International Journal of Advanced Research in Engineering Technology & Science

ISSN: 2349-2819

Email: editor@ijarets.org Volume-7, Issue-7 July- 2020 www.ijarets.org

MATHEMATICAL MODEL FOR COMPUTATION OF SUSTAINABILITY OF ONLINE OFF-CAMPUS PAPERLESS ADMISSION SYSTEM

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ABSTRACT

Indian governments have been using IT as a tool for the past 20 years to provide excellent governance in various areas of administration. Many e-Governance projects are being started around the world, however the success rate of such projects is frightening, with studies estimating it to be between 30 and 40%. Therefore, a "prediction model" of sustainability for projects was deemed necessary in order to prevent resources from being wasted or left unused from the unsuccessful ventures. In this context, the Government of Haryana, Department of Technical Education studied to create a mathematical model utilising SEM (Structural Equation Modeling) for prediction of sustainability. This project was known as the "Online Off-Campus Paperless Admissions" system. This system simplifies the admissions process for AICTE-approved programmes at State Universities, Colleges of Engineering, Management, Pharmacy, and Polytechnics in order to achieve transparency, reduce human interference, and provide a user-friendly system for students and parents that may also reduce their travel expenses. Students who meet the requirements can apply, submit their preferences for academic programmes and institutions, and pay fees in banks while at home or from any nearby internet location. The successful candidates can download the seat allotment notice to report to the designated institute for document verification and admission. This system's biggest accomplishments are transparency, "NO fear of leakages," and "NO human influence in seat allocation." Many other states have adopted the approach as a result of its success. It is challenging to guarantee the development system's performance under various technological platform, planning, implementation, management, support, and functional requirements. The likelihood that a product will "perform" a necessary function under specified "operation conditions" for a specified "period of time" is known as reliability. Reliability also refers to the repeatability of results as assessed by bulk power system reliability standards; in other words, would the study's conclusions be the same if it were repeated? If so, then both the data and the product are trustworthy.

KEY WORDS: Mathematical Model, Computation Of Sustainability, Online Off-Campus Paperless, Admission System.

INTRODUCTION

The goal is to build a Mathematical Model and Equations to quantify and forecast IT systems' sustainability and efficiency in order to measure and analyse their behavioural characteristics in order to provide an early understanding of project success or failure. In the planning and implementation stage of e-Governance initiatives, the measure of sustainability will help to minimise their failure rates. As Westney (2001) explained, failure is usually caused by various reasons: non-feasibilities, resistance and shortcomings that are usually overlooked by planners at the beginning and noticed at the later stage of the Project Life Cycle (PLC), by the time the project consumes a lot of resources and public funds.

If we recognise that e-governance projects have become an integral part of institutional changes that are an ongoing phase of government functioning, efforts are being made to bring about sustainable reforms around the world. Good governance has become an unavoidable part of change and can be accomplished by e-governance. For more than two decades, Indian governments have already geared in this direction and have launched State and Nation-wide e-governance mission mode projects (NeGP-Digital India) for hassle-free delivery of services to common people well in time in all important socio-economic sectors with the requisite transparency.

A number of e-governance initiatives under major socio-economic sectors taken by the ministries and government departments concerned have been studied to enhance the delivery of services, including land records, agriculture, transport, jobs, judicial courts, health education, social welfare, finance, taxation, MGNREGA, PDS, IRCTC, online admissions, passport, Bhoo-Lekh, Lokwani, e-Sewa, Voter-II, IRCTC, online admissions. Shaking hands with technological giants has taken over the design, production and implementation of ICT-driven systems (IT-GoI Initiative, 2003, 2009). For various administrative reasons in the public interest, governments liberally allocate funds for the production, execution and maintenance of IT projects for better MIS generation. However, it is not only difficult and expensive to create and execute e-government programmes, but also tedious to provide hassle-free services within the legal framework to the people at large. Few programmes are effectively implemented and have a positive impact on society, but many projects are partly implemented or can not be implemented at all. However some of the measures well executed in one State, despite public need, the same ventures could not see daylight in other States. SAI (Supreme

Auditor Institution of India) studies indicate that with 35 percent as complete failures and 50 percent as partial failures, only 15 percent of e-government projects can be termed as successful.

In order to reduce the rate of failure or delays of e-governed projects, in order to gain new information that can quantify and forecast the viability and efficiency of IT systems (projects) on the basis of project planning, architecture, technology, results, availability, benefits, features, risks, public participation, etc.

