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A MATHEMATICAL APPROACH OF EXPLORATION TOWARDS EXTREME RISK FACTOR IN CANCER OF OPTIMAL CONDITION

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ABSTRACT: The aim of this present investigation is to identify the most important risk factor for cancer by means of a mathematical model. The study begins with considering some types of cancer *viz.* breast, colorectum as well as lung and bronchus cancer as most of the cancer patients suffer from these types of cancers. Teaching-Learning-Based Optimization technique is applied to sorting out the most lethal cancer among all cancer consider in this study and it is found that lung and bronchus cancer is the most fatal. Further, we investigate the risk factor associated to lung and bronchus cancer by means of Literature, Expert and Local Hospital survey. All the risk factor has their own importance for death from cancer in medical aspects. Multi-Criteria Decision Making technique is applied to recognize the most significant risk factor among all the factors in statistical scenario. It is identified that smoking is the most concerning risk factor. The information related from the study may help to take necessary measure to control the death rate due to lung and bronchus cancer.

INTRODUCTION: Human body contains millions of cells; it grows divides and dies in the conventional manner. Sometimes the system goes wrong and uncontrolled no of cells grows, which leads to cancer. The cancer cells combine and form extra mass tissue known as tumor [1]. Cancer is a common disease which spreads throughout the blood stream in the human body. Leukemia alters the blood cell and involve in its maturity and immaturity [2]. Some of the tumors do not spread throughout the body, but grow uncontrollably like benign tumor [3].

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Normal / healthy cell controls their growth and when they become unhealthy, destroys by themselves. In Asia high prevalence of chronic viruses like hepatitis B [4] and C, the Epstein Barr virus and human papilloma viruses (HPV) [4] increases the high risk of cancer.

Mutations in p53 gene [5] leads to cancer as well as nutrition [6] Plays a vital role in mortality of cancer [7]. Exposure to aldehydes and formaldehyde associated with high risk of lymphoma cancer [8]. Hypoxia [9] is a solid tumor growth in cancer which is common and disturbs molecular pathways [10]. It is not possible to find out the specific cause of cancer. Cancer cells are modulated by culture condition and extracellular microenvironment condition [11]. But there are many risks which increase the cancer, such as intake of tobacco, alcohol, poor diet, obesity, exposure to UV radiation, lack of physical activity [1].

According to the literature survey, there are so many lethal cancers namely breast, colorectum, lung and bronchus [12]. Of the 7 million deaths from cancer worldwide in 2001, an estimated 2.43 million (35%) were attributable to nine potentially modifiable risk factors. Of these, 0.76 million deaths were in high-income countries and 1.67 million in low-and-middle-income nations.

Among lower and middle income regions, Europe and Central Asia had the highest proportion (39%) of deaths from cancer attributable to the risk factors studied. 1.6 million of the deaths attributable to these risk factors were in men and 0.83 million in women. Smoking, alcohol use, and low fruit and vegetable intake were the leading risk factors for death from cancer worldwide and in low and middle income countries. In high income countries, smoking, alcohol use, and overweight and obesity were the most important causes of cancer. Sexual transmission of human papilloma virus is a leading risk factor for cervical cancer in women in low and middle income countries. More than 12 million new cases of cancer occur annually worldwide. Of those 5.4 million occur in developing countries and 6.7 million in developing countries [13, 14].

Aline *et al*., developed the Proactive Molecular Risk Classifier for Endometrial Cancer (ProMisE), a molecular classification system based on The Cancer Genome Atlas genomic subgroups, and sought to confirm both feasibility and prognostic ability in a new, large cohort of ECs [15]. Evaluate the relationship between health beliefs (perceived susceptibility to breast cancer, perceived benefits of AI treatment, and perceived barriers to AI treatment) and adherence to AIs by Moriah *et al*., [16]. Filip *et al*., evaluated factors associated with stage-specific cancer therapy and survival, focusing on temporal trends and sociodemographic disparities [17]. To identify the variability of short- and long-term survival outcomes among closed Phase III randomized controlled trials with small sample sizes comparing SBRT (stereotactic body radiation therapy) and surgical resection in operable clinical Stage I non-small cell lung cancer (NSCLC) patients by Pamela [18].

In the present study, we heave aimed to recognize the most fatal cancer (whose death rate is maximum) and to find the most important factor (MIF) responsible for causing cancer. To carry out study, we have obtained the regression function of death rate of each cancer that have been considerable in our study of the data given in [19]. Next, we have optimized the death rate due to different cancers by Teaching Learning Based Optimization (TLBO). In the second part of the study we have found out the factors. Most lethal cancer among the cancers considered in our study y literature review, expert survey and survey from a local hospital. The Analytic Hierarchy Process (AHP) has been applied to identify the most important factor responsible for that cancer.

