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Software Process Model for Agricultural Productivity Analysis

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***Abstract*: Software Process Model for Agricultural Productivity Analysis refers to the various steps required to be executed for development of a web based software model for analysis of agricultural productivity. The paper presents different steps in developing the software for agricultural productivity analysis.**

Keywords: SAPA, agricultural productivity, software, process model.

NOMENCLATURE

SAPA: Software for Agricultural Productivity analysis

I. INTRODUCTION

Software are being in use for analysis purposes for many decades. In a big country like India agriculture plays a very important role in the livelihood of its people. Within India there is wide difference in the resource involved, topography, climatic condition resulting in lot of differences in agricultural production within this country (Bhalla and Singh, 2010; Chand et. al, 2009) . Research on how these variations within India affects the production will help in increasing agricultural productivity. Analysis of agricultural productivity can help to sort out the factors that are affecting the agricultural production and thereby take necessary action to improve its production in near future.

The states of India are very large in area and there are also wide difference in the climatic condition, resource available etc. within the state itself. So, when state is taken as a unit for some agricultural studies lot of information which might be coming if the study is considered in smaller unit are missed. One solution for this will be to study the agricultural research in a smaller unit like district. This paper presents a software development for the analysis of agricultural productivity at district level. Waterfall model has been used in this paper to explain the software development process. It is not flexible. Its phases are strictly linear (Munassar and Govardhan 2010). Requirement analysis, design, coding, testing and maintenance, the different phases of this model have been discussed.

II. REQUIREMENT ANALYSIS

Requirements are set of functionalities and constraints that end-user (who will be using the system) expects from the system. They include input requirements, computational requirements, user requirements etc. (Sommerville, 2009). These requirements are specified briefly for SAPA in following sub-sections.

A. Input Requirements

The data should be preferably provided through an EXCEL sheet because stakeholders which are agricultural economist, statisticians are using Excel for computing and storing data.

B. Computational Requirements

Computational requirements include estimating the following:

1. Value of Crop (VOC) for each district.
2. Computation of Productivity/Ha (NSA) for each categorization of districts.
3. Identification of factors of agricultural productivity within each category.

C. User Requirements

The sequence diagram help the user to know the steps required for functioning of this software (Sommerville, 2009). It is shown in Figure I.

III. DESIGN

The purpose of design is to plan a solution of the problem specified by the requirement document.

A. Input design

A data flow diagram (DFD) illustrates how data is processed by a system in terms of inputs and outputs. As its name indicates

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its focus is on the flow of information, where data comes from, where it goes and how it gets stored. The data flow diagram of software for agricultural productivity is given below in Figure II. The user should create an Excel file of all the required variables (Table I).

