Pharmaceutical Stock Level Intimation to Analyze Seasonal diseases by implementing Fuzzy Matrix algorithm using IoT

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***Abstract*—** This research work helps the pharmacist by sending notifications and ensure the availability of medicine for seasonal diseases. There are some diseases which are predominant during a certain season. Sometimes people suffer from these diseases due to normal stock level maintenance by the pharmacist. To avoid this problem the pharmacist must ensure the availability of medicines for these seasonal diseases. This paper describe the three stages which are used to get the efficient stock level intimation. They are: (i) Obtain dataset for various seasonal diseases in significant years (ii) Implementation of Fuzzy matrix algorithm which gives decision for the seasonal diseases (iii) Generate a novel approach using IoT in the pharmaceutical field for stock level intimation.

***Keywords*—**IoT, Fuzzy Matrix Algorithm,CETD Matrix, Stock level, Seasonal diseases, Pharmaceutical

I. INTRODUCTION

In this modern world, lot of diseases are impending day by day and the equipments used for giving treatment is also increased. People from Thanjavur region face more difficulties for these seasonal diseases every year due to the not availability of sick drugs. So people find it difficult to recover from the season illness. This research paper is used to find out which diseases are in peak in a particular season.

The Climate of India includes a wide scope of climate conditions over an immense geographic scale and differed geography. Tamil Nadu is one of India's biggest states. It is located in the southern part of the mainland of India . Based on the Koppen system, India hosts six major climatic subtypes, ranging from arid desert in the west, alpine tundra and glaciers in the north, and humid tropical regions supporting rainforests in the southwest and the island territories. Many regions have starkly different microclimates. The country's meteorological department follows the international standard of four climatological seasons with some local adjustments: winter (December, January and February), summer (March, April and May), a monsoon rainy season (June to September), and a post-monsoon period (October and November). So, for this work these four seasons are taken into account. [1]

Worldwide climate change is associated with human diseases. Technology can help to find out the diseases and the drugs for those diseases which come due to climate change. The existing method used by the

pharmacist can able to give only the current stock position of medicine without considering the seasonal diseases. They are facing difficult to find out the current seasonal diseases and stock level of medicine related to seasonal diseases. In this scenario the automatic intimation to the Pharmacist about seasonal diseases by implementing IoT will solve the problem. The IoT devices use the data base which is created using fuzzy matrix methods. This research paper gives an idea, how to combine the real time problems to the IoT for human beings.

II. RELATED WORK

Dhara VR and Schramm PJ et.al indentified climate change has the potential to influence the earth's biological systems. Developing nations with limited resources are expected to face a host of health effects due to climate change, including vector-borne and water-borne diseases such as malaria, cholera, and dengue. This article reviews common and prevalent infectious diseases in India, their links to climate change, and how health care providers might discuss preventive health care strategies with their patients. [2]

Hamid Reza Rezaei found the key issue of inventory management is the problem of safety stock control. The existence of imprecise data makes this control complex. Fuzzy logic (FL) is widely used to develop expert system, due to its ability in representing imprecise data. Therefore, in this study a fuzzy logic system and theory have been used that incorporate the linguistic variable more practically and also help in eliminating the imprecision and vagueness of the system. In addition to it, weighted association rule has been applied to extract related target items as inputs to Fuzzy Inference System (FIS) according to their significance in the dataset rather than their frequency alone. Three inputs to FIS are: 1- proposed index, i.e., WFSN(Weighted-Fast Slow-Non moving) which take both the item movement in inventory and value into account, computed based on support in association rule.2-WC(Weighted cost), extracted from association rule 3- Leadtime and output is Safety stock ,based on interview with experts. In this paper they propose integration of weighted association rule and FIS to develop an intelligent model of inventory control system. Then a calculation example is presented in MATLAB7.8.0 (R.2009.a) to test the feasibility of the model [3].

In 1998, W.B.Vasantha and V.Indira developed CETD Matrix to study the passenger's transport problem in perticular time interval. To study this problem, four types of new matrices were divided and defined: Initial Raw Matrix, Average Time Dependent Data Matrix (ATD), Refined Time Dependent Data Matrix (RTD Matrix) and CETD Matrix. Over the year in 2003, the first author used the same technique to study migrant workers affected by HIV / AIDS. In 2004 this technique was used by B.Vasantha and A.Victor Devedoss to study farm workers. In 2012, S.Narayanamoorthy used this model to study the problem of silk weavers as bonded coffee cultivators in kodai hills workers and the problems encountered were analyzed by Dr. A.Kalaichelvei and S.Gnanamalar. To study the life style of people we use various fuzzy matrix techniques.

