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Assessment of Enterprise Architecture Implementation Capability and Priority in Public Sector Agency

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Abstract

The objective of this study is to assess the capability and priority for Enterprise Architecture (EA) implementation in the context of Malaysian public sector agency. This study uses the Analytic Hierarchy Process (AHP) based on the judgments and opinions of EA team members from three different agencies at federal level. There are 27 assessment criteria which are grouped into six categories, Internal Process, Learning and Growth, Authority Support, Cost, Technology and Talent Management. The top capability of all cases is Internal Process and the top criteria for priority assessment is Authority Support. From the findings it can be concluded that AHP is a useful and cost effective method to assess, priorities and plan for EA implementation. Addressing the capability and priority criteria will ensure the optimum EA is implemented thus it shall reduce the risk of EA implementation failure.

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1. Introduction

Enterprise Architecture (EA) is a hierarchical approach for aligning business and information technology (IT) by integrating the information systems, processes, organisational units and people in an organisation. The aim is to further enhanced various IT systems in public sector to provide better services to the citizens and business^{3, 23, 32}. A

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robust architecture of IT system will facilitates better communication between the government and citizen¹⁹. EA also translates the organisational vision and mission into operational reality and leverages on current technology to improve the public sector service delivery system^{27, 40}.

It provides a blueprint for defining the structure and operation of organisation through these four layers, business, data, application and technology³³. In brief, EA is a hierarchical way of describing how the information systems, business processes and people in an organisation function as a whole^{9, 15, 39}. EA helps in bringing together business process and IT by providing clear direction in managing information, applications and technology. Through EA, the process of sharing information between organisations will be more efficient.

Although the discussion on EA implementation has started 25 years ago²⁴, most organisation are still facing issues in ensuring a successful and optimal EA implementation. Despite of comprehensive guidelines from existing EA frameworks and methodologies, in reality implementation of EA is not an easy task. Organisation still unable to translate the proposed EA solution provided by existing EA frameworks/methodologies according to their own organisation needs³⁷. Many organisations especially those in public sector agencies are having difficulties in implementing EA due to inflexibility and complexity of the business and IT structures³⁷. Study by Roeleven and Broer²⁵ reveal that more than 66 per cent of EA program in Netherlands did not fulfil the expectation and this has resulted longer time spend for EADI process. Gartner Group predicted 40 per cent of all EA programs would be terminated caused by failure to demonstrate sufficient value to the business¹¹. Whereby in United States, most of the Federal EA programs also produced unsatisfactory results and some have not produced any results at all¹². Meanwhile in Malaysian scenario, none of the public sector agencies successfully operationalised their EA yet.

Hence, it is predicted that, if there is some kind of assessment mechanism in place, it shall assist the EA implementation process^{16, 35}. Therefore, this research aims to assist EA implementation process by proposing an EA implementation capability and priority assessment model. The paper is organised as follows; next section discusses on the proposed assessment model and research methodology. Next is the results and discussion section where the each case study capability and priority assessment analyses were explained. Finally this paper ends with conclusion and proposed future works.

2. Proposed EA Implementation Capability and Priority Assessment Model

This study proposed an EA Implementation Capability and Priority Assessment Model with aim to assess the level of capability and priority of each proposed criteria in EA implementation process. The underpinning theory of this study is Balanced Scorecard (BSC) by Kaplan and Norton¹⁸ and Analytic Hierarchy Process (AHP) by Saaty²⁸. This model proposed 27 assessment criteria and they are grouped into six categories which are internal process, learning and growth, authority support, cost, technology and talent management. All these criteria were derived from previous literatures and case studies conducted in Malaysian Public Sector agencies. Table 1 explains how the assessment criteria were derived.

Table 1. List of EA implementation assessment criteria.