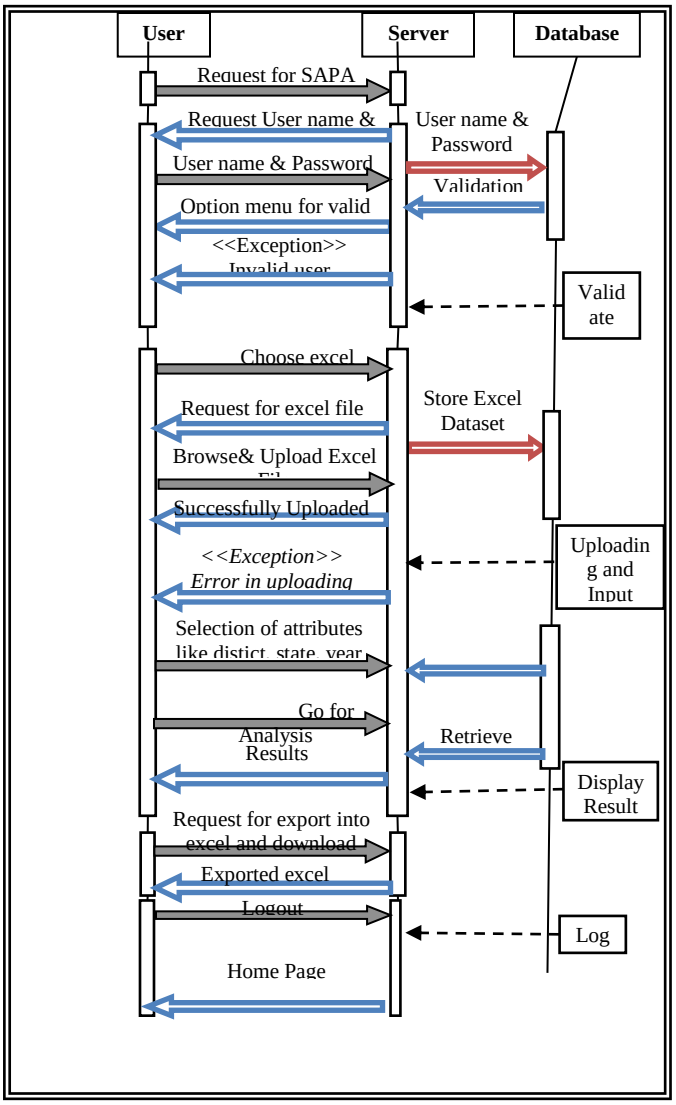


Fig. 1. Sequence diagram of SAPA

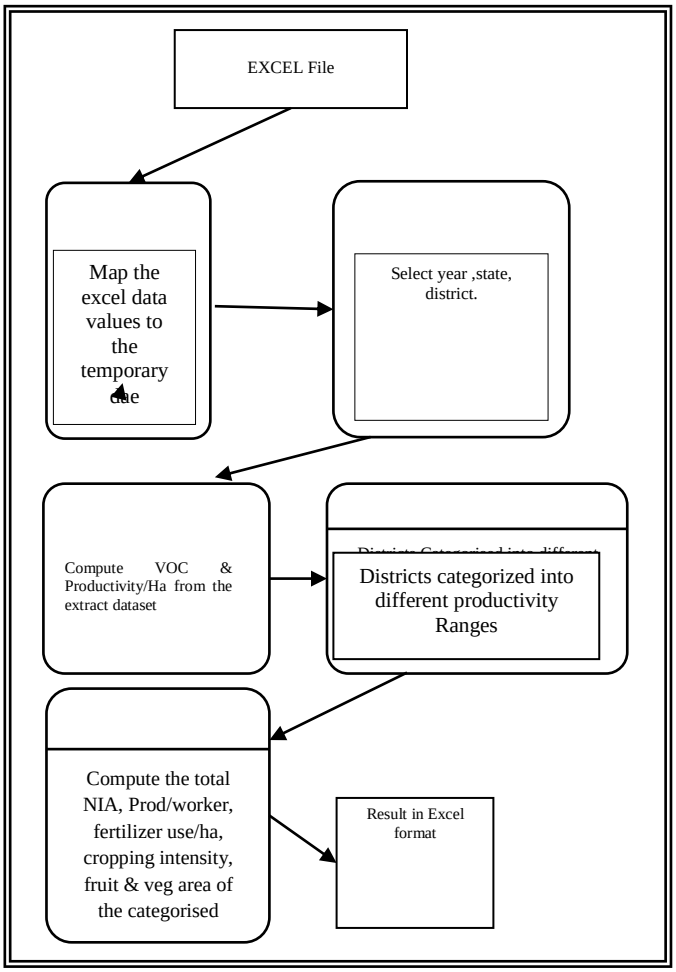


Fig. 2. DFD OF SAPA

TABLE I. REQUIRED VARIABLES IN INPUT DATA

Variables	Description
Loc_Id stat	Particular Id number given to a state
Loc_iddist	Particular Id number given to a district
State	Name of a state
District	Name of a district
Year	Given particular year
Crop_TA	Area of a particular crop of a district for a particular year
Fruit_TA	Area of Fruit for a district
Veg_TA	Area of vegetable for a district
Crop_TQ	Total production of a crop for a particular district for a given year
Fruit_TQ	Total production of fruits for a particular district for a given year
Veg_TQ	Total production of vegetables for a particular district for a given year
FHP	Farm Harvest Price of a crop from published records
Fruit FHP	Farm Harvest Price of fruits from published records
Veg FHP	Farm Harvest Price of vegetables from published records
NSA	Net Sown Area from published records
GCA	Gross Cropped Area from published records
NIA	Net Irrigated Area from published records
NPK	Fertilizer used for a district for a year
Cult_Rural	Agricultural worker number

