Project Report: Decision Support System For Catering Expenditure

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***Abstract*—Every Catering management develops their own management theories to achieve their goals and to sustain in the food service industry.But the core concepts are customer's satisfaction,maintaining food and hygiene standards that measure the performance of the catering management.The food wastage and the maintenance of the catering expenditure are the main issues of the catering management.Our project's main objective to provide a full fledged decision support system for the catering management.The elements in our decision support are the Database system , DSS model,GUI application.Our database system consists of all the previous data which is used by the model for decision making Our model is trained using Random forest regression algorithm to predict food wastage with high accuracy and the GUI application provides the interaction between model and user so they could predict the expected amount of food wastage and calculate catering expenditure.**

***Index Terms*—Decision Support System, Random Forest Regression, Food wastage, Raw materials, Visualization, Database**

I. Introduction

It is estimated that 1.3 billion tons of food is being wasted every year i.e is one- third of all food produced for consumption is being wasted.The food production must increase by 60% by 2050 in order to meet the requirements and demands due to growth of world population Food wastage is being regarded of quality edible food at different consumer levels, mostly in developing countries.The food wastage represents a missed opportunity to improve food security and comes at a steep environmental price. [1] .A decision support system analyze the big amount of data for making the decisions. A DSS must support management,planning, executing level of organization in a flexible way.

II. Division Of Work

All the team members have equally contributed to the project development, all the work assigned to members were completed in schedule and all the components were integrated in a defined way. The project needed steps like data generation, data pre-processing, GUI development, Model training and implementation, Deployment and Visualizations. The information regarding the steps have been include in the final project report.

The individual contribution is shown in following Table-I :

Project Duties	**Name of teammates**
Data Collection& Preprocessing	Manideep Yama
Model Training & Implementation	Naga Preethika Mule
Deployment & Visualization	Sai Teja Palla

TABLE I
Division Of Work

III. Problem-Description

Catering management is part of the food services industry, and involves the planning and organization of food and beverage services for various types of events. Important aspects of catering management include, meeting customer expectations, maintaining food and hygiene standards, and meeting financial targets. Food wastage is main issue in catering business, hence we need a proper system that will help in proper food management. There is no proper decision supported system related to minimizing food wastage. There is no proper way to calculate the amount of food being wasted on a daily basis in hotel, events, households etc. . Efficient food allocation may result on lower level of food wastage, saved costs for business, environmental sustainability.

A. Objective

To develop a Decision Support System on Catering Services that will allow customers to choose packages and create their own package according to their budget.
To develop a Decision Support System, that will calculate the expected wastage of food (using past data) by the customers, which can be regulated by increasing quality of food being prepared.
Another Model is designed such that model needs to predict the amount of raw materials, before hand so that one doesn't buy more than needed materials and waste them.

B. Stakeholders Involved

The stake holders involved in our project are the customers,and the catering management.

The customers can place their order for the food by entering the information asked in the page i.e.,name of customer, number of people, cuisine and is given a option to select the dishes from respective cuisine. Firstly, the catering management can predict the estimated expected food wastage for the inputs given by the customer, to make choices accordingly to minimize the wastage of food. Secondly, catering management is giving another option where they can calculate the expected weight of raw materials for the inputs given by the customer, so that they don't buy more than needed materials and waste them.

IV. Solution Architecture

Model-driven DSS. These type of decision support system includes financial and accounting.They generally depend on statistical and analytical tool, model driven dss used only data and parameter given by decision maker [4]. Since our project is depending upon statistical and olap system hence we conclude our system to be model-driven DSS.

