Measuring sustainability for an effective Information System audit from public organization perspective

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***Abstract*—Information System (IS) auditing is generally used to assess the effectiveness and efficiency of control measures for the overall IS performance. Incorporation of sustainability within the existing audit process aims to enhance the execution of the IS audit for an effective information system. Commonly, the performance of a IS service is evaluated through quantitate scales such as Likert Scale. However, such measurement does not provide an accurate value of the audit context due to lack of precision. Our work attempts to address this limitation. In particular, we propose a Sustainability-driven Information System Audit (SISA) approach that integrates Analytical Hierarchy Process (AHP) and the Fuzzy Set Theory (FST) to determine the performance of sustainability in IS focusing on the public organisation. Sustainability consists of five dimensions as audit criteria, i.e., economic, environmental, resources, social and technology. These audit criteria are also contain sub-criteria such as cost, green IS. ..etc. In our case, the AHP is used to identify the relevance importance of the sustainability dimensions and its related attributes so that we can prioritize the relevant audit areas. The priority is then used to determine the level of the satisfactory of the IS sustainability using the FST. Finally, we provide a case study from the National Audit Department of Malaysia to demonstrate the applicability of our approach. The results show that this approach is useful for an effective audit towards sustainability, where auditors are able to produce effective justification for IS audit findings.**

***Index Terms*—Information systems audit, sustainability, sustainability measurement**

I. INTRODUCTION

The purpose of IS audit in general is to evaluate and report the adequacy of system controls, efficiency, economy, and security practices for the protection of data integrity within the applicable policies, laws and regulations. Furthermore, IS audit also assesses that the organizational goals are effectively achieved and resources are efficiently used. In government organisation, the IS audit are conducted based on compliance [7] and performance audit [8] approaches. The compliance audit focuses on adherence to the legislature obligations, policies, standards and best practices, while the performance audit emphasizes on efficiency, effectiveness and economic on the management of IS project. The traditional audit approaches does not effectively assess the overall information system and auditors are encountered with various inherent challenges such as the inability of the IS to meet user's expectation, inadequacies in management and technical practices [15]. These challenges pose potential risks such as IS project cost and schedule overrun, unable to fulfil user's expectations and fail to achieve the objective of the project [23,24]. But, such failures were not published to the wider community due to the national reputation and security [12].

The IS becomes a catalyst in promoting effective service delivery of the public organisation and also an instrument for managing public service and information. The traditional role of IS audit seems to be more straightforward on the assessment without addressing interrelated factors such as supporting capability from IS, benefit of IS, green IS implementation and technical capability of IS. These factors are essential to measure IS performance against those best practices and most importantly is to widen the scope of IS audit in identifying potential risks to the IS. It is evidenced from the Auditor General Report that most of the IS issues reported were on non-compliance without any supplementary comments about the related factors that will affect the implementation of IS within the organization [29]. In this view, this paper attempts to enhance the audit effectiveness by investigating the alignment of sustainability as a strategy to highlight internal and external factors that will affect IS implementation as well as to produce effective audit report. Sustainability driven in IS audit is perceived to be more practical and reliable as it develops realistic audit criteria to measure IS controls, IS investment, security and risks. In addition to traditional audit criteria, the establishment of sustainability related criteria is more practical as it incorporates economic, environmental, resources, social and technical aspects. Each criteria contains specific sub criteria that would aid auditor in evaluating IS controls, value for money and addressing factors related to perceptions from auditee, users and auditors.

This paper proposes a Sustainability-driven Information System Audit (SISA) process to measure sustainability using Analytical Hierarchy Process (AHP) and the Fuzzy Set Theory (FST). This paper suggests some initial judgments on the IS performance and forms audit conclusions based on the sustainability requirements. The AHP is a method for analysing and making decision from various alternatives based on computation of weight and ranking. In this paper, the AHP assists in identifying relative importance of criteria and sub criteria in auditing the IS performance. The matrix signifies a priority between one criteria to other paired criteria, one is

dominating and the other is dominated. The matrix is read by reading down the left side. The FST is used to measure the criteria and sub criteria on a nine-type linguistics terms of fuzzy set with a set of statement about the economic, environmental practices, social concerns, resources and technical capability. The evaluation is performed based on the importance and criticality of each criteria and sub criteria in IS implementation. Finally, a case study from the National Audit Department of Malaysia is used to demonstrate the applicability of the approach.

II.RELATED WORKS

There are studies in the literature that focus on IS audit, sustainability and sustainability measurement as shown below.