Assessment Category	Code	Assessment Criteria	Description	Literature Review [As per Reference Number]	Malaysian Public Sector Case Studies
[IP] INTERNAL PROCESS	IP1	Business Driven Approach	EA is driven by own business approach	21,29,41,2,42,30,17	✓
	IP2	Strategic Planning	EA is aligned with business organisation strategic planning	40,17,30,42	✓
	IP3	Implementation Roadmap	Clear communication and roadmap on EA implementation	2,17,30,42,37	✓
	IP4	Governance	Strong and clear EA governance exist	2,17,30,42,37	✓
	IP5	Rules and Process	Standard business rules and process exists	3,42,2,37	✓
	IP6	Organisation Value	EA is linked with business organisation value		✓
[LG] LEARNING AND GROWTH	LG1	Assessment	EA implementation assessment and evaluation exist	4,23,26	✓
	LG2	Documentation	EA documentation are complete and available	2,42,30,17	✓
	LG3	Learning Culture	EA is empowered and shared in the organisation learning culture	42,2	✓
	LG4	Skill of Architect	Sufficient and skilful EA architect is in place	2,37,42	✓
	LG5	Training and certification	Relevant EA awareness program, training and certification provided throughout the organisation	2,37,42	✓
	LG6	Community of Practice	EA communities of practice is created, in order to gain knowledge from employees and share it in the organisation		✓
[AS] AUTHORITY	AS1	Stakeholder Support	EA gain continuous support from all stakeholders	13,31,43,30,42,37,14	✓
	AS2	Stakeholder Benefit	EA benefits are acknowledged by all EA stakeholders	17	✓

Assessment Category	Code	Assessment Criteria	Description	Literature Review [As per Reference Number]	Malaysian Public Sector Case Studies
SUPPORT	AS3	EA Recognition	EA importance are recognised by all EA stakeholders	10,17,30	✓
	AS4	Comprehensive Mandate	EA rules and processes are mandated		✓
	AS5	Political Influence	EA received positive political influence	13	
	AS6	Stakeholder Understanding	Mutual understanding of all EA stakeholders exist		✓
[CS]	CS1	Financial Resources	Sufficient financial resources is allocated	2,17,30,42,37	✓
COST	CS2	Non-financial Resources	Sufficient supply of other resources are available (e.g. people, technology, training)	2,17,30,42	✓
	CS3	Central Funding	Central funding on EA implementation is allocated		✓
[TC] TECHNOLOGY	TC1	Practical EA Technology	EA tools, methodology, framework are available, suitable, easy to be used and understand	1,34,36	✓
	TC2	EA Technology Support	Competence and reliable vendor/customer support for EA tools, methodology, framework and repository exists	6,20	✓
	TC3	EA Repository	EA repository is available		✓
[TM] TALENT	TM1	Talent Management Plan	Specific plan is created to retain the EA expertise in the organisation		✓
MANAGEMENT	TM2	Centralised Enterprise Architect team	Centralised EA experts team is created and govern by central agency		✓
	TM3	Retention Program	EA knowledge retention programs is created to ensure the sustainability of EA initiative		✓
Total Criteria				18	27

3. Research Methodology

Next, to operationalise the proposed assessment model following steps are executed.

Step 1: Selection of EA team member

Initially, this study identified 11 Malaysian Public Sector agencies that implemented EA. However, after further investigation, only three agencies were short listed for this study as they obtained the highest EA maturity level in Malaysian Public Sector and have started the EA initiative for more than two years. Each case study consists of three to five team members. All of them are actively involved in EA implementation for more than two years in their respective agency. They were requested to give their personal opinions, based on their knowledge and experience on the capability and priority of each factor that might influence the EA implementation process.

Step 2: Setting objective and focus area.

The objective is to assess the EA implementation capability and priority in public sector organisation. This objective was finalised after the extensive process of literature review and multiple case studies interviews by the researcher prior the execution of this assessment. This is to ensure the feasibility of the assessment criteria used.

Step 3: Determine the assessment criteria.

Next step is to formulate the EA assessment criteria. These criteria were derived from literature review and multiple case studies as explained in Table 1.

Step 4: Presenting the assessment criteria into a hierarchy.

Following an AHP method, a hierarchy list was developed on three levels. The top level shows the objective of the process which is to assess the EA implementation capability and priority in public sector organisation. The second level lists the assessment categories which are internal process, learning and growth, authority support, cost, technology and talent management. Finally, the third level is the list of 27 assessment criteria grouped by it assessment category. All these level are interrelated and according to AHP algorithm, value from the lowest level will impact the upper level and so on until it reached the top level. Fig. 1 shows the hierarchy of assessment criteria.

