Using Analytical Hierarchy Process (AHP) to Evaluate Barriers in Adopting Formal IT Governance Practices

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***Abstract*—The adoption of formal standards and frameworks that facilitate effective IT Governance (ITG) continues to be an important issues by todays' CIO's. Organisations continue to focus their attention on adopting these formal ITG practices. However, the adoption of formal ITG practice can be a major challenge due to the existence of several barriers. Therefore, this work aims to identify and evaluate barriers related to the adoption of formal ITG practice. A total of 10 barriers in adopting formal ITG practice are listed through literature and expert inputs. The listed barriers are then evaluated to determine their relative importance using an Analytical Hierarchy Process (AHP) technique. The usefulness of the proposed work is shown by taking the case example of a financial sector organisation in Malaysia. According to the findings, the category of barriers related to "Organisational factors" was attributed the highest importance among other barriers in adopting formal ITG practices. Overall, the purpose of this work is to aid managers and practitioners through important insights as well as support their decision-making in terms of managing formal ITG practice implementation issues in the financial sector, in an effective and efficient manner.**

***Index Terms*—Adoption Barriers; Analytical Hierarchy Process (AHP); Financial Institutions; Formal ITG Practice.**

I. INTRODUCTION

Appropriate governance of information technology (IT) is critical to harness the benefits of IT investments in organisations. Research has shown that organisations with proper governance of IT will result in at least 20 percent higher returns on assets than organisations with weaker governance [1]. Another study finds that better IT governance practices lead to improved IT outcomes [2].

Consequently, extensive efforts has been made in the development of various standards and framework that facilitate effective IT Governance (ITG)[3]. Voluntary standards such as ISO/IEC 20000 for IT Service Management and ISO/IEC 27001 for IT Security Management have been introduced as a means to enable organisations to obtain certification. This enables them to gain competitive advantage, facilitates many of the legal and regulatory requirements as well as providing an objective validation by an impartial certifying body that the organisation is vigilant in undertaking its due diligence [4] . Meanwhile, frameworks such as COBIT and ITIL which consists of a set of best practices and are often implemented according to the needs of the organisation.

Yet, despite the availability of well-defined standards and frameworks for effective ITG, research has shown that large proportions of organisations have yet to adopt any. [5] in her survey on US companies found that less than half had implemented any type of IT service management standards or frameworks.

While there have been many studies that have looked upon the drivers and critical success factors for their adoption [7][8], less research has been accorded to the factors that inhibit them, much less in developing countries. Notable exceptions include a case study research by [9] which found that a lack of enforcement as a major issue. Meanwhile, [10] identified several challenges to ITIL adoption in their case study of a major public utility company in Malaysia. These challenges include the lack of awareness, lack of standard terminology and lack of clear defined roles and responsibilities. Furthermore, initial research done by [11] and [12] as well as their subsequent research in [13] goes to show that there exist many possible barriers to the adoption of formal ITG practice and their impact and importance will vary among the different industries.

Therefore, it is important that organisations from these different industries be able to identify and thus deal with the various challenges, hurdles, and barriers associated with formal ITG practice adoption.

The present research attempts to answer the following research questions:

- What are the existing barriers in adopting formal ITG practice?
- What is the required research framework that should be used to evaluate barriers in adopting formal ITG practice?
- What is the practical applicability of the proposed framework in the context of Malaysian organisations?

The first objective of this work is to recognise the barriers to the adoption of formal ITG practice. While certain barriers can be identified through the literature or experts' opinions, there remains the fact that different organisations may have different views regarding barriers in adopting formal ITG

practices. In view of this, the same formal ITG practice adoption barriers may differently impact a certain industry and therefore hold a specific importance for that industry. Thus, a set of feasible barriers needs to be proposed and evaluated to manage the adoption of formal ITG practices in various business operations and acitivites .

This is the reason for which the second objective of the present research is to evaluate the formal ITG practice barriers. In light of this, an AHP approach is used for determining the relative importance of the barriers to adopt formal ITG practices in the industry [14] .

A case example of the Malaysian industry is discussed to reveal the practical applicability of the suggested model. It has been observed that the financial industry remains one of the more regulated industries in Malaysia and its adherance to standards and best practices frameworks is expected.