A. IS Audit

The IS audit implementation in public sector address mainly on internal controls evaluation and internal controls system audit, system development and maintenance audit, application program and data file audit [17]. Auditors are using IT related practices framework provided by the professional bodies such as ISACA, IIA, COBIT, ISO 17799 and ITIL which focus on IT controls assessment and the evaluation of value for money for the effective management of IS. Despite the important role of IS auditor to provide reasonable assurance that the objective of controls have been achieved, many organisations are still experiencing failures in IS implementation. During the course of audit work, auditors are confronted with inherent risks such as operational risks, financial risks and IT related risks. These risks are differ from one organisation to another and the limitations are also depends on how the internal controls are implemented. Risks have changing in nature and may led to IT failures due to inadequate of risk management processes.

Goldfinch in [12] summarised that failures of IS development in public sector derived from three aspects; project, system and user. Project failure refers to the inability of the project to meet contract agreements, system failure is when the system fail to perform as expected and user failure appears when user resist to use the system. Whitney and Daniels in [22] defined four categories of IS failures; correspondence, process, interaction and expectation from stakeholders. The correspondence failures refer when the system design objectives of specification are not fulfilled. Process failure due to budget or time overrun. Interaction failure refers to user dissatisfaction of the IS and expectation failure is when the system does not meet stakeholder's expectation. It can be observed that the current audit practice is overlooked to address issues from technical and non-technical perspectives of IS. In this sense, the IS audit needs an improvement to highlight the demand from project, system and user regarding IS performance to help auditee to understand the IS processes as well as a guidance for identifying related risks. The introduction of sustainability into IS audit is capable to expand the scope of auditing by incorporating sustainability dimensions into the IS audit processes.

B.Sustainability and Sustainability Measurement

Sustainability is perceived as a motivation to improve performance, therefore it is necessary to incorporate sustainability as part of strategic planning process for competitive advantage. Asif et al., in [25] claimed that the integration of sustainability into business process become important for decision making and to fulfil the changing demand from key users. Several studies in the domain of information systems has addressed issue and challenges of sustainability within the IS management [26], a strategy to incorporate environmental and social dimensions for enhancing IT services [14] and the role of IT to promote sustainability within service oriented information technology [14]. It is commonly observed that sustainability have been discussed within IS projects [21], within IS utilization [16] and to develop IT strategic plan [14]. Considering that sustainability preserved social benefits, a number or literatures has investigated the potential of values based approach to support sustainability within business process. In their study, [1, 28] mentioned that sustainability is capable to improve project value in terms of quality, productivity, profitability, life cost reduction and business enhancement. Going by this definition, Abidin and Pasquire in [1] proposed a structural model for integrating sustainability issues into value management to assist the sustainability implementation from three (3) phases; input, process and outcome. While, Gasparatos in [11] explored the implications of incorporating value systems in a sustainability assessment tools which values are emphasised on evaluating IS infrastructures and IS applications within IS audit practice in order to justify benefits and impact of the IS adopted to organisation. From the perspective of IS audit, the scope of sustainability will address audit process, benefits, technology, and financial situation of public organisations.

There are numerous methods for developing sustainability indicators and they are varies according to business process. Delai and Takahashi in [10] denoted that sustainability measurement implementation needs to consider four (4) situations; 1) the sustainability measurement criteria, 2) theme and sub themes to be applied, 3) selection of groups in the measurement process and 4) sphere of the company impacts to be taken into account. Ness et al., in [18] suggested that the sustainability framework may be developed based on indicator/indices, product-related assessment and integrated assessment tools. Whereas, Rajesh et al., in [20] summarised details of the development of sustainability indicators, establishment of framework, scaling, normalisation, weighting and aggregation methodology. The authors specified that sustainability framework and the sustainable development indicator (SDI) may be developed either by top down approach or bottom up approach. Top down approach is applicable when experts and researchers establish the framework and the SDI. The bottom up approach refers where there an involvement of stakeholders in the design of framework and the SDI. Becker et.al. in [16] introduced the Karlskrona Manisfesto for Sustainability Design to express the commitment from Software Engineering community in relation to sustainability by taking into consideration the associate factors such as risks, cultures and technical features. Another aspect of sustainability dimensions are from the hybrid systems perspective or systems of systems. Hessami et al., in [3] introduced Weighted Factor

Analysis methodology (WeFA) to examine context, components, topology and the scope of sustainability from micro systems to macro systems.

III.THE APPROACH

The proposed approach incorporates sustainability into the traditional IS audit process. We consider value based approach along with performance and compliance to perform the audit. Figure 1 shows the conceptual view of the audit approach. Exisstting approaches were considered to develop the proposed approach. For instance, we relied on the internal auditor IT related activities by Abu-Musa in [2], value for money and rule of law by Grönlund et al. in [13] and Bai and Jiang in [5] who addressed the perception of using IT include perceived benefits and costs. Furthermore, we also used the Analytical Hierarchy Process (AHP) and Fuzzy Set Theory (FST) to determine the relative importance of the criteria and sub criteria.