A. Code-Snippets

```
tot=IntVar()
Adu=IntVar()
Chil=IntVar()
NameC=StringVar()
Customer=Label(root,text="Name of Customer").grid(column=0,row=0)
cus=Entry(root,textvariable=NameC, width=50).grid(column=1,row=0)
total=Label(root,text="Total number of People ").grid(column=0,row=1)
et=Entry(root,textvariable=tot, width=50).grid(column=1,row=1)
adult =Label(root,text="Number of Adults").grid(column=0,row=2)
ea=Entry(root,textvariable=Adu, width=50).grid(column=1,row=2)
child =Label(root,text="Number of Children").grid(column=0,row=3)
ec=Entry(root,textvariable=Chil, width=50).grid(column=1,row=3)
cuisine=Label(root,text="Cuisine").grid(column=0,row=4)
pwa= partial(pwa,Adu,Chil,NameC)
mget= partial(mget,tot)
button = Button(root,text="Calculate Expenditure",padx=20,pady=30,command=mget).grid (column=1,row=5)
buttone = Button(root,text="Predict Wastage",padx=20,pady=30,command=pwa).grid (column=1,row=6)
combobox = ttk.Combobox(root,values=["Swedish", "American", "Mexican", "Indian"],width=48).grid(column=1,row=4)
#Indian
checkGroupV = LabelFrame(root, text = "Indian", padx=10,pady=10)
checkGroupV.grid(row=10,column=0,padx=20)
biryani=IntVar()
Checkbutton(checkGroupV,text="biryani",variable=biryani).grid(row=10,column=0)
pulav=IntVar()
Checkbutton(checkGroupV,text="pulavv",variable=pulav).grid(row=11,column=0)
Idli_s=IntVar()
Checkbutton(checkGroupV,text="Idli Sambhar",variable=Idli_s).grid(row=12,column=0)
Roti_Curry=IntVar()
Checkbutton(checkGroupV,text="Roti Curry",variable=Roti_Curry).grid(row=13,column=0)
Rasmalai=IntVar()
Checkbutton(checkGroupV,text="Rasmalai",variable=Rasmalai).grid(row=14,column=0)
```

Fig. 1. GUI-Code

The Figure-1 is the implementation code of the user interface of the project.

```
def pwa(adult,kid,cust) :
    myconn = mysql.connector.connect(host = "localhost", user = "root",passwd = "mysql", database = "project")
    dataset=pd.read_sql('select * from dss',con=myconn)
    dataset.head()
    X = dataset.loc[:,['Number of adults','Cuisine','Rating','Adult serving size','number of dishes']].values
    y = dataset.loc[:, ['adult_waste']].values
    X1=dataset.loc[:,['Number of children','Cuisine','Rating','child_serving_size','number of dishes']].values
    y1 = dataset.loc[:, ['child_waste']].values
    from sklearn.compose import ColumnTransformer
    from sklearn.preprocessing import OneHotEncoder
    ct = ColumnTransformer(transformers=[('encoder', OneHotEncoder(), [1])], remainder='passthrough')
    X = np.array(ct.fit_transform(X))
    ct1 = ColumnTransformer(transformers=[('encoder', OneHotEncoder(), [1])], remainder='passthrough')
    X1 = np.array(ct.fit_transform(X1))
    from sklearn.ensemble import RandomForestRegressor
    regressor = RandomForestRegressor(n_estimators = 20, random_state = 0)
    regressor.fit(X, y.ravel())
    regressor.fit(X1, y1.ravel())
    connection = pymysql.connect(host="localhost",user="root",password="mysql",port=3306,db="project")
    mycursor = connection.cursor()
    item_name=cust.get()
    mycursor.execute( "Select Rating from customer where `Name of customer`=%s",(item_name))
    rating=10
    a=0
    myresult = mycursor.fetchall()
    for i in myresult:
        rating=i[0]
    y1_predadult = regressor.predict(arradult)
    y1_predkids= regressor.predict(arrkids)
```

Fig. 2. Model Code

The Fig-2 is the implementation code of the DSS model of the project

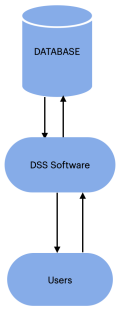

Fig. 3. Database Model

B. Database Model

The Fig-3 represents the database model of DSS system. The data set stored in database is in tabular format where each column represents each feature and the various columns are used as inputs to the model.

The required data is extracted from the database and used in the Model, The users give the input through the user interface, and these inputs are used by the DSS model and predict a output ,which is in-turn displayed to the users.after the model had predicted the output, this new data is updated back to the database for future reference and to make the model more accurate.

The dataset in our project consists of nearly 1000 rows. The data was initially in csv file, which was imported to the MySQL database for future use.

The database we used in our model is **MySQL**,It is a open source relational database management system, The MySQL Workbench which we used is a visual database design tool , providing an environment where it was easy to import our input csv file into the database .

C. User Interface

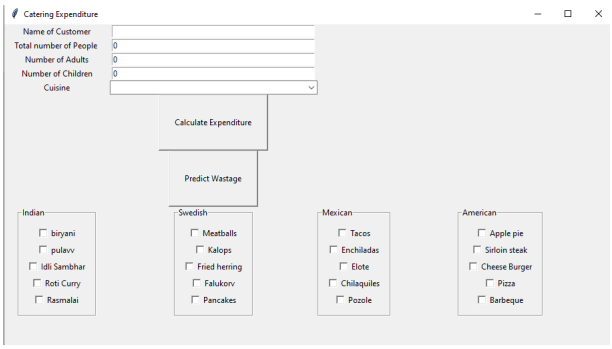

Fig. 4. User Interface-1

We have used Tkinter,which is a standard GUI library for Python to create our user interface.We have used various components like labels, textfields ,buttons combobox etc.,to build the user interface.

