A Method for COBIT 2019 Process Selection

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Abstract

COBIT (Control Objectives for Information and Related Technologies) provides a framework that supports enterprises in achieving their objectives in the governance and management of enterprise IT. The current method for the selection and prioritisation of Management Objectives in COBIT 2019 does not provide enterprises with the flexibility to customise their Design Factors, which means that it is not possible to adapt the framework to their context. In this research, we propose an alternative method to the current one provided by COBIT 2019, which aims to solve this problem. We use a multicriteria decision-making method called the Analytic Hierarchy Process (AHP) in combination with the COBIT 2019 Design Factors to help organisations establish their priorities for a better implementation of COBIT 2019. In the evaluation step, we conduct a simulation and compare the results from both the current method and our proposed method against the decision of domain experts.
Keywords: Enterprise Governance of IT, COBIT 2019, Goals Cascade, AHP, Design Factors.

1. Introduction

The issues, opportunities, and challenges of effectively managing and governing an organisation's Information Technology (IT) investments, resources, and significant initiatives have become a major concern of enterprises on a global basis [22]. Long-term success in organisations requires a secure connection between business and IT, to maximise benefits and reduce the uncertainties of IT projects [2].

Enterprise Governance of IT (EGIT) can be defined as "an integral part of corporate governance and addresses the definition and implementation of processes, structures and relational mechanisms in the organisation that enable both business and Information Technology (IT) people to execute their responsibilities in support of business/IT alignment and the creation of business value from IT-enabled business investments" [5]. EGIT can be deployed using a mixture of structure, processes and relational mechanisms [6] that encourage behaviours consistent with the organisation's mission, strategy, values, norms, and culture [29].

Enterprises are increasingly making tangible and intangible investments in improving their EGIT [4]. In support of this, enterprises are drawing upon the practical relevance of generally accepted good-practice frameworks such as COBIT, ITIL and ISO 27000 [4]. In this thesis, we decided to analyse COBIT since researchers have agreed that it is among the most popular, valuable frameworks and frameworks/standards currently being adopted [15,21]. Several researches have also shown that COBIT is widely adopted by organisations in practice [7, 13, 6].

COBIT presents a framework to support enterprises in accomplishing their goals in the governance and management of enterprise IT [12]. According to ISACA, 'COBIT 5 provides a comprehensive framework that assists enterprises to achieve their objectives for the governance and management of enterprise IT. COBIT 5 enables IT to be governed and managed holistically for the whole enterprise, taking in the full end-to-end business and IT functional areas of responsibility, considering the IT-related interests of internal and external stakeholders' [10].

In 2018, ISACA released COBIT 2019, the first update of COBIT after almost seven years. One of the major differences between COBIT 5 and COBIT 2019 is related to the Goals Cascade mechanism. In the new version, the Goals Cascade is not the core entry point, but just part of a broader mechanism.

In COBIT 2019, different Design Factors were introduced, namely Enterprise Strategy, Enterprise Goals, Risk Profile, Enterprise Size, Threat Landscape, Compliance Requirements, Role of IT, Sourcing Model for IT, IT Implementation Methods and Technology Adoption Strategy.

These Design Factors influence the design of an enterprise's governance system, representing what an enterprise must consider in tailoring governance systems to realise their most IT value[11].

In this research, the method suggested by ISACA to choose Management Objectives was studied. This method has a toolkit, also provided by ISACA, which is the practical implementation of the method in question. To better understand this method, different scenarios were simulated during this research. The authors concluded that the suggested method has some flaws that may influence the choice of Management Objectives, such as lack of customisation and rigidity in the pre-defined criteria. As a result, instead of having a method that adapts to the organisation, this new method requires the organisation to adjust the tool.

In this research, we propose an alternative method to help organisations achieve better results when selecting the Management Objectives. Multi-Criteria Decision Making (MCDM) methods support decision making in the presence of multiple, usually conflicting, criteria [30]. Based on the literature review carried out by Velasquez and Hester [28] we concluded that the Analytical Hierarchy Process (AHP) and Multi-Attribute Utility Theory (MAUT) are the most popular MCDMs.

