015	0.02	0.05	0.06	0.05
4	0.06	0.06	0.07	0.03	0.05	0.03	0.07	0.06
5	0.02	0.02	0.03	0.02	0.02	0.02	0.05	0.04

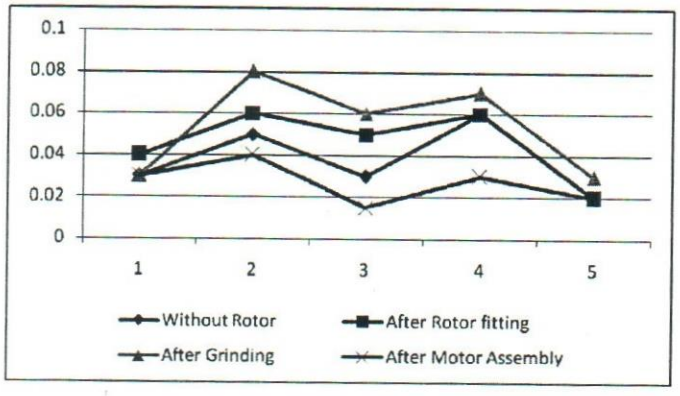

Figure 6a Run-out Keyway side

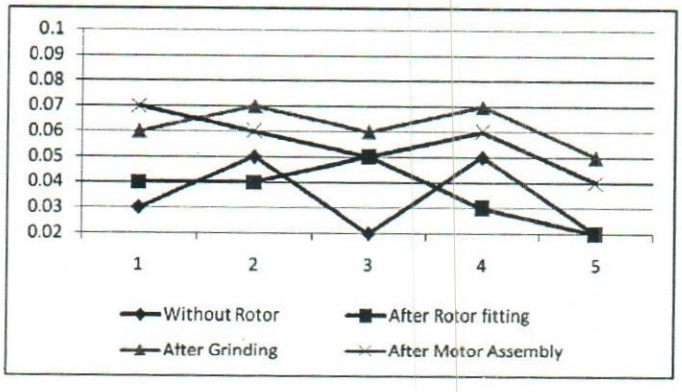

Figure 6b Run-out Fan side

Results and Discussion

1. It was observed that maximum numbers of shafts are bent and deflected during grinding operation due to higher depth of cut. Results after implementation shows that the run out is reduced after reducing the depth of cut. The grinding operation should not be with excessive depth of cut. Since this is a finishing operation, the maximum depth of cut should be 0.01 to 0.02 mm. The maximum grinding allowance on shafts should be up to 0.2 mm, so the grinding process can be made faster.
2. The rotor is also found non concentric and spigots length is found insufficient for concentricity of the assembly. In this case, little care is required for assembly to maintain concentricity.
3. The further design changes like increase in diameter of shaft, increasing spigot lengths are recommended but not implemented at this stage.

Conclusion

1. Finally, with straight shaft assembly of flour mill, it was observed that the noise is reduced drastically. The successful product improvement is carried out with the support of customer feedback.
2. It was observed that negative feedbacks or customer complaints are indicative of potential area for the further development/improvement of the products. So, it should be taken positively.

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Without continual growth and progress, such words as improvement, achievements, and success have no meaning.

—Benjamin Franklin

Database

Benchmarking the Indian Healthcare System in the Global Economy

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Introduction

Institute for Management Development (IMD), a top-ranked global business school based in Lausanne, Switzerland, ranks 60 major economies for 2014 in its latest edition of the World Competitiveness Yearbook (WCY) 2014. IMD World Competitiveness Center also looks at how each country is perceived as a place to do business. The World Competitiveness Yearbook (WCY) ranks and analyzes the ability of nations to create and maintain an environment in which enterprises can compete. WCY assumes that wealth creation takes place primarily at enterprise level (whether private or state owned) - this field of research is called: "competitiveness of enterprises".

However, enterprises operate in a national environment which enhances or hinders their ability to compete domestically or internationally - this field of research is called: "competitiveness of nations". Based on analysis made by leading scholars and IMD's own research and experience, WCY methodology divides the national environment into four main factors:

- Economic Performance
- Government Efficiency
- Business Efficiency
- Infrastructure

The WCY approach to benchmarking health relies on hard measures, such as *expenditure on health, life expectancy, healthy life expectancy and infant mortality* and qualitative indicators drawn from the WCY's Executive Opinion Survey, such as *health infrastructure and health problems*.

Most countries have to deal with rising costs and aging populations. Medical breakthroughs are effective, but expensive. Rising wealth is one of the key elements propelling growth in demand for healthcare – especially in driving expectations. Per capita spending on healthcare strongly correlates with GDP per capita.