In our User Interface we have name of customer, number

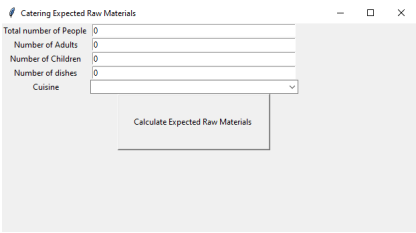

Fig. 5. User Interface-2

Total no of numbers	Cuisine	Rating	Number of adults	Number of children	child_serving_size	Adult serving size	number of dishes	child_waste	used_raw_material	adult_waste	total_amt_c
125	Indian	1	100	25	150	200	1	1.875	23.75	10	3.75
320	Indian	2	200	120	150	200	4	7.2	58	16	18
260	Indian	3	139	121	150	200	3	5.445	45.95	8.34	18.15
184	Indian	4	121	63	150	200	1	1.89	33.65	4.84	9.45
175	Indian	5	141	34	150	200	1	0.51	33.3	2.82	5.1
155	Indian	1	131	24	150	200	3	1.8	29.8	13.1	3.6
228	Indian	2	151	77	150	200	5	4.62	41.75	12.08	11.55
220	Indian	3	143	77	150	200	2	3.465	40.15	8.58	11.55
199	Indian	2	132	67	150	200	1	4.02	36.45	10.56	10.05
321	Mexican	5	200	121	240	300	3	2.904	89.04	6	29.04
145	Mexican	4	132	13	240	300	3	0.624	42.72	7.92	3.12
166	Mexican	2	141	25	240	300	3	2.4	48.3	16.92	6
196	Mexican	1	151	45	240	300	5	5.4	56.1	22.65	10.8
267	Mexican	2	191	76	240	300	1	7.296	75.54	22.92	18.24

Fig. 6. features in database

of people, cuisine, and we are displaying different dishes available under each cuisine to choose the dishes as per individual choices, and budget.
Fig 4 and Fig 5 are the user interface of the project.

D. Decision Making Criteria

Decision making criteria used in our decision support system are :

- Total members
- No.of Adult
- No.of Child
- Cuisines
- Rating
- child_wastage
- adult_wastage
- adult_serving_size
- child_serving_size
- total_raw_materials
- wastage_raw_materials
- no_of_dishes
- total_amt_child
- total_amt_adults

E. Implementation:

In our DSS model, we are trying to predict the food wastage, so that accordingly we could reduce it and try to predict the required raw materials so that we do not buy more than needed materials and waste them.
The Random Forest Regression Algorithm is the main decision-making algorithm in our model.
Data set consists of almost 1000 entries, we are training our model on 80% as train dataset and rest 20% is used to test the model and trying to improve the accuracy of the model. Python packages used in our model are pandas ,numpy, mysql.connect ,tkinter.

- *Step1:Data Collection* Data used in DSS model building is very important and needs to be legit to obtain proper results, hence data needs to be acquired properly from reliable sources see that data is relevant to the project

- Step 2: Data Pre-processing
  Data Acquired directly from sources can be incomplete and irrelevant in some cases, hence proper data pre-processing is needed before data is used in training the model, the preprocessing steps included in our project are:

  1) missing values in our dataset are filled by the calculating the mean value of respective feature
  2) Categorical data is converted into a binary column as required by the model, in our project we are converting cuisine into binary columns by using OneHotEncoder from sklearn.preprocessing

- Step 3: Model Training In our project we are considering different serve sizes for adults and children and accordingly consider wastage of adult and children separately which would finally help us to analyze the food wastage The cost of each dish is different and the costs includes adding external factors such as cost of preparation, transport ,wages, etc. In our data, food wastage is dependent on many factors just as number of members, cuisine, number of dishes etc., which are independent, hence to predict food wastage we needed to use regression models. In our first model , we are training our model with inputs such as number of adults, number of dishes selected, cuisine selected ,serve size of adult and rating of the food with their previous experiences ,i.e. if rating is low, people tend to waste more food and vice versa, and we are using Random Forest Regression Algorithm for predicting our Food wastage by Adult, similarly we are predicting our food wastage by child, using data related to child and adding both the wastages to output the total expected Food wastage of the event.
  After food wastage is predicted, we are using this data to calculate how can we change the serve size to minimize the wastage in our present event. After the event is over, we ask the customers to rate the food and food wasted in that event is determined and this data is added back to the database to use in future. The random forest regression model has highest accuracy compared among other models while predicting results to our data .
  For catering Managements user interface, we have build another model which will predict the expected required raw materials as output, where the inputs to the random forest regression algorithm are the number of members, cuisine , number of dishes, serve size. (Since in our project we considered raw material wastage also as a major source of waste, it can be reduced with proper management)