AHP has some advantages and disadvantages to consider. The ease of use of the AHP is a recognisable strength. The AHP takes as its premise the idea that it is our concept of reality that is crucial and not our conventional representations of that reality by means such as statistics. With the AHP, practitioners can assign numerical values to what are essentially abstract concepts and then deduce from these values decisions to apply in the global framework. [1, 14]. This simplicity is crucial, as more complex methods require a more significant learning effort, something that does not fit in with this problem.

Therefore, in this research, we propose to use the AHP to help organisations establish the priorities for the COBIT 2019 process implementation. AHP was developed in the 1970s by Saaty and has since been extensively studied, and is currently used in decision making for complex scenarios, where people work together to make decisions when human perceptions, judgments, and consequences have long-term repercussions [3].

The results of this research are demonstrated using Design Factor (DF) 2 (COBIT 5 Goals Cascade) since the transition from the old Goals Cascade to the new DF2 is minimal. It also makes it considerably more accessible to find experts in the field willing to collaborate. However, this method can be applied to any of the Design Factors without losing any of the advantages that will be referenced throughout this document.

To evaluate the proposed method, a series of interviews were conducted with experts. During these interviews, each specialist compared their answers with those obtained using the method proposed by COBIT 2019 and the method proposed in this research.

1.1. Research Challenge

COBIT 2019 introduced a new method that attempts to solve the problems of COBIT 5 discussed in the literature [15, 1, 23]. During our research, however, we discovered that this method exhibits some major flaws which limit its adaptability and usability. These problems are summarised in this chapter.

COBIT 5 Goals Cascade is a method to translate the enterprise goals into specific processes. However, this method had several problems that were identified by different authors such as Lee et al., Almeida et al. and Steuperaert [15, 1, 23].These publications are detailed in Section 4 (Related Work).

COBIT 2019 defines ten different Design Factors to be selected, which are factors that can influence the design of an enterprise's governance system and position it for success in the use of Information & Technology [11].

In COBIT 2019, a new method is proposed to select and prioritise specific design factors to be considered for an enterprise's customised governance program [11]. This new method aims to mitigate the problems of the COBIT 5 Goals Cascade.

COBIT 2019 claims that it is a tailored governance solution that every enterprise should adopt as its "governance system for enterprise I&T", or "governance system" for short [11]. However, this claim is not entirely fulfilled due to the following problems with the method:

- The addition or removal of Design Factors is not possible in this method, which limits the set of possible Design Factors that can be selected by an organisation. These Design Factors are portrayed in the literature as Contingency Factors, which are covered in the Theoretical Background and Related Work chapters. In these chapters, it is demonstrated that a limited and non-modifiable set can be a limitation for the method.
- Each Design Factor has its own set of evaluation parameters that are impossible to be modified, added or deleted. Therefore, customisation in the evaluation methods of the Design Factors is not possible.
- Due to the absence of customisation possibilities, this process cannot be adapted to the particular context of an organisation or improved based on the experiences and knowl-

edge of experts. Therefore, its potential is limited.

- There is a lack of theoretical evidence to support this method, as no concrete mathematical formulas are presented in the Design Guide Research book [11] to explain its underlying mechanisms.

There is limited scientific literature that supports the problems identified by the authors, given that this new version of COBIT was published very recently and thus the number of publications on the topic is limited. Some researchers [16] have shown that there are several factors (Contingency Factors) that influence the correct implementation of EGIT (e.g. Industry and Maturity). However, in the method presented by COBIT, it is not possible to add or remove any of these factors, which makes this method not adaptable to different organisations, thus limiting its performance.

To summarise, we may conclude that COBIT 2019 method is inflexible and lacks theoretical evidence for the selection and prioritisation of Management Objectives. Therefore, its utility in practice is limited and is prone to misleading results.

