Mathematical Model for Prediction of Sustainability of "Online off-campus Paperless Admissions" System

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Abstract—For last two decades Indian Governments are geared up to provide good governance in different spheres of administration by adopting IT as a tool. A number of e-Governance projects are being initiated worldwide, however, success rate of such projects is alarming, studies says it is somewhere between 30-40%. Therefore, need felt for a 'prediction model' of sustainability for projects to save resources from going waste/unutilized out of the un-successful projects. In this regard, the system of "Online Off-campus Paperless Admissions" a initiative by the Government of Haryana, Department of Technical Education since 2006, studied to formulate a mathematical model using SEM (Structural Equation Modeling) for prediction of sustainability. This system streamlines the admissions process across AICTE approved courses across the State Universities, Colleges of Engineering, Management, Pharmacy and Polytechnics to achieve transparency, to minimize human interference and to provide students and parent's friendly system which could also minimize travel burden on them. Eligible students can apply and submit choices of disciplines and institutions and can also pay fees in banks sitting at home or from any nearby internet point. Finally, Seat allotment letter can be downloaded by the successful students to report in the allotted institute for documents verification and taking admission. Big achievement of this system is Transparency, 'NO fear of leakages and NO human interference in allotment of seats. On its success many other states have also followed the system. However, it is difficult to ensure, the success of the developed system in different conditions of Technological platforms, Planning, Implementation, Management, Support and Functionality requirements. Therefore, to formulate the Mathematical Model using SEM a data set of 114 institutions processed using the LISEREL 9.2 to know the relationships between Observable and Latent variables helping to predict sustainability of like e-governance initiatives. The data inputs to the model consists of adoption of technology and 28 other parameters on Planning (Resources, Cost and Duration), Design & Development (Scalable, Technology Independent, Requirement, Requirements, Branding, Secure), Implementation & Measurement (Ownership, Institutionalization, Testing, Operation), Support (Training, Capacity building, Change Management Maintenance), Participation (Students & Parents, Banks, Institutions), Reliability (Quality, Quantity, Continuity, Performance), Sustainability (Satisfaction, Benefits, Availability, Functionality, Income). . Result of the study produces mathematical equation of sustainability model, Index of Sustainability which ranges between 0.705 to 3.927 and Standard Deviation and RMSEA 0.118 and analysis for Goodness Fit for the model, also recommended methodology for decision making about the project.

Index Terms— Prediction, Sustainability, Online admissions, Structural Modeling equation, Mathematical Model

1. INTRODUCTION

Web based admission workflow systems were less successful during 1995-2003 in the country mainly due to less penetration of Internet-web-based technology among public as well as less techno savvy officials in the institutions. The Department of Technical Education, Govt. of Haryana, in 2006 took bold decision and get developed &implemented the web based system of admissions through NIC across the state for admission to Engineering, Architecture, Management, Pharmacy, Hotel Management and Diploma level courses through AICTE approved Govt. / Govt. Aided / Private Institutions and University departments. Table-1 shows the number of institutions participated in the year 2006 & 2016 along with number of seats. Besides streamlining of admission process, the objective of online admission system was to provide a transparent, hassle free system of admissions with minimum human interference and minimized travel burdens on students and parents. The increased participation of number of institutions itself depicts that system is sustaining and have adoptability and popularity.

Table:1 Technical Institutions and Annual intake

#	Type of institution	No of institutions		Annual intake	
	Year of Admissions	2006	2016	2006	2016
1	Engineering Institutes	41	137	36070	90830
2	MBA Institutes	34	115	3142	8771
3	MCA Colleges/UTDs	32	44	1805	2760
4	Pharmacy Colleges	27	30	2900	1786

5	BHMCT College	3	-	180	-
6	Polytechnics	42	178	25250	92526
	Total	179	504	69347	196673

Sustainability of the online admissions system as and when implemented in any other State can be predicted by modeling. This paper discusses prediction of sustainability of the online admission system using a Mathematical Model. The model is build from the project data and analyzed by using the Structural Equation Modeling (SEM); a statistical method of multi variance analysis. SEM with latent variables is routinely used in social science research and is of increasing importance in biomedical applications (Duson et al.2005). In environmental research, SEM has been used for investigating the interaction of submerged plants with environmental factors (Hung et. al., 2007).The information work flow of the online system of admissions resemble with the information flow give by Creamer, Michael B,(2002) Technology Utilization in the Field of Counseling, Action Research Exchange Journal spring 2002,Vol.1,Retrieved from figure:1

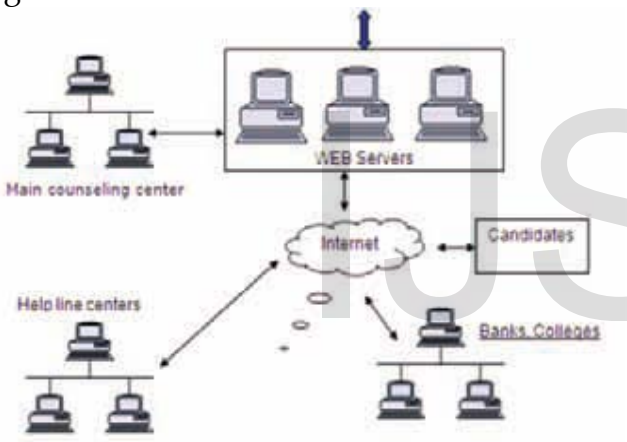

Figure:1 Technical Diagram of information flow

2. METHODOLOGY

2.1 System Development & Implementation Strategy

The National Informatics Centre (NIC), is entrusted to accomplish the task of study, software development, testing & implementation of paperless entrance examination & web based On-line off-campus counseling ensuring paper less admissions to all technical courses. To build the model of sustainability, online admission data of last 8-9 years of different participating institutions of State has been studied along with other prominent factors which affect sustainability. State wide implementation of the system and handling of admissions data online is solely the responsibility of the State Govt. department and Participating Institutions. The net result of sustainable implementation is seen in the figure-2.

2.2 Change Management and Analysis.

The study was conducted using a case study approach. Data selection has been done by observing the online admission systems database which is available on central server. Interactions were held with the respective officer-in-charge of admissions at participating intuitions by calling them in knowledge sharing programmes at centralized location every year, it helps in collection of segregated change requirements, review and incorporation in the system. The data were quantitative and qualitative ones that consist of physical location &condition of institutions, technology updates and infrastructure, ownership, availability and usability of technology, availability of operational manpower and admission data etc.