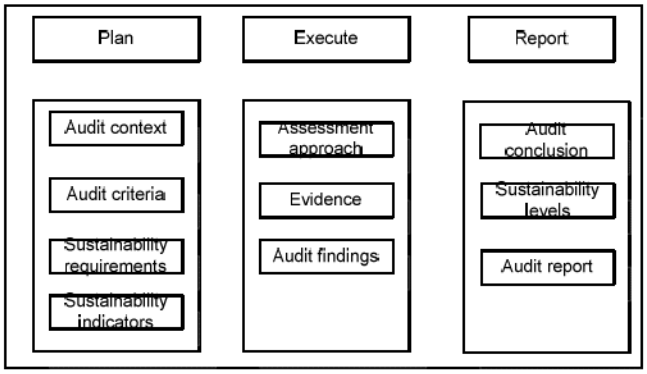

Fig. 1. Conceptual framework of IS audit with the incorporation of sustainability

Three key users (Organisation as an auditee, public users, and auditors) perceptions were also used to develop the audit criteria. These key users perceptions are linked to the sustainability requirements, which, in its turns, allows us to develop a sustainability driven IS audit process. Audit

A.Sustainability and its measurement

In general, sustainability is defined as a balanced assessment of social, environmental and economic dimensions to maintain competitiveness without compromising the ability of future generation to meet their own needs [27]. We categorised sustainability definition from two perspectives; non-technical and technical aspects. From the non-technical viewpoint, sustainability is defined as environmentally sustainable, cost minimisation, resources efficiency and social concerns in relation to information systems development and implementation. Whereas, from the technical point of view, sustainability is defined as an efficiency and effectiveness of a system which emphasised on resiliency, flexibility, efficiency and robustness. The process of integrating sustainability begins with the identification of audit context which include audit plan, scope, methodology, formulation of audit criteria and sub-criteria, define sustainability requirements and determine appropriate sustainability indicators. The establishment of criteria and sub-criteria are derived from the key users' expectation in relation to IT benefits and costs. Each criteria and sub-criteria are associated with sustainability dimensions and categorised into specific sub-criteria.

Audit execution is about collecting data from the IS controls evaluation and performance audit assessment by using sustainability driven criteria and sub-criteria. Auditors examine whether the actual condition are confirmed with the specified criteria and sub-criteria. This activity consists of weighting and ranking the selected criteria and sub criteria by using AHP and FST. Final audit report should include a decision according to predefined criteria and sub criteria. In this exercise, based on the results obtained from sustainability measurement, some decisions and advice for improvement can be made on the current IS implementation.

Figure 2 shows sustainability dimensions as audit criteria and sub-criteria. For instance, 'Social' is influenced by the 'Supporting capability' and 'Benefit of IS'. Both criteria and sub-criteria were measured qualitatively and quantitatively with the use of indicators and also were weighted and ranked by the AHP and FST.

The definitions are given below:

Criteria

- *Economic:* refers to the economic performance of IS project or IS investment.
- *Environmental:* refers to the proactive response of the organisation to green IS practice.
- *Social:* refers to social value derived from the use of IS.
- *Resource*: refers to benefit of IS to employee and third party reliability.
- *Technology:* refers to IS application or program of the organisation.

Sub-criteria

- *Cost effective:* This sub-criteria compares related total cost of IS (cost of system development, cost of maintenance cost and cost of integration and cost of migration compares with output/outcomes).
- *Green IS:* This sub-criteria is used to assess the extent of green IS policy applied by public organisation.
- *Social*: This sub-criteria is used to assess intangible value from the use IS.
- *Resource:* This sub-criteria is used to assess value of IS to stimulate competency, information sharing and
- reliability of third party.
- *Technology:* This sub-criteria is used to assess the qualitative behaviour if IS.