The remainder of this paper is organised as follows. A review of relevant literature discussing barriers related to the adoption of formal ITG practice is presented in Section 2. The solution methodology is described in Section 3, while an application case example with related results is discussed in Section 4. Discussions and implications of the research is given in Section 5. Finally, Section 6 provides conclusions, limitations of the work as well as directions for future research.

II. Literature Review

This section presents the literature related to formal ITG practice implementation and formal ITG practice barriers.

A. Formal ITG practice adoption and implementation

For the purpose of this research, we define formal ITG practice as standards and frameworks that facilitate effective ITG [6][12][7]. Within the context of Malaysia, there exists several studies that have looked upon ITG implementation. Early published research were identified from the public sector [8, 9]. Conversely, research in the private sector revealed that adoption of ITG was at an early stage and familiarity with ITG frameworks could be improved [10, 11].

In a study by [8] on ITG implementation in the Malaysian Ministry of Education, they found that the level of maturity for ITG implementation was between repeatable and managed. It was evident that there was a need for controls over several IT processes, thus a need for the adopting of a formal ITG implementation framework.

[12] concluded that the Malaysian public sector has been practicing ITG. They found that factors such as senior management involvement in IT, corporate performance measurement systems, corporate communications systems, risk management, strategic alignment, value delivery, ethics/ culture of compliance and resource management all contribute or influence ITG implementation in the Malaysian public sector. Meanwhile, [13] noted that Malaysian businesses appeared to exhibit awareness although ITG was only partially practiced. While most researchers looked into the issues of adoption, others looked into issues regarding the effectiveness of ITG within organisations [14, 15].

While existing research points to a positive outlook on ITG implementation, the level of adoption and maturity is still relatively low [6, 8, 13]. ITG implementation is influenced by external and internal factors [16].The literature and current frameworks and best practices fail to reveal a clear and concise identification of these factors [17].

B. Barriers to formal ITG practice implementation

The barriers to the adoption of formal ITG practice can be ascertain from the literature and from expert view inputs. However, different organisations might have different views regarding barriers in adopting formal ITG practice. In view of this, a barrier in one industry may not be such in another, or may have a different impact. Based on existing literature, 10 important barriers to the adoption of formal ITG practice were identified. These barriers were further validated through expert inputs. In addition, there barriers were divided into 3 main categories (Technological related barriers, Organisational related barriers, and Environmental related barriers) through expert judgements (data collection details are given in Section 5). However, the identified specific barriers are provided in Table 1 that discusses the research highlights for the study.

Table 1
Identification of barriers to formal ITG practice

Dimension of barriers	SI no	Key barriers to implementation	References
Technological related barriers (T)	1	Complexity (T1)	[1] [2] [3] [4] [5] [6] [7] [8] [9] [10] [11] [12] [13]
	2	Lack of compatibility (T2)	[1] [12]
	3	Costs (T3)	[1] [2] [3] [5] [6] [7] [14] [10] [15] [12] [13]
	4	Lack of perceived benefits (T4)	[1] [2] [3] [7] [10] [15] [16] [12] [13]
Organisational related barriers (O)	5	Lack of top management support (O1)	[1] [2] [4] [5] [14] [10] [17] [16] [12] [13]
	6	Resistance to change (O2)	[18] [19] [2] [4] [14] [9] [20] [10] [15] [12] [13]
	7	Lack of organisational resource availability (O3)	[21] [22] [2] [7] [8] [14] [23] [10] [12] [13]
Environmental related barriers (E)	8	Lack of external support (E1)	[1] [24] [25] [12]
	9	Lack of external pressure (E2)	[26] [24] [25] [12]
	10	Consultant ineffectiveness (E3)	[1] [27] [25] [11] [13]

III. Solution Methodology

The AHP method has been used extensively to study the critical success factors. [43] used AHP to set critical success factors priorities. Similarly, [44] used AHP to compare between traditional, open source, and on-demand office suites on the fulfilment of evaluation criteria.

