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Mathematical Statement of Dynamic Factors Affecting the Development of Electron Government

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Abstract

Today, the development of ICT as a means of opportunity has a great influence on the internal and external governance of the world. It is not a secret that globalization of information and the widespread and effective introduction of electronic technologies in public relations with the state will benefit materially and morally not only the public administration, but also the parties (state, citizen and business). This, in its turn, has given rise to the popularity of e-government. One of the important issues is the study of the important factors that influence the development of e-government in a dynamically changing state of time. The article analyzes the factors influencing e-government in many of the relevant literature. The UNO also studied e-government rating methodology and developed a general mathematical tool for this methodology. As a result of the research, the dynamic nature of the factors influencing e-government system development has been proposed and illustrated in time-dependent retaliatory space.

Keywords: E-government, e-services, e-participation, CSFs, EGDI, EPI, mathematical tool, UNO, Uzbekistan

I. INTRODUCTION (ANALYSIS OF RESEARCH ON THE FACTORS INFLUENCING E-GOVERNMENT)

It is well-known that in any country the e-government implementation is not perfect and effective. The real factors that influence e-government success / maturity / development are poorly studied [1-12]. This implies that there is a need for continuous study of the factors that influence the development of e-government (CSFs - critical success factors) that are diverse and variable in global and regional areas. So far, many researchers have identified many CSFs for effective e-government implementation. However, these success factors are not universal, meaning they are neither universal nor systematic. For example, Altameem (2006) identified [13] factors associated with e-government implementation [12], while Ebbers Van Dick (2007) summarized the factors into groups [14-23]. Fortune & White (2006) has published [21-23] papers on e-government initiatives [12]. When the CSFs in the three studies mentioned above are compared, some of the factors they show are in common. For example, Altameem's (2006) study, "Supporting Senior Management," Fortune & White (2006), "Senior Manager Support," and Ebbers Van Dick (2007), "The presence of senior management," are actually the same it makes sense. This implies that Senior Management Support is needed for e-government implementation.

D. Napitupulu & D.I. Sensuse (2014) worked with Analysis and Synthesis of Research Focusing on CSFs in E-Government and tried to summarize the existing factors. To identify CSFs he searched for 230 articles and conference materials using keywords such as e-Government, Development Impact Factor and Development Factor. The content of these materials, found in IEEE Xplore and Science Direct / Scopus, has 94 issues (48 journals and 46 conferences) related to the problem under consideration, with approximately 600 e-government CSFs identified. It is well-known that when analyzing a large number of textual material, the key elements, terms, concepts and ideas of similarity are taken into account. The researcher used the meta-ethnographic process proposed by Noblit and Hare in the analysis. The Noblite and Hare process consists of seven stages (recruitment, willingness, reading material, interdependence of research, translation from researcher's language, synthesis translation, synthesis expression), and in practice these steps can be consecutive and parallel.

The linkages between the terms and concepts of each research identified during the analysis and synthesis process have been studied and summarized. As a result, [20-23] new CSFs were released.

Many scholars have done research on the detection of CSFs within a single country. At the same time, experts of different levels were recruited from different organizations as respondents and received answers through a special questionnaire-rating system. The collected questionnaires were summarized by specific methodologies and the importance of CSFs was determined. [24].

For example, the study by Ewa Z., Tomasz P. (2013) aims to identify CSFs andcreate model for e-government development

in Poland. In introducing the CSFs model 1) the literature was studied to identify CSFs, 2) the analytical results of all publications were observed the e-government in the Silesian Voivodship region; 3) This model was developed and tested based on Delphi methodology. 22 experts took part in the Delphi method. In particular, 16 staff and 6 professors from the ICT and e-government sectors. Experts answered questions from 1 to 5: "... do the following factors influence the development of e-government?" The Likert scale was used in the assessment (1 - strongly disagree, 2 - disagree, 3 –agree and disagree, 4 - agree, 5 – strongly agree). As a result, the factors are classified into four categories (economic, socio-cultural, technological organizational). All CSFs are considered in three phases: (1) ICT capacity, (2) ICT capacity, and (3) ICT use. The factors identified are based on the economic, socio-cultural, technological and organizational features of e-government construction as follows.

