III. Capacity Planning

Capacity planning is the efficient use of resources by projecting the healthcare needs. The process of capacity planning involves collecting a significant amount of data on how healthcare currently operates. It is one of the ways in which we prepare ourselves, to use that capacity data to make changes to the healthcare infrastructure to keep up with the demand.

Forecasting is a very important step in capacity planning. It is the response to the forecast that ensures the integrity of the healthcare processes. The steps used in Capacity planning are [20]:

1. Collect the Data and Identify the trend
2. Make projection against those trends
3. Develop a plan to mitigate the risk and ensure the integrity of the healthcare processes

Use of System Dynamics in Capacity Planning: System dynamics models as a forecasting tool can add value in four ways [21]:

1. System dynamics models can provide more reliable forecasts of short- to mid-term trends than statistical models, and thus lead to better decisions
2. System dynamics models provide a means of detecting changes in industry structure, as part of an early-warning-system or on-going learning system
3. System dynamics models provide a means of determining key sensitivities, and therefore of developing more carefully thought out and robust sensitivities and scenarios.
4. System dynamics models allow the determination of appropriate buffers and contingencies that balance risks against costs.

IV. Objective of the Research

1. To find out the number of doctors required by the year 2025 to deal with diabetes in India
2. To find out the number of beds required by the year 2025 to deal with diabetes in India
3. To estimate the number of deaths due to diabetes by the year 2025

V. Methodology

The System Dynamics model was used to estimate the number of beds and doctors required to deal with diabetes in India in year 2025.

We developed the SD diabetes model using well-established techniques for model formulation and testing. The literature published on diabetes and healthcare were reviewed to estimate the parameters used in the model. We were able to draw parameter estimates directly from the available information in literature. The software used for SD Modeling was Vensim.

The SD diabetes model specifies how normal population converted into a population inflicted with diabetes. The figure below depicts a simple model for estimation of Doctors and Beds required for effectively tackling the challenges posed by diabetes in India.

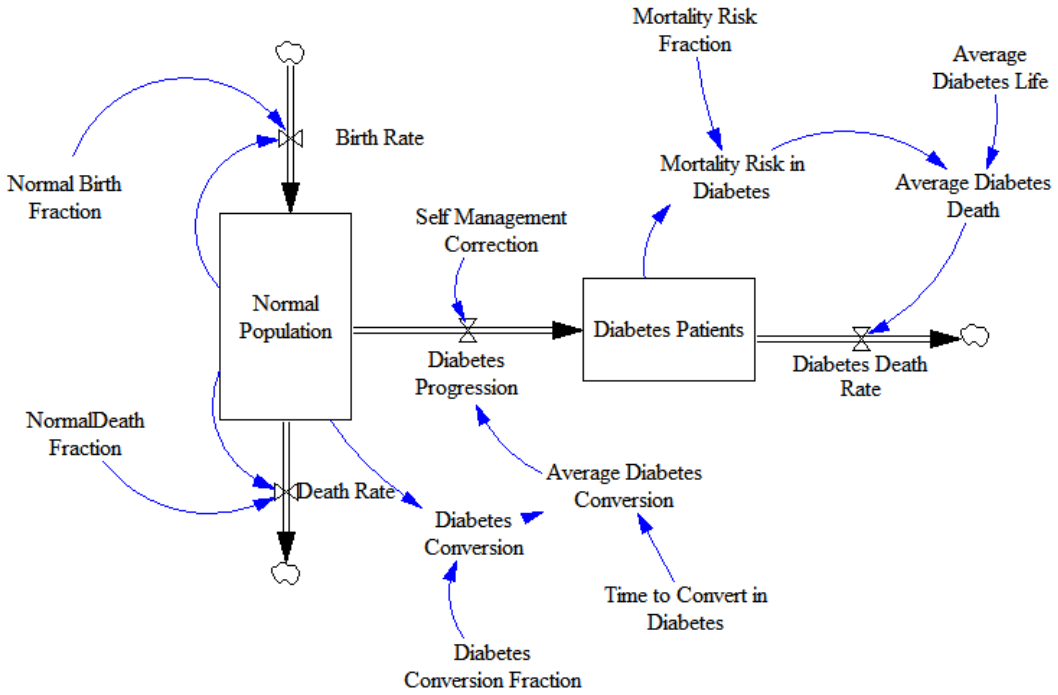

Figure 3: SD Model for Diabetes for Estimation of Infrastructure Demand

Following is a summary of the elements of Figure 2 used in Diabetes SD Model:

1. Normal Population: 1.236 Billion (Estimation in July 2014) [24]
2. Normal Birth Fraction:1.25% [23]
3. Normal Death Fraction: 8 per thousand [22]
4. Diabetes Conversion Fraction: 0.028[28]
5. Mortality Risk Fraction: 0.029 [26]
6. Patient Doctor Ratio: 250[18]
7. Patient Bed Ratio:1000 (assumed)
8. Diabetes Patients: 62 Million [25]
9. Time to convert into diabetes: 5(assumed)
10. Average Diabetes Life: 10 (assumed)

Calculation of Diabetes Conversion Factor:

Taking Rural IGT: 7.9, Urban IGT: 8.7 and assuming 2:3 as urban to rural weight the average IGT was found 8.22 [28]. Considering 35% IGT suffer from Diabetes, the conversion factor becomes 2.8%.

VI. Diabetes System Dynamics Model

(01)Average Diabetes Conversion=SMOOTH (Diabetes Conversion, Time to Convert in Diabetes) Units: thousands
(02)Average Diabetes Death=SMOOTH (Mortality Risk in Diabetes, Average Diabetes Life) Units: thousands
(03)Average Diabetes Life=10 Units: Years
(04)Birth Rate=Normal Population*Normal Birth Fraction Units: thousands
(05)Death Rate=Normal Death Fraction*Normal Population Units: thousands
(06)Diabetes Conversion=Normal Population *Diabetes Conversion Fraction Units: thousands
(07)Diabetes Conversion Fraction=0.028

(8) Diabetes Death Rate=Average Diabetes Death Units: thousands
(9) Diabetes Patients= INTEG (Diabetes Progression-Diabetes Death Rate, 62000)
Units: thousands
(10) Diabetes Progression=DELAY3 (Average Diabetes Conversion*Self Management Correction, 5) Units: thousands
(11) FINAL TIME = 100 Units: Years
The final time for the simulation.
(12) INITIAL TIME = 0 Units: Years
The initial time for the simulation.
(13) Mortality Risk Fraction=0.024
(14) Mortality Risk in Diabetes=Diabetes Patients*Mortality Risk Fraction Units: thousands
(15) Normal Birth Fraction=0.0125
(16) Normal Population= INTEG (Birth Rate-Death Rate-Diabetes Progression, 1.236 Billions) Units=thousands
(17) Normal Death Fraction=0.008
(18) SAVEPER =TIME STEP Units: Years
The frequency with which output is stored.
(19) Self Management Correction=0.2
(20) TIME STEP = 1
Units: Years
The time step for the simulation.
(21) Time to Convert in Diabetes=5
Units: Years

VII. Results & Discussions

The simulation of the System Dynamics Model provides the results which can help us in planning the infrastructural needs to address the healthcare demand due to diabetes. The table only lists first ten years result out of hundred time periods.

Table 2: Results of the Simulation Run

Time (Years)	Diabetes Patients (thousands)	Diabetic Deaths (thousands)
0	62000	1798
1	129418	1798
2	196836	1993.51
3	264059	2364.99
4	330910	2894.26
5	397231	3564.47
6	462880	4359.99
7	527722	5266.34
8	591640	6270.1
9	654528	7358.85
10	716290	8521.1