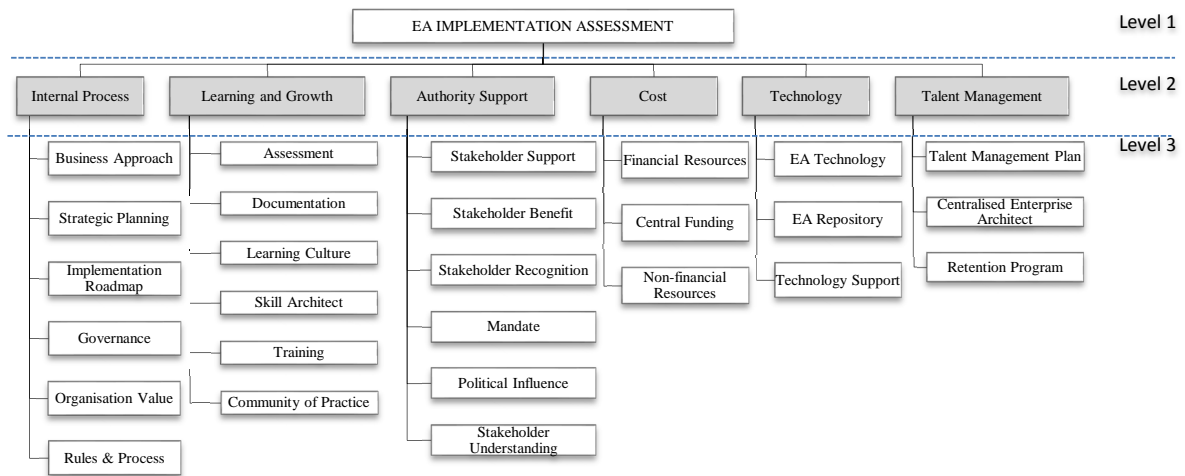


Fig. 1: Hierarchy of EA implementation criteria

Step 5: Assessing the importance of variables.

The importance of the variables was assessed comparatively using a scale from 1 to 9 defined by Saaty²⁸. The assessment process involved all EA team from these three selected case studies. The step is carried out by the participants by using pairwise matrices questionnaires to evaluate the relative importance of each variable at level two and three against other variables within the same category. The AHP importance scale is shown in Table 2.

Table 2. Saaty's scale of relative importance.

Quantitative importance	Qualitative relative importance	Explanation
1	Equal importance	Two factors contribute equally to the problem
3	Weak importance of one over another	Experience and judgement slightly favor one over the other (3 times more important)
5	Essential or strong importance	Experience and judgement strongly favor one over the other (5 times more important)
7	Demonstrated importance	Experience and judgement very strongly favor one over the other (7 times more important)
9	Most important	The evidence favoring one over the other is of the highest possible validity (9 times more important)
2,4,6,8	Intermediate values applied between groups	When participants are not sure about choosing among the respective important comparison

Step 6: Consolidation of the scores.

The scores obtained through the above mentioned scale from individual participants, were then consolidated into one comparative matrix through geometric mean. This paper applies the aggregate individual judgment (AIJ) and not the aggregated individual priority (AIP) because the aim of this study is to get the collective judgment of the group rather than the individual prioritization^{5, 7}.

$$b_{ij} = (a_{1ij}.a_{2ij}..a_{kij})^{1/k}. \quad (1)$$

Then, the scores are normalised accordingly. They are calculated by dividing the value in each cell in the consolidated tables by the sum of their columns.

Step 7: Calculation of Eigenvector and Consistency Index (CI).

The Eigenvector for each factor is then calculated by averaging its normalised values in each row. Followed by calculating the Consistency Index (CI) based on the given formula;

$$CI = (\lambda_{\max} - n) / (n - 1) \quad (2)$$

where; n = number of compared alternatives, λ_{\max} = the maximum Eigenvalue. and

$$\lambda_{\max} = \sum_{i=1}^n [(w_1.t_1) + (w_2.t_2) \dots (w_i.t_i)] / n \quad (3)$$

where; w is the Eigenvector for alternatives, t is the sum of columns and n is the number of alternatives. The consistency ratio (CR) is then calculated through dividing the consistency index by the Random Index (RI).

$$CR = CI/RI. \quad (4)$$

RI is obtained from the RI table of indices generated by Saaty based on the nine values scale as shown in Table 3.