"A fuzzy matrix is a matrix with elements having values in the fuzzy interval" In this article the unit interval [0,1] and the interval [-1,1] are called fuzzy interval. Fuzzy matrix (or) CETD matrix model is the one which helps to analysis. Now we use the same model to study how frequently people and pharmacist collect information on seasonal diseases [4].

Klaus-Peter and Adlassnig explains the use of Fuzzy set theory and fuzzy logic are a highly suitable and applicable basis for developing knowledgebased systems in medicine for tasks such as the interpretation of sets of medical findings, the single or differential diagnosis of diseases from various areas of medicine, the optimal selection of medical treatments, and for real-time monitoring of patient data. This was verified by trials with the following systems: FuzzyKBWean–an open-loop fuzzy control system for optimization and quality control of the ventilation and weaning process of patients after cardiac surgery at the intensive care unit (ICU), FuzzyARDS–an intelligent on-line monitoring program for ICU data from patients with acute respiratory distress syndrome (ARDS) employing fuzzy trend detection and fuzzy automata, and CADIAG-II and MedFrame/CADIAG-IV–framework programs (shells) for consultation systems to aid in the differential diagnostic process in Internal Medicine. All the above-mentioned computer systems have reached the state of extensive clinical integration and testing at the Vienna General Hospital.Fuzzy logic matrix are a highly good and related for developing knowledge-based systems in medicine for tasks such as the in understanding of sets of medical findings, the single or other possible diagnosis of sicknesses from different areas of medicine, the best selection of medical treatments, and for without any delay supervising of patient data [5].

K.Mohan Kumar and K.Thiyagarajan compared the patient administration system of a hospital using manual and IoT method with authenticated sample data. Patient waiting time for hospital services is identified as one of the key measurements of a responsive health care system. So, this study addresses the issue of longer patient waiting time in the outpatient department (OPD). Outpatient administrations always take long waiting time for a treatment that has a short time of consultation by the physician. Queuing theory formulas are used to predict the waiting time of the patient. The main goal of this research is to focus on how the IoT method can able to reduce patient waiting time [6] .

B. Sai SubrahmanyaTejesh and S.Neeraja In general, warehouses are used to store goods or products. In the Warehouses, if the user wants to locate any product it is very difficult, because user have to do a detailed search manually in all the available stockrooms this requires a lot of effort. So to avoid this problem the warehouse inventory management system is very helpful because it maintains the detailed product information and tells us in which stockroom the product is present. The warehouse inventory management system is playing a significant aspect in many productions and goods based methodology. Though there are many wireless communication technologies the RFID suits the best for the warehouse inventory management

system. The tag information is transferred from the transmitter section to open source hardware via a wireless link with the aid of internet. The warehouse inventory management system built on the architecture of the Internet of Things is developed to track the products attached to the tags with product information and their respective time stamps for further verification. The Raspberry Pi acts as a central server, monitoring all the information. The total system gives an archetype to correspond the information flow and material flow. The web page which was built is convenient and an interface to the user to track the products. The developed system results a very low cost system and works dynamically compared with the existing present warehouse inventory management systems[7].

III. METHODOLOGY

The primary data collected from some of medical centres in Thanjavur, Tamilnadu, India for this study. The following Table 1 shows the template used for data collection. This table used to get the data for a period of one year from five different medical centres in Thanjavur.

MONTH WISE ADDMISIONS
MEDICAL CENTRE NUMBER:

Month and No.of Cases	Type of Disease						Total No.of Cases
	D1	D2	D3	D4	D5	D6	
January 2018							
February 2018							
March 2018							
April 2018							
May 2018							
June 2018							
July 2018							
August 2018							
September 2018							
October 2018							
November 2018							
December 2018							

Table 1 : Template for data collection

The Type of Diseases set D1, D2,D3,D4,D5 and D6 are considerd as below.