Background: Cancer is the name given to a collection of related diseases. In all types of cancer, some of the body's cells begin to divide without stopping and spread into surrounding tissues. Cancer can start almost anywhere in the human body, which is made up of trillions of cells. Normally, human cells grow and divide to form new cells as the body needs them. When cells grow old or become damaged, they die, and new cells take their place [20]. **Fig. 1** showing a cancer cell. **Fig. 2** showing the new cancer cases annually per 100,000 people (age-adjusted) in the world.

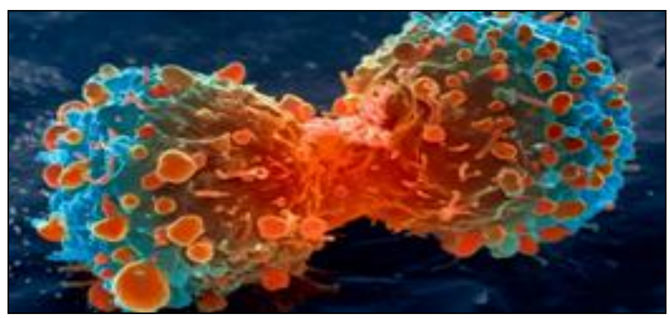

FIG. 1: A DIVIDING CANCER CELL (NATIONAL INSTITUTES OF HEALTH)

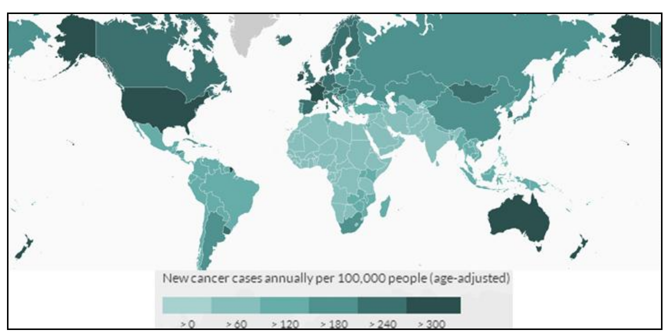

FIG. 2: RECENT CANCER SCENARIO IN THE WORLD

Breast Cancer: Breast cancer starts when cells in the breast begin to grow out of control. These cells usually form a tumor that can often be seen on an x-ray or felt as a lump. The tumor is malignant (cancer) if the cells can grow into (invade) surrounding tissues or spread (metastasize) to distant areas of the body. Breast cancer occurs almost entirely in women, but men can get breast cancer, too [21]. Breast cancer is the most common malignancy affecting women worldwide [22]. Breast cancer is a very important health issue in developed and developing nations of the world [23]. In several developed countries, breast cancer incidence increases faster with age before age 50 than after [24]. There are various type of risk factors for breast cancer, with some having greater importance than others. A review of the literature on such risk factors was thus undertaken, with these been grouped into four broad categories, namely: sociodemographic factors, reproductive factors, lifestyle factors and hormonal status. **Table 1** shows all important risk factors of lung cancer. Equation 1 represents colorectal cancer risk factor (b_{rf}).

$$b_{rf} = sf + rdf + lf + hs........(1)$$

Where $sf = b_1$

$$rdf = b_2 + b_3$$

$$lf = b_4 + b_5 + b_6$$

$$hs = b_7 + b_8 + b_9 + b_{10}$$

TABLE 1: RISK FACTORS OF LUNG CANCER

Type	Name of factor	Notation	Intrinsic factor	Extrinsic or environmental factor
Sociodemographic factors (*sf*)	Age	b_1	√	×
Reproductive factors (*rdf*)	Age at menarche	b_2	√	×
	Age at first pregnancy	b_3	√	×
Lifestyle factors (*lf*)	Diet	b_4	×	√
	Body weight (postmenopausal)	b_5	×	√
	Alcohol	b_6	×	√
Hormonal status (*hs*)	Oral contraceptives	b_7	×	√
	Hormone replacement therapy	b_8	×	√
	Radiation	b_9	×	√
	Family history	b_{10}	√	×

Colorectum Cancer: Colorectal cancer develops in the colon or the rectum, also known as the large intestine. The colon and rectum are parts of the digestive system, also called the gastrointestinal (GI) system.