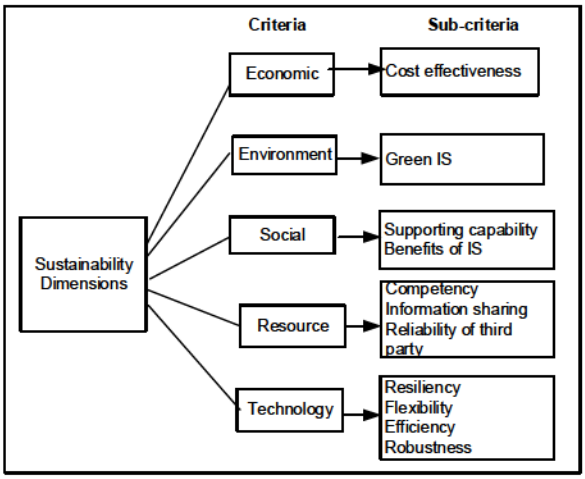

Fig. 2. Sustainability dimensions

C. *The Sustainability-driven Information System Audit (SISA) process*

The SISA process consists of three activities. Each activity includes single or multiple steps to perform a specific task for an activity. This research enhances the traditional audit process by taking into account the sustainability dimensions. Figure 3 depicts the activities, steps of the proposed process.

Fig. 3. Sustainability-driven information system audit process

Activity 1: Define Audit Plan

Planning the audit is an important step for auditor as it specifies audit objectives, audit scope and methodology, audit criteria and related audit informations. The audit plan is considered as a guide in conducting audit works. It also specifies key areas to be audited, background of the entity, and the complexity of the information systems.

Step 1.1: Establish audit context

In common practice, the objective of audit is derived from the aim of the project or audit tasks that need to be achieved. It should be related to the rationale of the project and provide an independent analysis and information to public and stakeholders. Precisely, the objective of audit is to provide an independent conclusion on a subject matter based on audit evidence. Therefore, audit objectives should be clearly defined and can be broken-down into sub-objectives. The scope of audit should include the areas to be audited, times and duration, the key systems, program, and module or unit within the organisation. In the course of preparing audit plan, a set of audit procedures is developed to assess the systems, controls, risks, and operational activities of the organisation. Once the audit context is completely developed, the next step is defining audit criteria.

Step 1.2: Establish audit criteria

Audit criteria are standards or controls against which auditor assess actual condition of the information system implementation. Generally, audit criteria should correspond to the audit objective and the criteria may constitute of regulations, policies, laws, standards and experts opinion. Audit criteria is used to evaluate current implementation, provide a basis for analysing evidence, developing audit findings, and conclusions to identify whether the current process meets the audit objectives. In addition to the establishment of audit criteria, auditor needs to perform risk assessment.

Step 1.3: Perform risk assessment

Risk assessment follows the existing risk management practice within the organization. Generally, such process should include how to identify the possible risks from the audit perspectives and to analyse the risks so that appropriate control actions could be identified and implemented.

Activity 2: Execute the audit

The audit execution is about collecting and analyse the evidences for the audit conclusion. Therefore, the scope and objective from the previous activity is necessary to understand what types of evidences are necessary for the audit. It includes three steps;

Step 2.1: Collect evidence

In this step, auditors gathered evidences based on the assessment of five sustainability dimensions (economic, environment, social, resource and technology). These data were obtained via audit techniques such as inspection, review documents, records, and transactions produced by the IS, survey, re performance, and interviews of the practitioners and experts within an organisation. The method used to gather these data was influenced by the factors of sub criteria. For instance, the sub criteria of economic is cost effectiveness and the influencing factors for cost effectiveness are operating cost, development cost, and maintenance cost. It is worth mentioned that the data used for sub criteria were collected from IS contractual agreement, electronic payment systems, electronic procurement systems and annual budget documents.

Step2.2: Analyse evidence

This step presents an analyses of the collected evidences. For instance, the social sustainability criteria contains two sub criteria (Supporting Capability and Benefit of IS). Both are intangible benefit value from the use of IS and data is collected in a qualitative form. The assessment of supporting capability is associated with internal controls evaluation, therefore the level of risk used is categorized as low, medium and high. Result from risk assessment will aid management decision regarding the significant level of risk. For economic sustainability assessment, cost effectiveness analysis is performed to evaluate IS investment by weighing the cost of IS project against the expected benefits. Environmental

sustainability is related to green IS practiced by the public organisations. Environmental Impact Assessment (EIA) is applied to measure green IS. Resource criteria concerns on employee competency in utilizing IS, efficiency of information sharing, and reliability of third party services (if any). These values are measured based on scale categorized as low, medium or high. Technology criteria is related to resiliency, flexibility, efficiency, and robustness of IS which are expressed qualitatively with a scale type of employee's opinion. The comparison matrix is shown in Table I and scales for relative importance in Table II. The following criteria are used for the comparison matrix.