AgL_Rural	Agricultural worker number

B. Output design

The output of this software includes two important reports which are generated after computation of agricultural productivity of districts under each selected states. The first report shows the number of districts falling under the calculated productivity range. The second report helps in characterizing different productivity ranges in terms of Productivity/worker, Area under Fruit and Veg, Fertilizer use/ha, Cropping Intensity, NIA

TABLE II. DESIGN OF REPORT ON DISTRIBUTION OF DISTRICTS UNDER VARIOUS CATEGORIES

State	Very Low <V1	Low V1 to V2	Average V2 toV3	High V3 to V4	Very High >V4	Overall b
State 1	d11	d12	d13	d14	d15	b1
State 2	d21	d21	d23	d24	d25	b2
.	.	.	.	.	.	.
State i	di1	di2	di3	di4	di5	bi
.	.	.	.	.	.	.
State n	dn1	dn2	dn3	dn4	dn5	bn
Overall a	a1	a2	a3	a4	a5	B

* dij represents the number of districts of ith state falling under jth range where j= 1, 2, .. 5, i = 1, 2, .. n.

* aj and bi, represent the total number of districts falling under jth range and ith state respectively where j= 1, 2, .. 5, i = 1, 2, .. n.

* B represents the total number of districts used from input data.

* V1, V2, V3 and V4 are the cut-off points for the productivity ranges.

The second report helps in characterizing different productivity ranges in terms of Productivity/worker, Area under Fruit and Veg, Fertilizer use/ha, Cropping Intensity, NIA (Table 4).

TABLE III. DESIGN FOR REPORT OF DIFFERENT CHARACTERISTICS OF CATEGORISED DISTRICTS

Productivity category	Productivity /Agriculture worker (Rs/ha)	Area Under Fruit & Veg (%)	Fertilizer Use/ha(NSA) (kg/ha)	Cropping Intensity (%)	NIA (%)
Very Low	R1	P1	K1	C1	I1
Low	R2	P2	K2	C2	I2
Average	R3	P3	K3	C3	I3
High	R4	P4	K4	C4	I4
Very High	R5	P5	K5	C5	I5

Where Rj, Pj, Kj, Cj, Ij represents total productivity per agriculture worker in Rs/ha, total area under fruits and vegetables in percentage, total fertilizer use per unit of Net Sown Area in kg/ha total fertilizer use per unit of Net Sown Area in kg/ha total net irrigated area in percentage for jth category of agricultural productivity respectively and j varies from 1, 2,..5.

C. Design of module

Description of various modules which are used in software for agricultural productivity analysis is given in Table IV.

TABLE IV. DESCRIPTION OF DIFFERENT MODULES IN SAPA

Module Name	Description
Registration	Create new account for a new user
Log In	Allow access of user to the software
Home	Direct user to the homepage
Data Entry	Entry of data in excel format
Analysis	Analysed data already stored in database
Saved File	Update the already stored data with new data
Contact Us	Contact details of the development team
Reference	Research papers involved in developing the software
Help	Online help about the software

D. Database Design

Database has been designed following Codds rules (Date et al., 2006) The database has four tables namely table User, table input, table Tempdata and table range. The purpose of each table is as follows:

Table User contains the information about the user (Table V).

Table input contains the data provided through Excel sheet (Table VI). Table Tempdata contains the calculated average value (Table VII). Table Range contains calculated ranges of the productivity (Table VIII).

TABLE V. DESIGN FOR TABLE USER

Field Name	Data type	Description
id	int	Primary Key
Name	navchar(100)	Name of the user
Email	navchar(100)	Email of the user
Password	Navchar(100)	Password used by the user

Table input contains the data provided through Excel sheet by the user. Required fields in the table are mentioned in Table 8. The table also contains the field vop, PD/GCA, PdperhaNSA, Id and Rangensa. These fields are populated by the software after computation. Rangensa is the name of the category for each year of the districts. The possible values of the ranges are very low, low, average, high and very high.