2. Research Methodology

Design Science Research Methodology (DSRM) is the research methodology adopted in this research. Design science creates and evaluates IT artifacts intended to solve identified organisational problems [8]. It requires a rigorous process to design artifacts to solve problems, to make research contributions, to evaluate the designs, and to communicate the results to suitable audiences [9]. The goal of design science is to create and evaluate IT artifacts intended to solve identified organisational problems [8]. IT artifacts can be constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices) or instantiations (implemented and prototype systems) [8].

The DSRM process is based on a six steps approach [8]:

1. **Problem identification and motivation:** The primary goal is to come up with a well-defined problem that can justify the value of the solution and motivate the investigator to conduct the research to look for a possible solution.

2. **Defining the objectives for a solution:** Identification of the quantitative or qualitative objectives of a solution from the problem definition and knowledge of the state of the problem and possible solutions

3. **Design and development:** Decision on the artifact's desired functionality and architecture followed by its construction. A design research artifact can be any created object embedded with research contributions.

4. **Demonstration:** Demonstrate the application of the artifact to solve one or more cases of the problem. cases of the problem.

5. **Evaluation:** Observation and measurement of how well an artifact supports a solution.

6. **Communication:** Communication of the problem and its importance, the artifact, its utility and novelty, the rigour of its design and its effectiveness to researchers and other relevant audiences.

In summary, the guiding principles, practice rules, and a process of DSR for artifact development and artifact evaluation are used to conduct this research.

3. Theorical Background

3.1. Enterprise Governance of IT

IT projects still suffer from recurring costs, time overruns and failure to fully deliver the expected benefits to the users or the organization [17]. Because of this dependence and the constant lack of proper management in IT projects, EGIT appeared as a possible solution to solve these problems. In this research, the following reference is used to describe EGIT: "EGIT is defined as an integral part of enterprise governance addressing the definition and implementation of processes, structures, and relational mechanisms in the organization that enable both business and IT people to execute their responsibilities in support of business/IT alignment and the creation of business value" [27]. Some studies have shown that companies with good EGIT models gain far higher returns on their IT investments than their competitors, mainly because they make better IT decisions [29].

3.2. EGIT Contingency Factors

In our literature research, we found some approaches that deal with the EGIT contingency factors [16, 20, 29]. Pereira and Mira da Silva [16] states that the factors that influence the EGIT implementation are: Culture, Structure, Size, Industry, Regional Differences, Maturity, Strategy, Ethical and Trust. Weill [29] claims that EGIT is influenced by these factors: Strategic and performance goals, Structure, Governance experience, Size and Diversity and Industry and Regional differences. Sambamurthy and Zmud [20] states that EGIT is influenced by Overall Governance mode, Firm size, Diversification mode, Diversification breadth, Exploitation strategy for scope economies and Line IT knowledge.

In conclusion, there is no consensus in the literature on which factors influence the correct implementation of EGIT. It is, therefore, challenging to define a set of Contingency Factors on which all organisations should rely. In the method developed in this research, the organisation is free to choose or eliminate any factor, thus making it more customised than the method presented by COBIT.

3.3. Multi-Criteria Decision Making

MCDM has been one of the fastest growing problem areas in many disciplines [26]. MCDM methods can be applied into diverse real-world decisions. The progression of technology over the past couple of decades has allowed for more complex decision analysis methods to be developed [28].

The role of MCDMs in different application areas has increased significantly, especially as new methods are developed and as old methods are improved [28]. In our literature research, we identified the research of Velasquez and Hester [28] as a good resume of the advantages and disadvantages of the most well-known MCDMs. After analysing this literature review, we decided to use AHP as a possible solution to this research.

3.4. Analytic hierarchy process

AHP is a multi-criteria decision-making algorithm proposed by Saaty in 1977 [18]. AHP is a method for ranking decision alternatives and selecting the best one when the decision maker has multiple criteria [25].