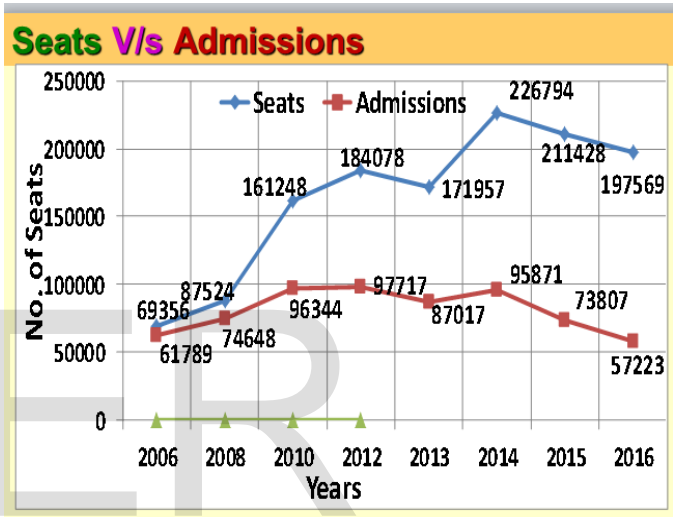

Figure:2 A Line graph showing Admissions and Seats

2.3 Situation before IT Initiatives

Manual handling of lacs of applications received on paper for checking, sorting, and dispatch of admit cards and processing of results within stipulated time frame, on the other hand students and parents always afraid of postal delays and losses of documents and consequently traveling to the Board's office at State HQ for getting duplicates.

Students did not have choices to appear in the exams on a date & time of their choice.

Fear of leakage of the question papers, human interference in evaluations and preparation of merits

Calling all students for counseling at a single location for entire State, resulted in heavy rush at one point, all participants have to travel to the counseling place, it becomes difficult for organizers to manage within the limited resources, also it becomes more difficult for female candidates when schedule timings over runs and they wait for their turn till late in the evening.

No transparency in availability of seats, Candidates do not get enough time for selection of streams and institutions, they are bounded to opt the stream and institution whatever was available & shown to them on paper chart by the counseling team

No iterative method of seat allotment

No Transparent sliding and up gradation of seats in subsequent rounds of counseling

No digital data processing and availability at different levels. Deposition of fees by students was through bank demand drafts and was very costly and cumbersome.

2.4. Development of Data-Driven Model

The model built in this research was a qualitative one; the model based on qualitative data; and can be applied to predict a phenomenon based on qualitative data and not solely on quantitative data of admissions. Development of the model begins from the theoretical model that was tested by using indication test. For development of this model, online admission data of last 8-9 years of different participating institutions of State has been studied which needed for training of the participants as well as for development and validating of the model, respectively. SEM has used in development of the model. SEM with the complete structure consists of two main parts, the measurement model (relationship between observed and latent variables) and the structural model (which describes the relationship among latent variables). The model is expressed as mathematical equations. The two types of equation are described as follow:

1. Measurement Model Equation:

- Equation of measurement model of independent variables:

$$\mathbf{X = \Lambda_x \xi + \delta} \qquad \mathbf{(1)}$$

- Equation of measurement model of Dependent variables:

$$\mathbf{Y = \Lambda_y \eta + \varepsilon} \qquad \mathbf{(2)}$$

2. Structural Model Equation:

$$\mathbf{\eta = B\,\eta + \Gamma\xi + \rho} \qquad \mathbf{(3)}$$

Where:

X = q×1 vector of observed variables of ξ
Λ_x= q×n matrix of coefficients relating X to ξ
ξ = n×1 vector of independent latent variables
δ= q×1 vector of measurement errors for X
Y= p×1vector of observed variables of η
Λ_y = p×m matrix of coefficients relating Y to η
η= m×1 vector of dependent latent variables
ε= p×1vector of measurement errors for Y
B= m×m matrix of coefficients for the Dependent latent variables
Γ= m×n matrix of coefficients for the independent Latent variables
ρ = m×1vector of latent (structural) errors

2.5. Development of Mathematical Equation

Based on results of SEM, the Mathematical equation is developed on the basis of Mathematical Model depicted in the figure 3 & 4. The equations consists of vectors and matrices that are constructed from the model. The equation can be used for predicting sustainability of the online admissions system. Solution of this equation is obtained with the help of MATLAB & LISREL software.

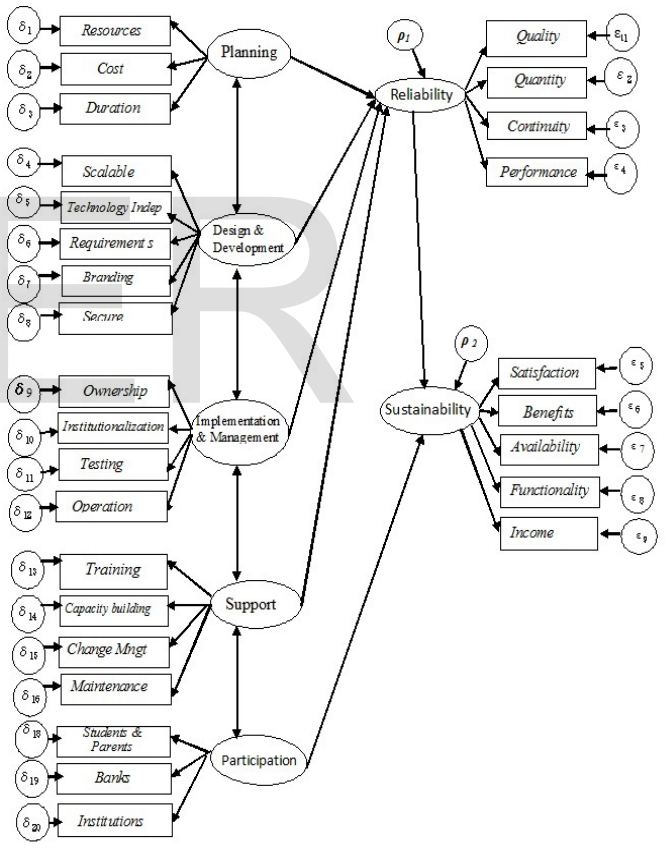

Figure-3 Path Diagram of model that depicts influence of variables to the sustainability.