TABLE VI. DESIGN FOR TABLE INPUT

Variables	Data types	Description
Loc_Id stat	int	Particular Id number given to a state
Loc_iddist	int	Particular Id number given to a district
State	navchar(255)	Name of a state
District	navchar(255)	Name of a district
Year	int	Given particular year
Crop_TA	float	Area of a particular crop of a district for a particular year
Fruit_TA	float	Area of Fruit for a district
Veg_TA	float	Area of vegetable for a district
Crop_TQ	float	Total production of a crop for a particular district for a given year
Fruit_TQ	float	Total production of fruits for a particular district for a given year
Veg_TQ	float	Total production of vegetables for a particular district for a given year
FHP	float	Farm Harvest Price of a crop from published records
Fruit FHP	float	Farm Harvest Price of fruits from published records
Veg FHP	float	Farm Harvest Price of vegetables from published records
NSA	float	Net Sown Area from published records
GCA	float	Gross Cropped Area from published records
NIA	float	Net Irrigated Area from published records
NPK	float	Fertilizer used for a district for a year
Cult_Rural	float	Agricultural worker number
AgL_Rural	float	Agricultural worker number
vop	float	Calculated Value of product
PD/GCA	float	Calculated Productivity per Gross Cropped Area
PDperhaNSA	float	Calculated Productivity per Net sown Area
Id	int	Auto generated
Rangensa	navchar(50)	Category name

Table Tempdata of the database provides template for storing temporary computations done by the software on the user data which is uploaded in Excel sheet format. ID is auto generated primary key. State name and district name from the user data are stored in the field State and Location-dist respectively. Counted number of repetition of district name for various years is also stored in this table. The averaged value of data provided through Excel sheet like VEG_TA, FRUIT_TA, Cult_Rural, Agl_Rural, NCA, GCA, NIA are calculated using the counted number of repetition of district and stored in Table VII.

TABLE VII. DESIGN FOR TABLE TEMPDATA

Field Name	Data type	Description
id	int	Primary Key
State	nchar(100)	Name of the state
Location_dist	nchar(100)	Name of the district
avg distcount	int	Number of district name repeated for various year given
avgPDperhaNSA	float	Average productivity per hectare of a district
VEG_TA	float	Average vegetable area of a district
FRUIT_TA	float	Average fruit area of a district
Cult_Rural	float	Average agricultural workers number
Agl_Rural	float	Average agricultural worker numbers
NCA	float	Average net cropped area of a district
GCA	float	Average gross cropped area of a district
NIA	float	Average net irrigated area of a district
Rangsnsa	nvarchar(50)	Name of the category of productivity under which the district is fall

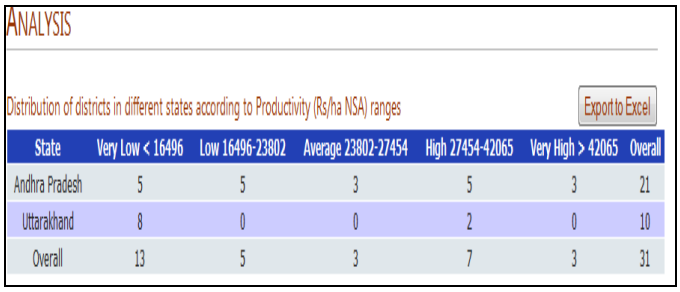
The value of ranges of productivity through which districts are categorised as very low, low, average, high and very high producing districts are stored in table Range in field Valuerange and corresponding category name is stored in field Range.

TABLE VIII. DESIGN FOR TABLE RANGE

Field Name	Data Type	Description
id	int	Primary Key (auto)
Range	nchar(50)	Name of the productivity category
Valuerange	nvarchar(50)	Value of productivity range which define category

IV. IMPLEMENTATION AND TESTING

Implementation was done using three tier architecture using user interface layer using HTML, C# Application layer 2, and SQL server 2008 as Data Base Layer3. More details about three tier architecture are available in any text book on web application development (Grove 2010; Powell, 2001). The results shown in screen I and Screen II have been verified using manual calculations. These result can be downloaded in the form of excel file by clicking the Export to Excel button of the tables. Homepage of the software SAPA is shown in Screen III. The data for the analysis can be provided by the user using Excel sheets prepared by him as per the structural details available in SAPA (screen IV).


