Selecting General Entities for TOGAF's Core Content Metamodel using Best Worst Method

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Abstract*: Enterprise Architecture (EA) Developments are often faced with metamodel complexity problem. The data for metamodel exploration significantly affects the depth of an EA analysis. In practice, however, it is limited by the scope, cost, time and quality. The entities in the EA initiation metamodel is crucial in forming an optimal metamodel based on data completeness, time, cost, quality, and scope. In this study, entities in the EA metamodel were selected from general entities in the TOGAF's core content metamodel, combined with various standards related to the upstream petroleum industry. The entity selection methodology consists of two stages, namely Preparation and Screening, as well as Analysis and Selection. Entity data are extracted from the needs of the upstream petroleum industry. The analysis was done using the best worst method (BWM). The criteria are based on the EA development goals of the Federation of Enterprise Architecture Professional Organizations. BWM analysis produces a relatively meaningful ranking of the entities that forms as general entities in the core content metamodel. This study proposes the methodology, ranking order of entities, and entities composition that form general entities for the core content metamodel.

***Keywords* : Best Worst Method, Enterprise Architecture, General entities, Metamodel.**

I. INTRODUCTION

The Open Group Architecture Framework (TOGAF) [1] provides a process life cycle in the form of Architecture Development Method (ADM) [1]. ADM is a reference to be used in creating and managing architecture in corporate practice. At each ADM phase, it discusses the input, output, and steps that explain and present the output of developmental activities or commonly referred to as artefacts. Examples of artefacts are business processes and applications. The ADM formal structure describes the metamodel content to maintain the consistency of artefacts. Metamodel must provide a basic model with a minimum set of features, whereas the core metamodel provides a minimum collection of architectural content that supports the tracing capability between artefacts. In its implementation, the metamodel core content is defined in the form of several entities that enable architectural concepts to be understood, stored, filtered, queried and represented consistently, entirely and traceably. General entities represent entities of architecture principles, vision, and requirements. General entities consist of entities in related contexts that affect formal architectural models. Context entities include architecture principles, strategic contexts that are input into architectural modelling, and requirements that construct during architectural development. Architectural context explores in the preliminary and architecture vision phases. Determining the general entities in the core content metamodel is a crucial activity in the early stages of developing Enterprise Architecture. In the context of upstream petroleum industry, the process of determining the general entities is even more crucial and challenging.

After several years of excessive world oil supply, the upstream petroleum industry began to move away from the crisis with favorable oil prices over the past 12 months. The prices were range between \$40 and \$50 per barrel (bbl) [2], and now move positively to be traded above \$70 [2]. This fact indicates that the industry has improved, and need to be supported by stringent investments, portfolio adjustments, and production efficiency, to maintain the performance.

In Indonesia, the upstream petroleum industry began to show a positive trend since 2018. This increase occurred after the Indonesian upstream petroleum industry experienced a slowdown from 2015 to 2017. This phenomenon led to an increase in investment in this sector. Based on data from Special Task Force for Upstream Oil and Gas Industry (SKKMigas), upstream oil and gas investment in 2018 recorded at USD 11.9 billion [3], [4]. This value represents an increase of around 16.7 % compared to 2017, which only reached USD 10.2 billion [4], [5]. In comparison, upstream oil and gas investments in 2015 and 2016 were recorded at USD 15.3 billion [4], [6] and USD 11.6 billion [4], [7].

Improvement steps can be done by prioritizing the efficiency and effectiveness of work processes and improving performance from all aspects that support corporate performance. Efficient use of the budget has become an inevitable element. Increasing the efficiency and effectiveness of the budget has been carried out with a variety of strategies. Generally, upstream petroleum companies in Indonesia implement Enterprise Architecture (EA). EA is believed to support the achievement of efficiency and effectiveness. The planning, budgeting and operational processes are areas of improvement that can be controlled through EAs. EA can control the budgeting mechanism both in the short, medium and long term.

