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How to Optimize the Implementation of ITIL through a Process Ordering Algorithm

Juan Luis Rubio [1,*] **and Magdalena Arcilla** [2]

[1]   UDIMA, 28400 Collado Villalba, Spain
[2]   UNED, 28040 Madrid, Spain; marcilla@lssi.uned.es
*   Correspondence: juanluis.rubio@udima.es; Tel.: +34-918561699

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Abstract: One of the main points when implementing the Information Technology Infrastructure Library (ITIL) is which order the processes must be implemented. In the systematic literature review (SLR) developed, it is possible to find references about strategies and factors that ease the implementation of the ITIL, static sequences for the processes to be implemented, and recommendations about the first process to implement, but it is rather complicated to find references that explicitly define the order (adapted to a specific company) of the processes to be implemented. Thus, once it is shown that there is no methodology/algorithm providing a sequence of ITIL processes specifically adapted for each company, an algorithm to solve this problem is presented: The algorithm has a deep mathematical basis and returns a sequence of ITIL processes to optimize the efforts during implementation, so the company implementing the ITIL gets the closest to the competitors. The optimization is made considering parameters such as staff, age of the company, IT size, industry, etc. Thus, the sequence proposed is specific for each company. Finally, a comparative of the sequence obtained (from the proposed algorithm) with sequences discovered in the SLR is presented and applied to a real case.

Keywords: ITIL; implementation sequence; process implementation order; optimization; algorithm

1. Introduction

There is no doubt about the importance of information resources in organizations. The management of organizations may be very different from one to another but in all cases the quality of IT (information technology) services is directly dependent on common principles, such as adding value, improvement of customer satisfaction and productivity, and/or reducing costs [1].

The main goal of an IT manager is providing the best quality service with fewer resources as possible, and achieving parameters of efficiency, time, cost, etc. To do it, it is possible to adopt and adapt several standards, good practices handbooks, and rules [2–6].

The Information Technology Infrastructure Library (ITIL) is a market standard practices library completely oriented to services and its management, development, and operation [7]. It defines a complete set of processes to offer better IT services from IT companies and IT departments. It could be deduced that these ITIL reference practices are specifically designed for software, technology, or information systems companies, but, in fact, the ITIL can be applied to any organization as it does not depend on its activity. It is just required that the organization is using technology for internal purposes or as services offered to clients. ITIL has been developed to be applied in any type of company [8].

Currently, ITIL is divided in five groups of processes (service strategy, service design, service transition, service operation, service continual improvement) but ITIL does not define a strategy to implement the processes: No order of processes is presented, no dependency on the company where

ITIL is implemented, no dependency on the industry, etc. It just includes the processes needed for proper management of IT Services [9].

There is much interest in companies about ITIL implementation [10], and, more specifically, in how it should be implemented: The order of processes to implement, factors that may affect the success of implementation, strategies to follow when implementing, among others. But this interest is just partially solved as there is no a clear methodology or algorithm which provides, to companies, a clear and sequence of processes to implement the ITIL. This lack of criteria (in the order of implementation of the ITIL processes) is one of the reasons that leads to a failure in ITIL implementations. It is clearly addressed in [11]: "Many of the organizations attempt to implement all or many of the ITIL processes at once, that it causes confusion, staff unrest, and poor integration between the processes. Therefore, it is better to select the most important processes for target organization and then schedule their implementation."; and in [12], a single report explaining why implementations fail: "Traditionally most organization start implementing Incident Management/Problem Management/Change Management/Service Request processes without fixing a configuration management database (CMDB)".

There are several studies which make approaches around ITIL implementation and how this implementation should be conducted. These studies consider different points of views [13]: Analysis of success factors [14–16] (i.e., the factors that most affect the implementation of the ITIL and may have a great influence on the success of the ITIL implementation); the strategy that should be followed to implement ITIL in [10,17,18], that is the overall steps to follow when implementing ITIL; order of how processes should be implemented [9,19,20] (i.e., the sequence of processes should be followed to implement the ITIL properly to maximize success options); considering the characteristics of the organizations [21], which means to consider the size, age, and other specific parameters that may influence the implementation of the ITIL; and finally, an approach considering other specific topics.

