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Strategic Management of IT Practices in Tourism for Operation and Service Enhancement

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Abstract: The information technology infrastructure library (ITIL) standard describes processes that should be implemented in Information Technology (IT) departments for proper operations management, which includes human resources management, economic management, and strategic management, among others. This should be especially considered in the business management of industries with no relation to information technologies (IT), such as tourism and hospitality companies. This work aims to present a method to establish the order of adoption of the IT management processes in companies that belong to the tourism industry. We conducted a survey to obtain the necessary data and developed a methodology that is based on an optimization procedure. This procedure generates the optimal sequence of IT tasks to adopt in a generic small company in the tourism industry. The methodology was then applied to a representative tourism company. Through the sequence obtained, it is shown that it is necessary to implement operative processes, and subsequently, strategic processes. A comparative study was developed to find the differences with other authors' proposals. The most important result we found was the possibility of efficient use of organizations' information to build an optimized list of IT procedures to improve their administration. The obtained list of processes is specific for each organization, and not dependent on the solutions offered by other authors who proposed a general or underoptimal list of processes.

Keywords: IT service administration; business information; optimization

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Citation: Juan Luis, Rubio Sánchez, García Revilla Mercedes Raquel, and Martínez Moure Olga. 2023. Strategic Management of IT Practices in Tourism for Operation and Service Enhancement. *Administrative Sciences* 13: 2. https://doi.org/10.3390/admsci13010002

Received: 4 November 2022
Revised: 13 December 2022
Accepted: 15 December 2022
Published: 21 December 2022

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1. Introduction

The ITIL practices handbook can be considered as a set of several concepts and best practices that are used for the management of information technology departments. Even if there is currently no standard guide for its adoption in its reference book, it is contemplated as a top reference in the field of IT departments and services management (Gervalla et al. 2018; Polard and Cater-Steel 2009). Depending on several factors (Cater-Steel and Tan 2005; Tan et al. 2007), like the type of activity or company, whether it is a private or a public organization, its number of employees, or the country (Tawar 2013; Orlandi et al. 2020) where it operates among others, there are different approaches to its implementation (Schaefer et al. 2020). Thus, one of the biggest problems is the absence of overall ITIL adoption criteria or method (Caixabank Research 2022). This lack of unique implementation criteria becomes particularly important in the tourism and hospitality sector, as most of its companies are considered small or very small, having less than fifty employees. When focusing on the improvement of IT procedures and tasks, it is observed that those small companies cannot afford the same resources as the big companies, which forces them to look for external assistance. So, the problem to solve is how to help these small companies to implement procedures in IT that will improve the management of the IT department and services.

We have carried out a systematic literature review to analyze how different authors have tried to solve the question of the adoption of ITIL practices. The main conclusions about the different ideas and approaches are enumerated in the following points:

1. The first idea managed by different authors (Orlandi et al. 2020; Masarat et al. 2009) is the definition of a general and unique sequence of ITIL processes. This sequence is meant to be the same for all companies. Even if the sequences proposed for the adoption of ITIL are different among authors, this approach is suggested in recent studies (Orlandi et al. 2020; Lema 2015) and older papers (Masarat et al. 2009; Cater-Steel et al. 2009). Obviously, these sequences of IT procedures and tasks present advantages and inconveniences: (a) the main advantage is its uniqueness and simplicity (as a fixed sequence of processes for IT departments is proposed, no more calculations are needed); (b) conversely, the disadvantage of this approach is that, independently of the companies' characteristics, all authors suggest a static, general, and universal sequence of ITIL procedures and tasks that should be used by the companies: the main inconvenience hereby is the fact that the proposed set of IT procedures are not specifically adapted to the needs of each company neither to its specific characteristics.
2. Another approach is the definition of an adaptive sequence, where the characteristics of the company are taken into account and a specific sequence of the ITIL procedures can be proposed specifically for that company (Schaefer et al. 2020). Some examples of this dynamic approach can be seen in the previous literature (Rubio Sánchez 2021; Miller 2017; Shojafar and Zarrazvand 2012) where specific sequences of the ITIL procedures and tasks are proposed for each company. This method allows the generation of specific sets of IT procedures and tasks for each company. The authors define methods to obtain the sequences in several ways, such as an example (Schaefer et al. 2020), and (Rubio Sánchez 2021): they refer to mathematical optimization techniques, where the objective function is fixed to some requisites defined by the company. Another example can be found in (Miller 2017). This author obtains the sequence from the company's priorities and business objectives. On the other hand, (Shojafar and Zarrazvand 2012) consider this fuzzy logic. So, the conclusion is that even if the dynamic sets of procedures for IT fit better for each company, there are different ways to obtain this dynamic set of IT procedures.
3. Alternatively, the 'critical implementation factors' methodology focuses on determining the factors that might help in the IT procedures adoption (Cater-Steel and Pollard 2008). This choice does not clearly set a process order for the adoption of IT procedures, however, it simply defines its conditions to succeed. This type of approach has already been used in different relevant studies (Iden and Eikebrokk 2015).
4. It is possible to find another strategy (Case 2007) that is focused on general steps for the implementation of ITI. In this case, the implementation is based on different periods or phases, as suggested by (Case 2007). There is no specific intention to define the order of procedures and tasks for the IT department. It is preferable to lead the implementation as an overall project with the definition of the phases that are necessary to succeed. This approach was definitively abandoned as the adoption and implementation of ITIL is, however, treated from a project management perspective. So, the conclusion is that no clear sequences specifically adapted for small tourism and hospitality organizations can be found.