EA is not a framework that is ready to be used immediately. Decision-makers must determine the steps to implement EA consistently and in detail. Experience in implementing EA needs attention. The causes of failure of EA implementation include inconsistent leadership support [8], level of complexity of the scope of EA and lack of anticipation of the impact of very rapid business

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change [9], selection of frameworks and methodologies that do not fit to company characteristics [10], [11], and the formation of metamodels that are not in accordance with company requirements [12].

This study attempts to assess the level of importance of each entity in the core content metamodel general entities. The ranking of entities in general entities was a challenge at the beginning of EA development. The test data uses data collected from Indonesian upstream petroleum companies. EA practitioners were selected from four upstream petroleum companies as experts. Focus group discussions were conducted with experts.

In Section 2, the related research regarding EA metamodel to support alignment between Information technology (IT) and business needs is presented. Section 3 discusses the methodology used in this research. There are two steps methodology based on BWM. First step is preparation and screening. Second step is analysis and selection. Section 4 presents the results and related discussion, and finally, a conclusion and prospective future research in Section 5.

II. RELATED WORKS

The needs to align between Information technology (IT) services and business needs, drives many researchers and practitioners to conduct more studies in this area. This study was attempted to align IT with business metamodel. The EA metamodel based on TOGAF [1] was combined with the agile enterprise development metamodel based on the Scaled Agile Framework (SAFe) [13] published in [14]. The results from using both the TOGAF and SAFe were further simplified to minimize the level of complexity. The minimized complexity is be used to guide the EA implementation for various industrial domains. Alignment between IT and business is also carried out through a combination of studies [15] between the TOGAF and Strategic Alignment Maturity Model (SAMM) [16]–[18]. In [15], a mapping process was carried out between the SAMM attributes for each artefact in ADM.

Based on existing research, it can be seen that the determination of metamodel is needed in ensuring the link between IT and business. Referring to various entities in the metamodel, the study [19] discusses the analysis of entities in the EA principles. EA principles are one type of entity in TOGAF general entities in addition to entities in architecture vision, and requirements.

III. METHODOLOGY

This study examines the importance of general entities in the core content metamodel to support the initiation of EA development in the upstream petroleum industry. The following research questions were used for analysis:

RQ1. How to select an entity sources to form the general entities?

RQ2. How to select a ranked entity to form the core content metamodel?

The comparative study of expert preferences is usually done using multi-criteria decision-making (MCDM) method. In the MCDM, several alternatives are analyzed based on several criteria to determine the best alternative. Based on [20], this study uses the best-worst method (BWM) [20]–[22]. BWM requires less comparative data than other MCDM methods [20]. It can produce more reliable results with simple data comparison [20], and leads to higher level of consistency.. Based on BWM, this study follows the following steps:

1. Preparation and Screening
2. Analysis and Selection.

A. Preparation and Screening

This study seeks to recommend a sequence of entities that are applied in the initial EA development. The study used data from the upstream petroleum industry. Four upstream petroleum companies in Indonesia that are already implemented or will be developing EA within the next year, were selected. The experts are EA managers in their respective companies. Focus Group Discussion (FGD) attended by four to seven experts from each company. The results of the assessment came from the FGDs and agreed by each expert.

The criteria judgment refers to the EA development goals. EA studies are carried out based on the EA development objectives, as discussed by the Federation of Enterprise Architecture Professional Organizations in [23], [24]. The purpose of EA development consists of aspects of effectiveness, efficiency, agility, and durability.

This step used a general entities of the core content metamodel for the upstream petroleum industry refer to several standards to answer the RQ1. The referred standard consisting of TOGAF [1], the Public Petroleum Data Model Association (PPDM) [25], The Petroleum Upstream Process Classification Framework (PCF) of the American Productivity and Quality Center (APQC) [26], Industry Reference Architecture: Business Capability Maps, Value Streams, and Strategy Maps for Upstream Oil & Gas [27], Digital Transformation Initiative Oil and Gas Industry from the World Economic Forum [28], and The Microsoft Upstream Reference Architecture [29]. The collected entities are then grouped to form a list of entities as general entities in the core content metamodel. These general entities consist of 17 entities:

1. Vision,
2. Principle,
3. Organization Value,
4. Strategy,
5. Requirements,
6. Capability,
7. Assumption,
8. Constraint,
9. Standards,
10. Gap,
11. Work Package,
12. Area Type,
13. Area,
14. Location,
15. Field,
16. Reserve, and
17. Hydrocarbon Sources.