Summarizing, authors focus their attention on next issues [13]: 1—Strategy. 2—Success factors. 3—Order of processes. 4—Characteristics of organizations. 5—Specific implementation topics.

Thus, there is not a clear approach to define the strategy to implement the ITIL. It does not matter if we look at the steps, the sequence, the factors, the characteristics of organizations, or if we look at specific issues that may affect the implementation; there is not a clear solution for companies wishing to implement the ITIL. This leads us to one of the main problems to solve [11]: Is it possible to define an algorithm that returns the order of the ITIL processes that a company should implement? In the next sections we will answer this question following the methodology indicated in the coming subsection.

Methodology

This article presents a study that started with a systematic literature review (SLR) to discover how ITIL processes are ordered by the companies during the implementation phase. Once it was found that no algorithm was used to order processes, we set up the math basis for the optimal ordering algorithm presented in this article. Following this, we built the database (filled up with data from real companies—see Appendix A for the polling details). After that, we deployed the algorithm in a website (https://sqitil.sytes.net.) to facilitate its usage on different companies and, finally, we applied the solution proposed to real cases.

2. State of Art

A systematic review of literature to get a deep understanding of the state of art was developed. The references about how to perform a review can be found in [22–25] applied to different disciplines; however, it is preferable to follow other similar approaches that fit better in engineering disciplines [26]. These references were used to develop the research and analysis of publications. The main question to solve with the SLR is to find methodologies, algorithms, or proposals of sequencing the ITIL processes so companies can implement the ITIL and optimize the efforts. This means that implementation of the ITIL optimizes its position with respect to competitors (in terms of implementation of the ITIL).

A summary of the results of the SLR developed is presented. In order to give an overall idea of the state of art of the ITIL sequences for implementation, next strategies were identified:

- Non-fixed sequences: These strategies include sequences which are objective dependent. That is, a general strategy or function to organize processes is given. This strategy or function is oriented to a specific objective—maximizing client satisfaction, minimizing implementation time, avoiding deadlocks, etc.—but they, finally, offer the same sequence for every company having the same objective.
- Static sequences: This second group of strategies define a fixed sequence which is common to every implementation. That is, independently of the size, type, industry—or whatever factor—of the company, the same ITIL sequence is defined. These strategies are usually based on criteria such as polling to experts, dependencies between processes, among others.
- Implementation examples and critical success factors: The third group of strategies are focused on defining which factor affects the success or the failure of an ITIL implementation. This group also includes those strategies that define rules and methodologies of implementation based on previous cases of real implementations.

These groups of strategies to implement the ITIL are explained in the next paragraphs, based on the literature review developed previously.

2.1. Non-Fixed Sequences

A fuzzy logic-based proposal is presented in [2]. This model is based on the fact that the decision of sequencing is dependent on organizational and technical factors, which are essentially "abstract factors". It proposes to select the criteria that may influence the sequence through the opinion of experts and fuzzy techniques, to express numerically the ambiguity of such opinions. The main disadvantage of the model stands on the fact that is presented in an absolute manner (it does not consider the type of company, the industry, the size, its resources, and other aspects). A very similar idea was already exposed in [27], where an ITIL process selection model is exposed to be implemented also based on fuzzy logic.

The proposal [28] is oriented to early wins: The implementation proposes, in the first place, the processes that provide "quick wins", based on satisfaction surveys. Similarly, and depending on the needs, it proposes a strategy where the processes to be implemented are proposed for the medium and long term. The proposal of this author gives a solution for the problem of the order of implementation, but it is easy to verify that the implementation strategy is led by the clients opinions.