2.6 Derivations details of equations

Details of derivations of equations of Measurement models and Structural model are as under using the mathematical model shown in the figure-4 & 5

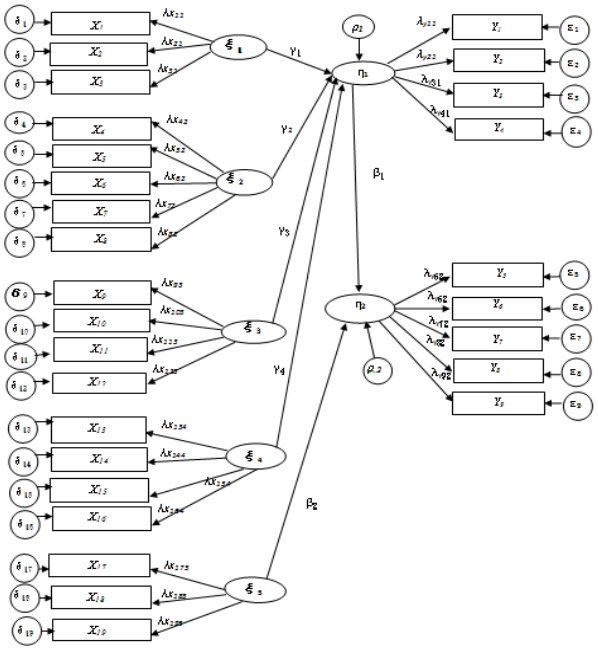

Figure-4 Model of sustainable Online admission system in mathematical notation.

We have 19 observable manifest variables (X) of independent variables of ξ in the model i.e. vector/set of observed variable of X. Path diagram (Fig.6) of measurement Model of X variables through CFA also called confirmatory factor analysis Model. The Matrix of such variables is formed as under: where,

$$X=\begin{bmatrix}X_1\\X_2\\:\\:\\X_{19}\end{bmatrix}_{19X1} \quad \xi=\begin{bmatrix}\xi_1\\\xi_2\\:\\:\\\xi_5\end{bmatrix}_{5X1} \quad \delta=\begin{bmatrix}\delta_1\\\delta_2\\:\\:\\\delta_{19}\end{bmatrix}_{19X1}$$

Matrix Λx[18x5] ....19 linear equations are as under

$X_1 = \lambda x_{11}\xi_1 + \delta_1$

$X_2 = \lambda x_{21}\xi_1 + \delta_2$

$X_3 = \lambda x_{31}\xi_1 + \delta_3$

$X_4 = \lambda x_{42}\xi_2 + \delta_4$

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$X_{18} = \lambda x_{185}\xi_5 + \delta_{18}$

$X_{19} = \lambda x_{195}\xi_5 + \delta_{19}$

Hence equation for Measurement Model of observed variables 'X' i.e. manifest variables of factor ξ(independent latent variable) form following matrix & Equation ...1

$$\begin{matrix}&&\xi1&\xi2&\xi3&\xi4&\xi5\end{matrix}$$

$$\begin{bmatrix}X_1\\X_2\\X_3\\:\\:\\X_{18}\end{bmatrix}=\begin{bmatrix}\lambda_{11}&0&0&0&0\\\lambda_{21}&0&0&0&0\\\lambda_{31}&0&0&0&0\\0&0&0&0&0\\0&\lambda_{42}&0&0&0\\&\lambda_{52}&0&0&0\\-&-&-&-&-\\-&-&-&-&-\\-&0&0&0&\lambda_{185}\end{bmatrix} x \begin{bmatrix}\xi_1\\\xi_2\\\xi_3\\\xi_4\\\xi_5\end{bmatrix}+\begin{bmatrix}\delta_1\\\delta_2\\\delta_3\\\delta_4\\\delta_5\end{bmatrix}$$

$$\mathbf{X=\Lambda_x\xi+\delta} \qquad \text{..... 1}$$

We have 9 numbers of Y observable variable i.e. manifest variables of the dependent latent variable of η_1 and η_2 as per the Path diagrams of measurement model of Y (Fig.8) dependent variable through CFA also called Confirmatory Factor Analysis Model. The equation relationship of such variables can be formed as under:

$$Y=\begin{bmatrix}Y_1\\Y_2\\:\\:\\Y_9\end{bmatrix}_{9X1} \quad \eta=\begin{bmatrix}\eta_1\\\eta_2\end{bmatrix}_{2X1} \quad \text{and } \epsilon=\begin{bmatrix}\epsilon_1\\:\\:\\\epsilon_9\end{bmatrix}$$

ΛY=[ ]9X2 Following equation can be formed as:

$Y_1 = \lambda y_{11}\eta_1 + \epsilon_1$

$Y_2 = \lambda y_{21}\eta_1 + \epsilon_2$

$Y_3 = \lambda y_{31}\eta_1 + \epsilon_3$

$Y_4 = \lambda y_{41}\eta_1 + \epsilon_4$

$Y_5 = \lambda y_{52}\eta_2 + \epsilon_5$

$Y_9 = \lambda y_{92}\eta_2 + \epsilon_9$

$$Y=\begin{bmatrix}Y_1\\Y_2\\:\\:\\Y_9\end{bmatrix}_{9X1}=\begin{bmatrix}\lambda_{11}&0\\\lambda_{21}&0\\\lambda_{31}&0\\\lambda_{41}&0\\0&\lambda_{52}\\0&\lambda_{62}\\0&\lambda_{72}\\-&\lambda_{82}\\-&\lambda_{92}\end{bmatrix}\eta=\begin{bmatrix}\eta_1\\\eta_2\end{bmatrix}+\begin{bmatrix}\epsilon_1\\\epsilon_2\\\epsilon_3\\:\\\epsilon_9\end{bmatrix}$$

$$\mathbf{Y=\Lambda_Y\eta+\epsilon} \qquad \text{----------2}$$

$$\begin{matrix}&\eta&&\xi&&&\\\eta1&\eta2&\xi1&\xi2&\xi3&\xi4&\xi5\end{matrix}$$