B. Analysis and Selection

The selection of general entities as required to answer RQ2 is done using MCDM method. BWM is the MCDM method chosen to solve the core entity selection problem. BWM is an MCDM method that makes two comparisons stage. The first comparison is the comparison between the most important entity (best criterion). The second comparison is the comparison of all entities with the least important entity (worst criterion). This mechanism produces two comparison vectors. The objective of BWM is to find the optimal weight for each entity. The consistency ratio checks through an optimization model based on a comparison process. BWM consists of five steps [20], [21]:

Step 1. Determine the set of criteria

This step determines the criteria (C_1, C_2, ..., C_n) to support decision making. The criteria are used to determine the weight of each alternative.

Step 2. Determine the best and worst criteria

The best criteria are the criteria that are most needed, most important, or most dominant. The worst criterion is the least needed, least important or weakest influence on the initial EA development.

Step 3. Determine the best criteria preference compared to other criteria

Comparison between the best criteria and other criteria based on a Likert scale with a value of 1 to 9. A value of 1 represents the same level of importance as the other criteria. A value of 9 represents the best criteria in an extreme way is more important than the other criteria. The results from the Best-to-Others assessment produce the following vectors:

$$A_B = (a_{B1}, a_{B2}, \dots, a_{Bn}) \tag{1}$$

where a_{Bj} states the preference of the best criteria B compared to criteria j.

Step 4. Determine the preference of other criteria compared to the worst criterion

Comparison of all the criteria and the worst criteria is made based on a Likert scale with a value of 1 to 9. The results of the Others-to-Worst assessment produce the following vector:

$$A_W = (a_{1W}, a_{2W}, \dots, a_{nW})^T \tag{2}$$

where a_{jW} is the preference of criterion j compared to the worst criterion W.

Step 5. Determine the optimal weight

Determination of the optimal weight for each criterion refers to the absolute maximum difference $\{|w_B - a_{Bj} w_j|, |w_j - a_{jW} w_W|\}$ for all minimum j. Next it can be formulated as follows [20]:

$$\min \max_j \{|w_b - a_{Bj} w_j|, |w_j - a_{jW} w_W|\} \tag{3}$$
$$\text{s.t.}$$
$$\sum_j w_j = 1$$
$$w_j \geq 0, \text{for all } j$$

The above equation can be answered with a linear programming formulation as follows:

$$\min \xi^L \tag{4}$$
$$\text{s.t.}$$
$$|w_B - a_{Bj} w_j| \leq \xi^L, \text{for all } j$$
$$|w_j - a_{jW} w_W| \leq \xi^L, \text{for all } j$$
$$\sum_j w_j = 1$$
$$w_j \geq 0, \text{for all } j$$

Problem (4) is a linear problem and has a unique solution. Solving this problem will produce an optimal weight (w^*_1, w^*_2, ... , w^*) and the optimal value of ξ^L expressed as ξ^{L*}. ξ^{L*} is the consistency ratio of comparisons made between criteria. If the value of the consistency ratio approaches zero, then the comparison is more consistent. This parameter states the consistency of the expert in providing a comparison value between the criteria.

BWM produces the optimal weight of each criterion expressed as w_j^*. Based on optimal weights and normalized scores, it can be used to calculate the scores of each criterion for various alternative x_{ijk}^{norm} entities. The final score per alternative entity k expressed as V_{ik} can be calculated based on the following equation:

$$V_{ik} = \sum_{j=1}^{n} w_j x_{ijk}^{norm} \tag{5}$$

$$x_{ijk}^{norm} = \begin{cases} \dfrac{x_{ijk}}{max\{x_{ijk}\}} \\ 1 - \dfrac{x_{ijk}}{max\{x_{ijk}\}} \end{cases} \tag{6}$$

IV. RESULT AND DISCUSSION

A. Application of BWM in Determining Weight Criteria

The application of BWM to the problem determines the entities in general entities from the core content metamodel. Based on the results of the assessment from four upstream petroleum companies in Indonesia, a series of assessment results were obtained.