The approach of [29] describes an ITIL adoption based on the technology adoption model (TAM). For these authors, the sequence of processes depends on the requisites exhibited by the organization, but the critical processes are known and should have priority over the rest. This idea of dependence on such issues (industry, organization, size, etc.) is also explained in [21]. The authors developed a complete study on the implementation of the ITIL. In this study they show the reasons that make organizations implement the ITIL and define the three definitive elements for the level of implementation of the ITIL: The region or geographical area, the size of the company, and the industry in which it operates.

A compilation work is presented in [13], which is the basis for the sequence proposed: A sequence of processes defined from the validation of a series of variables that may affect the ITIL implementation. These variables take in consideration internal elements of the ITIL: The set of tasks needed to implement an ITIL process, the distribution of data, and the correct flow of information among processes.

2.2. Static Sequences

The reference [20,30] are examples of static sequence where the authors establish a way to measure the relationship among the different processes. These processes, conveniently classified, determine a graph in which cyclical or dependent paths can be found. Thus, the more elements a path has, the

more dependencies it contains, and so all the processes involved in that path are compromised: The cycle with the largest number of nodes (that is, processes) or processes is selected.

In [31] the idea of fixing a static sequence is taken again: In this paper, ITIL implementation is organized from the definition of three models:

- A first model of isolated ITIL processes.
- Another model that contains the dependencies between ITIL processes.
- A final model to relate the capacity level of the processes and the maturity level of the organization. One of the main characteristics of this proposal is the combination of concepts of the ITIL and Capablity Maturity Model Integration (CMMI) to propose a sequence.

It could be thought that this proposal describes a dynamic sequence, but in fact the result is a fixed (or very close to be fixed) sequence. The reason is that the second model of the mentioned above, determines which processes should be implemented to implement the next one; so only slight differences in the initial processes can be found. Once these ones have been implemented, the rest of the sequence hardly vary from one organization to other.

A fixed sequence of implementation is also shown in [32]: Although there is not an explicit justification, it shows a sequence that may be used as a reference. It means that companies can use the same sequence, as it is presented as company, geographically, and industry-independent.

In some cases, the objective is not to define explicitly a sequence but, rather, address a starting point, which means defining the first process to implement. This is the case in [9,17,19]—where the proposal has empirical basis supported by market analysis. Once more, the first process to implement the proposed is Incident Management, followed by Service Level Management, and Service Catalog Management.

2.3. Strategies and Critical Success Factors

(a) Critical success factors: Another research area is composed by those authors who try to identify success factors on ITIL implementation: [14,33], where a survey is used to get info about success factors of ITIL implementation in different companies. Another example can be found in [34], where specific success factors are analyzed: Management involvement, organization commitment and effectiveness, and key factors to implement the ITIL.

It is possible to identify also a group of works that provide methodologies and strategies to implement the ITIL [16]: It analyzes the steps to consider when implementing the ITIL (taking in consideration four big companies). From this experience, success factors are defined to a proper implementation of ITIL. It also proposes to start with the Incident Management process, but it does not show any sequence from this starting point.

A different view is proposed in [35], where success factors indicate tools and management as key elements. It is explained how the success does not depend on the sequence but on the software and tools use to a proper management of the implementation task. This point is also addressed by [36], where software tools (mainly BPM) are critical for success.

A compilation work can be found in [18]: An excellent systematic review of success factors and a methodology based on AHP (analytical hierarchical process) are proposed. AHP is a model to evaluate, average, and eliminate inconsistencies among a group of expert opinions.

A vast, extensive work is presented in [34]. In this case a set of success items are presented (mainly they are like those ones in the works indicated before) but compared with more than 160 companies (although—as it is indicated in the publication—it suffers limitations due to geographical issues).

A methodology based on business process change (BPC) is explained in [15]. BPC is used to determine the success factors, although there is nothing about the sequence of processes. A different approach can be found in [37], where failure factors are described: In fact, they are factors that may make the ITIL implementation difficult.