$$\eta 1 = 0 \quad 0 \quad \gamma_{11}\xi_1 + \gamma_{12}\xi_2 + \gamma_{13}\xi_3 + \gamma_{14}\xi_4 + 0 + \rho_1$$
$$\eta 2 = \beta 21 \quad 0 \quad 0 \quad + \quad 0 + 0 \quad + \gamma_{25}\xi_5 + \rho_2$$

$$\begin{bmatrix}\eta_1\\ \eta_2\end{bmatrix} = \begin{bmatrix}0 & 0\\ 0.975 & 0\end{bmatrix}\begin{bmatrix}1\\ 1\end{bmatrix} + \begin{bmatrix}0.450 & -0.71 & 0.008 & 0.646 & 0.221\\ 0 & 0 & 0 & 0 & 0\end{bmatrix}\begin{bmatrix}1\\ 1\\ 1\\ 1\\ 1\end{bmatrix} + \begin{bmatrix}0.001\\ 0.001\end{bmatrix}$$

$$\begin{bmatrix}\eta_1\\ \eta_2\end{bmatrix} = \begin{bmatrix}0.926\\ 0.904\end{bmatrix}$$

$\eta = \beta\eta + \Gamma\xi + \rho$ ----------3

Where ;

$\eta \rightarrow \begin{bmatrix}\eta_1\\ \eta_2\end{bmatrix}_{mx1}$ Endogenous variables (Dependent Latent) where m=2

$\xi \rightarrow \begin{bmatrix}\xi_1\\ \xi_2\\ \vdots\\ \xi_5\end{bmatrix}_{nx1}$ → Exogenous variables (Independent latent)

$\gamma \rightarrow \begin{bmatrix}Y_1\\ Y_2\\ \vdots\\ Y_9\end{bmatrix}_{px1}$ → Observed manifest variables of η

$X \rightarrow \begin{bmatrix}X_1\\ X_2\\ \vdots\\ X_{19}\end{bmatrix}_{qx1}$ = Observed manifest variables of ξ

$\rho = \begin{bmatrix}\rho_1\\ \rho_2\end{bmatrix}_{mx1}$ = Structural err of latent variable of η

$\varepsilon = \begin{bmatrix}\varepsilon_1\\ \varepsilon_2\\ \vdots\\ \varepsilon_5\end{bmatrix}_{px1}$ = measurement error of variable Y

$\delta = \begin{bmatrix}\delta_1\\ \delta_2\\ \vdots\\ \delta_{19}\end{bmatrix}_{qx1}$ = measurement error of variable X

$$\mathbf{\Lambda x}_{[19x5]} = \begin{bmatrix}\lambda_{11} & 0 & 0 & 0 & 0\\ \lambda_{21} & 0 & 0 & 0 & 0\\ \lambda_{31} & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 0\\ 0 & \lambda_{42} & 0 & 0 & 0\\ 0 & \lambda_{52} & 0 & 0 & 0\\ - & - & - & - & -\\ 0 & 0 & 0 & 0 & \lambda_{195}\end{bmatrix}_{qxn}$$ where q=19, n=5

$$\Lambda_{y[9x2]} = \begin{bmatrix}\lambda_{11} & 0\\ \lambda_{21} & 0\\ \lambda_{31} & 0\\ \lambda_{41} & 0\\ 0 & \lambda_{52}\\ 0 & \lambda_{62}\\ 0 & \lambda_{72}\\ - & \lambda_{82}\\ - & \lambda_{92}\end{bmatrix}_{pxm}$$ where p=9, m=2

$$\beta = \begin{bmatrix}0 & 0\\ \beta_{21} & 0\end{bmatrix}_{mxm}$$ where m=2

$$\Gamma = \begin{bmatrix}\gamma_{11} & \gamma_{12} & \gamma_{13} & \gamma_{14} & 0\\ 0 & 0 & 0 & 0 & \gamma_{25}\end{bmatrix}_{mxn}$$

Where $\Lambda x_{[18x5]}$, $\Lambda y_{[9x2]}$, $\beta_{[2x2]}$ and $\Gamma_{[2x5]}$ are coefficients matrices of X to ξ, Y to η, dependent latent variable of η &independent latent variables of ξ.

3. ANALYSIS

3.1. Factors Affecting Sustainability

The mathematical model has derived using SEM. The SEM shows the factors that influence sustainability as illustrated in Figure 3 & 4. Magnitude of the influences is shown by the regression weight and loading factor values as listed in Table 2, also on the path diagram (fig. 5) processed using LSREL 9.2. Error of model that is expressed as root mean square error of approximation (RMSEA) is 0.118. The influence of some variables to the sustainability, resulted by this study, confirms many previous studies as described in Table 3.

3.2. Mathematical Model of Sustainability

Model of online admission system as depicted in Figure 3 & 4 is illustrated again in Figure 5 that how relationship between observable and Latent variables are illustrated and corresponding mathematical equations are constructed, where λ is loading factor of relationship between observed and latent variables, γ is regression coefficients between exogenous (independent) variables and endogenous (dependent) variables, and β is regression coefficient

between endogenous variables and other independent variables.

Basic Eqn of SEM are Eqn (1), (2) & (3). By substituting Equation (1) and Equation (2) into equation (3), the model of sustainability equations are obtained as follows

$$\eta = B\eta + \Gamma\frac{(X-\delta)}{\Lambda x} + \rho \quad \text{.....(4a)}$$

$$\eta = B^*\eta + \Gamma^*(\Lambda x \backslash (X-\delta)) + \rho \quad \text{..... (4b)}$$