MATHEMATICAL MODEL

Mathematicians frequently separate the cosmos into two distinct categories: mathematics and everything else, or the rest of the world, which is also referred to as "the actual world." There is a widespread misconception that the two are unrelated to one another; yet, nothing could be further from the truth in this regard. When we use mathematics to get an understanding of a situation that exists in the real world, and then utilise that understanding to maybe take action or even to forecast the future, we are guaranteeing that both the real-world situation and mathematics are taken seriously.

The sense in which the term "mathematical model" is used that is explained in this article is the opposite of the sense in which the term is used when referring to an item that is intended to illustrate a mathematical concept.

A description of a system that makes use of mathematical concepts, notations, and terminology is referred to as a mathematical model. The act of creating a mathematical model is referred to as "mathematical modelling," and the phrase describes the process itself. Mathematical models are utilised not only in the natural sciences (including physics, biology, earth science, and meteorology) and engineering disciplines (including computer science and artificial intelligence), but also in the social sciences (including economics, psychology, sociology, and political science). Mathematical models are utilised to the greatest extent by physicists, engineers, statisticians, operations research analysts, and economists. In this particular investigation, the SEM was useful in assisting with the explanation of a system, the investigation of the effects of various components, and the formulation of hypotheses regarding the behaviour of IT systems.

Mathematical models can be dynamical systems, statistical models, differential equations, or game theoretic models, as shown in Figure 1. These are only some of the possible shapes that mathematical models might take, but there are many more.

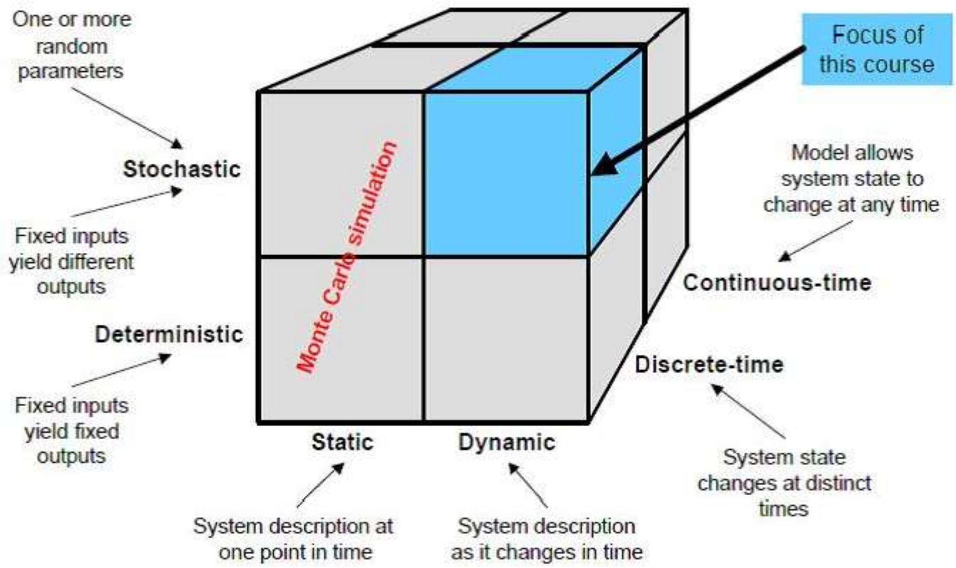

FIG 1. MODEL TYPES

Okubo (1980) has created a taxonomy based on the interrelationships between the variables that we use to describe the mathematical models we have developed and employed in this investigation. Loading factors, weights, regression, etc., are used to characterize relationships. Quantifiable and observable model parameters of interest can be represented using variables. The models used in this analysis are categorised as follows:

Linear Model: Since linearity is a property shared by all mathematical-model operators, the resulting linear models serve as the basis for this study. Nonetheless, nonlinear expressions may also be present in linear models. For instance, a linear model in statistics could presume a linear connection between its parameters, even though the underlying predictor variables are nonlinear.

Dynamic: A static model estimates the system in equilibrium and is therefore time-invariant, while a dynamic model takes into account time-dependent changes in the state of the system, including the relationship, loading factors, and measurement errors.

Explicit model: Given that all model inputs, besides measurement errors and dependent variables, are known. Alternative model geometries and descriptions are shown and described in Figure 2.