Leble for Disease sets	List of Diseases
D1	Typhoid, chicken pox, sunburn
D2	Cold, cough, flu, bronchitis
D3	Malaria, flu
D4	Cholera, chikungunya
D5	Dengue, viral diseases, flu
D6	Hepatitis A, stomach infections and Others

Here, the disease set is created by selecting all the diseases occurred in particular season without redundancy**.**

Fuzzy Matrix Algorithm

In this work the next step is the constuction of Fuzzy matrix using the following algorithm.

Algorithm to construct fuzzy matrix

Step 1: Build the raw data matrix. Here seasons are represented in columns and diseases are represented in rows. The initial raw matrix is in the size m x n for seasonal diseases.

Step 2: Find the Average Time Dependent (ATD) Matrix. For this matrix constuction, divide each element of raw data matrix by the number of months in each season.

Step 3: Find average(μ_j) and Standard Deviation $\boldsymbol{\sigma_j}$ of every column of ATD matrix.

Step 4: Compute $var1 = (\mu_j - (\alpha * \sigma_j))$ **and**
$var2 = (\mu_j + (\alpha * \sigma_j))$
$\alpha \Rightarrow$ interval [0,1]

Setp 5: Build RTD matrix with differebt values of α . For this matrix elements var1 and var2 are compared.
if $a_{ij} \leq$ var1 then $e_{ij} = -1$ else
if $a_{ij} \in$ (var 1, var 2) then $e_{ij} = 0$ else
if $a_{ij} \geq$ (var 2) then $e_{ij} = 1$

Step 6: Build the fuzzy matrix by adding all RTD matrices with various intervals.

This paper explain how to create the Fuzzy Matrix for knowledge database and also explain the IoT model which uses the knowledge database. IoT devices send the message to pharmacist using the knowledge base. Based on the message given by IoT devices the pharmacist maintain the stock level of medicines for seasonal diseases. The following Figure.1 shows the implementation methodology of developed knowledge database with IoT.