Stage	**Impact factors CSFs**	**Impact**				
		5	4	3	2	1

CSFs in e-government implementation was studied in Jordan by Ali M. AL-Naimat and others (2013). The research included information from Jordanian leaders and decision makers, existing problems and constraints in e-government, CSFs and practical initiatives.In addition, the actual situation with the introduction of e-government in Jordanian ministries was fully analyzed. This study was conducted in three ministries (Ministry of Labor, Ministry of Information Technology and Ministry of Education). Ministries were selected as follows: Ministry of Labor - Accounting for Government-Business Relations (G2B); Ministry of Information Technology - Ministries of various ministries due to use of ICT technologies (G2G);The Ministry of Education is the exchange of information between government and citizens (G2C). A qualitative Nvivo analysis program was selected to analyze the questionnaires and interviews of 30 experts from selected ministries. In implementing e-government, CSFs vary across countries. The study identified the following 10 key factors influencing e-government in Jordan: 1) financing; 2) IT infrastructure; 3) political and legal issues; 4) awareness; 5) support of the leadership (political) of the supreme government body; 6) efficiency of users working on a computer 7) incentive system;8) resistance to change; 9) understanding and strategy; 10) education. These CSFs are grouped into three groups (organizational factors, technological factors, and human factors).

Muhaya FB, Bakry SH, AlAlmaee SM (2015) studied the CSFs in e-government development in the case of Saudi Arabia. In his research, he divided CSFs into 7 levels: 1) international, 2) state, 3) industry, 4) organization, 5) demand, 6) services, and 7) user. He selected 5 key factors for each level.Separate questionnaires have been developed for professionals who meet the levels of the 35 CSFs considered. There were two issues for all factors: (1) the importance of the factor and (2) the current status. Assessment was conducted on 6 scale (0-none, 1-less, 2-less than average, 3-average, 4-higher than average, 5-higher).The questionnaire was attended by 88 experts from the participants of the meeting on the e-Government Development Program YESSER in Saudi Arabia. According to the results, out of 35 factors, 29 are above average and 6 are below average. 4 of these low CSFs belong to the international level and 2 to the user level. It also revealed that there is a significant difference in the overall performance between the factors and their current status. This study concludes that 35 factors need to be further refined, namely the inclusion of dynamic factors such as human factors, management factors and technical factors in CSFs.

H.Fitriani and others (2016) analyzed the scientific publications of scientists engaged in CSFs in e-government. The analysis identified 12 CSFs needed to build e-government within the organization: 1) overview and strategy, 2) technological support, 3) senior management support, 4) human resource availability, 5) change management, 6) effective project management, 7) strong state leadership, 8) business process reorganization, 9) professional development, 10) awareness, 11) communication, coordination and collaboration, 12) organizational culture. A questionnaire with a scale of 1-5 was created to implement the idea of significance.

Respondents were asked by gender, age, education, specialty, and length of service before completing the questionnaire. The study was conducted by the Indonesian Financial Audit Board, which involved IT and Human Resources, Finance bureaus, Strategic Planning Performance Management, and Audit staff and executives. Many of the factors considered in the case have had the greatest impact on e-government, except one factor, the effectiveness of project management, being low. As a result of the study, the e-government development projects in Indonesia need to be effectively implemented.

II. E-GOVERNMENT RATING METHODOLOGY IN UNO

Since 2001, the United Nations has conducted an index of e-government development around the world. The E-Government Development Index consists of two parts, namely EGDI (e-Government Development Index) and EPI (e-Participation Index). These in turn have internal subindex factors.

EGDI	EPI
OSI –online service index	e-information
TII – telecom. infrastructure index	e-advice
HCI – human capital index	e-decision

It should be noted that EPI performance is directly related to OSI. This is because the use of online services only increases the amount of participation. To identify the EGDI is the average of the key subindexes in each country. That is:

$$EGDI = \frac{1}{3}(OSI_{normalized} + TII_{normalized} + HCI_{normalized})$$

Also, for each subindex calculation, it is necessary to define their own internal parameters accordingly. Including

OSI = {primary information service (Emerging information services); wide-spread interactive services (Enhanced information services); Transactional services; integrated service (Connected services)}.

TII = {Mobile-cellula subscribers per 100 people; wired telephone communication (fixed-telephone); wireless broadband access (wireless broadband); wired broadband access (fixed (wired) -broadband); percentage of individuals using the Internet per person (percentage of individuals using the Internet)}.

HCI = {Adult literacy % (adult literacy); % of the total population of primary, secondary and higher education (gross enrolment ratio); the expected academic year (expected years of schooling); actual years of schooling (mean years of schooling).

Before normalizing the three subindex values in the above formula, a separate Z-value (Z-score1) is standardized for each component. This is because, in calculating the total EGDI, the Z-value ensures that the three subindexes to be equal in magnitude, that is, after standardization the Z-value allows comparing each subindex variance. If there is no Z-value standardization, then the EGDI depends on the largest dispersed subindex. The formula for calculating each Z-value is as below:

$$X_{new} = \frac{x - \mu}{\sigma}$$

Here x is standardized primary score, μ is average number of population, σ is standardized value of population. Next, calculating Z value by indexes will be observed.