Tourism and Hospitality Companies

The tourism industry has been and continues to be, one of the most heavily invested industries in information technologies (Romero 2020; Sayles 1963; Roach 1991; Garayar 2021). Generally, bigger companies invest in specific systems such as PMS (Property Management System) (Hotelogix 2014) in order to increase the distance from competitors. Nevertheless, smaller businesses do not usually invest in PMS or similar systems. These small or medium-sized companies do not rely on the effectiveness of the automation pro-

cesses in their day-to-day business operations, and they typically keep using traditional resources. Thus, the technological transition is still being obstructed. On the other hand, more and more big companies entrust all responsibilities regarding their business information security, clients' personal data, system integrations, and transition to cloud computing supported by the IT departments (Fundación Orange España 2016).

Nowadays, to remain competitive it is crucial for any tourism business or company to adopt new technologies and implement processes to satisfy business requirements. As stated in various studies (Fundación Orange España 2016; Figueroa Domecq and Ballestero 2007), the adoption of these technologies and processes in the IT departments of tourism companies help in different areas.:

- Revenue management: Yield Revenue Management (YRM) (Jones 2000; CERIUM 2022) systems, help in yield management in hotels.
- Customer Relationship Management (CRM): (Jones 2000; Kimes 1997): client communications to achieve overall client relationship management.
- Room and visit management: including check-in and check-out processes, room management, as well as visitor management, and selling terminals through a PMS (Property Management System) (Jones 2000; Jafari and Medina 2000).
- Reservation management: Central Reservation System (CRS) (Arellano Díaz 2017), principally for room booking management.

The context described above will make it possible to increase the entire tourism value chain in the organization (Benavides 2019). This is because, nowadays, technology is configured as an essential factor that has a positive impact on all the processes of the tourism organization. As Chourabi et al. (2012) would say, technology is "a meta-factor that influences all processes" (Chourabi et al. 2012). Many authors refer to a "technology bias" when emphasizing the importance of technology in tourism enterprises, such as Dirks and Keeling (2009). The importance of technology becomes so essential that, from the doctrine in the tourism framework, it is established that software applied to businesses could be called "cognitive competence" (Chourabi et al. 2012). This innovation environment, based on technology (Komninos 2002) becomes a priority axis for the achievement of competitiveness in tourism and hotel companies.

Small businesses still do not adopt technology-based solutions, such as YRM, CRS, or CRM, among others, in the same way larger companies do. Furthermore, when technology supports the companies' tasks, the lack of IT processes (for example, ITIL) makes it difficult to benefit from these technology solutions (Polard and Cater-Steel 2009), as different companies might use different approaches depending on its characteristics (Tan et al. 2007; Tawar 2013; Orlandi et al. 2020). Nevertheless, research showed and highlighted the importance of IT in the tourism industry (Hotelogix 2014; Fundación Orange España 2016; Figueroa Domecq and Ballestero 2007; Jones 2000; Jafari and Medina 2000; Arellano Díaz 2017; Kimes 1997; CERIUM 2022). This is the crucial and core point of our work, namely how to help these small tourism companies implement or adopt IT procedures to improve the services offered by their IT departments. Helping these departments will enhance business management by allowing new and better technological services (to its own company and the market).