Step 1. Determine the set of criteria

Based on the preparation and screening stage discussed above, the criteria used in determining general entities consist of effectiveness, efficiency, agility, and durability, which are presented in Table- I.

Table- I: Criteria used for the BWM comparison

Criteria	Symbol
Effectiveness	C_1
Efficiency	C_2
Agility	C_3
Durability	C_4

Step 2. Determine the best and worst criteria

The second step in the BWM series is determining the best and worst criteria.

The best criteria are the criteria that are considered the most important following the preferences of EA managers in four upstream petroleum companies in Indonesia. The worst criteria are the criteria that are considered the least important criteria. FGDs conducted at four EP companies are represented as EP1, EP2, EP3 and EP4. The preferences of each upstream petroleum company are presented in Table- II.

Table- II: EP companies' preferences for best and worst criteria

Criterion	Best Entities by EP company	Worst Entities by EP company
Effectiveness	EP1, EP2	
Efficiency	EP3, EP4	
Agility		EP3, EP4
Durability		EP1, EP2

Step 3. Determine the best criteria preference compared to other criteria

The third step is to identify the preferences of experts who compare the best criteria with each other criteria. This comparison was carried out using the FGD approach. The FGD produces a Best-to-Others (BO) vector, as shown in Table- III.

Table-III: BO vector for four EP companies in Indonesia

BEST-TO-OTHERS		Criterion			
Companies	Best	Effectiveness	Efficiency	Agility	Durability
EP1	Effectiveness	1	5	3	9
EP2	Effectiveness	1	3	6	9
EP3	Efficiency	2	1	9	7
EP4	Efficiency	2	1	9	7

Step 4. Determine the preference of other criteria compared to the worst criteria

The fourth step is a step to compare all the criteria with the worst criteria. As in step 3, this step also uses an FGD approach with experts from four upstream petroleum companies in Indonesia. The FGD produced an Others-to-Worst (OW) vector as in table IV.

Table- III: BO vector for four EP companies in Indonesia

	OTHERS-TO-WORST				
	Companies	EP1	EP2	EP3	EP4
	Worst	Durability	Durability	Agility	Agility
Criterion	Effectiveness	9	9	8	8
	Efficiency	3	6	9	9
	Agility	5	3	1	1
	Durability	1	1	3	3

Step 5. Determine the optimal weight

The weight of each criterion is determined using a linear model from BWM. The average weight of each criterion gathered on FGDs with four companies in Indonesia. The FGD produces a weight vector, as shown in Table- V.

Table- IV : Overall weights

		EP Companies				
	Weights	EP1	EP2	EP3	EP4	Mean
Criteria	Effectiveness	0,5903	0,5967	0,3159	0,3159	0,4547
	Efficiency	0,1319	0,2320	0,5433	0,5433	0,3627
	Agility	0,2199	0,1160	0,0505	0,0505	0,1093
	Durability	0,0579	0,0552	0,0903	0,0903	0,0734
	a_{BW}	9,0000	9,0000	9,0000	9,0000	
	CI	4,4700	5,2300	5,2300	5,2300	
	ξ^*	0,0694	0,0994	0,0884	0,0884	
	ξ^{L*}	**0,0155**	**0,0190**	**0,0169**	**0,0169**	

ξ^{L*} is the ratio of consistency between criteria that have been done by experts. The value of ξ^{L*} in Table- V is close to zero which implies that the comparison is consistent. The most important criteria for EA development in the upstream petroleum industry are effectiveness. It followed by efficiency and agility. Entity durability in supporting EA construction has a low weight. These results represent the focus of EA development in the upstream petroleum industry is on the criteria of effectiveness in achieving business goals. The efficiency criteria examined after the level of effectiveness needed by the company is achieved.

B. Comparative Assessment of General Entities

The weights of each criterion are then used to answer the problem of selecting core entities. Criteria weights use as multipliers of the preference values of each entity in general entities. In the preparation and screening step, entities have assigned to general entities. General entities expressed in 17 entities, namely Vision, Principle, Organization Value, Strategy, Requirements, Capability, Assumption, Constraint, Standards, Gap, Work Package, Area Type, Area, Location, Field, Reserve, Hydrocarbon Sources.