(b) Strategies: Regarding strategies, [8] show how to select processes, but without any sequence. This work proposes a model in which the ITIL processes are classified de-pending on the issues such as infrastructure, resources, actions, and so on. As an alternative, [38] presents a work to define a procedure that may ease the implementation: The rule is based on the level of maturity of the organization for every task. A similar idea is presented in [39], as it also highlights the importance of maturity to decide the processes to be implemented according to objectives, practices, inputs and outputs. Something similar is shown in [40].

In [1], the proposal just indicates the existence of two implementation strategies: One for very small companies and another one for aged companies, but without mentioning anything about the sequence. Finally, a multiagent architecture proposal can be found in [41] (it does not attend for the sequencing problem).

2.4. Non-Fixed Optimal Ordering Algorithm

As it has been shown before, there is no any specific approach offering a methodology, neither an algorithm to define the complete order of processes when implementing the ITIL. This means: (a) No algorithm for non-fixed sequences has been published; and (b) no algorithm for an optimal sequence specifically adapted for each company has been published.

This conclusion leads us to the define the algorithm presented in the next paragraph, where we present how to optimally order the ITIL processes for a specific company depending on: (a) The level of implementation of the ITIL it has already reached; and (b) on the characteristics of the company.

3. Algorithm for Optimal Ordering of ITIL Processes

3.1. Model Basis

The algorithm presented here assumes that a set of companies and its characteristics (size, industry, age, etc.) are available. The objective is to define an algorithm that maximizes the position of a company compared with its competitors in terms of ITIL implementation. The selection of processes to implement depends on the strategic needs of the company and the degree of implementation of every ITIL process compared to the competitors. The algorithm selects the process that maximizes the benefits of ITIL implementation in front of its competitors.

Let Ω_e be the set of available companies from which characteristics are known and stored. Usually this set of data is taken from a great poll:

$$\Omega_e = \{e_1, e_2, \ldots, e_n\}. \tag{1}$$

Let E be any company included in the dataset:

$$E = e_e \in \Omega_e. \tag{2}$$

Let Ω_{ne} be the complementary set of Ω_e, that is the set constituted by companies that have not been included in the data set:

$$\Omega_{ne} = \{e_1, e_2, \ldots,\} \forall e_x \notin \Omega_e. \tag{3}$$

It will be noted by E_{sel} any company included in this last data set:

$$E_{sel} = e_x \forall e_x \notin \Omega_e. \tag{4}$$

Let us denote by Ω_p the set of the p_{ITIL} processes that can be implemented out of the available data:

$$\Omega_p = \left\{p_1, p_2, \ldots, p_{p_{ITIL}}\right\}. \tag{5}$$

Let p_{ITIL} be the number of ITIL processes that can be implemented, so:

$$p_{ITIL} = |\Omega_p|. \tag{6}$$

Let p_i any of the p_{ITIL} potential processes that can be implemented and d_i the assessment of p_i process in a particular company, E:

The possible value of d_i are:

$$d_i(E) = \left\{ \begin{array}{l} 1 \; if \; C_1(p_i) = True \\ 2 \; if \; C_2(p_i) = True \\ 3 \; if \; C_3(p_i) = True \\ \cdots \\ M \; if \; C_M(p_i) = True \end{array} \right\}, \tag{7}$$

where $C_m(P_i)$ is a Boolean function that indicates if the p_i process satisfies an implementation degree of c_m. The possible values for the degrees are in the interval [1..M], so 1 represents the worst option and M represents the best option. That is:

$$Cm : \Omega_p \rightarrow Boolean \left| Cm(p_i) = \left\{ \begin{array}{l} True, \; if \; p_i \; satisfies \; c_m \\ False, \; if \; p_i \; satisfies \; \neg c_m \end{array} \right\}, \right. \tag{8}$$

For example, the c_1 condition could mean that the process is not implemented, neither will it be in the long term; in that case $C_1(p_i)$ = True would indicate that p_i is not implemented, neither will it be implemented in the long term in company E; in such case $d_i(E)$ = 1.

It should be noticed that {1...M} represents the values given to the different degrees of implementation that a p_i process may have in company E.