Ec=Economic
Env=Environment
S=Social
R=Resource
T=Technology

TABLE I. COMPARISON MATRIX

	Ec	Env.	S	R	T
Ec	$CM_{i,j}$	--	--	--	$CM_{i,5}$
Env.	$CM_{i+1,j}$	1	--	--	$CM_{i+1,5}$
S	$CM_{i+2,j}$	--	1	--	$CM_{i+2,5}$
R	$CM_{i+3,j}$	--	--	1	$CM_{i+3,5}$
T	$CM_{i+4,j}$	--	--	1	$CM_{i+4,5}$

TABLE II. MATRIX SCALE FOR SUSTAINABILITY DIMENSIONS

Importance level	Definition
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very importance
9	Extreme importance
2,4,6,8	Intermediate values

However, in order to reach a conclusions of the audit findings, auditors are required to analyse the relative importance of each audit criteria to derive a conclusion about the level of IS sustainability. Therefore, the auditors need to respond to the following questions as depicted in Table III, which shows a list of sample questions that should be used for collection the relative importance of the criteria based on the importance levels.

TABLE III. SAMPLE QUESTIONS FOR SUSTAINABILITY CRITERIA

Relative importance of sustainability criteria *Please follow the definition of importance level before answering the questions*		
No	**Questions**	**Scale (1-9)**
1	What is the relative importance of Economic comparing with Environment?	
2	What is the relative importance of Economic comparing with Resource?	
3	What is the relative importance of Economic comparing with Social?	
4	What is the relative importance of Economic comparing with Technical?	

The same processes are generated for the rest of criteria. In addition to the AHP method, auditors need to justify the actual implementation of the criteria, therefore, auditors may interview the related employee.

Some example questions for 'Economic criteria';

- What do you include as the 'Cost' and 'Benefit'
- How do you treat non-financial cost or benefit?
- Are there limitation to the cost allocated?

In addition to the relative importance of each criteria, the AHP calculates a measure of judgment consistency. If the value of Consistency Ratio is smaller or equal to 10% the inconsistency is acceptable. If the Consistency Ratio is greater than 10%, then auditors may need to revise their subjective judgments. The sum of all relative importance should be one. Once the relative importance is obtained then auditors need to determine the consistency value of the relative importance.

Consistency Ratio (CR)= CR/RI
CI=consistency index
RI= Random Consistency Index (RI)
Where CR<=10% denotes consistent otherwise not

Calculating the weight of criteria and sub-criteria

Applying the linear additive decomposition principle to calculate the weights of indicators allocated from the corresponding aspect.

$$wi = \sum_{1-5}^{n} \mathbf{Wij}$$

Where,

- wi= is the weight of sustainability criteria
- i:1---------5
- wij= is the weight of indicator j under the criteria i.

Calculating the score of criteria and sub-criteria

$$Ij = \sum_{1}^{n} Wij \times Iij$$

Where;

- Ij= score of jth sub-criteria
- Wij=weight of ith sub –criteria of jth criteria
- Iij= score of ith sub-criteria of jth sub-criteria

Step 2.3: Determine the sustainability index.

Sustainability index is the sum value of the criteria weight scores. Sustainability index is calculated for each dimension. For instance, Social dimension = score of SCI multiply by weight of SCI to obtain sustainability index of SCI. This sustainability index is used to identify the rank of criteria and sub-criteria and the level of sustainability of both criteria and sub-criteria.

$$I\ sustainability = \sum_{j} wjIj$$

Where,

- wj = score of jth sustainability dimension (criteria),
- *Ij* =weight of jth sustainability dimension (sub criteria),
- I *sustainability* = total sustainability index

Where,

- Sustainability index = SI
- Social dimension = SCI
- Economic dimension = EI
- Green IS dimension = GI
- Technology dimension = TI
- Resources dimension = RI
- Environmental dimension =EVI

This information is transformed into level of sustainability for linguistic terms of fuzzy sets. The linguistic value (0 to 0.33) is interpreted as a low sustainability (Ineffective) while maximum value (0.67 to 1.0) is defined as a high sustainability (Convincing). The middle value of (0.34-0.67) is considered as slightly sustainability (Reasonable). Summary to arrive at this value is depicted in Figure 4.

Activity 3: Aggregate audit findings

The final audit activity consolidates the entire audit finding to reach a conclusion.

Step 3.1: Generate audit report

In SISA, auditors are required to report on the level of sustainability of the IS and whether the sustainability requirements have been met. The audit report should include the following elements;

- The SISA objective.
- The audit scope.
- The audit methodology.
- The audit criteria and sub-criteria for SISA.
- Sources of evidence.
- Audit findings and relevant evidence.

Findings should answer audit questions and derive conclusion based on the AHP and FST analysis. The audit report, where appropriate, may include recommendations. Under this context, the audit report should highlight the three scales (high, medium, and low) of sustainability level of IS. If sustainability classified as low, this indicates ineffective of the IS implementation and auditors may need to justify the findings. However, for instance, if a sub criteria has low score, this means that criteria is definitely will be classified as low too. This is because the criteria is always influenced by the sub criteria.