Table 3. Random inconsistency table of indices.

Number of variables	1	2	3	4	5	6	7	8
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41

Results show the Consistency Ratio (CR) values ranged from 0.0000 to 0.0911, which means that all the pairwise comparisons are consistent are within the acceptable level (<0.1) as recommended by Saaty²⁸. Therefore, this shows that the results obtain are reliable and valid.

Step 8: Validation.

The AHP used in this study is validated at various approaches. Firstly, this assessment is only given to selected participants was based on their experience and familiarity with the topic. In addition, the assessment was done in group rather than single to ensure it reached a consensus assessment describing the whole EA implementation of that particular agency. The participants were given a face to face instruction on how to perform the assessment hence; this reduced the impact of individual inconsistencies. Following the suggestion by Vargas³⁸, the cut-off points to accept the matrices are consistency index of 0.1 or a consistency ratio of 10%. The participants were asked to reach a consensus or to re-evaluate their comparison scores whenever high inconsistency ratios are detected. Hence, the aggregation of judgments in this study has improved the results consistency^{7, 8}.

Step 9: Ranking of criteria.

The obtained weights of variables at different levels were then presented in the hierarchy. The importance of the root causes to the objective in the first level was calculated through multiplying the weights of the direct variables in the second level by the weights of their indirect variables in the third level.

4. Results and Discussion

This section describes the result of capability and priority EA implementation assessment from the three public sector agencies in Malaysia.

4.1. EA Implementation Capability

Capability is the ability to perform or achieve certain actions or outcomes through a set of controllable and measurable faculties, features, functions, processes, or services²². In this research context, EA implementation capability aims to identify what is the strength of the organisation in developing and implementing EA. Therefore, agency can start develops and implements EA based on the existing strength and at the same time, begin to build the

capability in other lacking areas. Fig.2 shows the result of EA implementation capability assessment result for Case A, B and C.

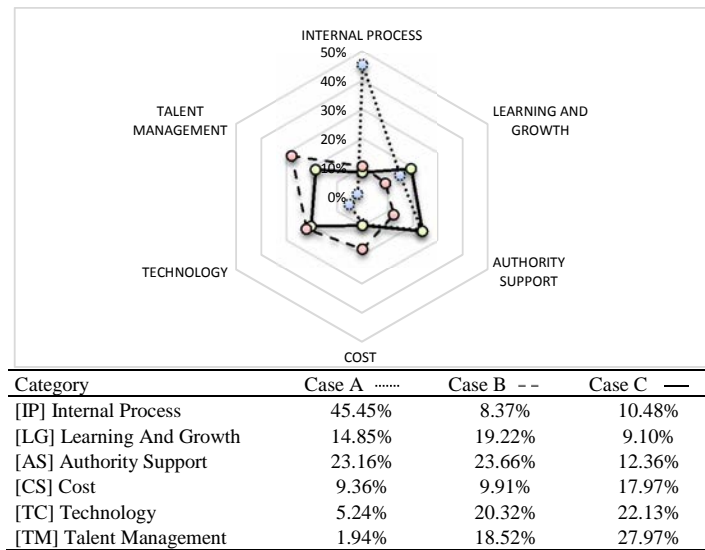


Fig. 2: EA implementation capability assessment result for Case A, B and C

As shown in the Fig. 2, level of capability in Case B and C are similar to each other and balanced. Further investigation found that, this may happen because both cases started the EA initiatives in the same period and have good progress. In Case B, the highest capability is *Authority Support* at 23.66%, followed by *Technology* at 20.32%, *Learning and Growth* at 19.22% and *Talent Management* at 18.52%. These followed by two relatively similar capabilities which are *Cost* at 9.91% and *Internal Process* at 8.37%. For Case C, the highest capability is for *Talent Management* at 27.97%. Investigation shows that this may be due to the high number EA team member of Case C with EA certification. Meanwhile *Technology* (22.13%) and *Cost* (17.97%) have moderate level of capability. Three capabilities such as *Learning and Growth* (9.10%), *Internal Process* (10.48%), and *Authority Support* (12.36%) are quite low as compared to others. Meanwhile, Case A shows extreme score for *Internal Process* (45.45%). This capability dominated the whole percentage whilst other capabilities only scores from 23.16% to 1.94%. The second highest capability is authority support with 23.16% followed by *Learning and Growth* at 14.85%. The rest of the capabilities have low scores with *Cost* (9.36%), *Technology* (5.25%) and *Talent Management* (1.94%).