AHP tries to answer which one of the different options should be chosen. This decision will be achieved by making pairwise comparisons between the alternatives. The decision-maker examines two choices by considering one criterion and indicating a preference. These comparisons are made using a preference scale, which assigns numerical values to different levels of preference [24]. The standard scale used to make these comparisons is 1-9. In the pairwise comparison matrix, the value 9 indicates that one factor is significantly more important than the other, and the value 1/9 suggests that one factor is remarkably less important than the other, whereas the value 1 indicates equal importance [21].

From now on, “Saaty scale” will be the term used to refer to this scale.

An important aspect of the AHP is the idea of consistency. The consistency ratio (C.R.) is obtained by comparing the consistency index with the appropriate one of the following set of numbers each of which is an average random consistency index derived from a sample of size 500 of randomly generated [19]. If it is 0.10 (10%) or less the results are consistent. If it is more than 0.10 study the problem and revise the judgments [19].

3.5. Summary

In short, to solve the problems mentioned before, or at least mitigate them, MCDMs was chosen as the basis for an alternative method to the current one. After an analysis of different MCDMs and checking whether there were similar problems in the literature, we found that AHP has appropriate characteristics for this type of problems and that it had been used in similar problems by several authors (Related work Section). The next step would be to try to figure out how to connect the AHP to COBIT 2019. In this step, we decided that each criterion of the different Design Factors would be the AHP criterion and that each Management Objective would be the AHP alternatives. However, as explained before, this research only focuses on Design Factor 2. For this Design Factor, it was decided that each of the Enterprise Goals would constitute the different criteria of the AHP, that each of the Alignment Goals would be the Sub-Criteria of the AHP and that the Management Objectives would be the alternatives of the AHP.

4. Related Work

The COBIT 5 goals cascade is a mechanism that converts the stakeholder’s needs into organisation goals [15]. In our research, we found some literature to improve the Goals Cascade (Design Factor 2) [1, 15, 23].

In the paper of Steuperaert [23], the quality of the Goals Cascade was assessed by looking at the accuracy of the published mapping tables, the dependencies between goals in the same goal set and the sensitivity of the Goals Cascade towards input variations [23].The questions that identify the scope of this research are the following [23]:

1. Is the Goals Cascade accurate?
2. Does the Goals Cascade allow easy prioritisation at the input side?
3. Does the Goals Cascade demonstrate sufficient sensitivity for process prioritisation?
4. Is it possible to complement the current Goals Cascade with a new artefact?

In Research Question 1, the author analyse the effect of two sets of mapping tables - one based on the original research made by a research group at Antwerp University, and another published by COBIT 5 - on the outcome of the goals cascade [23]. This is done by running a simulation where they feed the same input (a [1x17] matrix, representing the priorities of each of the generic enterprise goals as defined in COBIT 5, where each goal is deemed equally important) to both sets of mapping tables and compare the output of the Goals

Cascade (a [1x34] matrix, containing the resulting weights of each COBIT 5 process, obtained through multiplication of the input matrices with both mapping tables) [23].

In Research Question 2, the author used analytical review and peer review on a subset of enterprise goals and assess whether there exist dependencies between these enterprise goals [23]. To validate this assumption, the author took a subset of the Enterprise Goals [10] and had four researchers from his research group independently assess their interdependencies.

In Research Question 3, the author performed a simulation of the Goals Cascade and observed two dependent variables of the Goals Cascade: (a) The resulting process weight, normalised on a scale of 10, and (b) the relative process ranking in the ranked list of all 37 COBIT 5 processes [23].

In Research Question 4, the author took a design-science based approach. An expert panel has performed a first validation of the new artefact (Improving the Quality of the [23]. The result was a new artefact, the "Enterprise Strategies". The author defined the following set of four potential enterprise strategies that any organisation could pursue. Then, in order to validate the concept of the proposed solution, and in order to initially populate the new mapping table, the author worked with a limited expert panel who were given a questionnaire to map each of the four enterprise strategies to the COBIT 5 processes. The results from the expert panel were analysed, and the findings were as follows: the panel did not report any significant difficulty in completing the survey, thus indicating that the direct mapping between enterprise strategies and processes is viable and does not create any conceptual difficulties [23].