Especially in Spain, but also in other south European countries, very small, small, and medium-sized companies are highly important, and as pointed out by the Ministerio de Industria (30. Ministerio de Industria, Comercio y Turismo 2020), more than 99% of all companies are considered small scale companies. The tourism and hospitality industries also present quite similar ratios, where a typical business is small or very small (CIGREF 2009).

Considering the beforehand mentioned business characteristics, the main aim of this study is to propose an enhanced methodology to obtain a sequence of IT tasks and procedures considering limitations in the ITIL procedures (restrictions pointed out by the company) and taking into account the companies' purposes (a company could have different objectives, such as implementing all IT procedures in ITIL, implementing the minimum number of procedures to be as the competitors, and implementing the procedures typically

implemented by small companies, among others). As there is an elevated percentage of small-scale businesses in the tourism sector, the proposed enhanced method has been applied to this industry. The method is not limited to this industry, so it could be applied to any other industry by updating the database with a specific industry's company information.

As a result of the application of the methodology, we obtain an optimal sequence of the ITIL processes to be implemented in companies. The sequence considers the most outspread characteristics of small companies in the respected industry, in this case, the tourism industry.

To conduct our study, we intended to create a new and optimized method to select the optimal set of IT processes that should be adopted by a company implementing ITIL. Therefore, we combined our information obtained in the questionnaire with an improved approach (Rubio Sánchez 2021) which should make the implementation more efficient. In order to collect our necessary data, we performed a survey about the characteristics and implementation status of the ITIL processes of tourism companies. This combination is supposed to generate an optimal and more efficient sequence of ITIL processes, which can be used in small and very small tourism companies. It avoids unnecessary processes and makes the ITIL implementation project more efficient. We modified the initial mathematical model to consider new restrictions imposed by a company that implements ITIL. These restrictions reflect the companies' requirements concerning different aspects of the processes, such as time delays in implementation, process evading, and the inclusion of formerly excluded processes. Any small tourism company can benefit from this approach using the list of processes proposed, or define a new one (specifically adapted to that company), without the need of hiring external experts.

The main contributions of this paper are:

1. From the theoretical perspective, it offers a mathematical model to achieve an optimal sequence of processes and procedures that should be implemented in the IT departments of tourism companies. This mathematical model overcomes the disadvantages of previously known models since it does not consider implementing nonuseful or nondesired processes and procedures. This mathematical model is translated into an algorithm and finally into pseudocode to ease its implementation.
2. From the methodological point of view, the contribution is an implementation of the model previously addressed, which can be entirely used, as it is public domain, as pointed out in the Supplementary Material section. The database with the data gathered in the survey, the algorithm, and the implementation itself are available.
3. Finally, from the practical point of view, we have fully developed an application of the methodology to sequence IT processes to a generic tourism company, which clearly will help the organizations to improve their IT services.

In the following, we display the conducted survey, the mathematical basis, and the enhanced methodology we used for getting the optimal sequence. As a result, we obtain the sequence itself, which is contrasted to other generic sequences in other studies. Hereby the independence of the sequence obtained is revealed, and the main conclusions and future works are presented.

2. Results

2.1. An Example in the Tourism and Hospitality Industry

We selected a representative company of the tourism sector, in order to verify the application of the improved methodology. This company was defined through the survey data, using common values for the parameters and the degree of IT procedures adaptation. Through these values, we got the input for the mathematical model to calculate the best set of procedures.

The main aims of this application were to showcase the application of the methodology to a real organization, and the obtainment of a list of useful procedures in a hospitality orga-

nization. In the following, we present its application and the discrepancies in comparison to the preceding method.

