

## 博士論文審査報告書

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論文題目	A Post-Implementation Analysis of Digital Transformation Regime for E-Governance in Sri Lanka (日本語訳「スリランカ電子ガバナンスのためのデジタル変革レジーム」)
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### ○論文内容の要旨

#### 1. Summary of the Thesis

The thesis is about analyzing the state of affairs related to the digitalization of government functions in Sri Lanka. The process of digitalization was started in sync with the introduction of ICT in the country. ICTA designed and promoted the architecture, infrastructure, and digitalization of government functions in the country. In the following section, I have laid down the list of important research questions that need to be investigated and answered to form an informed opinion about the state of affairs in the country in the post ICT implementation scenario.

#### 2. Research Questions

I have formulated three crucial research questions for this thesis as follows:

- To what extent the operational efficiency has been achieved with ICT deployment in 20 D&Ms of the government of Sri Lanka?
- To what extent informational efficiency increased with the ICT deployment in the D&Ms?
- To what extent has PSD efficiency increased in a post ICT deployment scenario in the country?

These are essential questions that are central to the analysis and inquiry carried out in this thesis. In order to carry out a meaningful analysis to answer these questions, we needed some

relevant data. The nature of the data and data collection method is briefly explained in the next section of this chapter.

### **3. The Data**

The data was collected through a field survey conducted from February through March of 2020. In total, we surveyed 20 representative departments and ministries (D&M) of the government of Sri Lanka. It was a bifocal survey; on the one hand, I questioned the ICT regime implementors (officers and employees) about the ICT implementation. Ten questionnaires were distributed and collected from each of the entities. On the other hand, a similar number of questionnaires were distributed and collected from the general public who availed services from these D&Ms. In total, 400 responses were collected. We collected 200 each from both sides of the service spectrum. The questionnaire comprised 20 questions divided into input and outcomes questions (input for D&Ms and outcomes for the public). The responses were sought on a Likert scale: 5 standing for a strong agreement, 4 for agreement, 3 as neutral, 2 as disagreement, and 1 as strong disagreement. Input questions have been coded as ICT, whereas the outcomes have been coded to reflect the degree of satisfaction users of the ICT-based PSD had from the regime implementation. Originally the questionnaires were designed in English and then translated into Sinhala language, one of the major official languages of Sri Lanka, in order to assure ease of understandability and response to the questions. The data thus collected was recorded into a separate excel sheet and tabulated for further treatment and analysis. Keeping in view the ordinal nature of the data, a transformed binary variable agree/disagree (AD) was created from the variable "satisfaction" to allow better analysis and understanding of the data outcome without dropping other variables from the final analysis.

### **4. The Analysis**

In this thesis, I have applied a two-way analysis to cover multiple dimensions of the analysis and reach comprehensive results. **First**, I applied data envelopment analysis (DEA) to estimate the overall and relative efficiencies of various D&Ms studied in this thesis. **Secondly**, I carried out a regression analysis to understand the relationships between various ICT input measures and the outcomes of the implementation of the ICT regime.

#### **i. Data Envelopment Analysis**

**First**, I have applied a nonparametric-multistage data envelopment analysis (DEA) to understand how the ICT regime performed. The three outputs factors

(OP1, OP2, and Op3) were used in the analysis, and the technical efficiency (TE) has been measured on a variable return to scale (VRTS) from an output orientation. Using standard VRTS and DEA models, we assumed output orientation as the magnitude and the direction of input has already been defined and is not alterable in the short run (Fare et al. 1994). Thus, only outputs, i.e., services, information, and operations, can be adjusted to allow our entities to perform at optimum scale to achieve maximum efficiency. Farrell originally developed these efficiency measures; however, the DEA has evolved as a body of knowledge and technique over time.