TABLE 2: RISK FACTORS OF COLORECTAL CANCER

Type	Name of factor	Notation	Intrinsic factor	Extrinsic or environmental factor
Sociodemographic factors (*sf*)	Older age	cl_1	√	×
	Male sex	cl_2	√	×
Medical factors (*mf*)	Family history	cl_3	√	×
	Inflammatory bowel disease	cl_4	√	×
	Diabetes	cl_5	√	×
	Helicobacter pylori infection	cl_6	√	×
	Other infections	cl_7	√	×
	Large bowel endoscopy	cl_8	√	×
	Hormone replacement therapy	cl_9	√	×
	Aspirin	cl_{10}	√	×
	Statins	cl_{11}	√	×
Lifestyle factors (*lf*)	Smoking	cl_{12}	√	√
	Excessive alcohol consumption	cl_{13}	√	√
	Obesity	cl_{14}	×	√
	Physical activity	cl_{15}	×	√
	High consumption of red and processed meat	cl_{16}	×	√
Diet factors (*df*)				
	Fruit and vegetables	cl_{17}	×	√
	Cereal fibre and whole grain	cl_{18}	×	√
	Fish	cl_{19}	×	√
	Dairy products	cl_{20}	×	√

The digestive system processes food for energy and rids the body of solid waste [25]. Colorectal cancer is the third and second most common cancer, respectively, in men and women worldwide [26] and is a major cause of morbidity and mortality [27]. There are various risk factors for colorectal cancer, with some having greater importance than others. A review of the literature on such risk factors was thus undertaken, with these being grouped into four broad categories, namely: sociodemographic factors, medical factors, lifestyle factors and diet factors. **Table 2** shows all important risk factors of lung cancer. Equation 2 represents colorectal cancer risk factor (cl_{rf}).

$$cl_{rf} = \frac{sf}{mf + lf + df} \quad \text{..........(2)}$$

Where, $sf = \dfrac{cl_1}{cl_2}$

$$mf = \frac{cl_3 + cl_4 + cl_5 + cl_6 + cl_7}{cl_8 + cl_9 + cl_{10} + cl_{11}}$$

$$lf = \frac{cl_{12} + cl_{13} + cl_{14}}{cl_{15}}$$

$$df = \frac{cl_{15}}{cl_{16} + cl_{17} + cl_{18} + cl_{19}}$$

Lung and Bronchus: Lung cancer cells have defects in the regulatory circuits that govern normal cell proliferation and homeostasis. The transformation from a normal to malignant lung cancer phenotype is thought to arise in a multistep fashion, through a series of genetic and epigenetic alterations, ultimately evolving into invasive cancer by clonal expansion [28, 29]. Lung cancer has been the most common cancer in the world [30]. The incidence of cancer of the lung has increased precipitously since the early years of this century, and this disease is responsible for the deaths of many thousands of patients throughout the world [31]. There are multiple risk factors for lung cancer, with some having greater importance than others. A review of the literature on such risk factors was thus undertaken, with these being grouped into two broad categories, namely: factors inherent to the individual (intrinsic factors) and factors extraneous to the individual (extrinsic or environmental factors). **Table 3** shows all important risk factors of lung cancer. Equation 3 represents Lung cancer Risk Factor (l_{rf}).

$$l_{rf} = \frac{\{\sum_{i=1}^{7} l_i\}^2 + \{\sum_{i=8}^{23} l_i\}^2}{\sum_{i=8}^{23} l_i \sum_{i=1}^{7} l_i} \quad \text{..........(3)}$$

TABLE 3: RISK FACTORS OF LUNG CANCER

Name of factor	Notation	Intrinsic factor	Extrinsic or environmental factor
Heredity and genetic susceptibility	l_1	√	×
Genomic instability	l_2	√	×
Age	l_3	√	×
Gender	l_4	√	×
Race	l_5	√	×
Sex	l_6	√	×
Previous respiratory diseases	l_7	√	×
Tobacco and smoking	l_8	×	√
Composition of tobacco smoke	l_9	×	√
Nicotine	l_{10}	×	√
Cannabis sativa	l_{11}	×	√
Socioeconomic status	l_{12}	×	√
Micronutrients	l_{13}	×	√
Diet	l_{14}	×	√
Pre-existing lung disease	l_{15}	×	√
Macronutrients	l_{16}	×	√
Pneumonia and mycobacterial disease	l_{17}	×	√
Human papilloma virus	l_{18}	×	√
Human immunodeficiency virus	l_{19}	×	√
Second-hand tobacco smoke	l_{20}	×	√
Radon	l_{21}	×	√
Other environmental pollutants	l_{22}	×	√
Other occupational exposures	l_{23}	×	√

Methods: In this study apply one optimization techniques (OT) *viz.* TLBO and one MCDM method *viz*. AHP. OT is apply for identifying the fatal cancer whose death rate is maximized and to find the MIF responsible for causing cancer apply MCDM.