2.1.1. Characteristics of the Sample

To get the best set of IT procedures that can be adopted in a generic organization, we made use of the sequencing methodology in the tourism industry. As mentioned in (Ministerio de Industria, Comercio y Turismo 2020), this generic organization is a medium-sized business with less than fifty workers, and less than five workers in the IT area (Ministerio de Industria, Comercio y Turismo 2020), located in Spain and presenting a medium degree of IT procedures adoption. Although it is a Spanish company, it works in global markets looking for tourists to Spanish destinations.

In Figure 1 the inputs in the model are shown. These inputs come out from all the values obtained for each of the IT procedures.

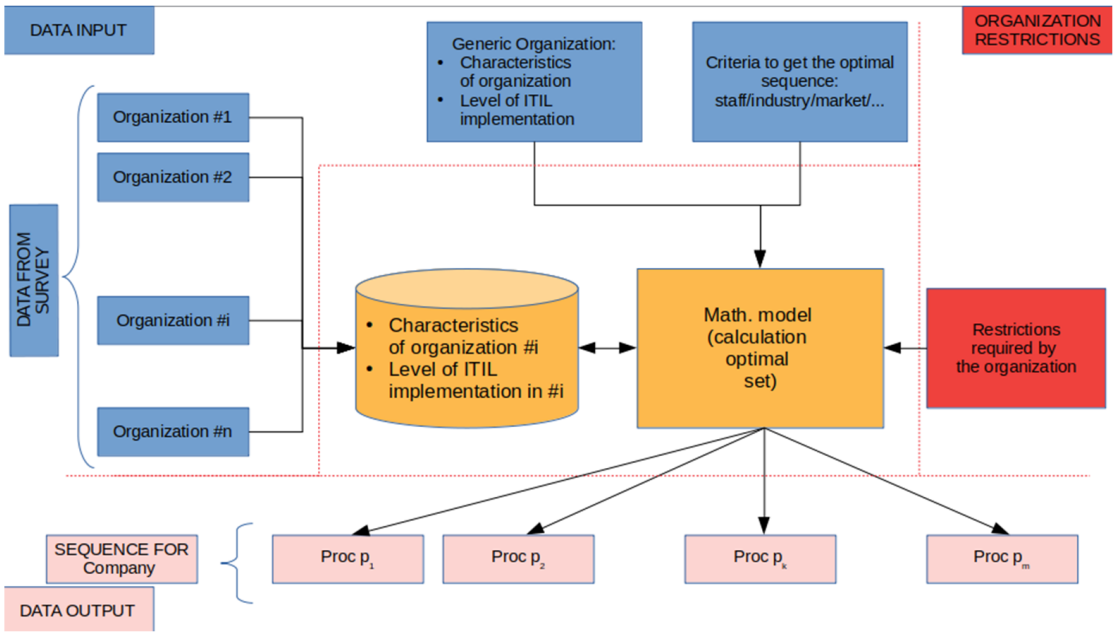

Figure 1. Methodology schema.

The definition of the optimization criteria was also necessary. Usually, companies want to obtain an ordered set of IT procedures to be adopted to become more competitive. Hence, we assume that the companies in the tourism sector (regardless of their characteristics) are the most suitable criterion for optimization. The mathematical formulae return an optimal set of tasks taking into account the size and the number of workers in the IT department, the age, or a mix of these items. The 'industry' is configured as the selected parameter to get the optimal set of IT tasks.

2.1.2. Calculus of the Best Restricted Set of the IT Procedures

Through the use of the algorithm, we obtained an ordered list of IT tasks that can be implemented in any tourism company. The database and the software that implements the calculations made can be found in the Supplementary Materials.

Following the Delphi method, as suggested by Miller (Miller 2017), we opted to not include the procedures in Table 1. These tasks in Table 1 are someway included in other tasks.

Table 1. Limitations: set of tasks excluded from the calculations.

Procedure
Strategic administration of Information and Communication Technologies (ICT)
Finance administration
Coordination for design service
Change management
Knowledge storing
Handling/Tracking of events
Administration of business relations (1)
Control of problems flow (1)

(1) Not considered due to a high number of missing data for this item in the responses, therefore the information obtained was not sufficiently relevant.

The processes included in Table 1 were not included in the optimization calculations. This is due to different reasons: the first and more important is that not all the companies answered these questions so the results would not be significant. That is, the procedure to obtain an optimal sequence works only in cases of having high-quality data. If the companies do not answer these questions, then we must delete these processes from the optimization procedure.