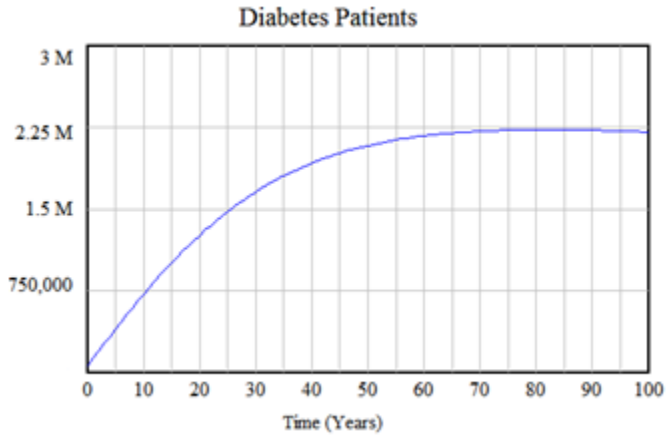

Figure 4: Graph for the Estimation of the Number of Diabetic Patients

The number of diabetic patients first increases and then becomes saturated around hundred years.

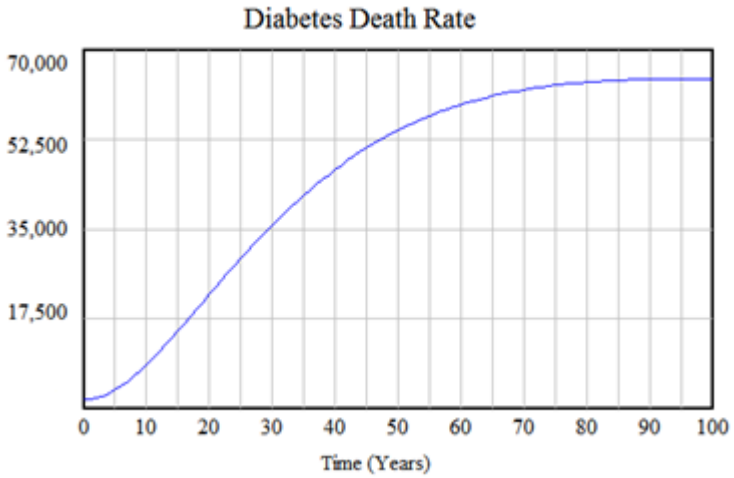

Figure 5: Graph for Estimation of Number of Deaths

The number of deaths due to diabetes like the number of diabetic patients, first increases then saturates. This is because we have used Self Management Correction factor (0.2) in the SD model used. In absence of this correction factor, the number would have increased more readily and then decreased like the typical epidemic curve [27].

Table 3: Estimation of Results in Year 2025

Diabetes Population(2025)	**Bed Required**	**Doctors (250:1 Ratio)**
716 Millions	0.72 Millions	2.86 Millions

According to the study, the diabetic population is expected to become 716 Million by considering IGT figure of 7.9 % for rural and IGT figure of 8.7 % for Urban Population. According to the Word Bank Indicator data, India has an availability o f 0.7 beds and one doctor per 9.2 thousand patients. Indian population is expected to become 1393 Million by 2025[8]. If India remains at the same level in infrastructure availability, the country will have 0.975 Million Beds and 0.015 millions doctors for all the diseases, while the requirement of beds and doctors is 0.72 Million and 2.86 Million respectively. The number of deaths due to diabetes is projected to reach 8.5 Million, which is a huge number in itself.

Indian government needs to open up more medical colleges, and encourage the private sector to enter the medical education sector, so that more and more number of healthcare professionals including doctor can be produced. The role of self help group is very important in promoting self management in diabetes and Non Government Organizations (NGO) can play an important role here. The government should allocate a higher percentage of GDP (present spend is around 5%) on building the healthcare infrastructure. The present out of the pocket spending on medical care is 75%, which needs to be brought down, by creating awareness about medical insurance. Considering the mortality in diabetes and the related complications, the medicines and hospitalization facilities in diabetes should be made affordable to a larger population.

VIII. Limitations of the Study

The data used for building the system dynamics model is taken from secondary sources and their claim is not consistent. Inclusion of more variables in the model will help us in understanding the diabetes management better.

IX. Future Directions of the Study

The future study may include the variables causing diabetes, and its progression in place of diabetes- conversion ratio. The future study should use data from primary sources. The study can also include the economic burden of diabetes in system dynamics model

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