Teaching Learning Based Optimization (TLBO): TLBO is one of the population based algorithm suggested by Rao *et al.*, [32, 33] where a group of students is considered the population and different subjects offered to the learners are analogous with the various design variables of the optimization problem. The main goal of this optimization is 'in a classroom every individual attempts to learn something from teacher to improve themselves'. This algorithm is based on two period *viz.* teaching phase and learner phase.

Phase I: During the Teacher Phase, the teaching role is assigned to the best individual ($X_{teacher}$). The algorithm attempts to improve other individuals (X_i) by moving their positions towards the position of the $X_{teacher}$ by taking into account the current mean value of the individuals (X_{mean}). This is constructed using the mean-values for each parameter within the problem space (dimension), and represents the qualities of all students from the current generation. Eq. (4) simulates how student improvement may be influenced by the difference between the teacher's knowledge and the qualities of all students. For stochastic purposes, two randomly-generated parameters are applied within the equation: r ranges between 0 and 1; and TF is a teaching factor, which can be either 1 or 2, thus emphasizing the importance of student quality.

$$X_{new} = X_i + r.\ (X_{teacher} - (TF\ .\ X_{mean}))\text{.............}(4)$$

Phase II: During the Learner Phase, student (X_i) tries to improve his / her knowledge by peer learning from an arbitrary student Xii, where i is unequal to ii. In the case that X_{ii} is better than X_i, X_i is moved towards X_{ii} (Eq. (5)). Otherwise, it is moved away from X_{ii} (Eq. (6)). If student X_{new} performs better by following Eq. (5) or (6), he / she will be accepted into the population. The algorithm will continue its iterations until reaching the maximum number of generations.

$$X_{new} = X_i + r.\ (X_{ii} - X_i)\text{...................}(5)$$
$$X_{new} = X_i + r.\ (X_i - X_{ii})\text{...................}(6)$$

The Analytical Hierarchy Process (AHP): The Analytical Hierarchy Process (AHP) is a decision-aiding method developed by Saaty [34, 35, 36, 37]. It aims at quantifying relative priorities for a given set of alternatives on a ratio scale, based on the judgment of the decision-maker, and stresses the importance of the intuitive judgments of a decision-maker as well as the consistency of the comparison of alternatives in the decision-making process [34].

Saaty [34, 35, 36, 37] developed the following phase for applying the AHP:

Phase I: Define the problem and determine its goal.

Phase II: Structure the hierarchy from the top (the objectives from a decision - maker's viewpoint) through the intermediate levels (criteria on which sub-sequent levels depend) to the lowest level which usually contains the list of alternatives.

Phase III: Construct a set of pair-wise comparison matrices (size n × n) for each of the lower levels with one matrix for each element in the level immediately above by using the relative scale measurement shown in **Table 4**. The pair-wise comparisons are done in terms of which element dominates the other.

Phase IV: There are n(n-1)/2 judgments required to develop the set of matrices in step 3. Reciprocals are automatically assigned in each pair - wise comparison.

Phase V: Hierarchical synthesis is now used to weight the eigenvectors by the weights of the criteria and the sum is taken over all weighted eigenvector entries corresponding to those in the next lower level of the hierarchy.

Phase VI: Having made all the pair-wise comparisons, the consistency is determined by using the eigenvalue, λ_{max} to calculate the consistency index, CI as follows: CI = (λ_{max} – n) / (1 - n), where n is the matrix size. Judgment consistency can be checked by taking the consistency ratio (CR) of CI with the appropriate value in **Table 5**.

The CR is acceptable, if it does not exceed 0.10. If it is more, the judgment matrix is inconsistent. To obtain a consistent matrix, judgments should be reviewed and improved.

Phase VI: Phase III - VI are performed for all levels in the hierarchy.

TABLE 4: PAIR-WISE COMPARISON SCALE FOR AHP PREFERENCES [34, 35, 36, 37]

Verbal judgments of preferences	Numerical rating
Equally preferred	1
Equally to moderately	2
Moderately preferred	3
Moderately to strongly	4
Strongly preferred	5
Strongly to very strongly	6
Very strongly preferred	7
Very strongly to extremely	8
Extremely preferred	9

TABLE 5: AVERAGE RANDOM CONSISTENCY (RI) [24, 25, 26, 27]

Size of matrix	1	2	3	4	5	6	7	8	9	10
Random consistency	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Methodology:

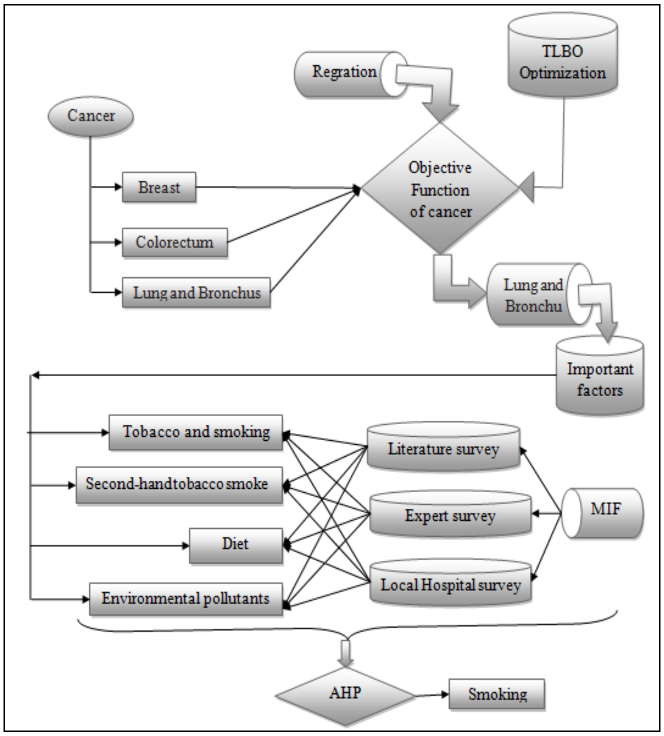

FIG. 3: FIGURE DEPICTS THE BASIC METHODOLOGY OF IDENTIFYING THE MIRF OF CANCER

In the present study apply OT and MCDM method for selection of most important risk factor (MIRF) for fatal cancer. Here OT is applied for selection of fatal cancer and MCDM is applied for selection for the most impotent risk factor of fatal cancer which is selected by OT. **Fig. 3** depicts the basic methodology of identifying the MIRF of fatal cancer.

Application of OT: The statistical technique multiple regression analysis (MRA) is used for developing the mathematical models by using the death rate data listed in **Table 6**. Here five objective functions are constructed with the help of **Table 6**. Using MINITAB 17 statistical software we obtain the objective function of each cancer. Each type of cancer is selected as input and average values are taken as output for this software and then obtain Regression. Here each Regression is considered as an objective function. All this data are collected from Cancer Statistics, 2016 [19]. Here this data is selected because each year, the American Cancer Society estimates the numbers of new cancer cases and deaths that occurs in the United States in the current year and compiles the most recent data on cancer incidence, mortality, and survival.

TABLE 6: DEATH RATES FOR SELECTED CANCERS INDIFFERENT STATES OF USA ET 2008 TO 2012

State	Beast	Colorectum	Lung and Bronchus	Average
Alabama	22.6	14.1	40.1	25.6
Alaska	21	13.7	44.8	26.5
Arizona	19.7	11.3	31.9	21
Arkansas	22.3	15.3	44.2	27.3
Califomia	21.2	12.2	30.5	21.3
Colorado	19.7	11.8	29.7	20.4
Connecticut	20.3	11	35.8	22.4
Delaware	22.1	12.2	45.2	26.5
District of Columbia	29	16.6	33.9	26.5
Florida	21	12.1	37.3	23.5
Georgia	22.9	13.1	37.2	24.4
Hawaii	15.1	10.7	25	16.9
Iaho	20.7	11.8	33.6	22
Illinois	23	14	40.7	25.9
Indiana	22.7	14	44.7	27.1
Lowa	20.7	14.3	37.5	24.2
Kansas	21.3	12.8	39.1	24.4
Kentucky	22.6	15.2	55.2	31
Louisiana	25	15.1	42.8	27.6
Maine	19.4	12.8	44.1	25.4
Maryland	23.7	12.8	38.6	25
Massachusetts	20.3	12.2	40.3	24.3
Michigan	23.1	13.2	42.8	26.4
Minnesota	20	11.8	35.6	22.5
Mississippi	24.5	16.5	41.4	27.5
Missouri	23.4	13.9	45.2	27.5
Montana	20.3	12.5	37.2	23.3
Nebraska	19.8	14.6	35.5	23.3
Nevada*§	23.3	13.8	44.1	27.1
New Hampshare	20.4	13	42.1	25.2
New Jersey	23.9	13.8	35.3	24.3
New Mexico	20.4	12.2	27.2	19.9
New York	21.5	13	35.1	23.2
North Carolina	22.2	12.3	39.1	24.5
Nort Dakota	19.8	13.1	31.8	21.6
Whio	23.8	14.1	43.8	27.2
Oklahoma	23.2	14.4	45.3	27.6
Oregon	20.9	12.8	41.2	25
Pennsylvania	23.2	14.1	38.7	25.3
Rhode Island	19.8	13.1	41.6	24.8
South carolina	23.2	13.4	38.9	25.2
South Dakota	20.7	13.2	35	23
Tennessee	22.6	14.8	45.1	27.5
Texas	21	12.5	33.7	22.4
Utah	20.8	10.2	15.6	15.5
Vermont	18.7	13.3	43.8	25.3
Virginia	22.8	12.9	38.2	24.6
Washington	20.3	12.2	39.7	24.1
Weast Virginia	22.5	15	49.3	28.9
Wisconsin	21	12.3	38.1	23.8
Wyming	19.5	12.2	33.7	21.8