Comparative assessment of general entities is carried out using the FGD approach of four upstream petroleum companies in Indonesia. Entity comparison refers to a nine-point Likert scale. A value of 1 means very important, and a value of 9 means very unimportant. The results of data collection from the FGD session are as shown in Table- VI.

Table- VI : Entity comparison assessment results

Entities	Effectiveness				Efficiency				Agility				Durability			
	EP1	EP2	EP3	EP4	EP1	EP2	EP3	EP4	EP1	EP2	EP3	EP4	EP1	EP2	EP3	EP4
Vision	1	1	1	1	1	1	1	1	1	2	1	3	1	2	1	1
Principle	2	4	2	5	2	5	2	6	2	6	3	7	2	4	4	3
Organization Value	2	2	1	2	2	2	1	2	2	1	1	2	2	1	1	2
Strategy	2	3	2	4	2	6	2	3	3	4	3	4	3	5	4	4
Requirement	3	5	3	6	3	7	3	5	4	3	2	1	4	7	2	7
Capability	3	6	5	7	3	3	4	7	3	5	4	6	4	3	3	6
Assumption	4	9	9	7	4	9	9	7	5	9	9	6	5	9	9	6
Constraint	4	7	4	7	4	8	5	7	5	7	6	6	5	6	5	6
Standards	4	5	3	3	4	7	3	4	5	3	2	5	5	7	2	5
Gap	8	8	4	7	8	4	5	7	5	8	6	6	6	8	5	6
Work Package	9	9	6	3	9	9	6	4	5	9	5	5	6	9	6	5
Area Type	5	9	8	8	7	9	8	8	6	9	8	8	7	9	8	8
Area	5	9	8	8	7	9	8	8	6	9	8	8	7	9	8	8
Location	6	9	7	8	6	9	7	8	7	9	9	8	8	9	9	8
Field	6	9	9	8	6	9	9	8	7	9	9	8	8	9	9	8
Reserve	7	9	9	9	5	9	9	9	8	9	9	9	9	9	9	9
Hydrocarbon Sources	7	9	9	9	5	9	9	9	8	9	9	9	9	9	9	9

Table- VII : Normalized entities score

Entities	Effectiveness		Efficiency		Agility		Durability		Score
	Mean	Norm	Mean	Norm	Mean	Norm	Mean	Norm	
Vision	1,0000	0,8824	1,0000	0,8750	1,7500	0,8000	1,2500	0,8611	0,8691
Principle	3,2500	0,6176	3,7500	0,5313	4,5000	0,4857	3,2500	0,6389	0,5735
Organization Value	1,7500	0,7941	1,7500	0,7813	1,5000	0,8286	1,5000	0,8333	0,7961
Strategy	2,7500	0,6765	3,2500	0,5938	3,5000	0,6000	4,0000	0,5556	0,6292
Requirement	4,2500	0,5000	4,5000	0,4375	2,5000	0,7143	5,0000	0,4444	0,4967
Capability	5,2500	0,3824	4,2500	0,4688	4,5000	0,4857	4,0000	0,5556	0,4377
Assumption	7,2500	0,1471	7,2500	0,0938	7,2500	0,1714	7,2500	0,1944	0,1339
Constraint	5,5000	0,3529	6,0000	0,2500	6,0000	0,3143	5,5000	0,3889	0,3140
Standards	3,7500	0,5588	4,5000	0,4375	3,7500	0,5714	4,7500	0,4722	0,5098
Gap	6,7500	0,2059	6,0000	0,2500	6,2500	0,2857	6,2500	0,3056	0,2379
Work Package	6,7500	0,2059	7,0000	0,1250	6,0000	0,3143	6,5000	0,2778	0,1937
Area Type	7,5000	0,1176	8,0000	0,0000	7,7500	0,1143	8,0000	0,1111	0,0741
Area	7,5000	0,1176	8,0000	0,0000	7,7500	0,1143	8,0000	0,1111	0,0741
Location	7,5000	0,1176	7,5000	0,0625	8,2500	0,0571	8,5000	0,0556	0,0865
Field	8,0000	0,0588	8,0000	0,0000	8,2500	0,0571	8,5000	0,0556	0,0371
Reserve	8,5000	0,0000	8,0000	0,0000	8,7500	0,0000	9,0000	0,0000	0,0000
Hydrocarbon Sources	8,5000	0,0000	8,0000	0,0000	8,7500	0,0000	9,0000	0,0000	0,0000