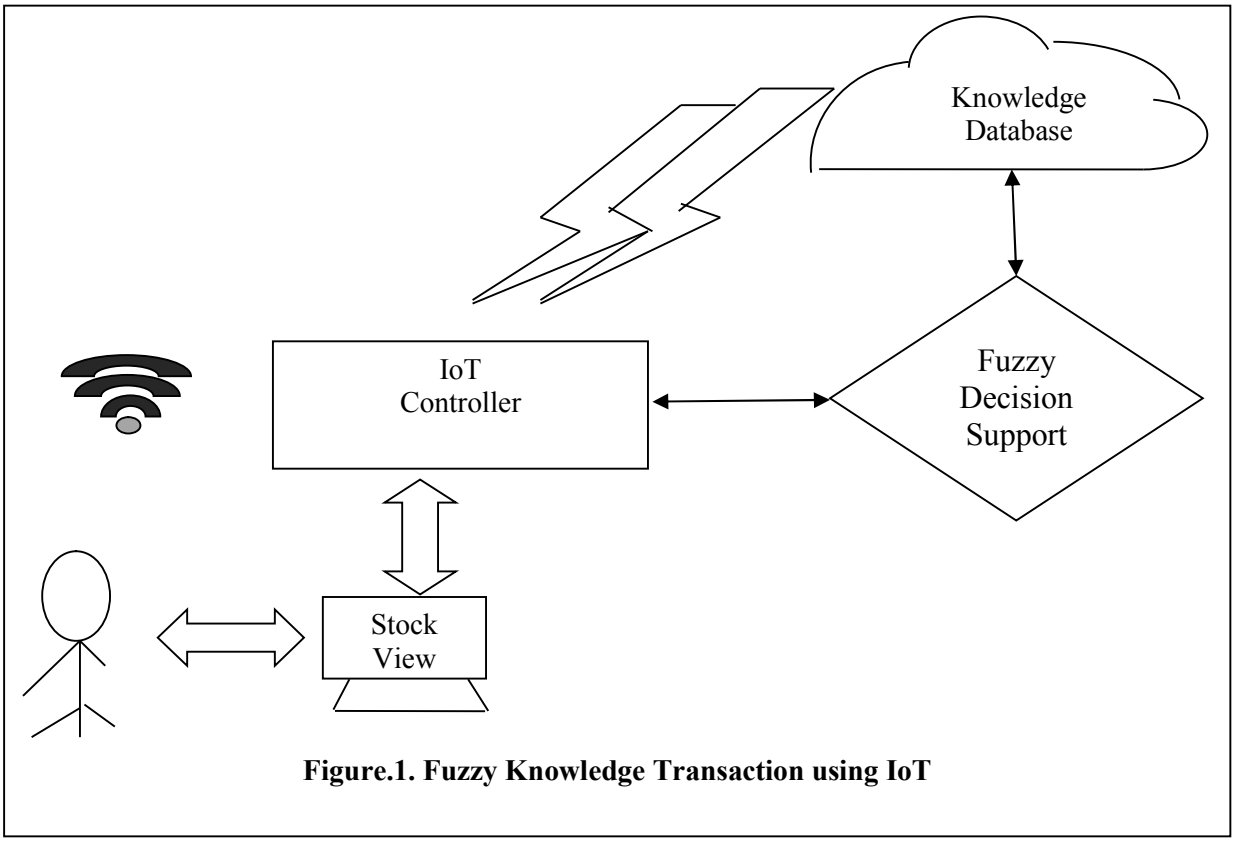

Figure.1. Fuzzy Knowledge Transaction using IoT

IV. RESULTS AND DISCUSSION

The following raw data matrix in Table-2 generated after consodidating the seasional diseases using Step-1 of the above algorithm discussed in methodology section of this paper.

Season / Diseases	S1	S2	S3	S4
D1	21	120	46	30
D2	132	112	65	20
D3	67	86	154	80
D4	64	43	90	60
D5	80	42	121	40
D6	50	67	101	44

Table 2: Raw data matrix

In the above raw data matrix the season groups S1, S2,S3 and S4 are creates with the deatails as below.

Label for Seasons	List months included
S1	December, January, February
S2	March, April, May
S3	June , July , August, September
S4	October,November

ATD Matrix

The following Table.3 shows the ATD Matrix created using the Step-2 of the algorithm.

Season / Diseases	S1	S2	S3	S4
D1	7.00	40.00	15.33	10.00
D2	44.00	37.33	21.67	6.67
D3	33.50	43.00	77.00	40.00
D4	32.00	21.50	45.00	30.00
D5	26.67	14.00	40.33	13.33
D6	16.67	22.33	33.67	14.67

Table 3: Average Time Dependent (ATD) Matrix

Average and SD table

The Table-4 created using the Step-3 of the alogorithm.The following formulas are used to create mean (μ_j) and Standard Deviation(SD).

Mean of n terms $x_1, x_2,..., x_n$ is given by

$$\mu_j = \frac{\sum x}{n}$$

and the standard Deviation of $x_1, x_2,..., x_n$ is given by

$$\sigma_j = \sqrt{\frac{\sum x^2}{n} - \left(\frac{\sum x}{n}\right)^2}$$

Average(μ_j)	**26.64**	**29.69**	**38.83**	**19.11**
S.D (σ_j)	**13.1**	**27.63**	**43.53**	**20.93**

Table 4: Average and Standard Deviation

RTD Matrix

Using Step4 of the above algorithm the Refined Time Dependent matrices are calculated with the varying intervals α [0 : 1]. The first element of RTD matrix is calculated as below..

For the first element $\mu_j = 26.64$ and $\sigma_j = 13.1$

Var1 $= (\mu_j - (\alpha * \sigma_j))$
$= 26.64 - (0.15 * 13.1)$
$=$ **24.67**

Var2 $= (\mu_j + (\alpha * \sigma_j))$
$= 26.64 - (0.15 * 13.1)$
$=$ **28.61**

Here $a_{11} = 7.00$. It is less than 24.67. So the first element of RTD matrix is -1. Similarly the other elements are calculated using the step5 of algorithem.

The following RTD matrices are obtained with various time interval such as 0.15,0.25 and 0.75.

α => interval 0.15

$$\begin{pmatrix} -1 & 1 & -1 & -1 \\ 1 & 1 & -1 & -1 \\ 1 & 1 & 1 & 1 \\ 1 & -1 & 0 & 1 \\ 0 & -1 & 0 & -1 \\ -1 & -1 & 0 & -1 \end{pmatrix}$$

α => interval 0.25

$$\begin{pmatrix} -1 & 1 & -1 & -1 \\ 1 & 1 & -1 & -1 \\ 1 & 1 & 1 & 0 \\ 1 & -1 & 0 & 0 \\ 0 & -1 & 0 & -1 \\ -1 & -1 & 0 & 0 \end{pmatrix}$$

α => interval 0.75

$$\begin{pmatrix} -1 & 1 & -1 & -1 \\ 1 & 1 & -1 & -1 \\ 1 & 1 & 1 & 0 \\ 1 & -1 & 0 & 0 \\ 0 & -1 & 0 & -1 \\ -1 & -1 & 0 & 0 \end{pmatrix}$$

Fuzzy Matrix

The fuzzy matrix obtained by adding all the derived RTD matrices. In this case the following matrix arrived by doing the matrix addition of all the three RTD matrices.