F. System Architecture

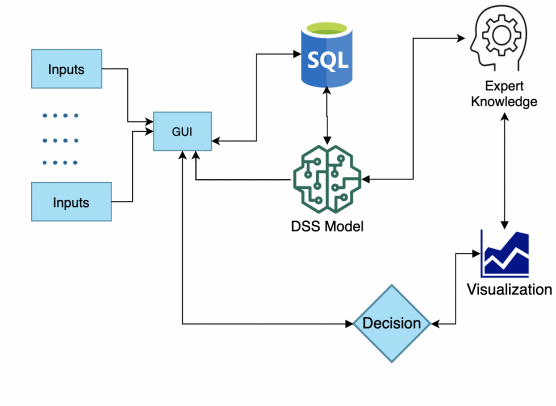

Fig. 7. Decision Support System

The figure-7 represents the overview of our decision support system and how it works,The inputs are take from user using GUI(Graphic User Interface) and the model is generated by extracting the data from database and using in the model. The inputs taken from user are used for predicting the food wastage,and help take decisions how to minimize the wastage by decreasing the serve size based on food wastage .
The results are visualized so that the user can easily understand whether to take the decision or not .

V. Data Visualization

Tableau is a powerful and fastest growing data visualization tool used in the Business Intelligence Industry.Its easy to use visualisation tool for the data analysis.Tableau's work interface is user friendly.we can connect our data which is in csv format to the tableau workspace in very easy manner .Its a powerful platform to work and experiment with our data to produce different kinds visualisations which is appropriate for our data. [5]
Visualization Of Data: In our project we have a dataset which is used in training the model and predict the outcome of food wastage.This dataset has all the factors that control the food wastage. We use tableau software to visualise the factors that influence the food wastage.The simple tabulated data may not be easy to truly understand what is it representing.Hence we use visualisations to easily understand the dataset. In Fig-8

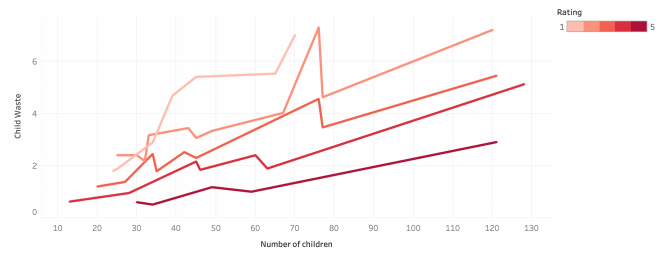

Fig. 8. Children Wastage

it represents the food wastage done by children grouped by the feedback rating. The feedback rating has 5 levels 1-5.We can get from the graph that low level rating has higher food wastage compared to 5 level rating.Food quality is a higher priority for the catering management.They have to reduce the serving size based on the wastage and the rating it received.

A. Findings:

The food wastage in Fig-8 is much higher when the rating is 1 compared to the highest rating.The food wastage is inversely proportional to the rating feedback.

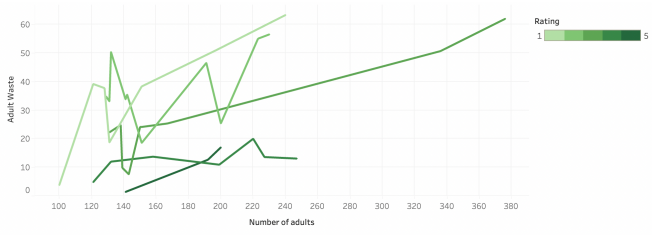

Fig. 9. Adult Wastage

In the dataset the food wastage and the serving size are divided for adults and children.The graph in Fig-9 represents the food wastage done by adults grouped by the rating feedback they have given.The rating feedback is same as the children 5 levels 1-5.The rating increases along the darkness of the colour.