From Equation (1) to (4b), there are matrices of vectors that can be obtained from Figure-5 & Table-2 by entering the matrices and vectors above, equation (4b) becomes

$$\begin{bmatrix}\eta_1\\ \eta_2\end{bmatrix} = \begin{bmatrix}0 & 0\\ 0.975 & 0\end{bmatrix} x \begin{bmatrix}1\\ 1\end{bmatrix}_{\text{assumption}} +$$

$$\begin{bmatrix}0.450 & -0.71 & 0.008 & 0.646 & 0.221\\ 0 & 0 & 0 & 0 & 0\end{bmatrix} x$$

$$\left[\begin{bmatrix}0.461 & 0 & 0 & 0 & 0\\ 0.383 & 0 & 0 & 0 & 0\\ 0.633 & 0 & 0 & 0 & 0\\ 0 & 0.310 & 0 & 0 & 0\\ 0 & 0.320 & 0 & 0 & 0\\ 0 & 0.385 & 0 & 0 & 0\\ 0 & 0.231 & 0 & 0 & 0\\ 0 & 0.323 & 0 & 0 & 0\\ 0 & 0 & 0.01 & 0 & 0\\ 0 & 0 & -0.037 & 0 & 0\\ 0 & 0 & -0.021 & 0 & 0\\ 0 & 0 & -0.009 & 0 & 0\\ 0 & 0 & 0 & 0.383 & 0\\ 0 & 0 & 0 & 0.473 & 0\\ 0 & 0 & 0 & 0.795 & 0\\ 0 & 0 & 0 & 0.285 & 0\\ 0 & 0 & 0 & 0 & 0.679\\ 0 & 0 & 0 & 0 & 0.779\\ 0 & 0 & 0 & 0 & 0.759\end{bmatrix} \backslash \begin{bmatrix}0.600\\ 0.478\\ 0.861\\ 0.557\\ 0.463\\ 0.558\\ 0.283\\ 0.483\\ 0.001\\ -0.039\\ -0.022\\ -0.011\\ 0.562\\ 0.691\\ 1.068\\ 0.396\\ 0.903\\ 1.157\\ 1.002\end{bmatrix} - \begin{bmatrix}0.195\\ 0.186\\ 0.196\\ 0.388\\ 0.249\\ 0.240\\ 0.188\\ 0.266\\ 0.124\\ 0.147\\ 0.150\\ 0.215\\ 0.251\\ 0.221\\ 0.139\\ 0.236\\ 0.148\\ 0.157\\ 0.126\end{bmatrix} + \begin{bmatrix}0.001\\ 0.001\end{bmatrix}\right]$$

---------- **(5)**

On solving the above equation using Matlab following results are obtained. However, the values of Factor loadings of X on ξ (Λx matrix) has been obtained using LISREL 9.2 (Linear Structural Relations). Also the values of X observed variables (indicators of ξ) have obtained from OUTPUT of LISREL 9.2 in the above matrix, hence following estimates of latent variables obtained

$$\begin{bmatrix}\eta_1\\ \eta_2\end{bmatrix} = \begin{bmatrix}0.926\\ 0.904\end{bmatrix} = \begin{bmatrix}\text{Reliability}\\ \text{Sustainability}\end{bmatrix}$$

The equation can predict the reliability η1 and sustainability η2 . Further To obtain observed variables (Indicators) Eqn. 2 need to be rearranged to become Eqn 6

$$Y = \begin{bmatrix}\gamma_1\\ \gamma_2\\ \gamma_3\\ \gamma_4\\ \gamma_5\\ \gamma_6\\ \gamma_7\\ \gamma_8\\ \gamma_9\end{bmatrix} = \begin{bmatrix}0.586 & 0\\ 0.726 & 0\\ 0.823 & 0\\ 0.862 & 0\\ 0 & 0.763\\ 0 & 0.579\\ 0 & 0.673\\ 0 & 0.684\\ 0 & 0.545\end{bmatrix} x \begin{bmatrix}0.926\\ 0.904\end{bmatrix} + \begin{bmatrix}0.119\\ 0.110\\ 0.0996\\ 0.0829\\ 0.126\\ 0.140\\ 0.160\\ 0.152\\ 0.183\end{bmatrix} \text{.....(6)}$$

$$Y = \begin{bmatrix}\gamma_1\\ \gamma_2\\ \gamma_3\\ \gamma_4\\ \gamma_5\\ \gamma_6\\ \gamma_7\\ \gamma_8\\ \gamma_9\end{bmatrix} = \begin{bmatrix}0.7417\\ 0.7823\\ 0.8618\\ 0.8812\\ 0.8707\\ 0.7051\\ 0.8168\\ 0.8196\\ 0.7149\end{bmatrix} \text{.....(7)}$$

Following Path basic diagram captured after processing of data set of 114 different engineering data samples obtained from the respective colleges ;