4.1. AHP with Balanced Scorecard (BSC)

In the research conducted by Lee et al. [15], the authors, in section four (4), identified a number of IT-related goals according to the Enterprise goals. However, the priorities required to achieve these goals are not provided [15]. This paper aims to give priority to the IT-related goals according to the Enterprise goals. The method proposed to achieve this is based in a AHP approach [15].

The authors conclude that "this study presented a way for companies to use COBIT 5 in a more quantitative way to create a business or IT value. In the COBIT 5 method, your financial and customer will always have priority, even if your organisation's goals change" [15].

From our perspective, this paper is of great value because it not only identifies an obvious problem of COBIT 5 which is the lack of prioritisation but also offers a possible solution - the use of AHP. The use of this type of solution serves as a basis for the method developed in this thesis.

4.2. AHP to prioritise COBIT 5 processes.

Almeida et al. [1] research identified that the COBIT 5 process prioritisation is an essential part of the COBIT 5 process improvement selection [1].

Based on their research, the authors have chosen the following criteria to prioritise the COBIT 5 processes selected in the Goals Cascade run: Allocate fewer resources (related to the reserved resources factor), Short development time (related to the scheduled time factor), Higher Improvement Impact (related to the quality factor), and Higher Business Value of IT/IS projects (also related to the quality factor) [1].

The authors used the scientific article by Velasquez and Hester [28] to choose the MCDM and, as in this thesis, the choice fell on the AHP [1].

This research [1] was of great value to this thesis. As with Lee et al. [15], they used the AHP to solve the existing prioritisation problem in COBIT 5. This research tries to prioritise Processes (currently called Management Objectives), similar to the method developed in this thesis. Thus, we can state that there are data in the literature that support the use of AHP as a basis to a method like the one developed in this thesis.

5. Proposal

This chapter describes how we intend to solve the research problem listed in Section 1.2.

5.1. Objectives

The main objectives of this research are:

- Getting a list of processes prioritised by their importance, which takes into consideration internal and external factors that affect the organisation.
- Developing a fully-customizable method

5.2. Proposal Description

Considering the macro objectives of this proposal, we can infer that in general terms, the proposed method tries to include all the real benefits in the current ISACA method, and on top of that, also attempts to solve or mitigate the previously identified errors: lack of flexibility, customizability and adaptability to the organisation (Section 1.2). More explicitly, we have divided the macro criteria into more specific criteria, intending to solve the problems encountered while retaining the benefits of the current method. Therefore, we will later evaluate this proposed method not only on its ability to achieve the current objectives but also on the quality of its results.

The more specific objectives are:

- **Universality:** The method should be applicable to all Design Factors.
- **Customisable Criteria:** The method should allow the organisation to determine the weight of each of the criteria.
- **Flexibility:** The method should allow the addition or removal of criteria as intended by the organisation.
- **Automatic:** Part of the process should be completely automated. The level of automation should be similar to that presented by the COBIT 2019 Toolkit.

To solve the previously mentioned problems and achieve the above requirements, the AHP algorithm is adopted. To integrate AHP with the problem context, the following questions need to be answered:

1. What should the criteria and sub-criteria, and how are they related?
2. What should the alternatives, and how are they related to the sub-criteria?
3. Who evaluates the different criteria?
4. How should different criteria and sub-criteria be evaluated?

The criteria and sub-criteria are the Enterprise Goals and Alignment Goals, respectively. They are related according to the table of relations provided by ISACA. The alternatives are the Management Objectives, which are related to the sub-criteria based on the relationships between the Alignment Goals and Management Objectives provided by ISACA. It should be noted that this set of relations are only a basis, which can be customised if desired.

The evaluation of the criteria, which is the only part of the process involving human interaction, is done by the user. The criteria and sub-criteria are evaluated using a method created by the authors, where the previously mentioned relationships are converted into numerical values on the Saaty scale.