B. Findings:

In the Fig-9 the adult food wastage the pattern resembles with the children food wastage.For the low level rating the food wastage is higher compared to high level rating. We

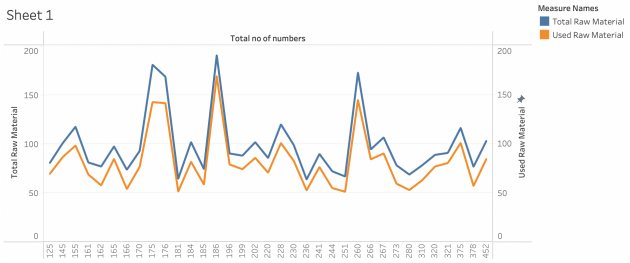

Fig. 10. Raw Material Wastage

have considered the Food wastage in 2 ways.The first one which is done by the customers and the second one as raw material wastage.We can depict from the Fig-10 graph that there has been significant wastage of raw materials through out the events.

C. Findings

The blue line in Fig-10 describes the total raw materials and the red one belongs to used raw materials.The gap represents the leftover raw materials.This data helps to understand the food wastage through raw materials.This wastage can be regulated by calculating the raw materials needed based on the past data and the number of customers input given by the customer.

VI. EXPERIMENT

Model	Training Accuracy	Testing Accuracy
Adult	93.5%	91%
Child	96%	94%
Raw Material	94%	93%

TABLE II
THE ACCURACY OBTAINED IN OUR MODELS

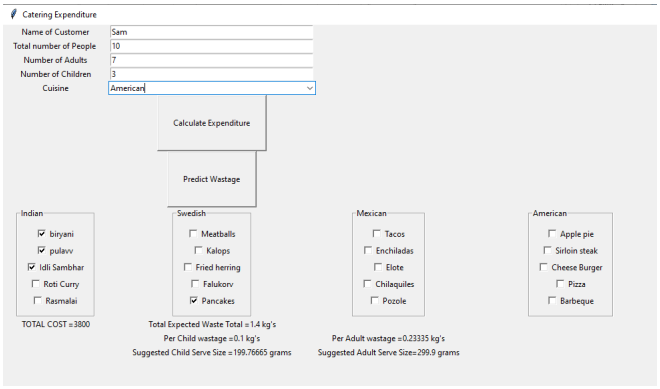

Fig. 11. Experiment-1

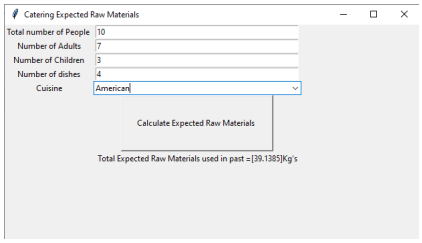

Fig. 12. Experiment-2

After the development process is over, we will run our DSS system and give random inputs to see if the system is working properly. Here now we are taking number of people as 10, number of adults as 7 number of children as 3 and cuisine is American and dishes selected are biryani, pulav,idli sambhar and pancakes and when we click the button Calculate expenditure we get the total price of catering for 10 members as 3800. When we click the other button i.e., Predict wastage we are getting total expected wastage as 1.4kg's and separately expected per child wastage as 0.1kg's and per adult wastage as 0.23kg's and using this data, we are concluding that serve size should be decreased, such as child serve size to 200 grams and adult serve size to 300 grams.

In the catering management interface the following inputs are given, they are namely total number of people as 10,number of adults as 7,children as 3,total selected dishes as 4 and type of cuisine is American.We get the amount of expected raw material used as 39.2kg's.

The accuracy obtained by our model using the data from database and random forest regression algorithm are given in the Table II.

VII. CONCLUSIONS

Food Wastage is a key issue in the catering management system.Therefore we have stressed on identifying all the features which impacts the food wastage and implementing them in the model to get the amount of food wasted. Our DSS model was able to predict the food wastage and expected raw material using the past data with average accuracy of 94%. Using the data generated from these model, with proper management, food wastage can be reduced. We have understood the factor's influence on the food wastage much clearer through data visualization.These factors were taken into account while creating the model for predicting the food wastage.Lastly with results from our DSS model,we suggest the appropriate serving size for the adult and the child.

VIII. FUTURE WORK

We have considered only three 4 types of cuisines to choose from food category. We can add additional cuisines when needed according to customer requirements. and Menu should be changed according to seasons and seasonal foods
The present GUI application can be enhanced can be extended to a desktop based application and mobile application. another future work includes to add calorie details for each dishes.The number of features could be increased such as climate,place,season,days.Another possible direction is to add more features to add quality of food.

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