When summarizing the state's TII in "X" state, the general arithmetic of the five standard indicators is as follows:

TII value = Average (Z-score Internet user + Z-score Fixed telephone + Z-score Mobile telephone + Z-score Active mobile broadband + Z-score Fixed broadband)

For example, if the state value of "X" is 1.3813, the lowest among all states is 1,11358, and the higher is 2,340, then the normalization result will be:

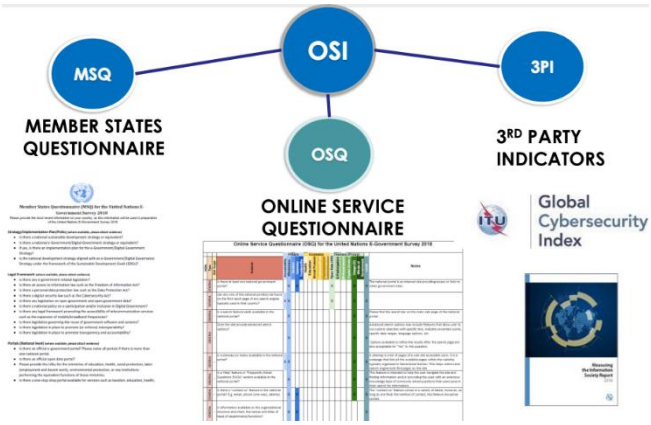
$$TII\ (\text{"}x\text{" state}) = \frac{x - X_{min}}{X_{max} - X_{min}} = \frac{[1.3813 - (-1.1358)]}{[2.3640 - (-1.1358)]} = 0.7192$$

HCIs and OSIs are likewise calculated.

HCI value = 1/3 × Z-score Adult literacy + 2/9 × Z-score Gross enrolment ratio + 2/9 × Z-score Estimated years of schooling + 2/9 × Z-score Mean years of school.

$$HCI\ (\text{"}x\text{" state}) = \frac{[0.8432 - (-3.2354)]}{[1.2752 - (-3.2354)]} = 0.9044.$$

Calculating the value of OSI normalization is complex and conducted in 5 areas (responsibility, efficiency, inclusion, transparency and reliability) on the OSQ (Online Services Questionnaire), the NQR (Membership State Questionaire) and 3PIs.



Resourse: Vincenzo Aquaro (2017)

The number of OSQ requests varies over the years based on modern requirements. In particular, in 2018, 143 questions with "yes or no" answers were developed in 6 thematic areas across 4 stages. Generally, normalization is as follows:

$$OSI\ (\text{"}x\text{"state}) = \frac{[114 - 0]}{[153 - 0]} = 0.7451$$

In the work of A.H. Nishanov, E.S. Babadjanov, and Sh. Saidrasulov (2019) the results of the evaluation of the UNO e-Government system for the period 2001-2018 were analyzed and developed the trend prediction across the factors in the Republic of Uzbekistan.

As we have seen, these key factors are also determined by processing the indicators of other relevant factors internally. These internal factors also contain a number of internal factors, which continue to some extent [25].

III. UNIVERSAL MATHEMATICAL TOOLS TO DETERMINE E-GOVERNMENT DEVELOPMENT

An important issue is to determine which factors to focus on in order to increase the rating of the e-government system, by many years of opportunity and future prospects, and the post-growth development index.

In this section, the mathematical representation and classification of CSFs in the e-government system is aimed at identifying and mathematically predicting low-impact CSFs with a strong impact.

Let us suppose that the maximum rating, which is the highest X0. Also, X0 itself consists of internal factors: $X^0 = (M^0: X_i^1, (\alpha_i^1)^l, \mu^0: \delta^0)(i = \overline{1, n_1})$. Here are the criteria for M0 – base of factor, δ^0 - state of the past, μ^0- factor of influence of previous indicator on the current calculation results, X_i^1- index of factors, α_i^1- weight of factors, $l = \langle -1,\ 1\rangle$ – is the level with any of the values. The criterion is a mathematical operation that has been established between the indicators of the factors determined. Operations can be arithmetic or geometric average mean [10]. Generally, a higher factor is determined by the following formula:

[1] https//www.wikihow.com/Calculate-Z-Scores (How to calculate Z-Scores)

$$X^k = \left[M^k \bowtie \left(\left(\alpha_i^{k-1}\right)^l \cdot X_i^{k-1}\right)\right] \bowtie \mu^0(\delta^0)$$