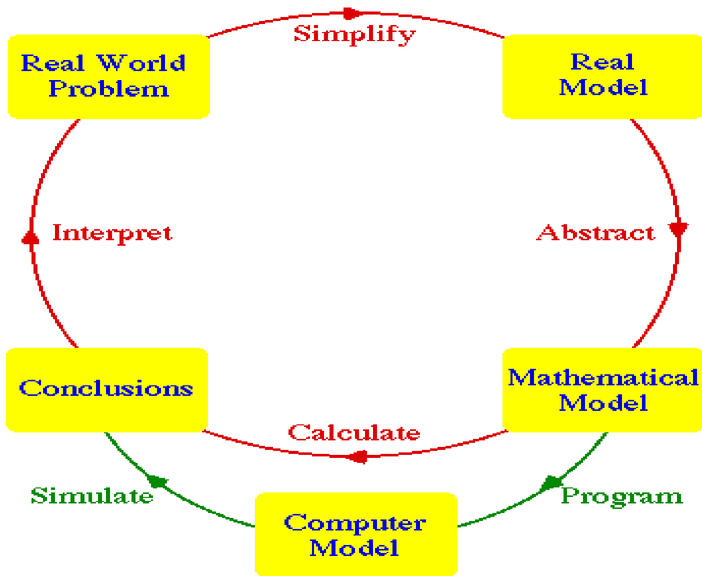

FIG 2 DIVERSE TYPES OF MODELS

Sustainability and reliability are examples of non-observable data elements; we cannot gain them through experiments alone. In order to eliminate non-observable information, it is necessary to conduct experiments and use models. The world is not always amenable to being expressed mathematically. There is always a discrepancy between the data gathered and the truth because of measurement errors. Since it is impossible to account for all of the experiment's parameters in a mathematical model, discrepancies between the two sometimes necessitate a look into the model's flaws.

Mathematical Model of Sustainability

Model has been described for single window Digital University framework has been illustrated again in Figure 3.5 that how relationship between observable and Latent variables are illustrated and correspondingmathematical equations are constructed, where λ is loading factor of relationship between observed and latent variables, λ is regression coefficient between exogenous (independent) variables and β endogenous (dependent) variables, and is regression coefficient between endogenous variables and other dependent variables namely sustainability.

Basic equations of SEM are (1), (2) & (3). By substituting (1) and (2) into (3), the models of sustainability equations are obtained as follows:

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

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

From equation (1) to (4b), there are matrices of vectors that can be obtained from Figure 3.6 and Table 3.4 by entering the matrices and vectors above, equation (4b) becomes

$$\begin{bmatrix}\eta_1\\ \eta_2\end{bmatrix} = \begin{bmatrix}0 & 0\\ 0.403 & 0\end{bmatrix} * \begin{bmatrix}1\\ 1\end{bmatrix}_{assumption} +$$

$$\begin{bmatrix}-0.0640 & -0.0480 & 0.4940 & -0.1240 & -0.1190\\ 0 & 0 & 0 & 0 & 0\end{bmatrix} *$$

On solving the equation (5) below using MATLAB, the following results have been obtained. However, the values of Factor loading of X on ξ (Λx matrix) have 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

$$\begin{bmatrix}\eta_1\\ \eta_2\end{bmatrix} = \begin{bmatrix}0.4466\\ 0.4040\end{bmatrix} = \begin{bmatrix}\text{Reliability}\\ \text{Sustainability}\end{bmatrix}$$

The equation can predict the reliability η_1 and sustainability η_2. Further to obtained observed variables of "Y" (Indicators of manifest variables). Equation (2) needs to be rearranged to become Equation (6)