The latest edition of the WCY indicates that the United States is paying nearly double the world average and 50% more than most wealthy countries for healthcare. As the populations of wealthy countries grow older, more spending is allocated to the elderly and on chronic diseases, involving more sophisticated and expensive technologies and medication. Countries like USA and European countries are making as high as 85%-86% public expenditure on health. India ranks the lowest i.e. 60th position with only 31% being spent on healthcare compared to China (46th position) with 55.89% public expenditure being spent on healthcare.

Since 1950, the overall life expectancy of the world's population has increased by 15 years thanks largely to improved healthcare and living standards due to rising GDP. Currently, the worldwide average life expectancy is 66 years. Of the 60 countries listed in IMD's 2014 WCY, Japan has the highest life expectancy, with an average lifespan of 83.6 years. The US meanwhile, despite its enormous expenditure on health, is right in the middle with a life expectancy of 78.8 years (30th in the rankings). India is 59th in the rankings out of 60 countries with a life expectancy of 65.8 years.

In terms of infant mortality, the India ranks worst at the 60th position. The US example shows a healthcare system that costs more does not necessarily deliver better care, at least not when the entire population is taken into account. India's health and environment performance retreated downwards by two places positioning itself at the bottom 60th spot (2012:58nd).

The conclusion is that tangible healthcare results can vary significantly even when two systems cost the same amount of money.

Switzerland scores 8.88 out of 10 in perceptions of how well its health infrastructure meets the needs of the population, while the US only scores 6.00. India with a 3.97 score is healthier than China with 3.84 score. India spends 3.9% of GDP compared to 5.2% of GDP by China.

The survey showed that most of the high-spending countries rated their health infrastructure from 6 to 9 (out of 10) for a range of spending that averaged from 9% to 12% of GDP except USA with about 18% of GDP.

The general assessment of health infrastructures in the emerging BRICS economies ranged from 1.7 to 4 out of 10. One of the best performers is Malaysia, which spends only 3.6% of GDP, but has a high health infrastructure rating of 7.9/10, whereas South Africa, which spends 8.5% of its GDP, suffers a high level of dissatisfaction at 2.86/10.

There is a wide variation in GDPs, so it is interesting to look at per capita expenditures. Switzerland comes in first with $9,046 expenditure per person compared to $8,889 in the US. At the other end of the spectrum, China spends $280 and India spends the least amount of $62 per person. If we look at how long one can expect to live in full health without being incapacitated by injuries or chronic medical problems, we see that in BRICS, healthy life expectancy has improved. This is mainly due to more people being taken out of poverty, improvements in nutrition and diet, greater access to education, especially female education, and more and advanced health technologies.

However, inequalities are still prevalent, mostly because of differences in living standards, measured by GDP per capita, that arise due to political instability, conflicts, poor governance, hunger, malnutrition and diseases that disproportionately affect the poor. These inequalities can be seen in the access to and quality of health services, the financial burden imposed on individuals and their families, and the responsiveness of the health system to the expectations and needs of users. The burden of out-of-pocket expenses impacts the poorest. This is a major challenge for developing countries.

Data presented here include measures of total health expenditure, total health expenditure per capita, health infrastructure, health problems, life expectancy at birth, healthy life expectancy, infant mortality and medical assistance.

Table 1: Health Expenditure

Percentage of GDP

Sr. No.	Countries	Rank		
		2011	2010	2009
1.	USA	17.9	17.9	16.2
2.	France	11.6	11.9	11.7
3.	Denmark	11.2	11.4	11.2
4.	Germany	11.1	11.6	11.3
5.	Switzerland	10.9	11.5	11.3
6.	United Kingdom	9.3	9.6	9.3
7.	Japan	9.3	9.5	8.3
8.	Brazil	8.9	9.0	9.0
9.	South Africa	8.5	8.9	8.5
10.	Korea	7.2	6.9	6.5
11.	Russia	6.2	5.1	5.4
12.	China Mainland	5.2	5.1	4.6
13.	Thailand	4.1	3.9	4.3
14.	**India**	**3.9**	**4.1**	**4.2**
15.	Malaysia	3.6	4.4	4.8

Table 2: Health Expenditure Per Capita

US$ per capita

S. No.	Name of Country	2011	2010	2009
1.	USA	8,889	8,379	7,346
2.	France	5,104	4,847	4,916
3.	Denmark	6,692	6,449	6,323
4.	Germany	4,995	4,694	4,557
5.	Switzerland	9,046	8,051	7,145
6.	United Kingdom	3,628	3,502	3,268
7.	Japan	4,284	4,077	3,278
8.	Brazil	1,142	1,011	765
9.	South Africa	620	647	488
10.	Korea	1,742	1,417	1,102
11.	Russia	826	547	465
12.	China Mainland	280	226	172
13.	Thailand	212	189	170
14.	**India**	**62**	**59**	**45**
15.	Malaysia	356	380	332