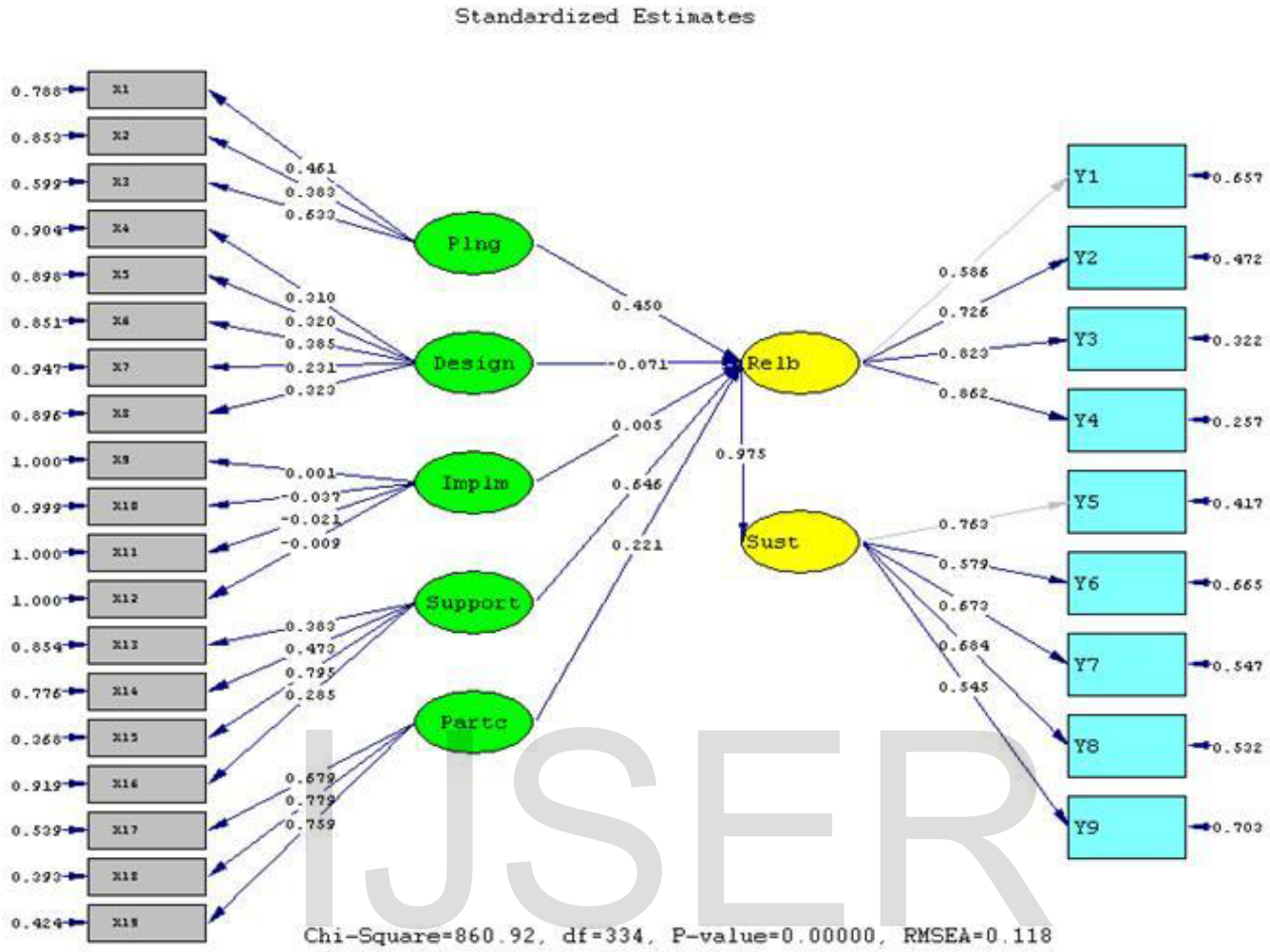

Figure:5 Path Diagram of Basic Model obtained using LISREL 9.2 . (Automated diagram of Figure:3) It shows Factor Loadings & Regression weights

3.3 Sustainability Index

Sustainability index states total value of five indicators namely user satisfaction, financial benefits, system availability, required functionality and Revenue (Income) generation from the system (Y5, Y6, Y7, Y8, Y9) as listed in equation 7. Value of each indicator is based on the assessment criteria that have highest possible value of 1 and the lowest value of 0. Thus, value of sustainability index will range from 0 to 5. Sustainability index is classified into three type i.e. high, medium and low sustainability. This classification is made by considering the following:

Results of simulation using the model shows that maximum and minimum value of sustainability index that may occur are 3.927 and 0.705, respectively, the average value of sustainability index in the study area is 0.785, the standard deviation of sustainability index in the study area is 0.072198.

Based on these considerations, classification of sustainability is determined to be three levels as follows:

- Low sustainability, if sustainability index
  = 0.705 to 1.576
- Medium sustainability, if index
  = 1.577 to 2.394
- High sustainability, if index
  =2.395 to 3.927

Table-2 Loading Factors and Regression weight Estimates

Relationship			Estimate	Standardized Estimates	Standard Error (S.E.)	Error (ρ)
Reliability	←	Planning	0.450	0.450	0.162	0.004
Reliability	←	Design &Dev	-0.071	-0.071	0.160	***
Reliability	←	Imp & Management	0.005	0.005	0.0129	***
Reliability	←	Support	0.645	0.646	0.209	***
Sustainability	←	Reliability	0.986	0.975	0.144	0.0011
Resources (Technology & Manpower)	←	Planning	0.600	0.461	0.195	***
Cost	←	Planning	0.478	0.383	0.186	***
Time-line	←	Planning	0.861	0.633	0.196	***
Quality	←	Reliability	0.870	0.657	0.199	***
Quantity	←	Reliability	0.952	0.472	0.110	***
Continuity/Consistency	←	Reliability	1.155	0.322	0.0996	***
Performance	←	Reliability	1.194	0.257	0.0829	***
Satisfaction	←	Sustainability	1.048	0.417	0.126	***
Benefits	←	Sustainability	0.749	0.665	0.140	***
Functionality	←	Sustainability	0.949	0.532	0.152	0.0011
Availability	←	Sustainability	0.946	0.547	0.160	***
Income	←	Sustainability	0.748	0.703	0.183	***
Ownership	←	Imp &Management	0.001	0.001	0.124	***
Institutionalization	←	Imp &Management	0.039	-0.037	0.147	***
Testing	←	Imp &Management	-0.022	-0.021	0.150	***
Operation	←	Imp &Management	-0.011	-0.009	0.215	***
Scalable	←	Design &Dev	0.557	0.310	0.388	0.033
Technology Independent	←	Design &Dev	0.463	0.320	0.249	***
Requirements	←	Design &Dev	0.558	0.385	0.240	***
Branding	←	Design &Dev	0.283	0.231	0.188	***
Secure	←	Design &Dev	0.483	0.323	0.266	***
Training	←	Support	0.562	0.383	0.251	***
Capacity Building	←	Support	0.691	0.473	0.221	***
Change	←	Support	1.068	0.795	0.139	***
Maintenance	←	Support	0.396	0.285	0.236	***
Students	←	Participation	0.903	0.679	0.148	***
Banks	←	Participation	1.157	0.779	0.157	***
Institutions	←	Participation	1.002	0.759	0.126	***

Note: ***: ρ<0.001 (values taken from OUT table of LISREL 9.2 standardized errors)

Table:3 Factors affecting sustainability of the system

Factors	Reference
Planning (Resources, Cost & Time duration)	The International Journal of Sustainable Development and Planning, Volume (2) 2007, issue 4, Sutton (2004), Musonda (2004)
Feasible, scalable , Tech Independent & Secure Design &Development	Sustainable Design Research Guide http://libguides.philau.edu/sustainable, Hasic, T. 2002. Strategic project management and systems approach in the reconstruction process , Kibert, 2005)
Management & Ownership	Kaliba (2002); Davus and Iyer (2002), Musonda (2004)
Full-fillment of requirements	Dr. Maya Thomas & Dr. M J Thomas J-124, UshasApts, 16th Main, 4th Block, Jayanagar, Bangalore - 560 011, National printing press
Implementation	7 Steps to Successful Systems Implementation Oct 01, 2010 9:30 PM By Curt Barry
Operational. Support	Brikke and Bredero (2003), sarmento (2001)
Training	GyoSik Moon (2002). A web-based Training System for Evaluating Online Educational Resources
Change management	Todnem, R. (2005) 'Organisational Change Management: A Critical Review', Journal of Change Management, 5, 4, pp.369 – 380
Community Participation	Mawanza (2003); Lockwood(2004)

3.4. Prediction of Sustainability

The decision making methodology for implementation of the system, comprises of few steps as shown in Figure-5 which are needed to be taken before a project plan is developed or implemented or rolled-out. The contents and requirements of the project plan should be reviewed for feasibility, sustainable development & implementation.