$$\left[\begin{bmatrix} 0.115 & 0 & 0 & 0 & 0 \\ -0.165 & 0 & 0 & 0 & 0 \\ -0.313 & 0 & 0 & 0 & 0 \\ -0.070 & 0 & 0 & 0 & 0 \\ 0.279 & 0 & 0 & 0 & 0 \\ -0195 & 0 & 0 & 0 & 0 \\ 0.964 & 0 & 0 & 0 & 0 \\ 0.483 & 0 & 0 & 0 & 0 \\ 0 & 2.221 & 0 & 0 & 0 \\ 0 & 0.039 & 0 & 0 & 0 \\ 0 & 0.011 & 0 & 0 & 0 \\ 0 & 0.009 & 0 & 0 & 0 \\ 0 & 0 & 0.967 & 0 & 0 \\ 0 & 0 & 0.904 & 0 & 0 \\ 0 & 0 & 0.744 & 0 & 0 \\ 0 & 0 & 0.288 & 0 & 0 \\ 0 & 0 & -0.131 & 0 & 0 \\ 0 & 0 & 0 & 1.003 & 0 \\ 0 & 0 & 0 & 0.258 & 0 \\ 0 & 0 & 0 & 0.995 & 0 \\ 0 & 0 & 0 & -0.041 & 0 \\ 0 & 0 & 0 & -0.048 & 0 \\ 0 & 0 & 0 & 0.119 & 0 \\ 0 & 0 & 0 & 0 & 0.503 \\ 0 & 0 & 0 & 0 & 0.967 \\ 0 & 0 & 0 & 0 & 0.446 \\ 0 & 0 & 0 & 0 & 0.497 \\ 0 & 0 & 0 & 0 & 0.518 \end{bmatrix} \backslash \begin{bmatrix} 0.1210 \\ -0.1200 \\ -0.4990 \\ -0.0381 \\ 0.5090 \\ -0.2040 \\ 0.5970 \\ 0.5450 \\ 1.4680 \\ 0.0786 \\ 0.00987 \\ 0.0169 \\ 1.7310 \\ 1.6340 \\ 1.4040 \\ 0.3370 \\ -0.2400 \\ 0.6020 \\ 0.4340 \\ 0.5960 \\ -0.0770 \\ -0.0895 \\ 0.1270 \\ 0.5580 \\ 2.0190 \\ 0.5040 \\ -0.4400 \\ 0.8510 \end{bmatrix} - \begin{bmatrix} 0.4230 \\ 0.2010 \\ 0.8660 \\ 0.1140 \\ 1.1700 \\ 0.4070 \\ 0.0147 \\ 0.3610 \\ 1.7620 \\ 1.6090 \\ 0.3360 \\ 1.5540 \\ 0.2690 \\ 0.3340 \\ 0.6660 \\ 0.4940 \\ 1.3020 \\ 0.00196 \\ 1.0290 \\ 0.00230 \\ 1.4130 \\ 1.3800 \\ 0.4430 \\ 0.3680 \\ 0.4860 \\ 0.4070 \\ 0.2340 \\ 0.785 \end{bmatrix} + \begin{bmatrix} 0.001 \\ 0.001 \end{bmatrix}\right] \qquad \textbf{(5)}$$

$$Y = \begin{bmatrix} \gamma_1 \\ \gamma_2 \\ \gamma_3 \\ \gamma_4 \\ \gamma_5 \\ \gamma_6 \\ \gamma_7 \\ \gamma_8 \\ \gamma_9 \end{bmatrix} = \begin{bmatrix} 0.3660 & 0 \\ -0.0300 & 0 \\ 0.6380 & 0 \\ 0.4650 & 0 \\ 0 & 1.4570 \\ 0 & 0.2450 \\ 0 & -0.3080 \\ 0 & -0.0020 \\ 0 & -0.3870 \end{bmatrix} x \begin{bmatrix} 0.4466 \\ 0.4040 \end{bmatrix} + \begin{bmatrix} 0.0365 \\ 0.1320 \\ 0.2990 \\ 0.3370 \\ 0.1850 \\ 0.2860 \\ 0.3600 \\ 0.3080 \\ 0.1150 \end{bmatrix} \qquad \textbf{(6)}$$

$$Y = \begin{bmatrix} \gamma_1 \\ \gamma_2 \\ \gamma_3 \\ \gamma_4 \\ \gamma_5 \\ \gamma_6 \\ \gamma_7 \\ \gamma_8 \\ \gamma_9 \end{bmatrix} = \begin{bmatrix} 0.2000 \\ 0.1186 \\ 0.5839 \\ 0.5447 \\ 0.7736 \\ 0.3850 \\ 0.2356 \\ 0.3072 \\ -0.0413 \end{bmatrix} \qquad \textbf{(7)}$$

Following Path Diagram along with the labeled values of loading factors, regression weights of relationships of observed and latent variables obtained after processing of dataset of State run Universities using LISREL 9.2.