In Table 2, the first ten processes obtained are presented; the whole sequence is included in Appendix A Table A1.

Table 2. Proposed set of IT procedures in a generic hospitality organization.

Procedure
Handling of incidences
Administration of continuous enhancements
Handling of validation and approval tests
Requesting government
Transition-on-production scheduling
Supply administration
Deployment and version control
Physical and logical security management
Capacities handling
Infrastructure-access control

The application of the procedure presented in Sections 4.4 and 4.5 returned a list of processes that are presented in Table 2 (the complete list of processes can be found in Table A1). It is presented the first ten processes due to their importance as it is usually done in the articles found in the literature review.

3. Discussion

3.1. Sequence Analysis

The obtained set of sequences shows the ordered list of the IT procedures. Those processes, once they have been implanted, will most likely improve a company's relative position.

The first obtained process is 'Handling of incidences', which also was obtained in previous studies (Polard and Cater-Steel 2009). This is due to the obtainment of the optimal sequence through the comparison of every organization in the tourism and hospitality

industries. This happens normally in all sectors and activities, as the biggest organizations are based on management conducted by procedures and processes, and so, they are a reference for medium and small organizations. The second task or procedure to adopt is the 'Administration of continuous enhancements'. Even if it is not proposed by other authors (Tan et al. 2007; Tawar 2013; Orlandi et al. 2020; Schaefer et al. 2020), our study shows that many companies have implemented it. So, an organization that wants to adopt the IT procedures described in ITIL is obliged to have an administration of continuous enhancements procedures. The procedures shown in the beforehand mentioned studies (Tan et al. 2007; Tawar 2013; Orlandi et al. 2020; Schaefer et al. 2020) are focused on daily operations of the IT areas instead of the improvement procedures or the strategic tasks. The requirements of management, the validation, and the transition scheduling management are the following processes. This is due to the focus of IT departments on having requisites for emerging IT needs and services, adopting them and putting them in the production infrastructures.

Afterward, the next ones that are proposed include 'Supply administration', which is compelling online interactions (with suppliers and clients) due to the growth of online relationships. The next proposed process in this optimal sequence focuses on 'Security management', which is likewise based on the increase of online activities in the tourism and hospitality industries. Finally, the last proposed tasks are 'Capacities handling' and 'Infrastructure-access control' (the full sequence can be found in Table A1).

3.2. Comparison to Other Methodologies

3.2.1. Comparison to Methodology with No Restrictions

We are interested in comparing the results obtained in Table 3 and applying the method proposed in this article with the results obtained by applying the method in Rubio Sánchez (Rubio Sánchez 2021).

Table 3. Proposed set of tasks in the ICT department.

Identification of Sequenced Procedures
Handling of incidences
Administration of continuous enhancements
Handling of validation and approval tests
Requesting government
Transition-on-production scheduling
Handling/Tracking of events
Supply administration
Deployment and version control
Change evaluation
Knowledge storing

Table 3 shows the list of processes obtained by applying the method in Rubio Sánchez (Rubio Sánchez 2021). We can now compare the results of the procedure presented in Sections 4.4 and 4.5 versus the results obtained by applying Rubio Sánchez 2021. It is important to highlight that the method presented in Sections 4.4 and 4.5 avoids implementing the nondesired processes instead of generating a global list of processes as it is done in Rubio Sánchez 2021.

After comparing Tables 3 and 4 we found that the five first IT tasks are exactly the same. The following tasks differ as new limitations were included to obtain the list of tasks (see Table 2). To put them in a line with other studies (Cater-Steel and Tan 2005; Tan et al. 2007; Tawar 2013; Orlandi et al. 2020; Schaefer et al. 2020; Masarat et al. 2009), we only listed the first 10 processes. The processes obtained are also more oriented to operative

issues, whereas the ones obtained previously were more oriented to strategy and concepts. This is due to the new limitations forced to exclude strategical procedures and tasks, i.e., the organizations prefer to choose the operative processes in the beginning, and before the strategical tasks.

Table 4. Comparing to other lists of processes (confidence β = 5%).