Let Ω_v be the set of the v parameters that define the characteristics of every company, which are identified by $\{v_1, v_2, \dots, v_v\}$. Such parameters could be the type of activity, the age, the number of employees, the geographical area where it operates, etc.,

$$\Omega_v = \left\{ v_1, v_2, \dots, v_v \right\} \Big| v = |\Omega_v|. \tag{9}$$

Following this, let us define the domain of each parameter that belongs to Ω_v:

$$\Omega_{v_k} = \left\{ v_{k1}, v_{k2,\dots}, v_{kn_k} \right\} \Big| k \in (1..v) \wedge n_k = \left| \Omega_{v_k} \right|, \tag{10}$$

where n_k represents the number of possible values for the parameter v_k.

Next, let us define every v functions $\{V_1, V_2, \dots, V_v\}$ which assign a value v_{ij} to the parameter v_i for the company E:

$$V_i : \Omega_e \rightarrow \Omega_{v_i} \Big| V_i(E) = v_{ij} \wedge v_{ij} \in \Omega_{v_i} \wedge i \in (1..v). \tag{11}$$

In such case, the v vector of parameters which define the characteristics of a company are given by:

$$V(E) = \left\{ \begin{array}{l} V_1(E) \\ \quad V_2(E) \\ \qquad \cdots \\ \qquad\quad V_v(E) \end{array} \right\} = \left\{ \begin{array}{l} v_{1t_1} \\ \quad v_{2t_2} \\ \qquad \cdots \\ \qquad\quad v_{vt_v} \end{array} \right\} where \; v_{it_i} \in \Omega_{v_i} \wedge t_k \in \left(1.. \left| \Omega_{v_k} \right| \right). \tag{12}$$

Next, s_{i1j} is defined as the average of the assessment of the p_i process for the companies that satisfy $v_1 = v_{1k}$:

$$s_{i1k} = \overline{d}_i(e_m) \forall e_m \Big| V_1(e_m) = v_{1k} \wedge k \in \left(1.. \left| \Omega_{v_1} \right| \right). \tag{13}$$

In a general way, the average of the assessment of the p_i process for all companies which satisfy v_j = v_{jk} can be denoted by s_{ijk}:

$$s_{ijk} = \overline{d}_i(e_l) \forall e_l \mid V_j(e_l) = v_{jk} \mid i \in (1..p_{\text{ITIL}}) \wedge j \in (1..v) \wedge k \in \left(1..v_j\right). \tag{14}$$

Or, expressed in a more formal way:

$$s_{ijk} = \frac{\sum_{l=1}^{n_e} d_i(e_l)}{n_e} \Bigg| V_j(e_e) = v_{jk} \wedge i \in (1..p_{\text{ITIL}}) \wedge n_e = \left|\Omega_{V_j(e_e)=v_{jk}}\right|. \tag{15}$$

This means that the average of the assessments d_i for the p_i process for every company e_e whose parameter V_j satisfies $V_j(e_e) = v_{jk}$. The ordinality of the set of companies that satisfy such condition is given by:

$$n_e = \left|\Omega_{V_j(e_e)=v_{jk}}\right|. \tag{16}$$

At this point, it is possible to show the algorithm that allows any company to decide which process should be first implemented.

Let us define E_{sel} as any company not included in the set Ω_e:

$$E_{\text{sel}} = e_x \mid e_x \notin \Omega_e. \tag{17}$$

3.2. Criteria for Establishing the Sequence

In order to decide which process should be first implemented, it is necessary to define a parameter containing information about the implementation of an ITIL process in other companies with similar characteristics. To define it, and taking in consideration the definitions presented in previous paragraphs, the next parameters are needed; where S_{ijk} is referred to the set of available set of companies in the database and D_i is specifically referred to the company E_{sel}:

$$\begin{aligned} S_{ijk} &= \left(M - s_{ijk}\right) \forall i \in (1..p_{\text{ITIL}}) \wedge j \in (1..v) \wedge k \in \left(1..v_j\right) \\ D_i &= (M - d_i) \forall i \in (1..p_{\text{ITIL}}) \end{aligned}. \tag{18}$$

In this expression, M represents the maximum value that the implementation of an ITIL process p_i can take. This M value represents a complete implementation of the p_i process or a very short-term implementation.