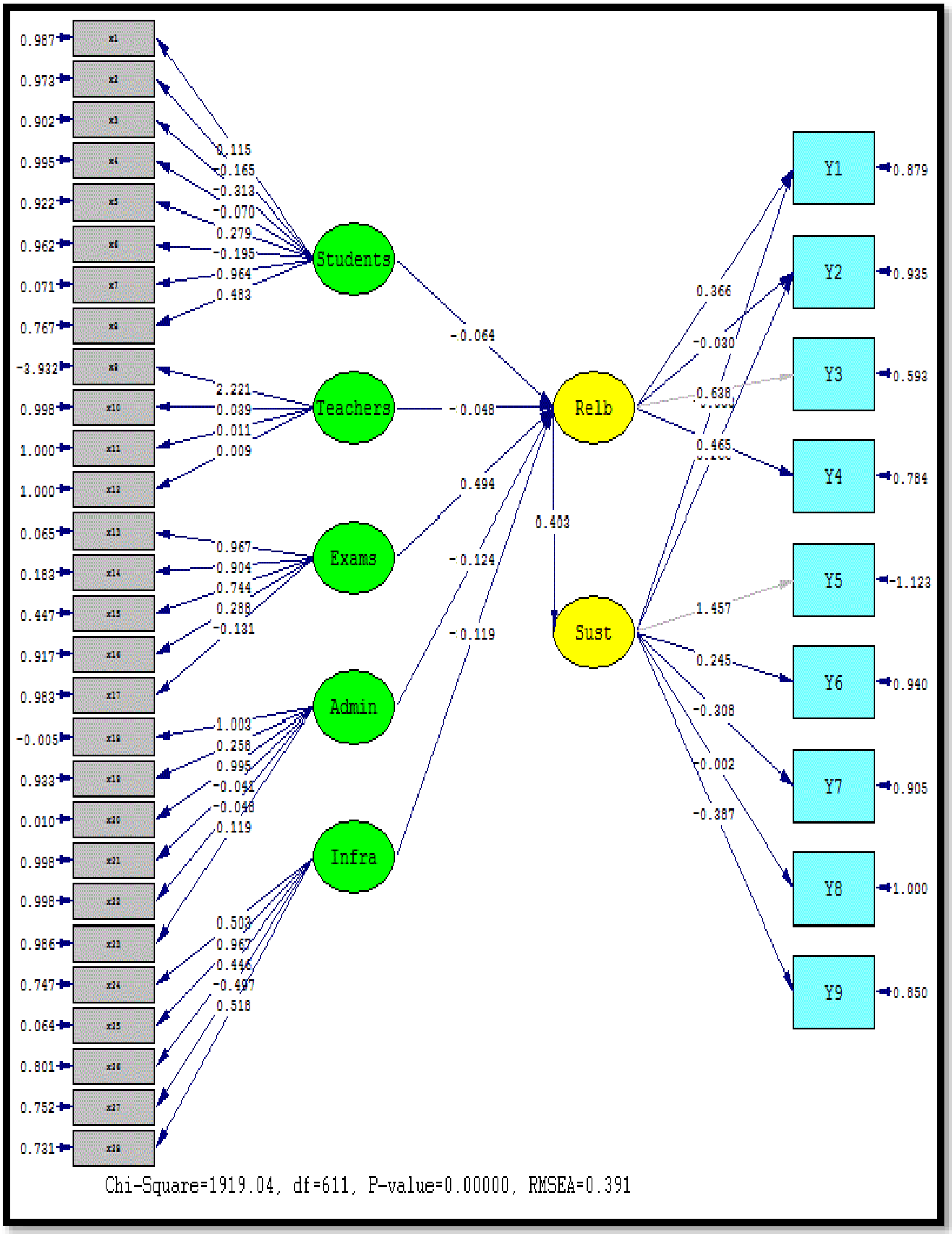

Fig 3 Path Diagram of Basic Model Obtained Using LISREL 9.2 showing factor loadings and regression weightss

Sustainability Index

Sustainability index represents total value of five indicators (Y5, Y6, Y7, Y8, Y9) namely user satisfaction which is indicated by Impact/New change, direct benefits, system availability, required functionality and revenue (income) generation from thesystem as listed in equation 7 above. 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 may range from 0 to 5 on this basis it may be classified into three categories 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 1.6601 and -0.0413 respectively, the averagevalue of sustainability index in the study area is 0.3320 & standard deviation (SD) ofsustainability index in the study area is 0.2946. Also minimum and maximum SD ranges between 0.0374 and 0.6266. Based on these considerations, classification of sustainability lies between 0 & 5 is determined to be of three levels as follows:

Low sustainability, if sustainability index

=-0.0413 to 0.1943

Medium sustainability, if index

=0.1944 to 0.5015

High sustainability, if index

=0.5016 to 1.6601

Since, sustainability lies between 0 to 5 and highest index of this case study is 1.6601 that is too low to predict that the system of Single window system is sustainable.

Therefore, required recommendation as per the investigations shall need to be considered while decision making for development and implementation of single window system of DUF.

Analysis Table showing regression weights, factor loadings and other different Graphical views of the model parameters obtained during processing of data using LISREL have been shown below in subsequent pages.