Equation 6a, 6b and 6c represents cancer function with respect to breast, Colorectum, Lung and Bronchus respectively. Upper bound and lower bound are selected maximum and minimum value of each cancer data.

$$\text{Max } Z_{Breast} = 51.8 - 6.76\,X_1 + 0.372\,X_1^2 - 0.006151\,X_1^3 \quad ..(6a)$$

Subject to $X_1 \geq 15.1$

$X_1 \leq 29$

$$\text{Max } Z_{Colorectum} = -42.4 + 8.9X_2 - 0.39X_2^2 + 0.0.0050\,X_2^3 \quad ..(6b)$$

Subject to $X_2 \geq 10.2$

$X_2 \leq 16.6$

$$\text{Max } Z_{Lung\ and\ Bronchus} = 9.66 + 0.029\,X_3 + 0.00745\,X_3^2 - 0.000074\,X_3^3 \quad ..(6c)$$

Subject to $X_3 \geq 15.6$

$X_3 \leq 55.2$

The validity of the regression model is further tested by plotting a probability distribution shown in **Fig. 4**, **5** and **6**. The probability values of the response parameters are scattered near to 95% line, which indicates perfect fitting of the developed regression model.

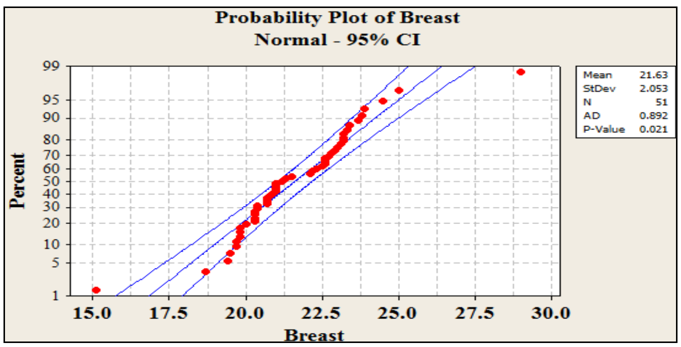

FIG. 4: PROBABILITY OF BREAST CANCER

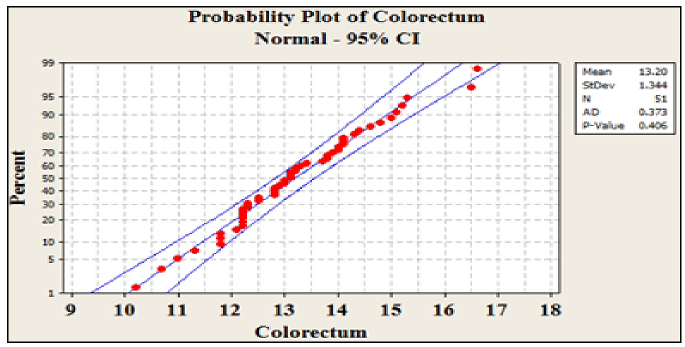

FIG. 5: PROBABILITY OF COLORECTUM CANCER

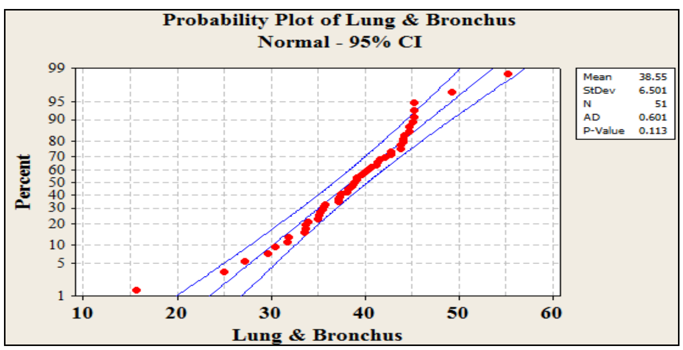

FIG. 6: PROBABILITY OF LUNG AND BRONCHUS CANCER

One of the aims of the present investigation is to find the fatal cancer. We select that cancer whose death rate is maximized. So in this study, we maximize the objective functions 6a, 6b and 6c also all this function 6a, 6b and 6c represents the death rate of each considering cancers.

Application of MCDM: In the present study, we have aimed 42 recognize the most important risk factor of fatal cancer (Whose death rate is maximum). The selection of that factors used AHP techniques. The steps below provide the methodology adopted to look for the weights of importance for each and every factor of the fatal cancer by the MCDM method.