List of IT Tasks (Author)	Test 1 * Results (Null Hypothesis Limits)	Test 2 * Results (Null Hypothesis Limits)	Conclusion
(Miller 2017)	−0.023 (−0.47; 0.47)	0.509 (−0.34; 0.34)	Could be dependent
(Pastuszak et al. 2012)	0.516 (−0.70; 0.70)	0.444 (−0.55; 0.55)	Dependency not found
(Caixabank Research 2022)	−0.417 (0.50; −0.50)	−0.101 (0.38; −0.38)	Dependency not found
(Marrone et al. 2014)	−0.111 (−0.47; 0.47)	−0.046 (−0.34; 0.34)	Dependency not found
(Zareravasan et al. 2014)	−0.50 (−1.00; 1.00)	0 (−1.00; 1.00)	Dependency not found
(Lucio-Nieto and González-Bañales 2019)	0.14 (−0.73; 0.73)	−0.071 (−0.64; 0.64)	Dependency not found

* Test1: Spearman; Test2: Kendal.

3.2.2. Comparing to the Standard List of Tasks and Procedures

The best set of processes obtained with the method previously explained is compared to other authors' proposals (Miller 2017; Pastuszak et al. 2012; Marrone et al. 2014; Zareravasan et al. 2014; Lucio-Nieto and González-Bañales 2019). This analysis shows the relationship (if it exists) between the set of processes obtained and those proposed by other authors, i.e., we want to know if the list in Table 2 is independent or not from other authors' proposals.

The way to calculate the dependency (or independence) is to use the Kendal test (KTest) and Spearman test (STest), as explained in Zhang et al. (2020):

Hypothesis 0 (H0). The series are independent.

Hypothesis 1 (H1). The series are not independent.

STest is calculated by:

$$\rho o = 1 - 6 \sum \tag{1}$$

where $(t_i - t_j)$ is the distance of the positions in the obtained set for a specific IT procedure or task.

On the other hand, the Ktest is calculated by:

$$\tau au = \frac{p_c - p_d}{\frac{p}{2}(p-1)} \tag{2}$$

Note that p_c and p_d are equal and different pairs (tasks or procedures).

It is commonly accepted that independence if both tests confirm the independence, otherwise, we cannot conclude about independence.

The results of the calculus are pointed out in the next table.

Table 4 above offers the results of the comparative analysis with the most representative authors in this area. We conclude that the best set of processes obtained as shown in this

paper is far from the most important researchers' results (with the exception of the sequence in (Miller 2017): the comparison is not statistically different).

The conclusion is that the set of tasks and procedures obtained with our method (that includes limitations to the possible procedures and tasks) enhances the earlier results by eliminating some tasks and procedures. This implies that the result is a set of procedures that fits better the needs of the organization and is statistically independent from the sets obtained by other researchers. In other words, the problem with the previous method is that the sequence of processes obtained included some nondesired processes. The companies were not willing to implement some processes due to the lack of resources or time. It means that the sequence obtained with the original method contained some processes that the company was not going to implement. This issue reduced the confidence in the sequence because it contained nondesired elements. But it was not just a question of deleting these processes from the generated sequence, since the optimal sequence could be different and in fact, it is, if the nondesired processes were ignored from the beginning. So, the method proposed here gets the optimal sequence of processes avoiding the nondesired processes, and so we can conclude it offers better results than the original one.

3.2.3. About Using the Method in Other Companies

The enhanced method explained in this article is based on a generic optimization method. The original model is not defined for a concrete company, industry, or activity. The importance of this method can be found within the content of the database. It is possible to obtain an optimal sequence that considers the specific needs and restrictions of a company. The original methodology (Rubio Sánchez 2021) has been applied in an entertainment company The enhanced method explained in this paper has also been applied to a generic hospitality company. The selected processes according to this methodology will successfully be fully implemented in the near future. Thanks to improved methodology the organizations have now an ordered set of tasks and procedures to adopt ITIL, which will help to achieve their objectives. Any company can take benefit from this method by entering new characteristics and objectives. There is no limitation in the application of this method to companies in the hospitality and tourism industries.

4. Materials and Methods

This research is based on a numerical perspective with a structured form that serves as the basis for a mathematical model. We collected information from tourism companies concerning their company characteristics and the level of implementation of ITIL processes. We used this as a premise for the methodology to sequence the ITIL processes for distinct businesses.