It can be seen how S_{ijk} represents, for a specific p_i process, the distance between the maximum value M and the average of the values of implementation for that particular process in companies with the same characteristics v_{jk} as E_{sel}. It can be also seen how D_i represents the distance between the maximum value M from the response of the company E_{sel}.

It is necessary to define an indicator or parameter to help us to decide the best process to be implemented next. This indicator should take high values when the relative position (in terms of implementation of a process) is better than the reference companies denoted by $V(E_{sel})$. This indicator should also take low values when the company is in a worse position than similar companies with characteristics $V(E_{sel})$.

Let r be the indicator "relative position" defined as follows:

$$r = \frac{S_\alpha^2 S_\beta^2 S_\gamma^2 \ldots S_\delta^2}{D^2}. \tag{19}$$

This indicator can be particularized for a particular process p_i and for all companies with the same characteristics $V(E_{sel})$:

$$r_i = \left. \frac{\prod_{j=1}^{v} S_{ijt_j}^2}{D_i^2} \right| V_j(E_{sel}) = v_{jt_j}, \tag{20}$$

where r_i represents the value of the r indicator for the company E_{sel} and for the process p_i.

This expression calculates r_i from the S^2 value for each group of companies that satisfy the condition of having the same characteristics as E_{sel}: Low values of D_i indicate that the process p_i is implemented or it will be soon in the company E_{sel}; on the other hand, high values of D_i indicate that process is not implemented, neither will it be in the short term. At the same time, high values for S_{ijtj} address that the p_i process is not implemented in the companies with the same characteristics v_{jt_j}, while low values show this process is implemented in companies with same characteristics, but it is not in E_{sel}.

As a consequence, if the p_i process is implemented in similar companies but it is not in the company E_{sel} (that is, E_{sel} position is worse than competitors), this leads to a really small value for r, compared to the maximum value it could take; it can be also shown that if a company has the process p_i implemented but similar companies do not (that is, the relative position of E_{sel} is better than competitors), then r will take a high value. Thus we can conclude that parameter r is a measurement of the relative position of a company for a specific process p_i compared to similar companies. Anyway, the value of r goes from 0 to 1.

Thus, we can formalize r_i as the relative positioning indicator and R_i as the function to evaluate r_i:

$$R_i : \Omega_{\text{ne}} \rightarrow \mathfrak{R} \,\middle|\, R_i(e_x) = r_i \in \mathfrak{R}^+ \,\forall e_x \in \Omega_{\text{ne}}. \tag{21}$$

Thus, R_i represents the function that evaluates the relative positioning r_i if a company e_x for the process p_i compared to similar companies.

Once this indicator is defined, it is possible to define the selection criteria for the first process to be implemented:

$$p_{opt} = p \,\middle|\, r_p = \text{mín}(r_i) \forall i = \{1, 2, .. p_{\text{ITIL}}\}. \tag{22}$$

This expression means that the best process and the one that should be first implemented, that is, the one that will most improve the rank of the company (in terms of ITIL implementation) compared to the competitors, is the one with the lowest value for r_p, that is, the one that has the lowest relative positioning.

The criteria shown previously needs a small correction: Due to the fact that relative positioning r has taken into account the situation of the process in the company itself, every process that is already implemented should be excluded; that is, the processes with $D_i = 0$. This obliges the exclusion of every process that has been already implemented and review only processes with $D_i \neq 0$.

$$P_{opt} = p \,\middle|\, r_p = \text{mín}(r_i) \forall i = \{1, 2, .. p_{\text{ITIL}}\} \,\middle|\, D_i \neq 0. \tag{23}$$

Thus, if we select iteratively the P_{opt} process (of course, on every iteration this process will be different as P_{opt} process has already been implemented in the previous iteration and so, dismissed as selectable), we get a sequence of processes to implement that optimizes the degree of implementation compared to the competitors, for the criteria defined (age, size, etc.).