The evaluations are done based on the relations between the Enterprise Goals and Alignment Goals as defined in COBIT 2019, which are described in Table 1. The assessment is done by comparing the Alignment Goals against the selected Enterprise Goal. The following example is a simulation of the proposed method: If the user chooses Enterprise Goal 1, the evaluation between Alignment Goal 04 and Alignment Goal 05 is made based on the relations that these two Alignment Goals have with Enterprise Goal 1, and the result is represented in Table 2. This matrix is filled in this way because Alignment Goal 05 has a ”P” relationship with Enterprise Goal 1 while Alignment Goal 04 has an ”empty” relationship. This method has been tested to meet consistency levels that the algorithm requires to execute correctly. It is important to note that these matrices can be filled in automatically as soon as the user has chosen the Enterprise Goals.

To fulfil our purposes, it is necessary to determine whether this method can be extended to all other Design Factors. This method can be extended to any existing Design Factor by converting the evaluation parameters into criteria. Taking into consideration Design Factor 1 (Enterprise Strategy), the different parameters (Growth/Acquisition, Innovation/Differentiation, Cost Leadership, Client Service/Stability) are the different criteria. Then, as was done for Enterprise Goals in the previous example, it is only necessary to create a matrix with all the parameters and evaluate them using the Saaty scale (respecting consistency, explained in Theoretical Background Chapter). After that, the organisation has to map the Management Objectives to the criteria.

This reasoning can be applied to any existing or created Design Factors. One of the advantages of this method is that it gives the organisation complete control over the mapping between Management Objectives and criteria and enables any addition or removal of Design Factors. It also makes it possible to test hypotheses and theories of how this map should work, no matter for scientific or business purposes. As mentioned, any parameter can be added or removed without affecting the normal working of the method. When a new parameter is added, it is only necessary to remap the Management Objectives to the new parameter.

6. Demonstration

To demonstrate that the proposal can be used to solve the research problem, we conducted an example of the COBIT 2019 Goals Cascade run. To do that, a prototype that is able to run the COBIT 2019 Goals Cascade and the AHP method was developed. It is important to note that all the translations are based on the translation maps provided by ISACA [10]

We will exemplify a possible scenario, following the steps of the method developed in this thesis algorithm:

6.1. Step 1: Stakeholders' Needs Cascade to Enterprise Goals.

To demonstrate the proposal, the following two stakeholders' needs were chosen to run the goals cascade: “How do I get Assurance over IT?” and “Does IT support the enterprise in complying with

Table 1: Comparison between Alignment Goal 04 and Alignment Goal 10

Country	Second Alignment Goal	Evaluation First to Second	Evaluation Second to First
“P”	“P”	1	1
“P”	”S”	3	1/3
“P”	””	9	1/9
”S”	”S”	1	1
”S”	””	5	1/5
””	””	1	1

Table 2: Comparison between Alignment Goal 04 and Alignment Goal 05

	AG04	AG05
AG04	1	1/9
AG05	9	1

regulations and service levels?”. These needs were translated into Enterprise Goal “Compliance with External Laws and Regulations” and “Compliance with Internal Policies”.

6.2. Step 2: Enterprise Goals prioritisation.

In this step, we compare the Enterprise Goal using the Saaty table mentioned before. In this example, both EGs have the same importance for the stakeholders.

6.3. Step 3. Enterprise Goals Cascade to Alignment Goals.

The chosen Enterprise Goals (Enterprise Goal 3 and Enterprise Goal 11) originated the following list of Alignment Goals: Alignment Goal 1 ”I&T compliance and support for business compliance with external laws and regulations” and Alignment Goal 11 ”I&T compliance with internal policies”. All the Alignment Goals that do not have a ”P” relationship with any of the previously selected Enterprise Goals are eliminated.

6.4. Step 4: Alignment Goals prioritisation.

In this step, an automatic comparison is made, based on the rationale explained in the proposal, all Alignment Goals are evaluated among themselves. The assessment is made taking into account the relationship that each pair of Alignment Goal has with the Enterprise Goal.