Selection of Criteria: In the present study the relative score of percentage of is required for weights of importance of the criteria The following steps are required for finding the relative score alternatives:

a) **a. Literature Survey (C_1):** A survey has been carried out within the literature of related fields from where it is found that the effect of each parameters which can Induce effects of the fatal cancer. The score of literature survey is given by equation 7.

Let, f = No. of literature which prefer the alternative.

F = Total number literature studied.

$S(A_1)$ = Score of literature survey = (f/F)%.......... (7)

Where $S(C_1)$ denotes the percentage of C_1

b. Expert Survey (C_2): A survey has been carried out within experts in related fields are participants were asked to suggest about the fatal cancer parameters that important for analysis of fatal cancer. According to responses received from the experts a percentage was given to the factors according to Equation 8. Here Expert survey denoted by C_2.

Let, r = No. of expert survey, which prefer the criteria; R= Total number expert survey.

$S(C_2)$= Score of expert survey= (r/R)%………… (8)

Where $S(C_2)$ denotes the percentage of C_2

c. Local Hospital Survey(C_3): A survey from local patient from cancer hospital has been carried out. Participants were asked to suggest about the fatal cancer parameters which can induce effect on the fatal cancer. According to the response from the local patient a percentage was given to the factors according to Equation 9. Here Local survey denoted by C_3.

Let, g = No. of local survey, which prefer the criteria.

G = Total number local survey.

$S(C_3)$ = Score from local survey = (g/G) %……… (9)

Where $S(C_2)$ denotes the percentage of C_2.

Selection of Alternatives: Some environmental factors will be found from a survey. We collect those factors as alternatives which are commonly found from three surveys and this survey. All these alternatives are denoted by Ai.

RESULTS AND DISCUSSION: The results for this present investigation can be sub-divided into two parts, *viz*., results of the OT to estimate the fatal cancer and lastly use selection of most important environmental risk of that fatal cancer use MCDM. All the three results are described in detail in the following three different Sections 5.1 and 5.2.

Result from OT: Table 7 shows the optimal value of the objective function and **Fig. 7a**, **7b** and **7c** represents the convergence graph of the objective function. Using TLBO it is found that the death rate of Lung and Bronchus cancer is maximum with respect to other two considering cancers. So it is clear that Lung and Bronchus cancer is the fatal cancer. In this study, we take population size 30 and number of iteration taken 100.