ANALYSIS

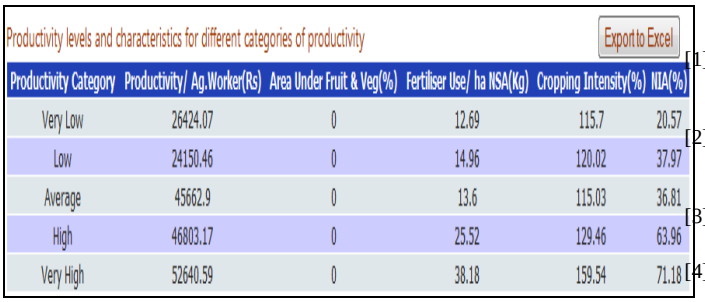
Distribution of districts in different states according to Productivity (Rs/ha NSA) ranges

Export to Excel

State	Very Low < 16496	Low 16496-23802	Average 23802-27454	High 27454-42065	Very High > 42065	Overall
Andhra Pradesh	5	5	3	5	3	21
Uttarakhand	8	0	0	2	0	10
Overall	13	5	3	7	3	31

Fig. 3. Screen I. Result for distribution of districts in different states according to Productivity

Let v1 is mean-(0.5*standard deviation), v2 be mean, v3 be mean+(0.25*standard deviation) and v4 be mean + (1.25*standard deviation). Now, 'very low' are the districts whose value is less than v1, low between v1 and v2, average between v2 and v3, high between v3 and v4, and very high are greater than v4. Further the characteristics of each category of productivity are analyzed and shown in Screen II.


Productivity levels and characteristics for different categories of productivity

Export to Excel

Productivity Category	Productivity/ Ag.Worker(Rs)	Area Under Fruit & Veg(%)	Fertiliser Use/ ha NSA(Kg)	Cropping Intensity(%)	NIA(%)
Very Low	26424.07	0	12.69	115.7	20.57
Low	24150.46	0	14.96	120.02	37.97
Average	45662.9	0	13.6	115.03	36.81
High	46803.17	0	25.52	129.46	63.96
Very High	52640.59	0	38.18	159.54	71.18

Fig. 4. Screen II. Result for productivity levels and its characteristics

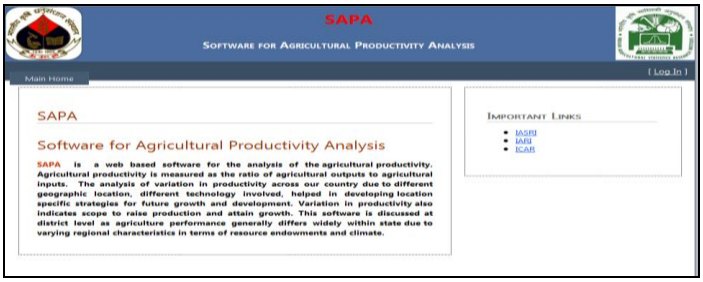


Fig. 5. Screen III. Home Page before Login

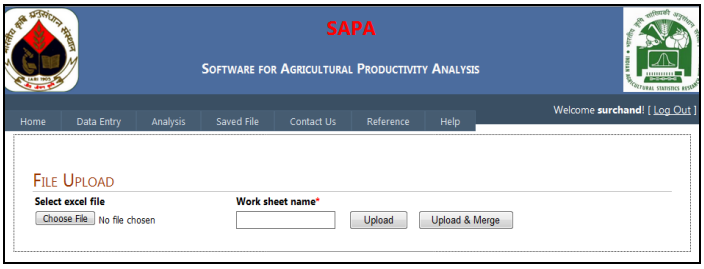


Fig. 6. Screen IV. Data Entry page

V. CONCLUSIONS

Software process model explains the requirement specifications, design for input, output, database and computational requirement. In this paper the software development life cycle of SAPA computation software is presented from its conception to its implementation stage. The process model helped to develop SAPA software that can fulfil the requirements of agricultural researchers. SAPA can provide online facility to analyse agricultural productivity on being hosted through a web server. It can save time by doing calculations automatically and generating reliable results very quickly. The software is user friendly and does not demand expertise of computer programming. User can register, login, compute, see results and save result in Excel file for further processing using client interface online.

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