4. Results: Comparative of Sequences in a Real Case

As mentioned before, there is not a generic methodology to sequence ITIL processes which takes into consideration the parameters of each company. A solution for this has been developed and it lays on data gathered from different companies. This information allows a candidate sequence to be

proposed for a company depending on the size, industry, age, and other parameters. Of course, this solution generates a sequence for each company that aims to implement ITIL.

It is necessary to compare the results of such optimal implementation with the sequences obtained in the literature review. The objective of this comparative is to determine if the sequence is significantly different from the ones proposed by different authors. The proposals of sequence selected are S1: [9], S2: [13], S3: [32], S4: [21], S5: [2], and S6: [31], as these proposals include a greater number of processes.

To determine if the proposed sequence and the reference sequence are independent, Spearman contrast and Kendall contrast were used. In both cases the null hypothesis is that both sequences (the reference one and the proposed one) are independent; and the alternative hypothesis is that both sequences are related (that is, there is not a significant difference). The level of confidence used was α = 0.1.

For every real company, an optimal sequence is obtained and, so, the comparison with the referenced sequences may lead to one of next results: The optimal sequence is significantly different from the reference sequence or the optimal sequence is not significantly different from the reference sequence. In addition, even in this second case it may occur that selected processes for implementation are the same, but they are selected in a smoothly different order (not statistically different).

As an example, a real, small, and young IT consultancy company located at Madrid (Spain) with less than nine employees was selected for testing. The algorithm is required to propose an optimal sequence considering five criteria (staff, IT employees, company age, industry, area). The application of the algorithm requires a database with data from other companies and make calculations with them (more information about this issue in Appendix A). The order of processes obtained is (just the 10 first processes are shown):

1—continuous improvement; 2—management of catalogue; 3—incident management; 4—validation and testing; 5—availability management; 6— service portfolio management; 7—financial management; 8—configuration management; 9—transition management; 10—access management.

Results of the comparative with other sequences are shown in Table 1:

Table 1. Comparative proposed sequence–reference sequence.

Reference Sequence	Spearman Contrast (|ρ Value|/|Limit Value|)	Spearman Contrast (|ρ Value|/|Limit Value|)
S1	0.35/0.39	0.05/0.28
S2	0.05/0.34	0.12/0.24
S3	0.38/0.53	0.05/0.04
S4	0.22/0.36	0.13/0.26
S5	0.08/0.80	0.20/0.73
S6	0.63/0.56	0.15/0.46

From Table 1, it is relevant to conclude that the optimal proposed sequence is significantly different from the first five reference sequences and, at the same time, is optimized for the criteria given by the company. For the sequence S6, the optimal sequence has a ρ value out of the limits (that is, we cannot accept the null hypothesis), although the value is quite close to the limit; nevertheless, for the Kendal contrast the τ value is clearly inside the limits (which allows us to accept the null hypothesis).

Let us remember that the optimal sequence selects processes iteratively, so the global degree of the ITIL implementation on a company is maximized when compared with similar companies in terms of size, IT size, age, industry, etc. This optimal sequence is significantly different from the published sequences by different authors.

The significance of the experiment is based on the fact that companies obtain a sequence of processes to implement ITIL at very low cost (no experts are needed), defining the criteria for optimization and considering the degree of implementation already reached at the moment.