The first step is data inventory, includes19 independent data items which required for running the reliability &sustainability model as shown in figure-4, follows as under:

a.) Availability of Resources(X1);It is assumed that data pertaining to resources like Technological platform, connectivity, Technical Manpower and Institutions (colleges) etc as required in development and implementation of the system are available.

b.) Project cost (X2); data about estimated project costs and sources of funding, easy availability and payment schedule & term as required for execution of different component of the project.

c.)Time duration (X3);during the planning phase itself, it is always better to chalk out the time line that is activities time schedule to achieve different mile stones for project implementation.

d.) Scalability (X4);The system design should be flexible to add/delete any institution and should seamless function for 'n' number of institutions, courses and students at any point of time.

e.)Technology Independent(X5);Design should be technology independent that is the system should run on any technology platform proprietary or open source.

f.) Functional requirements (X6);the System design should meet all functional requirements.

g.) Branding (X7);The system should have some trusted brand name for quality assurance to the users.

h.) Security (X8) The design system should secure and should not vulnerable to any external un authorize access.

i). Ownership (X9); The system should be owned by some agency or Govt., for better look ups, growth and implementation.

j.) Institutionalization(X10) The system once developed should have a option in the system legally for effective implementation.

k.) Testing (X11), the system should be well tested and required trail runs should be performed before formally launch

l.) Operationalization (X12), during implementation, system must be operated properly, for that trained manpower, computer and electricity resources should be in place.

m) Training & Capacity Building (X13)&(X14)of all the identified staff of institutions responsible for implementation & execution of the system is an essential part.

n.) Change management (X15)i.e the system should meet the local requirements, if any &maintenance (X16)i.e corrective action in the machinery due to breakdown /damage control.

o.) Participation of Students, banks and institutions (X17) & (X18) & (X19) is must, because the system has been developed for them, number of participating students, institutions reflects about the system sustainability and also help the owner and developers in scaling of technology, machinery etc.

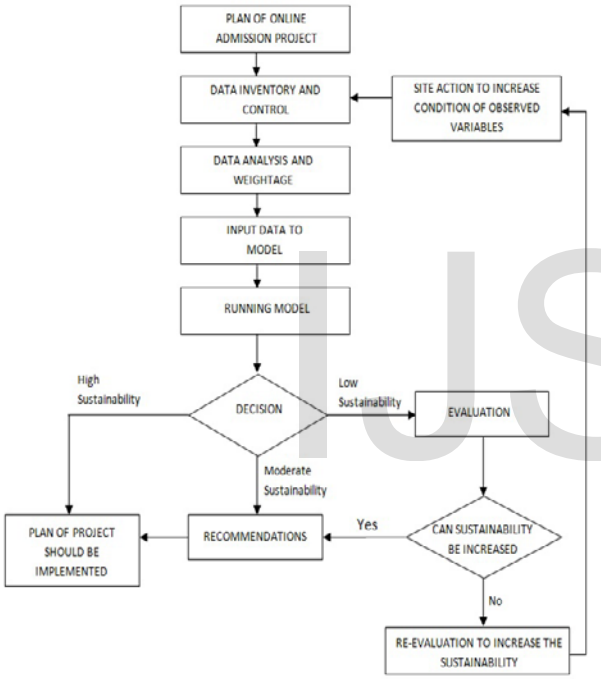

Figure:6 Broad Flowchart of Online admission system

4. Conclusion

This study, design, development and implementation of Online admission system has been carried out by taking admissions sample from 114 technical institutions under Department of Technical Education, Government of Haryana.. Results of the study are formation of the mathematical equation to give prediction estimates of Sustainability Model, Level of sustainability, and recommended methodology for decision-making of online off-campus admission system's sustainability. This methodology includes the steps that must be done before a project plan implemented.

The mathematical equation can predict the sustainability (η_2) on the basis of indicator variables namely satisfaction, benefits, availability, functionality, Revenue (income) where as reliability (η_1) indicators are quality, quantity, continuity and performance. This equation needs twenty eight data items; on Planning, Design & development, Implementation & mangt, Support & participation including resources, selection of technology, investment cost, technical operation, institutional management, design, development & implementation , existence and ability of operator, mechanism of change management, operation cost, and community participation etc. The predicted sustainability index which is classified into following 3 levels ;

-Low sustainability, if sustainability index

= 0.705 to 1.576

-Medium sustainability, if index

= 1.577 to 2.394

-High sustainability, if index

= 2.395 to 3.927

5. Impact Analysis

1. Huge cost benefits on account of resources mobilization could saved by the user department. Best & Low cost solution was provided by NIC / NICSI by charging only nominal facilitation charges.

2. e-readiness increased among technical institutions in the state, manpower wise as well as infrastructure wise. More than 1500 officials of various technical institutions were imparted special ICT operations training.