For example, in the e-government system, these include OSI, TII, HCI. That is,

$$X^0 = \left(X_i^1\right) = (X_1^1, X_2^1, X_3^1) = (OSI, TII, HCI),$$

$$l = 1, \qquad \alpha_i^1 = 1, \qquad (i = \overline{1, n_1})$$

M^0 is the arithmetic mean. Since the value of δ^0 is neglected at this level X^0, the μ^0 criterion is also not applied, that is, $\delta^0 = 0, \mu^0 \in \emptyset$. So,

$$X^0 = M^0 \bowtie \left(\alpha_i^1 \cdot X_i^1\right) =$$

$$\frac{1}{n_1}\sum_{i=1}^{n_1}\left(\left(\alpha_i^1\right)^l \cdot X_i^1\right) = \frac{OSI+TII+HDI}{3}$$

Now, level 2 factors are considered as $X_i^1 (i = \overline{1, n2})$. The following are the UNO subindex factors:

X_1^2– information service; X_2^2– interactive service;

X_3^2– transaction service; X_4^2– integrated service;

X_5^2– mobile subscribers; X_6^2– wired telephone communic.;

X_7^2– wireless broadband access;

X_8^2– wired broadband access; X_9^2– Internet user;

X_{10}^2 – students of primary, secondary and higher education;

X_{11}^2 – adult literacy; X_{12}^2 – the expected academic year;

X_{13}^2 – The actual duration of training;

Weights accordingly are determined as follows:

$\alpha_1^2 = \alpha_2^2 = \alpha_3^2 = \alpha_4^2 = \alpha_{12}^2 = \alpha_{13}^2 = 1.$

$\alpha_5^2 - \alpha_{10}^2 -$ since the weight is about 100 people.

$l = -1$

$\alpha_5^2, \dots, \alpha_{10}^2 = \frac{1}{\text{population)}}, \alpha_{11}^2 = \frac{1}{\text{adult population}};$

Also, sub-level 2 subindexes can be expressed as follows:

$$X_1^1 = \left(X_i^2\right)\left(i = \overline{1, n_2^1}\right),$$

$$X_2^1 = \left(X_i^2\right)\left(i = \overline{n_2^1 + 1, n_2^2}\right),$$

$$X_3^1 = \left(X_i^2\right)\left(i = \overline{n_2^2 + 1, n_2^3}\right),$$

$$n_2 = n_2^1 + n_2^2 + n_2^3 = 4 + 5 + 4 = 13$$

Also, for all sub-level 2 indexes the M1 zone applies equally, that is

$$M^1 = \frac{x - X_{min}}{X_{max} - X_{min}}$$

In fact, the M1 criterion is a method for normalizing general indicators: Xmin is the minimum value of total indicators considered in the corresponding class and Xmax is the largest value and "x" is the value for X1, X2 and X3. Also the value of Xj is included in the criterion. In e-government research "x" is taken from the state value Xmin as the ratio of Xmax to Xmin. Now the definition for subindex of sub-level 2 is set as follows:

$$X_j^1 = \frac{\frac{1}{n_2^j}\sum_{i=1}^{n_2^j}\left(\left(\alpha_i^2\right)^l \cdot X_i^2\right) - X_{min}}{X_{max} - X_{min}}, (j = \overline{1, n_1})$$

Next, we observe the mathematic definition for the subindex of sublevel 2 separately:

$$X_1^1 = \frac{\frac{1}{4}(X_1^2 + X_2^2 + X_3^2 + X_4^2) - X_{min}}{X_{max} - X_{min}};$$

$$X_2^1 = \frac{\frac{1}{5}\left(\frac{1}{\text{population}}(X_5^2 + X_6^2 + X_7^2 + X_8^2 + X_9^2)\right) - X_{min}}{X_{max} - X_{min}};$$

$$X_3^1 = \frac{\frac{1}{4}\left(\frac{1}{\text{population}}X_{10}^2 + \frac{1}{\text{adult popul.}}X_{11}^2 + \right) - X_{min}}{X_{max} - X_{min}}$$

$$X_{12}^2 + X_{13}^2$$

We have already considered the key factors in Level 1 and 2 of the e-Government Development Survey and how they are calculated. Calculation of Level 3 factors will be the basis of Level 2 internal factors, and they will also be calculated using various mathematical methods as above. This is to identify the sub-factors that influence the industry's development. The following factors make mathematical prediction possible using time-dependent mathematical methods.

In the above, we have analyzed the results of scholars working with e-government factors and proposed a method for calculating the rating in the UNO using a universal mathematical tool. In fact, parameters that play an important role in e-government always change over time, changing the importance of influencing factors. We now focus on dynamic factors.