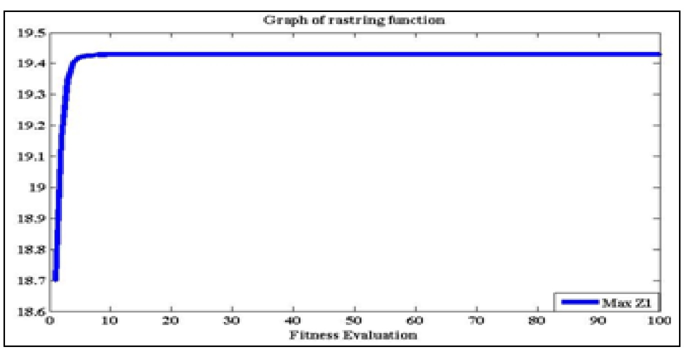

FIG. 7A: CANCER IMPACTED BY BREAST IN OPTIMAL CONDITION

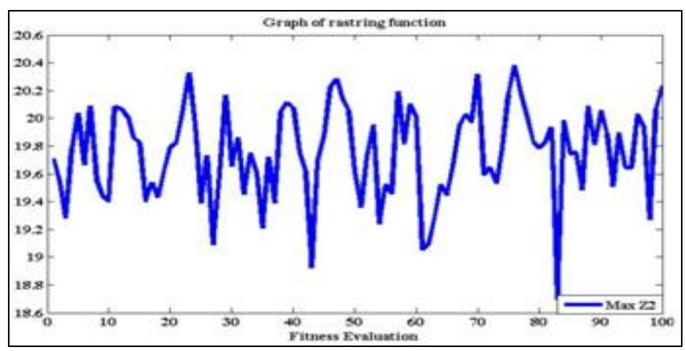

FIG. 7B: CANCER IMPACTED BY COLORECTUM IN OPTIMAL CONDITION

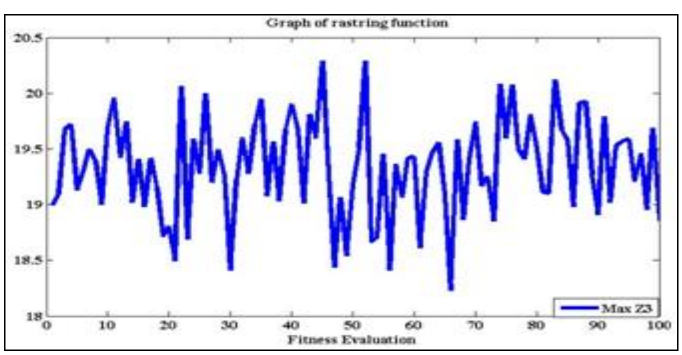

FIG. 7C: CANCER IMPACTED BY LUNG AND BRONCHUS IN OPTIMAL CONDITION

TABLE 7: TABLE SHOWING THE OPTIMAL VALUE OF CANCER

Name of cancer	Design variable (Normalized Form)	Optimal result (Normalized Form)	Number of iteration and populations ize
Breast	0.269536	0.314971	100 and 30
Colorectum	0.168776	0.33625	100 and 30
Lung and Bronchus	0.561689	0.348779	100 and 30

Here all of the objective function solved by MATLAB code of TLBO. Aronchick [38], Gasperino [39], Ruano-Ravina *et al.*, [40] they also say that Lung and Bronchus is now the leading cause of cancer death in men and women.

Result from MCDM: The percentage of the parameters with respect to each of the criteria is presented in **Table 8**. **Table 9** shows the pair-wise comparison of each factor with respect to each criteria. **Table 10** shows the final aggregations of AHP. According to OT result, it was found that lung and bronchus cancer is fatal. There are so many environmental factors are responsible for that cancer. According to literature, expert and local hospital survey, it was found that tobacco and smoking, second-hand tobacco smoke, diet and environmental pollutants are more responsible for lung and bronchus cancer. Here, all these factors are considered as an alternative. Here tobacco and smoking, Second-hand tobacco smoke, diet and environmental pollutants are denoted by A_1, A_2, A_3 and A_4 respectively.

TABLE 8: PERCENTAGE OF PAPERS, EXPERT AND LOCAL HOSPITAL SURVEY

	C_1	C_2	C_3
A_1	61.11%	75.45%	79.45%
A_2	44.44%	56.32%	51.25%
A_3	16.67%	33.33%	29.44%
A_4	16.67%	25.56%	18.57%

According to the result of AHP it was found that Tobacco and smoking are the most important risk factor for lung and bronchus cancer because the weights of A_1 is greater than other risk factors. Vincent *et al.*, [41], Spiro [42], Hecht [43] also suggested that smoking is very risky for Lung and Bronchus cancer.

TABLE 9: PAIR-WISE COMPARISON OF ALTERNATIVES WITH RESPECT TO CRITERIA

Criteria		Comparison of Alternatives				CR (%)	Principal Eigen value	Iterations	Delta	Priority (%)	
Literature Survey		A_1	A_2	A_3	A_4	3.0	4.081	4	2.0E-8	A_1	48.1
	A_1	1	2.00	4.00	4.00					A_2	29.5
	A_2	0.50	1	3.00	3.00					A_3	13.1
	A_3	0.25	0.33	1	2.00					A_4	9.2
	A_4	0.25	0.33	0.50	1						
Expert Survey		A_1	A_2	A_3	A_4	3.8	4.103	4	5.5E-8	A_1	51.4
	A_1	1	2.00	4.00	6.00					A_2	26.6
	A_2	0.50	1	3.00	2.00					A_3	12.9
	A_3	0.25	0.33	1	2.00					A_4	9.1
	A_4	0.17	0.50	0.50	1						
Local Hospital Survey		A_1	A_2	A_3	A_4	0.7	4.018	3	1.3E-8	A_1	54.9
	A_1	1	2.00	5.00	7.00					A_2	24.9
	A_2	0.50	1	2.00	3.00					A_3	12.7
	A_3	0.20	0.50	1	2.00					A_4	7.5
	A_4	0.14	0.33	0.50	1						

TABLE 10: TABLE SHOWING EIGEN VECTOR WEIGHT FOR EACH OF THE CRITERIA AND ALTERNATIVES CONSIDERED

Criteria	Weights of Criteria	Alternatives	Overall Eigen vector Priority of risk factor	Rank
C_1	63.5%	A_1	49.6%	1
C_2	28.7%	A_2	28.3%	2
C_3	7.8%	A_3	13.0%	3
		A_4	9.0%	4

CONCLUSION: In this study, we first find the regression of death rate of cancer by making use of different kinds of cancers data. Investigation performed on three types of cancer *viz*. breast, colorectum as well as lung and bronchus cancer. The conclusions drawn from the above analysis are as follows:

a. Lung and bronchus cancer is significant over other type of cancer.

b. Smoking is the most risk factor for lung and bronchus cancer.

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