Table -1 Loading Factors and Regression Weight Estimates

Relationship			Estimate	Standardized Estimates	Standard Error(S.E.)	Error (ρ)
Reliability	←	e-Services (students)	0.0643	-0.064	0.074	***
Reliability	←	e-Services (teachers)	-0.0480	-0.048	0.346	***
Reliability	←	e-Examination processes	-0.494	0.494	1.388	***
Reliability	←	e-Administrative services & support	-0.124	-0.124	0.794	***
Reliability	←	e-Infra support	-0.119	-0.119	2.101	
Sustainability	←	Reliability	0.403	0.403	0.254	***
e-Online admissions	←	e-Services (students)	0.121	0.115	0.423	***
e-document services	←	e-Services (students)	-0.120	-0.165	0.201	***
Digital Lockers	←	e-Services (students)	-0.499	-0.313	0.866	***
Cashless fees	←	e-Services (students)	0.509	0.279	1.170	
e-Hostel application	←	e-Services (students)	-0.204	-0.195	0.407	
e-course material	←	e-Services (students)	-0.0381	-0.070	0.114	
e-library	←	e-Services (students)	0.545	0.483	0.361	
Quality	←	Reliability	0.198	0.366	0.101	***
Quantity	←	Reliability	-0.0271	-0.030	0.288	***

Continuity/ Consistency	←	Reliability	0.703	0.638	0.299	***
Performance	←	Reliability	0.485	0.465	0.337	***
Impacts & changes	←	Sustainability	1.837	1.457	0.185	***
Direct Benefits	←	Sustainability	0.219	0.245	0.286	***

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

Measurement Model of Y manifest variables given below

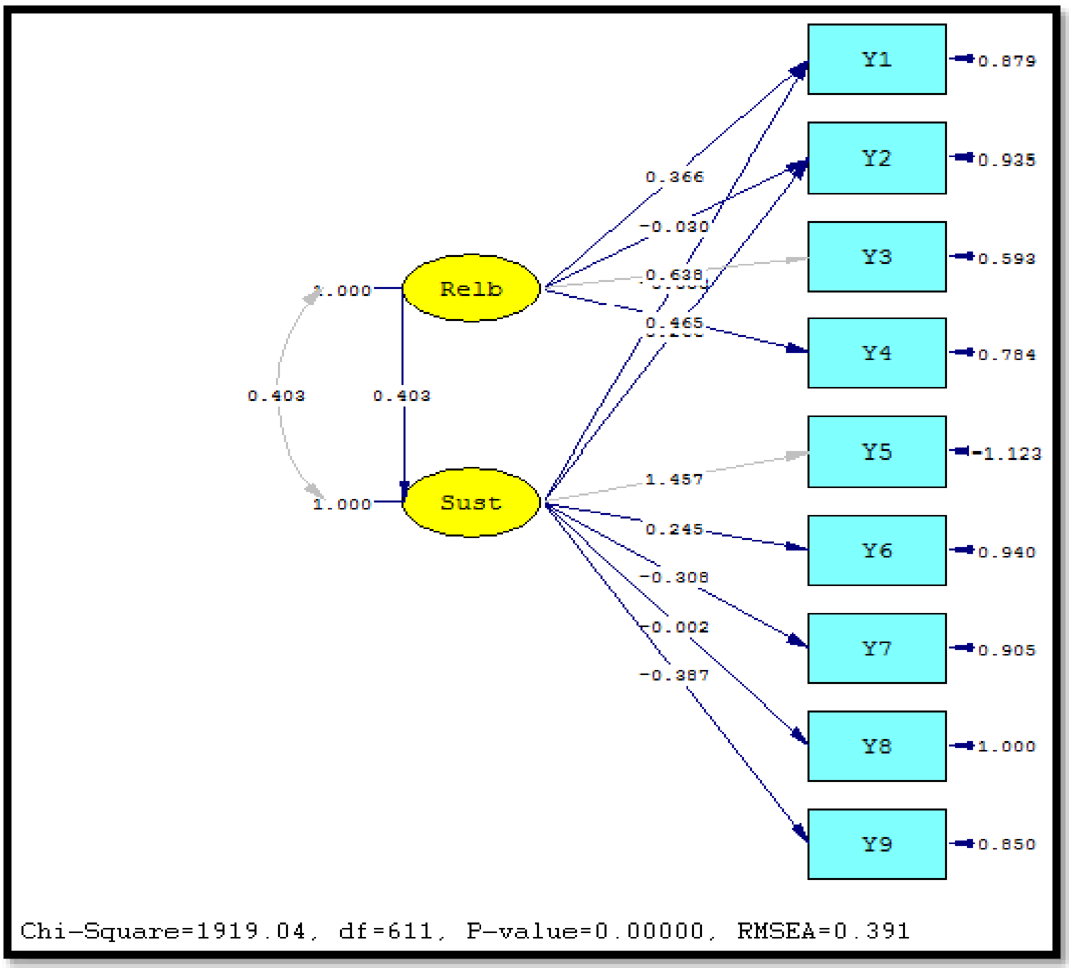

Fig 4 Path Diagram of Measurement Model of Dependent Latent Variables and their observable Y variables.