In light of this, auditors may conclude that the IS implemented by the organisation is ineffective from sustainability requirements perspectives. Therefore, auditors may recommend that the organisation need to identify the factors that caused such ineffective sustainability finding.

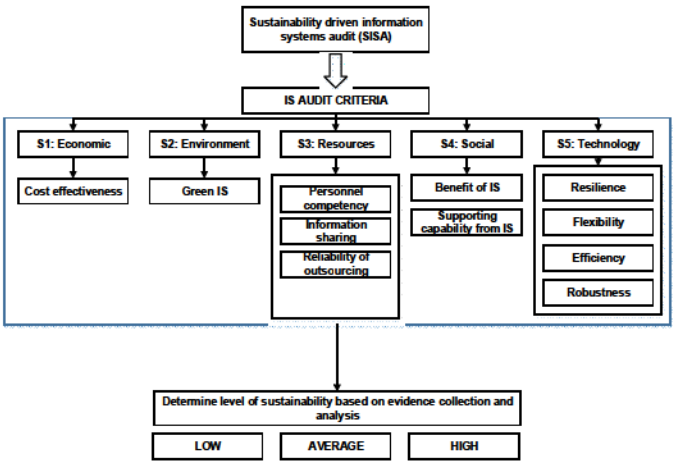

Fig. 4. The level of sustainability model

IV. Evaluation

A. Study Design

This research employed an empirical study method to SISA approach, and a case study was used for this purpose. In our case study auditors were directly involved in conducting and analysing the audit activities. Results obtained from audit activities were used to enhance the current IS audit performance.

B. Study Construct

The main focus of this study was to specify the impact of sustainability driven information systems auditing on the current IS audit process. The study goals are:

- Evaluate the advantages and limitations of sustainability driven IS audit.
- Improve understanding of the issues and factors that influenced the incorporation of sustainability dimensions into the IS audit criteria.

C. Data collection and Analysis

In order to fulfil the study objective, the researchers opt to follow top down approach to perform the audit. The case study used was obtained from a medium-sized public organisation. An audit plan which constitutes of audit objectives, audit scope, audit methodology and audit criteria were developed and used to demonstrate the application of SISA. In order to protect the identity of the audited organisation, all private information were set to be unidentified. In addition to practical application of audit work, questionnaires and unstructured interview questions were used to interrogate limitation, effectiveness and the efficiency of the processes.

Questionnaires were distributed to assess respondents' perception on the objective, criteria, sub-criteria and the implementation of SISA. In general, questionnaire aims was to identify the level of their understanding after implementing SISA. Some of the questions related to audit objectives, obtaining audit evidence, analysis and audit conclusions were used. The questionnaire and the responses were recorded in a fuzzy type scale. In addition, a formal interview sessions were conducted to evaluate applicability of sustainability in a subjective way. The audit team and audit manager were involved in the interview sessions. The interview sessions were used to identify the respondent's view on the current practice of audit compared to SISA implementation. The questions were unstructured as to allow spontaneity and new questions to be developed during the course of interview. In addition, relevant documents were reviewed to obtain information on IS audit such as audit report, annual budget plan and audit program.

D. Conducting the audit

SISA audit began with the examination of the economic sustainability. The economic criteria was measured by the cost of implementing the IS project which comprises of system development cost, integration cost, operating cost, and maintenance cost. Data were extracted from documents and records in relation to the annual budget allocation, electronic records from financial management, and minutes of meetings from the relevant committee. Findings from cost effectiveness analysis were recorded and analysed by using the AHP and FST methods.

The next activity was to examine the environmental sustainability. Policies and minutes of meeting were reviewed to inspect the applicability of the policies within the organisation. In addition, some audit techniques were applied such as observation, physical inspection, survey and interview to assess on the green IS implementation like IT equipment sharing, paperless environment and green disposal policy. Several aspects that need to consider during the course of audit for green IS assessment are;

- Percentage savings for paperless environment.
- Percentage savings for recycling.
- Percentage of IT equipment shared.
- Percentage of adherence to green disposal practice.
- Percentage of energy savings.
- The audit activity was continuously performed for social, resources and technology.

The research also reviewed the guidelines and checklists used by the auditors and any limitations exist when the SISA audit was performed. Findings from SISA were recorded and the result from the criteria and sub-criteria were examined to derive audit conclusion as a basis to produce audit report. Responses from IS audit team and manager in relation to SISA performance activities were mainly used to evaluate the benefits and weaknesses of SISA.