To gather the required information, we developed a web-based survey, which was delivered to two hundred organizations by mail, telephone calls, and, in case it was required, completed with face-to-face meetings. All results were finally introduced in a web form. Several primary verifications were carried out to eliminate inconsistencies or duplicated data. The data obtained from the questionnaire, as well as the code programming of the mathematical model in a web-based tool, are included in the Supplementary Materials.

To deploy the new optimized methodology based on Rubio Sánchez (Rubio Sánchez 2021), the data were stored in a database. As the optimal sequence through the new enhanced method is obtained not only by the application of the criteria chosen by the company that implements the IT procedures, it is also by imposing limitations on the sequence of IT procedures do the results become enhanced. The ordered set of procedures that best satisfies the companies' requirements and limitations is obtained by simply applying the mathematical model described in the next section. The restrictions on the processes are adjusted so that the adoption of certain processes can be avoided or delayed, which makes the new enhanced method more efficient from the perspective of the company implementing ITIL.

The enhanced method is deployed on a generic company by setting its parameters and restrictions in the model. More explicitly, the enhanced method was tested on a generic hospitality business, which will ease the adoption of IT procedures in other businesses. The selected company shows the most typical characteristics of medium and small organizations in the tourism and hospitality sector, including the following criteria:

1. Principal activity in the tourism and hospitality sector.
2. No more than fifty employees.
3. No more than 5 workers in the technological department.
4. Offering national and local destines and operating in international markets.
5. Not high or low level of IT procedures adoption, as concluded from the study of the responses to the questionnaire.

According to the methodology suggested by Rubio Sánchez (Rubio Sánchez 2021), a schema of the enhanced method applied has been developed (Figure 1). The main steps of this new enhanced methodology are exposed in the next points:

1. The collected data of the survey, which are saved in a database, show the tourism companies' characteristics and their level of implementation of ITIL procedures.
2. After the data are saved, a generic company in the tourism industry was defined and entered into the software application that supports the enhanced method.
3. It has also drawn up the criteria to obtain the optimal sequence of IT management procedures to obtain the optimal set of processes that best fit the needs of the company. The mathematical model offers different alternatives: a universal optimization, a single-parameter configuration, and a multiple-parameter calculation. In order to get a more general solution, we suggest a universal optimization.
4. The limitations required by the generic tourism and hospitality organization are modeled and introduced into the system. The enhanced method designed in this study allows the exclusion of several IT procedures from the list of possible candidates to be implemented.
5. Once executed, the mathematical model is an optimal sequence with the set of ordered ITIL processes that best fit the formerly established criteria obtained (fulfilling the imposed restrictions).

4.1. Survey Description

The main field of study is defined by companies connected to Spanish tourism whereas as well small and medium-sized companies were considered.

These represent more than 99% of all companies and add up to approximately 50,000 companies, excluding the ones in the food industry (dates from 2021). Predominantly, these companies are linked to activities within the hotel sector, travel agencies, car rental, and cultural industry.

Also, other close countries show similar company characteristics, as well as similar percentages of small companies (95%) (Urueña et al. 2019). The main aim of the conducted survey was the collection of information regarding each company's characteristics. Therefore, questions about staff information, number of IT employees, ages, working region, and the level of the ITIL implementation, inter alia, were asked. We randomly chose the organizations for the poll, and it was developed between December 2021 and February 2022. The study parameters can be found in Table 1.

4.2. Data Storage

The information gathered in the questionnaire has been saved in a database. This database will be used with the model explained in the next paragraphs, to calculate the best sequence of processes for a particular organization. It is important to clarify some concepts related to the database. The first one is that the database stores information about the 'characteristics' of the companies participating in the survey. These characteristics are age, staff, IT staff, geography, and industry. The second one is that the system also keeps

the information about the degree of adoption of every IT process since it will be used in the optimization model, which will be explained later on.

So, considering the characteristics of a particular company E, and considering the degree of adoption of IT tasks or processes in that company, the methodology proposed compares that data to the data stored and calculates the best list of tasks. The parameters to obtain the best sequence are defined by company E introducing the parameter values in the model, as will be explained later.