3. e-governance awareness increased among the candidates who shall would be students of various technical institutions. More than 2,00,000 students submitted their choices during multi number of counseling

4. ICT Infrastructure created/improved in most of the technical institutions specially in the rural/semi urban areas

5. Number of candidates registered for different counseling are as mentioned in Table-1 & Figure-2 above

6. Goodness of Fit of the Model

Degrees of Freedom for (C1)-(C2)	334
ML Ratio Chi-Square (C1)	860.917(P=0.0000)
Degrees of Freedom for Difference	0
Chi-square Difference (C1)	1.172 (P =1.0000)
Estimated Non-centrality Parameter (NCP)	526.917
90 Percent Confidence Interval for NCP	(444.057;617.443)
Minimum Fit Function Value	7.552
Population Discrepancy Function Value	4.622

90 Percent Confidence Interval for F0	(3.895 ; 5.416)
Root Mean Square Error of Approximation (RMSEA)	0.118
90 % Confidence Interval for RMSEA	(0.108 ; 0.127)
P-Value for Test of Close Fit (RMSEA < 0.05)	0.000
Chi-Square for Ind. Model (378 df)	1803.600
Normed Fit Index (NFI)	0.523
Non-Normed Fit Index (NNFI)	0.582
Parsimony Normed Fit Index (PNFI)	0.462
Comparative Fit Index (CFI)	0.630
Incremental Fit Index (IFI)	0.641
Relative Fit Index (RFI)	0.460
Root Mean Square Residual (RMR)	0.208
Standardized RMR	0.117
Goodness of Fit Index (GFI)	0.648
Adjusted Goodness of Fit Index (AGFI)	0.572
Parsimony Goodness of Fit Index (PGFI)	0.533

Measurement Model of Y manifest variables is given below

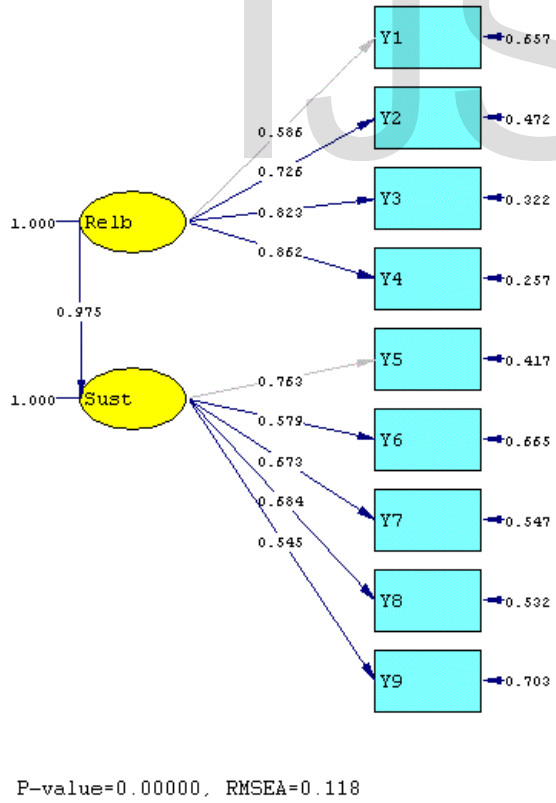

Figure: 7 Path Diagram of Standardized estimates of Measurement Model of dependent Latent variables and their Indicators(Observable) variables of Y

Measurement Model of X manifest variables is given below

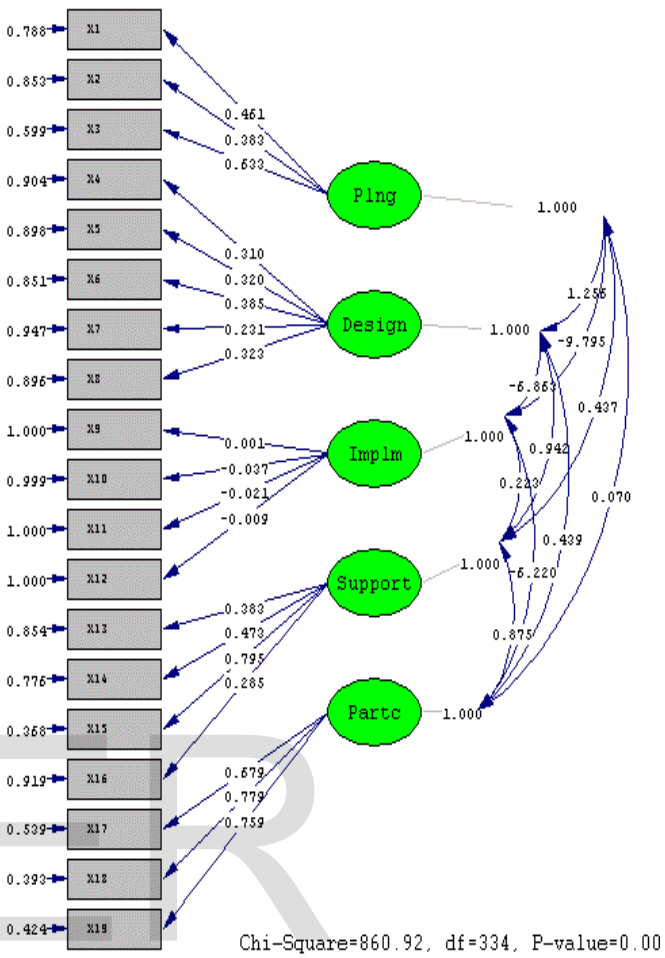

Figure: 8 Path Diagram of Standardized estimates of Measurement Model of Independent Latent variables and their Indicators(Observable) variables of X.

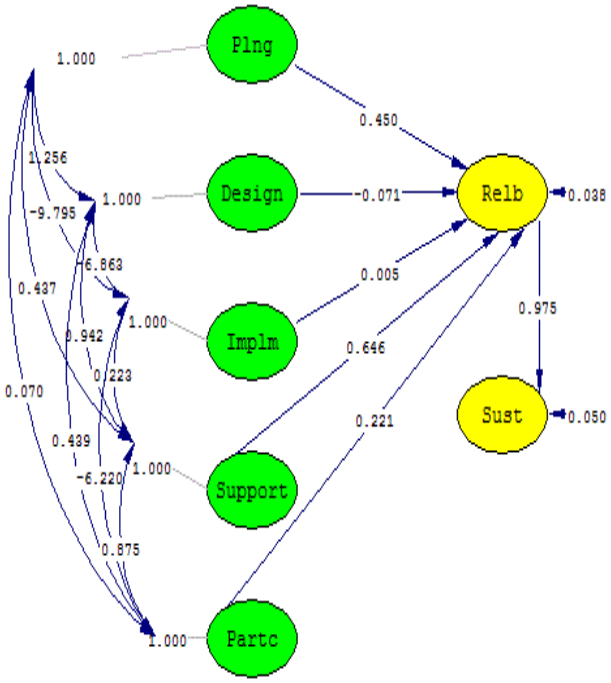

Figure:9 Path diagram of Standardized estimates of Structural Model of independent & dependent Latent variables.

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