Measurement Model of X manifest variables is given below in the Figure 5:

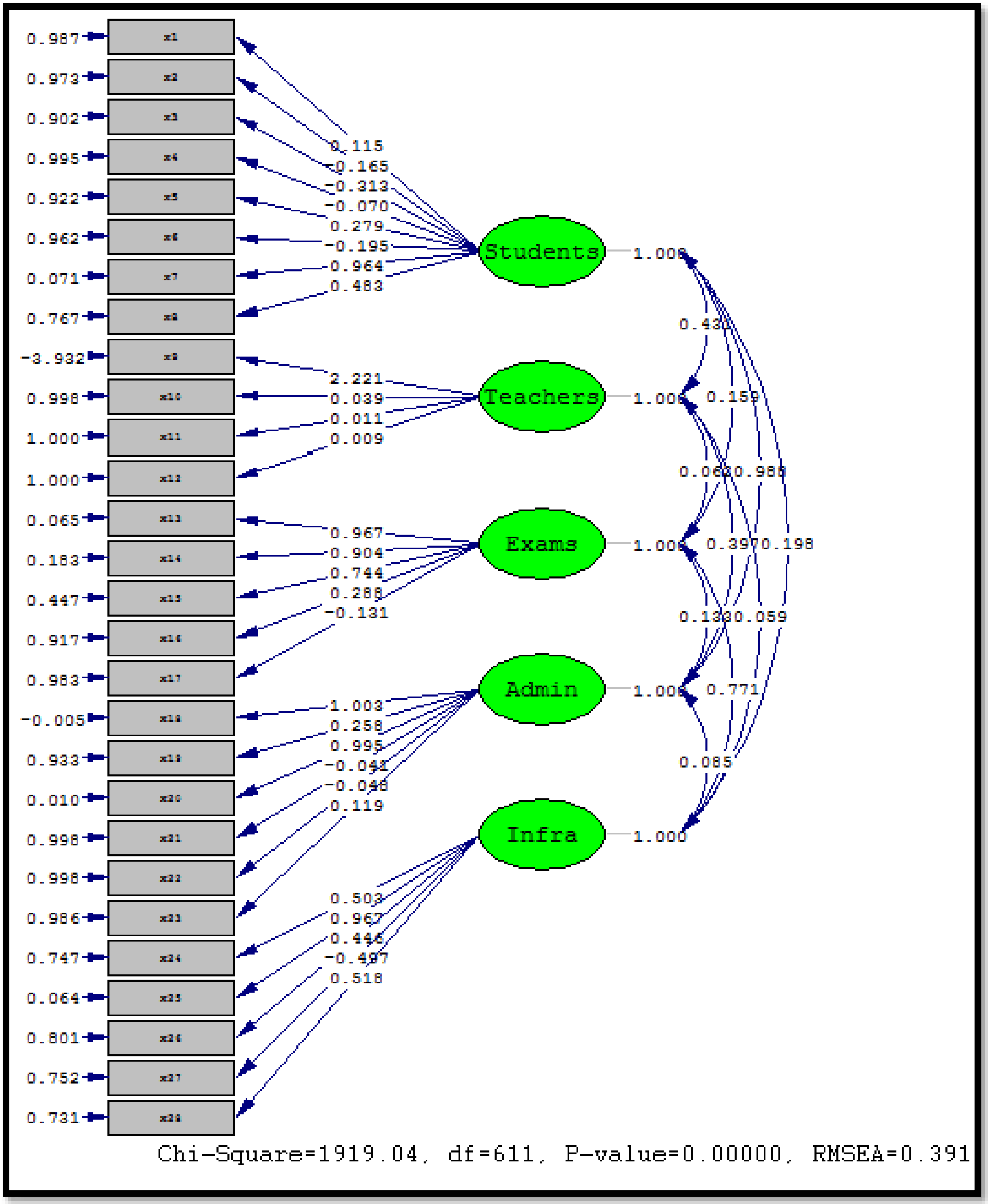

Figure 5 Path Diagram of Standardized estimates of Measurement Model of Independent Latent variables and their observable X variables

Structural Model of Independent and Dependent Latent variables as shown in Figure 3.9:

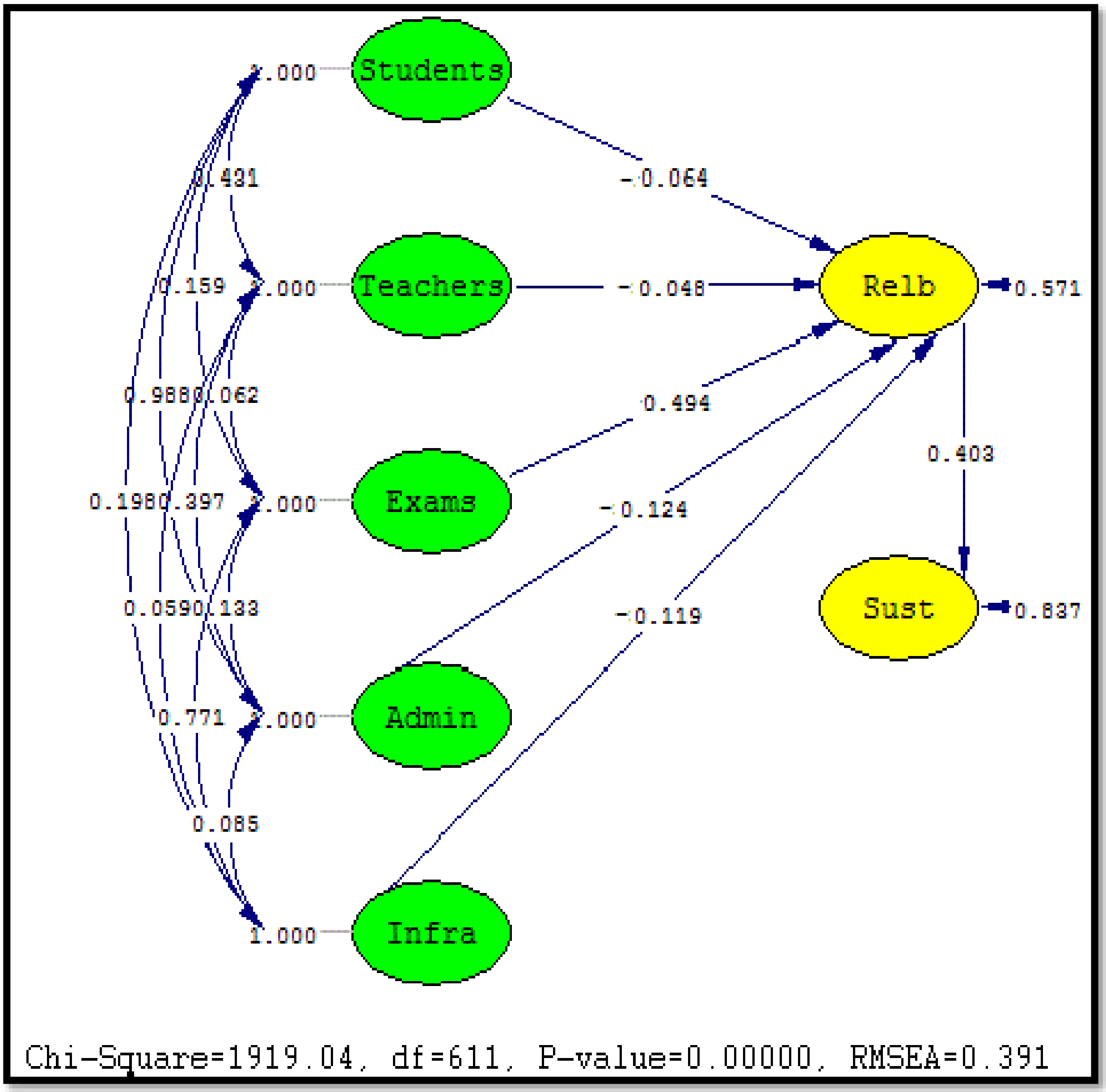

Fig 6: Path Diagram of Standardized Estimates of 'Structural Method of Independent and Dependent Latent Variables'

DISCUSSISONS AND CONCLUSIONS

It is concluded that the Chapter discusses about the implementation status of "Digital University Framework" across the 14 state aided Universities. Study of the system reveals that lot of duplication by all the Universities, neither data securities nor uniformity has found to segregate the data across the Universities, also students and parents are deprived from the benefits of single windows system for admissions to Universities on merit and also not getting various required services online. Therefore, sustainability of the single window system needs to be tested prior to development, implementation and replication. Results of the study are formulation of data model using SEM and deriving the mathematical equations to compute and predict sustainability and its range intervals. The sustainability index varies between 1.6601 and -0.0413 (against the interval 5- 0) It is also pertinent to mention that digitalization in the Universities are ranging from 9% - 53%, which is to be increased to near 100%. This methodology includes the steps that must be taken before a project plan is implemented. Also for decision making, recommendations like validation of Mathematical model using separate sample of dataset, selection of robust technology, core team for DUF design, capacity building, security of database, hiring of system integrator and establishment of help-desks etc may be followed for improved sustainability.

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