AHP is used as a solution methodology in this work. AHP is an approach which assists in decomposing, organising and analysing a complex problem. It converts the problem undertaken into a hierarchical structure consisting of various definite levels, such as goal, criteria and sub-criteria [45]. There are numerous additional methods, like ELECTRE and TOPSIS that have been presented to solve the multi-criterion decision making problem. However, AHP is suggested as a better tool in comparison to others due to its wide applicability and ease of use [46]. Therefore, we implement an AHP method to evaluate barriers related to the adoption of

formal ITG practice. The flow chart of this research work is illustrated in Figure 1.

The steps involved in the AHP are given as:

1. *Formulation of the aim of work*: evaluating the barriers in order to identify their relative importance in the adoption of formal ITG practice, is defined as the aim of this work
2. *Formation of the pair wise comparisons*: pair wise comparison is conducted by means of data collection from an expert panel and based on expert judgement, the pair wise comparisons among the factors are attained through a nine point Saaty's scale as shown in Table 2.
3. *Computation of the Eigen values and Eigen vectors and relative importance weights*: the framed pair wise comparisons matrices were operated to determine the Eigen values and Eigen vectors, which are further analysed to calculate the relative importance weights of the factors.
4. *Evaluation of the consistency ratio*: the consistency ratio (CR) is computed to ensure the consistency of pair wise comparisons. The used mathematical expression for finding the CR is given as, CR=CI/RI, where the consistency index is denoted by:

$$(CI) = (\lambda\_max\text{-}n) / (n\text{-} 1) \quad (1)$$

(λ_max is the maximum average value) and the value of the random cosistency index (RI) depends upon value of (n). the value of CR should be less than 0.10 to have better level of consistency.

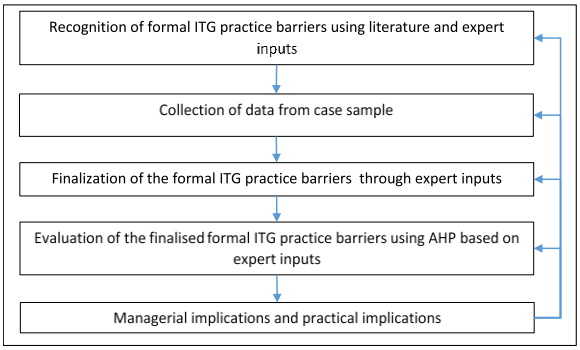

Figure 1: Flow chart of the research work

Table 2
Scales in pair wise comparisons

Importance intensity	Preference judgements
1	Equally important
3	Moderately important
5	Strongly important
7	Extremely important
9	Extremely more important
2, 4, 6, 8	Intermediate values between adjacent scale values

IV. Example Application

The proposed model is applied to a real world practical problem. The company addressed in the case study operates in the financial sector.

The managers are looking to adopt formal ITG practices to achieve better return on IT investment as well as to prepare for future regulations within the financial industry. After consulting with the managers, it is decided to extend the proposed flow chart to the case company. Thus, a procedure for identification and determination of relative importance of barriers related to formal ITG practice is conducted for the case study, further details are provided in subsequent subsections.

A. Data collection

In the process of data collection, a decision group of five experts is formed, consisting of a Chief Information Officer, a Financial Manager, a Human Resources Manager, IT Head of Department, and an IT support staff. After finalizing the expert panel, the next task was to gather data. Finally, the expert responses were collected and data were gathered. The data collected is used in two phases, described as follows:

1. Finalisation of the important barriers to adopt formal ITG practice
   There were 20 barriers to the adoption of formal ITG practice identified and collected through the literature. To validate the identified barriers, the experts were asked to add or delete any barrier relevant to adoption of formal ITG practice initiatives in a financial industry context. The responses were gathered and several discussion sessions were arranged with the experts to finalise the reported barriers for formal ITG practice in the context of financial industry. The experts show agreement with all the identified formal ITG practice based barriers, hence, a total of 10 barriers were selected.
2. Evaluation of the formal ITG practice barriers to determine their relative importance using AHP
   The finalised formal ITG practice barriers were evaluated using AHP, whose relative importance was invaluable identified through expert input. A hierarchical structure is formed using expert inputs (see Figure 2). This hierarchical structure has three different levels: evaluating the formal ITG practice adoption barriers for relative importance (Level-1), the 3 categories of barriers (Level-2) and 10 specific barriers (Level-3).