6.5. Step5: Alignment Goals Cascade to Management Objectives.

The chosen Alignment Goals (Alignment Goal 1 and Alignment Goal 11) originated the following list of Management Objectives: EDM01, EDM03, EDM05, APO01, APO13, APO14, DSS05, DSS06, MEA01, MEA02, MEA03 and MEA04. This list is generated by deleting all the Management Objectives that do not have a relation with any Alignment Goal.

MEA03	0,1307848685
EDM01	0,1307848685
APO01	0,1233468193
MEA02	0,1233468193
MEA04	0,1233468193
EDM03	0,06756938029
DSS05	0,06756938029
MEA01	0,06756938029
APO13	0,04313340468
APO14	0,04313340468
EDM05	0,03970742742
MEA01	0,03970742742
SUM	1

Figure 1: Results of the practical example

6.6. Step 6: Comparison of Processes

In this step, an automatic comparison is made, based on the rationale explained in the proposal. All Management Objectives are evaluated among themselves. The assessment is made taking into account the relationship that each pair of Management Objective has with the Alignment Goal.

6.7. Step 7: Run AHP

To run the seventh step (Run AHP), a software was developed and is available at the following link:

https://drive.google.com/open?id=14E3X2cw 2DPSyAg0WsQN9W5PIG4Ce2U6U

After these steps, we could obtain the results by running the AHP. We have performed a run on the given an example, and the results are displayed in the Figure 1.

6.8. Summary

As we can see, the demonstration includes a software prototype capable of simulating the rationale of the proposal, producing a list of Management Objectives, as can be seen in the Figure 2. It should be noted that, as mentioned above, the prototype was only developed for this specific problem. However, the authors reiterate the possibility of extending this reasoning to each of the existing Design Factors.

7. Evaluation

Part of the evaluation of the results of this research was carried out with the aid of specialists. To this end, two rounds of interviews were conducted with managers linked to the EGIT field. The objective of the first round was to collect information on the profile of the interviewee, present the toolkit of COBIT

2019, and introduce the concepts of AHP. In the second round of interviews, some candidates were eliminated from the process. This round aimed to evaluate the quality of our proposed method by creating a scenario in which the interviewee has to perform the Design Factor 2 (Goals Cascade) manually and simulate the same choices using both the COBIT 2019 toolkit and our proposal. In the end, the two results were presented to the interviewee without identifying the methods behind them. Then a discussion was conducted to analyse the results of the algorithms against the Management Objectives chosen by the expert.

8. First round of interviews

Twenty (20) IT managers and COBIT specialists from different backgrounds were invited via email and LinkedIn. Among these, only fourteen (14) were willing to participate in this research for a semi-structured interview. All candidates were classified according to the scale present below:

1. Fundamental Awareness (basic knowledge)
2. Novice (limited experience)
3. Advanced (applied theory)
4. Expert (recognized authority)

In order to be classified as Level 5 (Expert), an interviewee must hold a certification of COBIT 2019 or COBIT 5. For Level 4 (Advanced), a manager should have already worked with COBIT and have a certification in any EGIT framework. Level 3 (Intermediate) represents someone who has worked with COBIT but does not have a solid basis of understanding about it. We consider anyone who has worked with any framework in the area of EGIT, other than COBIT, at Level 2 (Novice). Finally, a person who holds a management position in the field of EGIT but has no experience with any framework is classified as Level 1 (Fundamental Awareness).

After conducting the first round of interviews and ranking our interviewees, only managers with Levels 4 and 5 are suitable to proceed to the next round of interviews.

8.1. Second round of interviews

In the second round, we proceeded with semi-structured interviews. All interviews were conducted in the following steps:

1. Review the previous interview
2. Choose the Prioritisation of Enterprise Goals
3. Choose of Management Objectives
4. Discussion of the results

After the second round of interviews, we were able to see that four of the five experts, in the end, preferred our proposal to the COBIT 2019 toolkit. The proposal, presented in this research, also showed a higher degree of accuracy in 4 of these 5 cases.