V. Case Study

This section demonstrates the auditors' feedback, who involved in the case study used in this empirical research. As mentioned before, for confidentiality reason we are required by law not to disclose the specific public organization's name where we performed the audit. The auditors were from the National Audit Department of Malaysia (NADM). The NADM has the mandate to perform an independent audit at several ministries, departments and agencies in accordance to the authority contained in the Audit Act 1957 in Malaysia. The NADM played a significant role in ensuring public fund are managed and used properly, the administrative activities are carried out in accordance with sound administrative principles & practices and desired objectives are achieved. The IS audit conducted includes the assessment of IS controls, system development audit, and performance audit in an IT environment. Computer Assisted Audit Techniques and Tools (CAATTs) are widely used to support audit work.

A. Introduction of Sustainability Information Systems Audit (SISA) process

Activity 1: Initialize sustainability driven IS audit

This work extends the traditional IS audit scope by including the sustainability dimension into the audit process. The proposed audit context are as follows;

- Audit objective: To assess IS performance from the sustainability perspective and to highlight the relevance importance of the criteria.
- Audit scope: IS controls, IS projects, IS investment.
- Audit methodology: Physical inspection, review documents, interviews and conduct surveys.
- Audit criteria: The audit criteria derived from value creations of key users with mapped into sustainability dimensions.

Activity 2: Audit execution

In this step, auditors justified the weight for both criteria and sub-criteria according to the comparison matrix (Table I & II). The weight index formula was used to calculate the scores of each criteria and sub-criteria to measure sustainability. The weight helps to generate accurate assessment as the basis of calculations are derived from the participant auditors. Table IV below shows the results of relative importance of the sustainability criteria from the studies context. Table V shows the weight factors of individual criteria followed by the relative importance of the criteria.

TABLE IV. THE PAIRWISE COMPARISON

	Ec	Env.	S	R	T
Ec	1	5	5	3	1/3
Env.	1/5	1	1/3	1/3	1/5
S	1/5	3	1	3	1/3
R	1/3	3	1/3	1	1/3
T	3	5	3	3	1

TABLE V. THE WEIGHT FACTORS

	Ec	Env.	S	R	T	WF
Ec	1	5	5	3	0.33	0.292441657
Env.	0.2	1	0.33	0.33	0.2	0.048414016
S	0.2	3	1	3	0.33	0.175631836
R	0.33	3	0.33	1	0.33	0.104115882
T	3	5	3	3	1	0.379396609
						1

- *Relative importance of Ec=0.2924*
- *Relative importance of Env=0.0484*
- *Relative importance of S= 0.1756*
- *Relative importance of R= 0.1041*
- *Relative importance of T= 0.3793*

The calculation's result obtained shows that the consistency ratio is 0.077 which is less than 10%. Therefore, the assumption for the relative importance of sustainability criteria is consistent.

$$CR = CI/RI = 0.087/1.12 = 0.077$$

At this stage, the auditor analysed the sustainability criteria based on the relative importance obtained before and the evidences were transformed into level of sustainability of linguistic terms of fuzzy scale (Table II). These values of fuzzy scale were used by the auditors to make a judgment on the importance and criticality of sustainability dimensions. Data gathered in this analysis was used as a basis to reach a conclusion on the status of IS within public organisation.

Activity 3: Aggregate audit findings

This activity includes steps to prepare an audit report that reflects the findings and conclusion of the audit.

Step 3.1: Generate audit report

In SISA, auditors are required to include in their final report an opinion on the level of sustainability of the IS and whether the sustainability requirements have been met. The audit report should include the following elements;

- The SISA objectives that are shown below;
  a) To assess the relevance importance of criteria.
  b) To evaluate the level of sustainability of IS.
  c) To highlight the low sustainability for further evaluation by the auditee.
- The audit scope of the sustainability assessment in relation to application systems, financial and IS projects.
- The audit methodology (interviews, survey, inspection, review documents, and observation of the processes).
- The establishment of audit criteria (economic, environment, resource, social and technology).
- Sources of evidences (minutes of meetings, annual budget, policies, management report on monthly activities, incident report, service level agreements, IS contractual agreement and, etc).
- Audit findings, conclusions and recommendations.

V. DISCUSSION

A. Results from the study

The overall score for environment, economic, social sustainability, resources and technology were calculated. Table VI demonstrates the obtained scores for overall criteria and sub-criteria.