Table 3: Public Expenditure on Health

Percentage of total health expenditure

S. No.	Country	2011	2010	2009
1.	USA	45.94	53.10	48.60
2.	France	76.74	77.80	76.60
3.	Denmark	85.16	85.10	80.10
4.	Germany	75.85	77.10	75.70
5.	Switzerland	65.42	59.00	59.60
6.	United Kingdom	82.70	83.90	83.60
7.	Japan	80.01	82.50	80.00
8.	Brazil	45.74	47.00	45.70
9.	South Africa	47.70	44.10	40.10
10.	Korea	57.33	59.00	54.10
11.	Russia	59.72	62.10	64.40
12.	China Mainland	55.89	53.60	50.10
13.	Thailand	75.46	75.00	75.80
14.	**India**	**31.00**	**29.20**	**32.80**
15.	Malaysia	45.68	55.50	44.80

Table 4: Health Infrastructure

US$ per capita

S. No.	Name of Country	2014	2013	2012
1.	USA	6.00	6.39	6.36
2.	France	8.49	8.40	8.25
3.	Denmark	8.43	8.57	8.21
4.	Germany	8.25	8.15	7.98
5.	Switzerland	8.88	8.72	8.86
6.	United Kingdom	6.61	6.78	6.70
7.	Japan	7.74	7.67	7.08
8.	Brazil	1.72	2.38	2.29
9.	South Africa	2.86	2.23	2.42
10.	Korea	7.03	7.24	7.29
11.	Russia	3.52	2.69	2.15
12.	China Mainland	3.84	3.66	3.42
13.	Thailand	6.21	6.30	6.45
14.	**India**	**3.97**	**3.74**	**3.91**
15.	Malaysia	7.97	7.54	8.00

Table 5: Life Expectancy at Birth

Average estimate

S. No.	Country	2012	2011
1.	USA	78.8	78.5
2.	France	81.7	81.5
3.	Denmark	79.0	78.8
4.	Germany	80.6	80.4
5.	Switzerland	82.5	82.3
6.	United Kingdom	80.3	80.2
7.	Japan	83.6	83.4
8.	Brazil	73.8	73.5
9.	South Africa	53.4	52.8
10.	Korea	80.7	80.6
11.	Russia	69.1	68.8
12.	China Mainland	73.7	73.5
13.	Thailand	74.3	74.1
14.	**India**	**65.8**	**65.4**
15.	Malaysia	74.5	74.2

Table 6: Healthy Life Expectancy

Average estimate

S. No.	Country	2012	2011	2010
1.	USA	70.9	70.8	70.2
2.	France	72.9	72.8	73.9
3.	Denmark	72.6	72.5	71.8
4.	Germany	73.8	73.7	73.2
5.	Switzerland	75.3	75.2	74.9
6.	United Kingdom	72.3	72.1	72.3
7.	Japan	76.5	76.3	75.7
8.	Brazil	66.3	66.0	65.0
9.	South Africa	50.5	50.0	48.1
10.	Korea	72.4	72.3	71.6
11.	Russia	62.6	62.3	60.7
12.	China Mainland	67.8	67.6	67.0
13.	Thailand	62.6	62.5	62.5
14.	**India**	**58.5**	**58.2**	**57.0**
15.	Malaysia	64.8	64.6	64.0

Table 7: Medical Assistance

Number of inhabitants

S. No.	Country	2013		2012		2011	
		Per Physician	Per Nurse	Per Physician	Per Nurse	Per Physician	Per Nurse
1.	USA	404	88	413	90	410	90
2.	France	292	100	292	106	298	109
3.	Denmark	276	60	283	61	281	64
4.	Germany	250	83	264	86	265	86
5.	Switzerland	255	56	260	63	254	63
6.	United Kingdom	359	118	358	102	366	102
7.	Japan	436	89	441	89	454	90
8.	Brazil	541	143	545	248	548	250
9.	South Africa	1345	206	1252	212	1233	212
10.	Korea	467	200	481	208	484	214
11.	Russia	198	119	228	118	229	118
12.	China Mainland	488	489	537	560	537	601
13.	Thailand	3435	501	3429	511	3493	530
14.	**India**	**1245**	**635**	**1421**	**643**	**1429**	**709**
15.	Malaysia	752	278	1026	352	1039	357

'Source: **IMD World Competitiveness Yearbook, Various issues**
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