Fuzzy Matrix

$$\begin{pmatrix} -3 & 2 & -2 & -2 \\ 3 & 2 & -2 & -2 \\ 2 & 2 & 3 & 2 \\ 2 & -2 & 0 & 0 \\ 0 & -2 & 0 & -2 \\ -3 & -2 & 0 & -1 \end{pmatrix}$$

The following Table.5 is created from the above matrix.

	S1	S2	S3	S4
D1	-3	2	-2	-2
D2	3	2	-2	-2
D3	2	2	3	2
D4	2	-2	0	0
D5	0	-2	0	-2
D6	-3	-2	0	-1

Table 5: Fuzzy table

The above Table.5 shows the fuzzy table for the taken problem. It gives the knowledge about the occurrence of various disease set in different seasons. The following Figure.2 shows the disease set D2 is having higher value compare with other desease sets. So the parmacist should maintain large amount of drugs for the disease set D2 in season 1.

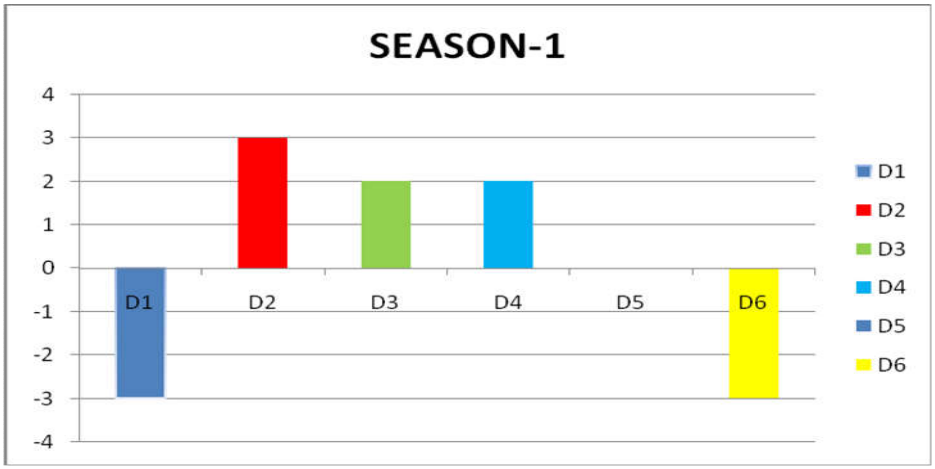

Figure.2 Season 1 Dataset

The following Figure.3 shows the disease set D1,D2 and D3 is having same higher value, compare with other desease sets. So the parmacist should maintain large amount of drugs for the disease set D1,D2 and D3 in season 2.

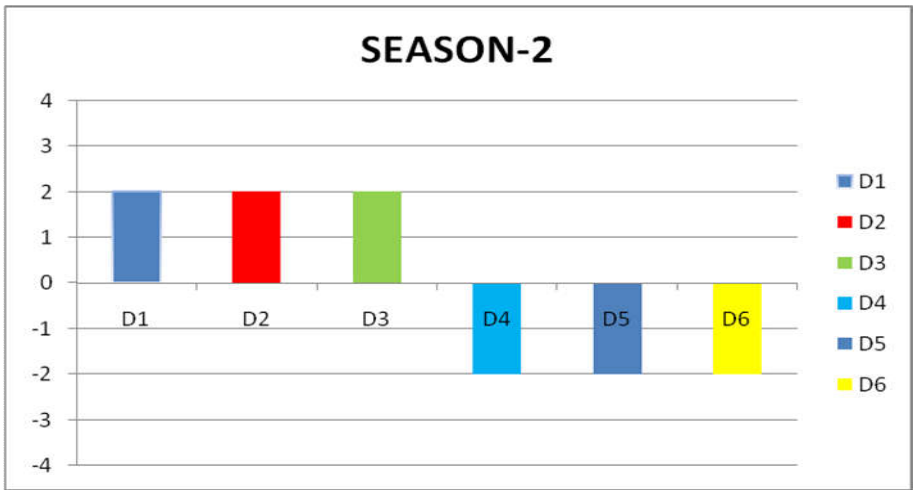

Figure.3 : Season 2 Dataset

The following Figure.4 shows the disease set D3 is having higher value, compare with other desease sets. So the parmacist should maintain large amount of drugs for the disease set D3 in season 3.