The value of each entity per criterion obtains by averaging the comparison value according to Table VI. The average value results are then normalized using (6). The final score per entity obtains by multiplying the normalization result by the weight of each criterion. Detailed calculations state in Table VII.

Sorting entity data based on the final score as in Table VII generates a sequence of recommendations for the use of entities in general entities from the core content metamodel. This recommendation refers to the importance of EA development in the upstream petroleum industry. The recommended sequence of entities in general entities stated in Table VIII.

Table- V : Overall entities ranked scores

General Entities for Core Content Metamodel	
Ranked Score	Entity
0,8691	Vision
0,7961	Organization Value
0,6292	Strategy
0,5735	Principle
0,5098	Standards
0,4967	Requirement
0,4377	Capability
0,3140	Constraint
0,2379	Gap
0,1937	Work Package
0,1339	Assumption

General Entities for Core Content Metamodel	
Ranked Score	Entity
0,0865	Location
0,0741	Area Type
0,0741	Area
0,0371	Field
0,0000	Reserve
0,0000	Hydrocarbon Sources

Based on the data in Table- VIII, the Vision entity is the most recommended entity to be used in the quick wins of the initial EA development. The next entity is the Organization Value, Strategy, Principle, Standards, Requirements, Capability, Constraint, Gap, Work Package, Assumption, Location, Area Type, Area, Field, Reserve, and Hydrocarbon Sources.

V. CONCLUSION AND FUTURE RESEARCH

This study proposes the scale of prioritization of the use of entities that are part of the general entities core content metamodel. Entities with priority scale will guide the initiation of EA implementation. This study uses data from the upstream petroleum industry in Indonesia.

The analysis consists of two stages. The first stage is Preparation and Screening. This stage takes preparatory steps to sort out and select the experts who have involved, and the upstream petroleum companies in Indonesia which have, or will be implementing EAs within the next year. In this step, determine the criteria which are the objectives of EA development. The purpose of EA development consists of aspects of effectiveness, efficiency, agility, and durability [23], [24]. Considering the BWM analysis, the value of ξ^{L*} is close to zero, so it means the comparison is consistent.

This step also determines the standard General entities of the core content metamodel for the upstream petroleum industry to answer RQ1. Standard refers to TOGAF [1], Public Petroleum Data Model Association (PPDM) [25], The Petroleum Upstream Process Classification Framework (PCF) of the American Productivity and Quality Center (APQC) [26], Industry Reference Architecture: Business Capability Maps, Value Streams, and Strategy Maps for Upstream Oil & Gas [27], Digital Transformation Initiative Oil and Gas Industry from the World Economic Forum [28], and The Microsoft Upstream Reference Architecture [29]. Entity aggregation is carried out on all standards to produce unique entities.

The second stage is Analysis and Selection. At this stage, the analysis is carried out according to the stages at BWM as required to answer RQ2. Data collected from each expert who represents the interests of each company. This step produces a priority scale for the use of entities in the initiation of EA development for the upstream petroleum industry. The ranked entities consist of Vision, Organization Value, Strategy, Principle, Standards, Requirements, Capability, Constraint, Gap, Work Package, Assumption, Location, Area Type, Area, Field, Reserve, and Hydrocarbon Sources.

In a further development, the number of upstream petroleum companies implementing EA can increase following the industry growth. The characteristics of each company can be an additional parameter in conducting MCDM analysis.