## **ii. Regression Analysis**

For the regression analysis, the response data was categorized as inputs and outcomes based on the nature of the response data. IT has been used as the independent variable. The independent variable is satisfaction. Another dependent variable, i.e., AD, has been used in the data; it is a transformed binary variable for which satisfaction and ICT are independent variables. We established a limit of 4 to convert outcomes (satisfaction) into a binary dependent variable AD of 1 (overall agreement) and 0 (overall disagreement). It may be noted that our response data is ordinal on a 5-point Likert scale where 5 stands for strongly agreed, 4 agreed, 3 neutral, 2 disagreed, and 1 for strongly disagreed. To achieve this transformation for all client responses  $\geq 4$ , we allocated a value of 1 to this additional variable, and for all responses  $< 4$ , we assigned 0. In this way, we assumed a careful approach in handling and analyzing the response data. The robustness of the data was checked via Cronbach's alpha. I calculated Cronbach's alpha to assess the reliability and internal consistency of data's test items.

Additionally, I produced multivariate ordinal logistic (logit) regression results to deepen our understanding of the relationships between various variables used in the analysis. Ologit regression model is a generalization of a binary logistic regression model when the outcome variable has more than two ordinal levels, which in our case is 5. Ologit estimates the probability of being at or below a specific outcome level, conditional on a collection of explanatory variables. Our survey's observed ICT satisfaction level is the ordinal outcome,  $y$ , ranging from 0 to 5, as described in the data section. As the response categories in our data are limited up to 5, using a nonparametric ordered logistic regression model seems most appropriate for our analytical purpose.

## 5. Results

The results thus obtained through a rigorous statistical analysis show that there is a reasonable and understandable basis for continuing to invest in the ICT infrastructure as it has positive bearings upon the PSD in Sri Lanka. The results of our study indicate disparate performance across the entities of the Sri Lankan government. One can identify benchmarks as well as slackers in the whole PSD structure through this study. It can suggest that apparent incongruity of results across various PSD entities should be minimized to allow a smoother ICT continuum ending in a complete transformation of the PSD structure in the country. We have, however, taken a 3-output factors (OP1, OP2, and OP3) approach towards performance assessment in this study; those three factors correspond to the first three factors of the ICTT continuum.

Consequently, I mapped out the performance of the public services in the wake of the ICT regime in three areas, i.e., services (OP1), information (OP2), and operations (OP3). Our findings suggest that OP1, i.e., technical efficiency score regarding public service delivery, is not consistent across all entities. With a TE score of 0.957 (CRTS) and 0.976 (VRTS), service delivery at the Department of Imports and Exports (E3) has been the least inefficient area as compared to others. That suggests that while departments and ministries have benefited from implementing the ICT regime, the same cannot be said for the public service delivery efficiency across all of them. There are few exceptions like E6, E10, E11, and E12 (the corresponding names of the departments or the ministries can be cross-checked in Table 1). Department of Labor (E11) has come out as a star performer in a comparative analysis with  $TE = 1$  and a constant returns-to-scale situation. It can serve as a peer to the highest number of other departments and ministries, which is 8 in total. This result suggests that other entities should at least replicate the Department of Labor's *performance*. Also, from a scalar perspective, the Department of Pensions (E8) has plenty of unused capacity; and, at the same time, is facing a decreasing returns-to-scale situation. This situation may indicate a structural issue of the department, and the situation requires more in-depth insight to pinpoint the exact cause of the problem with the department.

In regression analysis, I have analyzed the effectiveness and acceptability of the ICT regime in Sri Lanka, and results have shown that inputs of the regime are positively contributing towards the program's success. However, the contribution has not reached very significant levels so far. After explaining the summary statistics of the data collected and various correlations, we use ordinal logistics

analysis to understand the interrelations amongst various ICT inputs and their impact upon the outcomes. Cronbach alpha has been calculated to test the robustness of the data. Finally, we conducted specificity, sensitivity, and predictive values analysis in order to assess the accuracy of the model applied. Lastly, the findings suggest a positive, though a weak correlation between the inputs and outcomes of the ICT regime put into place to digitalize the PSD in the country. Also, sensitivity and specificity tests have been carried out for the AD, and the results show sensitivity and specificity results for our model.