TABLE VI. SCORES FOR OVERALL CRITERIA AND SUB CRITERIA

Criteria/sub-criteria	Score Criteria	Weighted Sub-criteria	Weighted criteria score
Economic		0.55	
Cost effectiveness	0.65		
Total sustainability index (EI)	**0.65**	**0.55**	**0.23**
Environment		0.45	
Green IS	0.43		
Total sustainability index (EVI)	**0.43**	**0.30**	**0.04**
Social		0.83	
Supporting capability from IS	0.55		
Benefit of IS	0.45		
Total sustainability index (SCI)		**0.83**	**0.18**

Resources		0.78	
Competency	0.31		
Information sharing	0.32		
Reliability of third party	0.37		
Total sustainability index (RI)		**0.78**	**0.10**
Technology		0.87	
Resiliency	0.20		
Flexibility	0.41		
Efficiency	0.25		
Robustness	0.14		
Total sustainability index (TI)		**0.87**	**0.37**

B. Audit findings

Based on the obtained result (Table VII), it was observed that green IS has a low sustainability score while resources and technology have a high sustainability score, as shown in the evaluation sheet in Table VII. Having a low sustainability score indicated that the organisation would require a comprehensive revision for the design and policy in relation to Green IS implementation. These findings can lead to a new data gathering and further analysis to explain the weaknesses. An average score signifies reasonable sustainability, implies that the IS has a better sustainability level and in terms of economic and social dimensions.

TABLE VII. EVALUATION OF ENVIRONMENTAL CRITERIA

	Value	1	3	5	7	9
Attributes	**Green IT**					
	Equip.	/				
	Recyle		/			
	Paperless	/				
	En. saving		/			

Audit conclusion

This study found that green IS policy has not been effectively practiced by the organisation. Out of five units of the auditee organisation, two units have planned to implement green IS for sharing IS equipment and exercise paperless environment. The directors of these two units agreed to execute the plan by next four months.

Corrective and/or preventive actions

Appropriate preventive actions should be taken by the organisation to enhance the enforcement on Green IS policy and motivate employee to apply paperless environment for administrative work.

Recommendations

Organisation should make its employee aware on green IS, its concept and implication by training or brainstorming. In addition, the implementation of green IS policy should be communicated effectively with users by actively involving them in each component processes of administrative, finance and operational.

C. Applicability of the SISA

The integration of sustainability for IS audit process provides several advantages such as:

- SISA provides a comprehensive approach of IS audit. SISA is designed on basic definition of the audit, measures IS performance from the view of key users.
- SISA aids auditor to produce concrete audit findings by prioritising the audit criteria and sub-criteria.
- SISA provides a broader view of IS audit report. In addition to IS controls evaluation and value for money assessment, SISA reported a qualitative behaviour of IS derived from the perceptions of the key users.
- SISA enhances the scope of audit work by focusing on balance approach of technology and sustainability benefits, measuring value in the three dimensions of sustainability and ability to apply continuous auditing method when performing audit works.
- SISA shows the significance criteria and sub-criteria with which difference audit tools or techniques may be emphasized.

Due to the several uncertainties related to IS initiatives which are return from the IS investment, benefit to the key users from the IS investment and the IS performance, this study found that the proposed SISA is the alternative approach to overcome these shortages, as it requires and addresses key users perceptions of the IS adoption. Furthermore, the role of SISA is seen to reduce uncertainties in decision making by reviewing results, processes and input. It also facilitates coordination and communication to produce effective audit report that provide effective value delivery to stakeholders and public.

The choice of SISA is directly determined with sustainability goals. However, it is important to note that small organizations limited by financial resources, knowledge and less complexity of IS. Large business organization may involve integration of IS, complex and sophisticated of IS where IS security is crucial. For an efficient implementation of SISA, auditors may consider changes to be made to sub-criteria as key users may have different perception between small businesses and large business organization. Despite of the advantages, the auditors of the case study have considered the lack of guidelines on how to use the comparison matrix, unclear sustainability measurement specifically focusing on IS audit, decision point and automated process as limitations of the proposed SISA.

VI. CONCLUSION

In this paper, sustainability dimensions are incorporated into the IS audit practice for evaluating different aspect of IS within public organisation. We presented the use of AHP and FST in prioritizing audit criteria as a strategy to produce a concrete justification on the audit findings. The applicability of sustainability drive IS audit process to a real case study has

been very promising. The result showed that a systematic and numerical approach is suitable for prioritizing audit criteria and to emphasize the key areas of concern for the audit purpose. The results indicate that the sustainability approach is a practical and reasonable method that can be employed at the public organization. However, the proposed IS audit process needs refinement based on the feedback obtained from the case study. Therefore, we are planning to redefine the activities and underlying methods within the activities based on the obtained feedback. Furthermore, it is also necessary to provide a guideline to the auditors to perform the audit activities. In particular, the process should provide a decision whether the organization is sustainable to meet its objective. All these are our planned future works.

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