9. Evaluation of requirements

In the Proposal Section, the following requirements were proposed:

Universality: In order to assess universality, it is necessary to realise that AHP can be used in several areas. In this case, it is only necessary to map the criteria and subcriteria with the different alternatives (Management Objectives). Using Design Factor 1 as an example, the COBIT 2019 already provides a mapping between the Management Objectives and the different criteria. To apply the AHP, it is only necessary to convert this table into Saaty values, respecting consistency ratio, as it was done in Design Factor 2 (explained in Proposal Section).

Customisable: To determine if the method in question is customisable, let us take Design Factor 2 as an example. To add or remove any relationship, it is only required to change the existing relationship table, and the algorithm will automatically incorporate these changes the next time it is executed. Each relationship has a weight assigned by the authors, which can also be modified.

Flexibility: This method allows to add and remove criteria, subcriteria or alternative. Let us take Design Factor 2 as an example. To add a new Enterprise Goal is necessary to add it to the table with the relationships and the algorithm will automatically take that new Enterprise Goal into account. The same applies to the Alignment Goals and Management Objectives. To remove any Enterprise Goal, Alignment Objective or Management Objective, delete this link from the corresponding table.

Automatic: This method needs a single interaction with the user: prioritise the criteria (in the case of Design Factor 2, to prioritise the Enterprise Goals). The whole other process is automatic.

10. Conclusion

The selection and prioritisation of management objectives are a critical feature in COBIT 2019 that tries to address some concerns raised regarding the Goals Cascade mechanism. However, this method does not conform to the statement by ISACA that EGIT systems should be tailored to the enterprise, thus posing a limitation to this framework. A method that allows the framework to adapt to each organisation should be provided, rather than one that uses a fixed set of closed method and parameters.

10.1. Achievements

In this research, we propose a method that allows organisations to select and prioritise Management Objectives using the Design Factors. In this method, users are given the flexibility to customise these Design Factors, as well as their parameters, according to their own judgements and needs, which is not possible with the current COBIT 2019 method. The results of our evaluation also allow us to assert that our method had better outcomes compared to the ones produced by the COBIT 2019 method. In summary, the method developed in this research allows organisations the autonomy to adapt the framework to their own context while producing better results than the one presented by ISACA. We conclude by highlighting the fact that every requirement we proposed was fulfilled: the method gives a prioritise method of Management Objectives, and is universal customisable, flexible and automatic.

Apart from providing an alternative method to this framework, this study also offers valuable insights into the choices of domain experts in different scenarios. It also demonstrates that there are no one-size-fits-all answers or algorithms to tackle this problem due to the complex differences between organisations and that the experience and knowledge of experts play a crucial role in understanding the context of an organisation and making an optimal judgment. Last but not least, this study also provides a means to verify if the relationships between the Enterprise, Alignment and Management Objectives are correct, thus providing new approaches to analyse this data.

10.2. Limitations

Despite the positive results obtained from the demonstration of this study, more empirical work is required to reveal more patterns in the experts' decision process that can, among other benefits, provide a better mapping from the relationships to the numerical Saaty scale values. This can be achieved through more interviews with experts or, instead of what has been done in this research, having each expert conducting more than one scenario per interview. Another limitation we would also like to highlight is human subjectivity, where under the same scenario experts can choose different solutions or even, the same expert can give different solutions to the same scenario if asked in different occasions. A further limitation is the fact that the specialists chosen are mainly from Portugal; greater geographical diversification is advisable. Apart from that, due to the recent publication of COBIT2019, there is a lack of literature related to this version of COBIT, which poses a limitation on our research process and also on the amount of support from prior works on our analyses. On the bright side, this also allows our work to be one of the pioneers in this field.

11. Future Work

Due to the limitations of AHP, we intend to test other approaches in our future work, such as Fuzzy AHP and the addition and/or removal of Design Factors that are not represented in the current version of COBIT 2019. We would also like to try techniques from data science, recommender systems and machine learning. These techniques have the potential to discover new patterns and connections that can increase the performance of the method. However, the implementation of such techniques would require a much larger quantity of data, which is the reason why we did not proceed with them.

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