Pair wise comparisons are derived for both categories of barriers and the specific barriers using expert's inputs through a Saaty scale. This way a pair-wise comparison matrix for categories of barriers was framed and their relative weights are summarised in Table 2.

The pair wise comparisons for specific barriers under each category and their corresponding relative weights are shown in Table 3-6.

The pair wise comparison matrices were operated to determine the relative importance and weights were assigned corresponding to each category of barriers as given in Table 7.

Organisational factors was the category of barriers (O) (0.443429) reported to be the most important for adopting formal ITG practice followed by Technological factors (0.387371) and Environmental factors (0.169200) as shown in Table 3 and 8. Next, the relative importance of weights of the specific barriers were calculated. Global preference weights of the specific barriers were also calculated, and correspondingly their relative importance order or ranks were calculated; other details are given in Table 7.

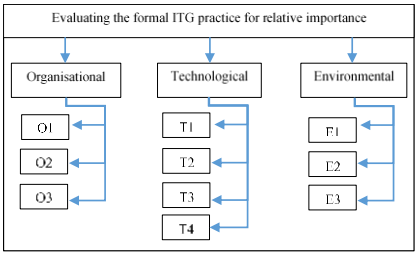

Figure 2: The developed decision hierarchy of barriers to adopting formal ITG practice

Table 3
Pair-wise assessment matrix for categories

Barriers	T	O	E	Relative weight	Rank
T	1	2	1	0.387371	2
O	1	3	1	0.443429	1
E	0.333	1	0.5	0.169200	3

Maximum Eigen value =3.01829; C.I. = 0.00914375

Table 4
Pair wise assessment matrix for "Technological related" category

Barriers	T1	T2	T3	T4	Relative weight	Rank
T1	2	2	1	3	0.424864	1
T2	1	0.5	0.5	1	0.161286	3
T3	2	1	0.5	2	0.270066	2
T4	1	0.5	0.333	1	0.143784	4

Maximum Eigen value =4.04582; C.I. = 0.0152731

Table 5
Pair wise assessment matrix for "Organisational related" category

Barriers	O1	O2	O3	Relative weight	Rank
O1	1	3	1	0.453322	1
O2	1	2	1	0.383323	2
O3	0.333	0.5	1	0.163355	3

Maximum Eigen value =3.01688; C.I. = 0.0152832

Table 6
Pair wise assessment matrix for "Environmental related" category

Barriers	E1	E2	E3	Relative weight	Rank
E1	1	0.5	0.333	0.142223	3
E2	2	1	1	0.392232	2
E3	3	1	1	0.465545	1

Maximum Eigen value =3.05432; C.I. = 0.0143321

V. Discussion and Managerial Implication

A. Discussions

Based on Table 3, the order of relative importance of categories of barriers is given as: O-T- E. The order of relative importance of specific barriers is also given is Table 7. A total of 10 barriers are divided into three categories of barriers, and keeping that in mind, this research has put forward several implications for managers.

To begin with, the category Organisational related barriers, hold the first position in the rank, and consequently, occupies the highest relative importance in comparison to other categories as a barrier to adopting formal ITG practice. This means that achieving formal ITG practice adoption is not possible without organisational related factors.

There are three specific barriers in this category. Amongst them, lack of top management support obtains the highest relative importance. Next, is the barrier resistance to change. The barrier related to the lack of organisational resource availability comes last in the list. Support for this finding is abundant, among them is [4] which found that 50% of his respondents revealed that lack of top management involvement was an obstacle to formal ITG practice adoption.

Technological related barriers holds second place among other categories of barriers. This particular category of barriers entails four specific obstacles. Complexity holds the highest importance. This is followed by costs. Lack of compatibility ensues. The last barrier which is lack of perceived benefit. Supporting this factor is [3] which found that the complexity of the formal ITG practice had hindered its adoption, especially by SMEs.