#### ○論文審査結果

##### ①テーマ：学術的・社会的意義を明確に意識したテーマ設定がなされているか

Ms. Alahakoon Mudalige Indeelinie Uthpala, the candidate, showed that she understood and reasonably explained the academic and social importance of the thematic aspects through the final exam presentation and the thesis she submitted. She provided many references on her research theme's academic and social relevance in the thesis. The candidate explained that introducing information communication technology (ICT) into national governance would significantly improve people's social conditions if handled well. Through the data and the analysis, she critically reviewed the performance of the ICT regime executed in Sri Lanka. She also explained that the thesis also serves as a benchmark for making changes in many other essential areas of the social life of the people of Sri Lanka through a proper introduction and implementation of ICT measures. The candidate explained how the research is academically unique as the thesis is about analyzing the state of affairs related to the digitalization of government functions in Sri Lanka. The process of digitalization was started in sync with the introduction of ICT in the country. Information Communication Technology Agency (ICTA) designed and promoted the architecture, infrastructure, and digitalization of government functions. The candidate also elaborated on its value and importance to scholars and practitioners working on digital transformation and related change management.

##### ②研究の位置づけ：先行研究や関連研究が幅広く十分に渉猟され、的確に理解されたうえで問題設定がなされているか

The examiners questioned at length about the candidate's understanding of the "academic positioning of the topic" as presented in the final examination and discussed in the thesis. The examiners noted that the candidate covered a large amount of literature to support the research and its positioning in the larger body of scientific research. The candidate explained that the thesis covered the most relevant empirical evidence in detail. After carefully examining the thesis, the examiners agreed with the contents and found the

explanations satisfactory. The candidate explained that the study falls into the purview of the "digital change management in public service" sphere. The examiners were satisfied by the explanation. The examiners also confirmed and concurred that the candidate had made minor textual improvements by the final examination as advised in the preliminary examination.

③論文構成・体裁：テーマに沿って問題が適切に設定され、一貫した論述が展開された上で明確な結論が論理的に導きだされているか

The examiners agreed that the candidate's explanation relating to the research questions was consistent with the topic of the thesis. The candidate formulated three crucial research questions for this thesis as follows:

- To what extent the operational efficiency has been achieved with ICT deployment in 20 departments and ministries (D&Ms) of the government of Sri Lanka?
- To what extent informational efficiency increased with the ICT deployment in the D&Ms?
- To what extent has public service delivery (PSD) efficiency increased in a post ICT deployment scenario in the country?

The examiners also inquired about the overall "placement of theme in the body of knowledge." The candidate explained that the topic is related to change management resulting from introducing ICT into a governance system that replaces a traditional "paper-based management" style. The examiners also asked specific questions about the efficiency resulting from the digitalization of public service systems. The candidate answered most of the questions in this regard satisfactorily. After the final presentation, the examiners had a prolonged discussion about the concepts presented, comparing them with the contents of the thesis. The examiners concluded that the facts presented and the contents of the thesis do match. The examiners did agree that the contents of the thesis in this regard were appropriate, and the thesis does not contain any false assertions.

④研究方法：テーマおよび問題設定にふさわしい研究方法が選択されているか／資料の取り扱いや分析結果の解釈は妥当か

The candidate explained that the data was collected through a field survey conducted from February through March of 2020. In total, the candidate surveyed 20 representative D&Ms of the government of Sri Lanka. It was a bifocal survey; on the one hand, the candidate questioned the ICT regime implementors (officers and employees) about the ICT implementation. Ten questionnaires were distributed and collected from each of the entities. On the other hand, a similar number of questionnaires were distributed and collected from the general public who availed services from these D&Ms. In total, 400 responses were collected; 200 from both sides of the service spectrum. The questionnaire comprised 20 questions divided into inputs and outcomes questions (inputs for D&Ms and

outcomes for the public).

The examiners noticed that the data was collected using a Likert field survey and that its nature and composition were original and very practical. They also agreed that analytical techniques used in the thesis to analyze variables of change management related to public governance in the context of ICT adoption are novel. The candidate explained how the research results were practical and applied. The examiners agreed that the state and society would benefit by implementing the proposals made in the thesis. These benefits would arise from better and more efficient government services based on digital transformation. Finally, the candidate explained how the questionnaire, the data, and the analytical approaches applied in this study should be of interest to academia. The examiners concurred that the candidate's assertions were weighty and that the contents of the thesis do match with the facts presented.