REFERENCES

1. T. O. Group, *The TOGAF ® Standard*. The Open Group, 2018.
2. G. Biscardini, R. Morrison, D. Branson, and A. Del Maestro, "Strategy shaped by volatility," 2018.
3. SKKMIGAS, "Laporan Tahunan SKK Migas 2018 : Good Governance, Foundation for Better Future," 2018.
4. I. P. Association, "Oil and Gas Industry Enters a New Era," *IPA News*, vol. 03, 2019.
5. SKKMIGAS, "Laporan Tahunan SKK Migas 2017," 2017.
6. SKKMIGAS, "Laporan Tahunan 2016 SKK Migas," 2016.
7. SKKMIGAS, "Laporan-Tahunan-Skk-Migas-2015."
8. M. E. Porter, "the Five Forces That Competitive Strategy," *Harv. Bus. Rev.*, vol. 86, no. January, pp. 78–94, 2008.
9. L. Kappelman, E. Mclean, J. Vess, and N. Gerhart, "The 2014 SIM IT Key Issues and Trends Study," *MIS Q. Exec.*, vol. 2014, no. December, pp. 237–263, 2014.
10. B. Van Der Raadt, M. Bonnet, S. Schouten, and H. Van Vliet, "The relation between EA effectiveness and stakeholder satisfaction," *J. Syst. Softw.*, vol. 83, no. 10, pp. 1954–1969, 2010.
11. H. Hendrickx, "Article How Easy is it to Standardize a Practice ?," no. June, 2017.
12. S. Roeleven, "Why Two Thirds of Enterprise Architecture Projects Fail An explanation for the limited success of architecture projects," 2010.
13. Scaled Agile Inc, "TitleSAFe® for Lean Enterprise." [Online]. Available: https://www.scaledagileframework.com/. [Accessed: 07-Oct-2019].
14. M. T. Gamble, "Can metamodels link development to design intent?," *Proc. 1st Int. Work. Bringing Archit. Des. Think. into Dev. Dly. Act. - Bridg. '16*, pp. 14–17, 2016.
15. N. B. Kurniawan and Suhardi, "Enterprise Architecture design for ensuring strategic business IT alignment (integrating SAMM with TOGAF 9.1)," in *2013 Joint International Conference on Rural Information & Communication Technology and Electric-Vehicle Technology (rICT & ICeV-T)*, 2013, pp. 1–7.
16. J. N. Luftman, P. R. Lewis, and S. H. Oldach, "Transforming the enterprise: the alignment of business and information technology strategies," *IBM Syst. J.*, 1993.
17. J. Luftman, "Assessing it/business alignment," *Inf. Syst. Manag.*, 2003.
18. J. N. Luftman, "Assessing Business-IT Alignment Maturity," in *Strategic Information Technology*, 2011.
19. S. Aier, "The role of organizational culture for grounding, management, guidance and effectiveness of enterprise architecture principles," *Inf. Syst. E-bus. Manag.*, vol. 12, no. 1, pp. 43–70, 2014.
20. J. Rezaei, "Best-worst multi-criteria decision-making method," *Omega (United Kingdom)*, vol. 53, pp. 49–57, 2015.
21. J. Rezaei, "Author ' s Accepted Manuscript Best-worst multi-criteria decision-making method : Some properties and a linear model," *Omega*, 2015.
22. J. Rezaei, T. Nispeling, J. Sarkis, and L. Tavasszy, "A supplier selection life cycle approach integrating traditional and environmental criteria using the best worst method," *J. Clean. Prod.*, 2016.
23. S. Paradkar, *Cracking the IT Architect Interview*. Packt Publishing, 2016.
24. Federation of Enterprise Architecture Professional Organizations, "A Common Perspective on Enterprise Architecture," *Archit. Gov. Mag.*, vol. 9, p. 6, 2013.
25. The Professional Petroleum Data Management (PPDM) Association, *PPDM Data Model version 3.9*. 2014.
26. APQC and IBM, "PETROLEUM UPSTREAM PROCESS CLASSIFICATION FRAMEWORK," no. April, 2016.
27. B. C. Maps and V. Streams, "Industry Reference Architecture."
28. World Economic Forum, "Digital Transformation Initiative In collaboration with Accenture," 2017.
29. Microsoft, "The Microsoft Upstream Reference Architecture," p. 30, 2013.

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