The category environmental related barriers acquired the third and last position on the importance scale. There are three specific barriers within this category. It has been suggested that consultant ineffectiveness is ranked first. This is followed by lack of external pressure. Last, in the importance order list, the barrier lack of external support is ranked. Often overlooked, consultants have a considerable effect on adoption as they are expected to provide practical first hand knowledge, as well as providing hand-holding sessions to first time adopters.

Table 7
Global ranking of formal ITG practice barriers

Categories of barriers	Relative weights	Specific barrier	Relative weights	Relative rank	Global weights	Global rank
Technological related (T)	0.387371	T1 Complexity	0.424864	1	0.1989680	2
		T2 Lack of compatibility	0.161286	3	0.0668224	6
		T3 Costs	0.270066	2	0.1124410	3
		T4 Lack of perceived benefits	0.143784	4	0.0596919	8
Organisational related (O)	0.443429	O1 Lack of top management support	0.453322	1	0.2372420	1
		O2 Resistance to change	0.383323	2	0.0671341	5
		O3 Lack of organisational resource availability	0.163355	3	0.0603244	7
Environmental related (E)	0.169200	E1 Lack of external support	0.142223	3	0.0442099	10
		E2 Lack of external pressure	0.392232	2	0.0532145	9
		E3 Consultant ineffectiveness	0.465545	1	0.0999514	4

B. Managerial and practical implications

The current research sets forward several implications for society and science, the major contribution among them is to facilitate industry experts and managers to become aware of the barriers with regards to the adoption and implementation of formal ITG practice. After acquiring a basic understanding on these barriers and issues, the concerned authorities are better able to eradicate the barriers to implementing formal ITG practice in organisations. They are also better able to recognise the most important barriers and to formulate strategies to coordinate their efforts in a most effective way. This research work ultimately assists decision makers to prepare and practice well for the widespread adoption of formal ITG practice.

The AHP based model may facilitate decision makers and managers not only to determine the relative importance of

formal ITG practice barriers but also enable them to enhance the sustainability of the business organisations in implementing formal ITG practice initiatives. The findings obtained in this work may provide guidelines to other developing countries like Indonesia or Thailand, to analyse the barriers in formal ITG practice initiatives' implementation. In this sense, the present work may serve as a benchmark study for business organisations in the financial sector to address their specific hurdles and problematic issues in successful adoption of formal ITG practice.

VI. CONCLUSION

This work proposes a structural model for evaluating the barriers associated with the adoption of formal ITG practice. Initially, three categories of barriers and 10 specific barriers related to the adoption of formal ITG practice were identified from the literature and from experts' inputs. Then, an Analytical Process Hierarchy (AHP) analysis was used to evaluate these barriers in order to determine their relative importance order. The importance order of recognised categories of barriers for adopting formal ITG practice is given as O-T-E. According to the findings, the category Organisational related factors possess the highest importance, which implies that it requires focused attention from top management.

This work also presents a case example to illustrate the real life applicability of the proposed network model. The findings of this research can be particularly useful for the case of companies aiming to become more capable in analysing the formal ITG practice implementation related barriers. This work may also help regulatory bodies, policy makers and practitioners/managers to prioritise the elimination of barriers to promote formal ITG practice initiatives.

This study has certain limitations. The AHP based structural model that is proposed in this work consists of 3 main barriers and 10 specific barriers to the implementation of formal ITG practice. The identification of barriers related to the implementation of formal ITG practice may be challenging. Further, the AHP based analysis uses expert inputs, thus, it is recommended for carrying out the procedure carefully. The adapted methodology AHP has several weaknesses such as vagueness, uncertainty and bias. In future research, fuzzy AHP may be used to remove the inherent vagueness and uncertainty. This work presents a single case study. Multiple case studies may be conducted in the future perspective. The proposed AHP based analysis model may also be extended to different industry sectors such as the financial and manufacturing sectors which are particularly known for their dependency of IT. Finally, in future studies, the identified barriers in the adoption of formal ITG practice can be analysed using other decision making methods like ISM [28], ANP [29], TOPSIS [30], and VIKOR [31].

ACKNOWLEDGMENT

This research was supported in part by UTeM and TRGS grant (TRGS/1/12014/FTMK/02/2/D00002).

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