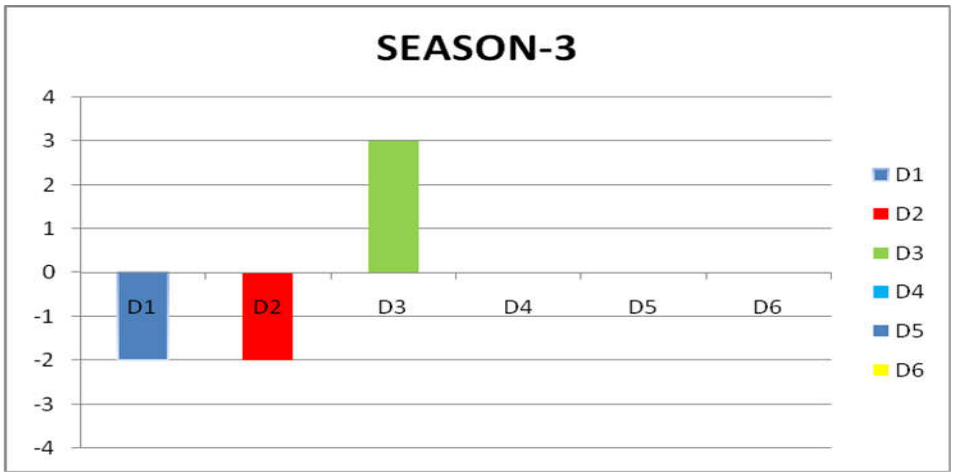

Figure.4 : Season 3 Dataset

The following Figure.5 shows the disease set D3 is having higher value, compare with other desease sets. So the parmacist should maintain large amount of drugs for the disease set D3 in season 4.

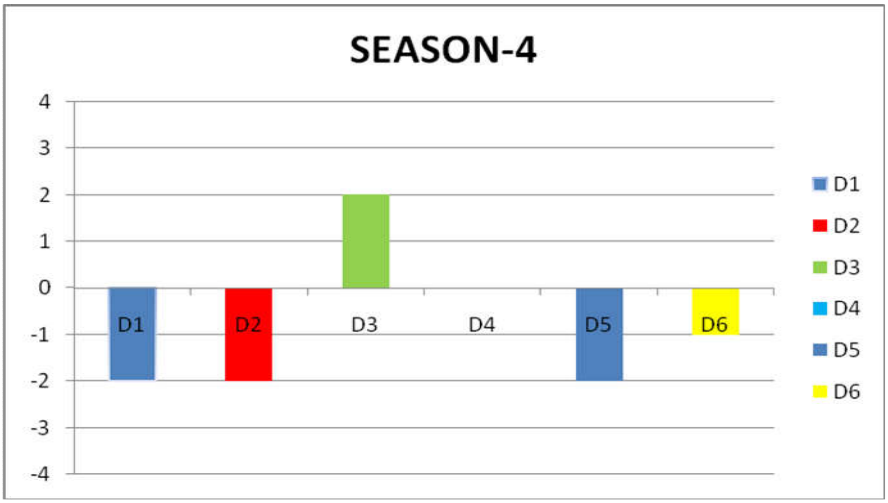

Figure.5: Season 4 Dataset

These fuzzy graphs give an idea about the seasonwise occurrence of various diseases. If these informations are stored in knowledge database, it can be reffered by the IoT model explained in methodology section. This IoT model can send the signals to parmacist as soon as the season starts. So he or she will come to know the required stock level of medicines needed for the corresponding season.

V. CONCLUSION

This work analyse the problems in the present stock level maintance for a pharmacy and provide a solution to avoid the existing problems. Instead of using normal database, a knowledge data base is used with the elements fuzzy matrix. That knowledge database is used by the IoT devices to give efficient and timely information to the pharmacist. Defnitely this idea will be very much useful to the pamacist pupil to promote their sevice at some extend.

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