IV. RESULTS/ DYNAMIC FACTORS

While the number of rankings above is still being investigated, CSFs at the most recent level remain time-invariant. That is, each of the smallest factors is time-dependent. Such dynamic data affecting e-government include:

- Population change and age demographics;
- change of educational stages and their periods;
- student demographics;
- ICT literacy level of the social strata of the society
- Existing demographic training in ICT;
- Demographics of the population (subscribers) with appropriate communication devices;
- Tools for access to e-government (mobile, tablet, PC, infokiosks, terminals, etc.)
- Internet operators, degree of geographical coverage;
- Changes in the cost of Internet racking to minimum wage;
- Information systems, the level of access and use of online services, etc.

It is well known that these factors are linked together with reforms, government programs, material support of population, projects and plans.

While the result of scholars analyzes show CSFs as technically, economically and socially, the UNO studies ICT infrastructure, e-services and human capital.

In this work, we propose to observe CSFs in the XYZ coordinate system, or a cubic matrix (X - reforms, Y - factors, and Z - time). Each axis variable also has its own internal variables. These basic parameters and their internal parameters are listed in Table 1.

Table 1. Dynamic Influencing Factors

Sides	Parameters	Internal options
Reforms	X_1 Politico-legal	Politics, law, regulations
	X_2 Economical	Gross Domestic Product, minimum wage, internal and external funds of the state
	X_3 Organizational	Reforms, Propaganda and Advocacy
Factors	Y_1 Technical	Background channels, Local network, Internet Server, and Service devices, mobile devices, Network connections, (Terminals, telephone, tablet, computer)
	Y_2 Software	Compatible Software applications, Software tools, technologies and developers for various social segments and users who access the e-government system
	Y_3 Accessibility	Availability of technical devices and tools, availability of software and applications for services, Internet access, ICT and Internet literacy advances than before (time, distance), capability and continuity (24/7)
Time	Indicator Impact on factors	

The organizers of the parties have their own specifications. In particular, there are important aspects of the reform, namely X_1 – time, X_2 – duration and X_3 – periodicity. There are three factors: Y_1 – the life cycle, Y_1 – cover (locality) and Y_1 – periodicity (renewal). We can express this by matrix in the form of Table 2 below:

Refor. / Fact.		Political			Econom.			Organiz.		
		$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$
Tech.	$\bar{Y}_1$									
	$\bar{Y}_2$									
	$\bar{Y}_3$									
Soft.	$\bar{Y}_1$									
	$\bar{Y}_2$									
	$\bar{Y}_3$									
Usag.	$\bar{Y}_1$									
	$\bar{Y}_2$									
	$\bar{Y}_3$									

Now, we observe discussions with definite examples. For example, distributing mobile that is considered technic factors (y_l^1) according to state legal documents ($x_{m1}^1 = \langle 2008, 2010 - 2025\ years,\ non-periodic \rangle$). The budget to implement this document ($x_{m2}^2 = \langle 2009,\ on\ the\ base\ of\ budget\ for\ 2010-2025\ years,\ periodic \rangle$), it should be organized ($x_{m3}^3 = \langle 2012,\ 1-quarter,\ non-periodic \rangle$).

In order to implement a service portal within the e-government, its design must be developed, supported by the authorities, and created by the portal's requirements. Then it is necessary to address the stage of focus on users to the portal, ie the issue of literacy and technical support.

For example, on the implementation of e-government literacy in Uzbekistan in the fifth section of the Strategy of Action with five priority areas of development of the Republic of Uzbekistan in 2017-2021, measures aimed at "increasing the literacy of the population" and the order of the Cabinet of Ministers dated March 27, 2014, "On additional measures to improve the skills of local government officials in the field of information and communication technologies".

As a result of the implementation of this reform in the Republic of Karakalpakstan, in 2014 2,200 learners, in 2015 5,500 learners, and in 2016 4,500 participations has led to an increase in e-participation number of the training of e-government.

Another example of the increase in internal parameters, such as accessibility and literacy, is the creation of online applicants for university entry in the 2019-2020 academic year. As a result, only one periodic online admission service received $ 1,066 million in June-July 2019. The appeal has already been made.

In general, it is necessary to take into account not only the current status of e-government factors, but also the expected indicators, which is likely to happen later.

We analyzed the factors influencing the e-government system in the literature above. Currently, the UNO has studied the e-government rating methodology and developed a general mathematical tool for this methodology. As a result of the research, the dynamic nature of the factors influencing e-

government system development has been proposed and illustrated in time-dependent retaliatory space.

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