4.2. EA Implementation Priority

Another assessment is on EA implementation priority. Priority is defined as something given or meriting attention before competing alternatives²². Therefore it refers to something that is more important than other things and need to be done with it first. In this research context, EA implementation priority aims to identify the rank of importance criteria in implementing EA. Therefore, the agency can execute EA initiative based on the task prioritisation and also synchronise it with the existing capability identified earlier on. By doing this, the resources and project efficiency can be increased thus contribute for better project success rate. Fig.3 shows the result of EA implementation priority assessment result for Case A, B and C

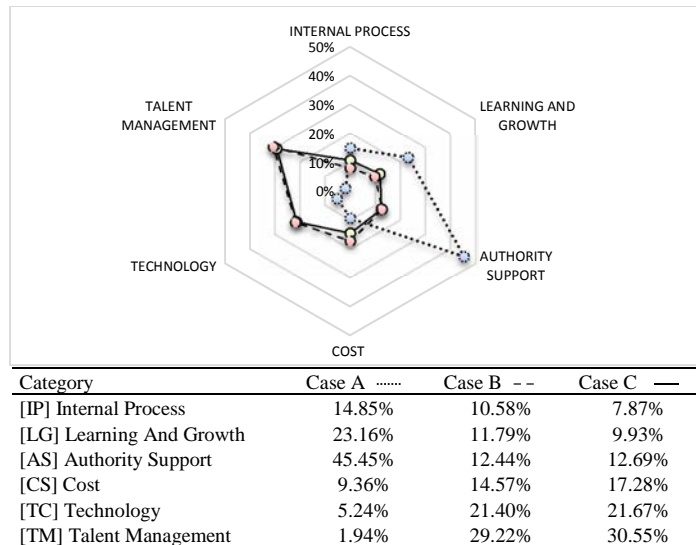


Fig. 3: EA implementation priority assessment result for Case A, B and C

Fig. 3 shows the EA implementation priority ranking for Case B and C are the same. This could be due to the same EA implementation period for both cases. For Case B and C, the highest priority is *Talent Management* at 29.22% and 30.55%. This is quite prominent from other existing criteria such as *Technology* and *Cost*, which only scores 21.40% for *Technology* Case B, 21.67% for *Technology* Case C and 14.47% for *Cost* Case B and 17.28% for *Cost* Case C. Meanwhile the forth priority goes to *Authority Support* which Case B scores at 12.44% and Case C scores at 12.69%. The fifth priority for both cases is *Learning and Growth* with Case B scores 11.79% and Case C scores 9.93%. Finally, the last priority is *Internal Process* where Case B scores 10.58% and Case C scores 7.87%.

However, Case A shows extreme score for *Authority Support* with 45.45%. This capability dominated the whole percentage whilst other capabilities only scores from 23.16% to 1.94%. The second highest capability is *Learning and Growth* with 23.16% followed by *Internal Process* at 14.85%. The rest of the capabilities have lower scores with *Cost* (9.36%), *Technology* (5.25%) and *Talent Management* (1.94%). These scores are quite similar to Case A EA implementation capability results discussed in earlier section.

5. Conclusion

This paper described an assessment process for EA implementation capability and priority based on AHP. From the extensive reviews on existing EA assessment model, we proposed a new assessment technique concentrating on EA implementation. The assessment conducted in three case studies proves that AHP assessment is workable and able to produce reliable results. Clear explanation prior the testing process thus this has increased the quality of test results. The strength of this AHP model is its ability to generate quantifiable analysis thus contributed for objective results rather than subjective judgement used by the existing EA assessment models. For future works, the result of both capability and priority assessment can be combined for further analysis. Ideally, the capacity and priority should complement each other to ensure the EA goal is aligned and EA planning works well. If there is mismatch between capability and priority, a reassessment and realigning of EA goal and activities is suggested. These assessments will help organisation in EA implementation process as it can prepare the EA team against those EA implementation requirements. By having this priority based assessment model, EA implementation team will be able to evaluate and monitor the progress to ensure a successful project delivered in line with organisation needs.

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