5. Discussion

The proposed algorithm offers a sequence of ITIL processes that in most cases is different from the known existing proposals. This approach has benefits, listed below:

- The proposed sequence is obtained from a mathematical model, so it does not depend on the opinion of experts—as most of the proposals in the literature review do—neither on subjective issues. This is a valuable point, because not all companies (especially small companies) can afford to pay a set of experts to decide how to implement processes of the ITIL. This is also a valuable issue as it avoids ambiguity and subjective opinions and leads to a repeatable process for the estimation of the best sequence for a company.
- The proposed sequence is obtained so the order of processes proposed maximizes the efforts of implementation: It gets the company the closest to competitors, if the implementation of ITIL processes in that company is far from the average, and it gets the company to a better position even if it is over the average. Due to the calculation of the relative position factor and its optimization, the process selected in every iteration is the one that optimizes the positioning in terms of ITIL implementation.
- The company may select the criteria to optimize efforts of implementation: size, age, region, etc. Thus, every company will obtain different sequences especially set for each one. As no approach defining a sequence that depends on characteristics selectable by the company has been found, this functionality represents an advantage; companies can decide what are the most important factors when implementing the ITIL and can obtain a sequence that best fits its needs.
- The solution proposed will get more accurate as the database is filled with more and more company data. The database used with the algorithm has information about five parameters of each company, as well as the value of the degree of implementation of every ITIL process: As more data it added, a better solution is produced from the algorithm, as more information is known about what other companies are doing (about ITIL implementation)
- Comparatively, this solution may be (and really it is) implemented in a software platform which is easier and cheaper than considering experts, as some approaches do. As it has been said before, the algorithm has a mathematical basis which simplifies its implementation in a software program.
- Due to fact that the solution proposed is specific for each company, a higher satisfaction of clients is expected (companies implementing the ITIL).
- Although it is not a benefit of the algorithm itself, the software platform used offers a comparative with other proposals. Based on this comparison, the statistics tests show how different this proposal is from other approaches.

On the other hand, the algorithm needs a database with characteristics of companies and the degree of implementation of every ITIL process, so the geographic limitation on its use could be considered a disadvantage. In the real case analyzed, the data for the database was obtained from Spanish companies. Anyway, the algorithm is valid once a data set for that specific region is available. Just an update of data makes the algorithm useful in other regions.

6. Conclusions

The selection of ITIL processes to be implemented is quite important in order for it to succeed. The literature about how to implement the ITIL is huge, but there is no a common approach about the selection neither the order of processes. The main approaches are: (a) A fixed sequence independent of the characteristics of the company; (b) a non-fixed sequence, in these cases there is a great influence of internal or experts opinions about the order of processes; and (c) to pay attention to factors that may help to succeed but without explicitly defining a sequence.

After the literature review, a model for selection was presented, which was based on selecting the process that places the company the nearest to competitors, taking in consideration several factors as

size, industry, market, IT size, etc. This proposal is referred to as optimal as it minimizes the distance between the company (in terms of ITIL implementation) and the rest of similar companies. The main advantage of this selection algorithm is that it allows the implementation to be optimized, taking into consideration the different characteristics or parameters of the company. In the literature review, no algorithm was found that allows an implementation sequence to be obtained in such a way.

Although extending the testing of the algorithm to more and more companies is needed, the initial results show that this different algorithm really produces a different sequence of processes. The initial comparison with other techniques shows that sequences are statistically different, and the companies obtain the optimal sequence to get the closest to competitors, as the selection algorithm is designed to do so.

Of course, the algorithm needs a database of companies with its characteristics and the degree of implementation for every ITIL process, as that is the basis to optimize the sequence proposed. Anyway, the database value improves with every company that is introduced, as that results in a better proposal of sequence.

For the small IT consultancy company examined, the results show that the new optimal sequence is significantly different from the existing ones. Future works are oriented to test the algorithm on more companies to get an idea of the overall discrepancies between the proposed sequence and the reference approaches.

Appendix A

The data for the database as obtained from a poll. Table A1 shows the characteristics of this polling:

Table A1. Description of the polling.

Concept	Value
Scope	Spain
Universe	Companies with more than one employee
Type of polling	Web form
Sent	200
Minimum to be significant	64
Confidence level	90%
Population	200.000
Error	<8.5%
Company selection	Random
Mode	Single-phase

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