⑤新規性：テーマや問題設定、研究方法や結論等に、学術的・社会的に注目すべき新規性が認められるか。

The candidate has applied a two-way analysis to cover multiple dimensions and reach comprehensive results. First, the candidate applied data envelopment analysis (DEA) to estimate the overall and relative efficiencies of various D&Ms studied in this thesis. The departments have been denoted as entities (E, E1, E2...E20). Secondly, the candidate carried out regression analysis using a nonparametric ordered logistic regression model. The model seems most appropriate for such an analytical purpose to understand the relationships between various ICT input measures and the outcomes of the implementation of the ICT regime.

The results thus obtained show a reasonable and understandable basis for continuing to invest in the ICT infrastructure as it has positive bearings upon the PSD in Sri Lanka. The study results indicate disparate performance across the entities of the Sri Lankan government. One can identify benchmarks and slackers in the whole PSD structure through this study. It can be suggested that apparent incongruity of results across various PSD entities should be minimized to allow a smoother ICT continuum ending in a complete transformation of the PSD structure in the country. The candidate has taken a 3-output factors (OP1, OP2, and OP3) approach towards performance assessment in this study; those three factors correspond to the first three factors of the ICT transformation continuum.

Consequently, the candidate mapped out the performance of the public services in the wake of the ICT regime in three areas, i.e., services (OP1), information (OP2), and operations (OP3). The findings suggest that OP1, i.e., technical efficiency (TE) score regarding public service delivery, is inconsistent across all entities. With a TE score of 0.957 constant returns to scale (CRTS) and 0.976 variable returns to scale (VRTS), service delivery at the Department of Imports and Exports (E3) has been the least inefficient area as compared to others. That suggests that while departments and

ministries have benefited from implementing the ICT regime, the same cannot be said for the public service delivery efficiency across all of them. There are a few exceptions like E6, E10, E11, and E12 (the corresponding names of the departments or the ministries can be cross-checked in table given in the thesis). Department of Labor (E11) has become a star performer in a comparative analysis with  $TE = 1$  and a constant returns-to-scale situation. It can serve as a peer to the highest number of other departments and ministries, 8 in total. This result suggests that other entities should replicate the Department of Labor's performance. Also, from a scalar perspective, the Department of Pensions (E8) has plenty of unused capacity; and, at the same time, is facing a decreasing returns-to-scale situation. This situation may indicate a structural issue of the department, and the situation requires more in-depth insight to pinpoint the exact cause of the problem with the department.

In regression analysis, the candidate has analyzed the effectiveness and acceptability of the ICT regime in Sri Lanka, and the results have shown that the regime's inputs are positively contributing to the program's success. However, the contribution has not reached very significant levels so far. The candidate also presented summary statistics of the data collected and various correlations and used ordinal logistics analysis to understand the interrelations amongst various ICT inputs and their impact on outcomes. Cronbach alpha has been calculated to test the robustness of the data. Finally, the candidate conducted specificity, sensitivity, and predictive values analysis to assess the model's accuracy. Lastly, the findings suggest a positive, though a weak correlation between the inputs and outcomes of the ICT regime put into place to digitalize the PSD in the country. Also, sensitivity and specificity tests have been carried out for agreement/disagreement (AD), and the results show sensitivity and specificity results for the model.

All examiners agreed that the theme, the data, and the analytical methods used in the paper are original and very practical. They concurred that the candidate has dealt with all critical aspects of the thesis in detail, the conclusions match the research questions, and the analysis is appropriate and comprehensive. The examiners also found that analytical techniques applied in the thesis to analyze the situation related to digital change management were novel. Examiners also agreed that the results of the thesis have sufficient potential utility. Moreover, as a result of implementing the findings of the thesis results, the state and the society will benefit from better and more efficient public service provision. In the end, all examiners agreed that the thesis covers and fulfills the standards required for such a thesis.