4.3. Survey: Technical Elements

Those companies to whom the questionnaire was sent were selected by a random process (a unique step) from a set of previously selected companies. The selected companies had the same characteristics and ratios as the whole population of companies. The minimum number of companies needed to obtain the significant result is calculated from the next Equation (3):

$$n_{\min} = \frac{k^2 \cdot \mathrm{p} \cdot (1-p) \cdot \mathrm{N}_0}{e^2 (N_0 - 1) + \mathrm{k}^2 \cdot \mathrm{p} \cdot (1-p)}, \quad (3)$$

where n_{min} represents the dimension of the sample required, that is, the minimum responses to obtain significative results; N_0 is the whole population (that is, the number of organizations in the hospitality sector in the geographic area analyzed); p is a parameter to measure the validity of the selected companies, its value is usually 0.5; k is a parameter related to the confidence level, for example, for a confidence degree of 90%, k equals to 1.65 and for a confidence level of 99%, k equals to 2.58; finally e is the error.

Table 1 shows the specific elements and parameters of the poll.

Table 5 indicates that the survey has been carried out in Spain, using different methods: online polling, phone polling, and face-to-face interviews. The number of valid responses got up to 110, so the minimum responses (i.e., 95 responses) had been reached. The calculation for the confidence level returns a value of 95%, while the error level drops below 8.5%. The organizations participating in the survey belong to the tourism industry and were selected randomly. The whole questionnaire can be found in Appendix A Table A2.

Table 5. Technical elements of the poll.

Technical Element	Value
Geographic area	Spain
Polling method	On lines/Phoning/Present
Tries	201
Responses	110
Required to be significative	95
Confidence degree	95%
Discrepancy	8.5%
Interest organizations	Tourism companies
Company selection	Random
Survey mode	One step
Channel communication	Email
Questionnaire	See Table A2

4.4. Methodology

As pointed out in the previous paragraph, the purpose is to improve the methodology (Rubio Sánchez 2021) based on a free restriction environment. It can be easily observed how the companies do not consider all IT procedures for the implementation phase. That is, the

organizations are usually constrained by some restrictions due to the lack of time, money, and resources, or simply because some processes are not interesting for the company.

So, the starting point for the optimization processes is a smaller subset of IT procedures. Also, companies are usually interested in prioritizing the importance of the processes to implement. So, we need to redefine the optimization expression by introducing some parameters to exclude/include the characteristics to consider in the optimization expression and some parameters to weigh the importance of each characteristic. Both issues can be solved with the model defined in the next lines.

Let *NP_restr* be:

$$\mathrm{NP\_restr}_i(\varphi) = \frac{\prod_{j=1}^{j=chr} \omega_j \cdot M_{ijk}^{2\cdot\delta_j}}{V_i^2}, \tag{4}$$

fixed to:

$$i \in \Phi_{\mathrm{subITIL}} = \left\{ \mathrm{pr}_1, \mathrm{pr}_2, \ldots \mathrm{pr}_i \ldots, \mathrm{pr}_{\mathrm{n\_ITIL}} \right\}, \tag{5}$$

The expression in Equation (5) limits the number of processes that can be used in the IT department. Moreover, the expression in Equation (4) can be configured with the δ parameters to decide the characteristics that will be included in the optimization expression used to calculate the set of tasks and procedures in the IT department. Finally, the ω parameters can be used to modulate the importance of each characteristic in the final decision. These elements (Equations (4) and (5)) allow the obtain sequences of processes that fit better the need of every company.

Parameter M and parameter V are measurements of the implementation of a process in a company and in the set of companies with the same characteristics (that is, considering those ones with $\delta_j = 1$). So, when a specific procedure is not adopted in a company, the parameter V is greater than that other V calculated for other procedures. In the same way, if a particular procedure or task is not adopted in organizations with similar characteristics to the selected company Φ, then the calculated value V will be greater. We can conclude that the ratio M/V is a ratio to measure the relative positioning of an organization compared to other similar companies, which referred to the degree of adoption of a specific IT task or procedure.

The ordered set of IT procedures considering the values of age, staff, IT staff, geographical area, industry, and the restrictions considered by the company is obtained by Equation (6):

$$p_{\mathrm{SEL}} = \mathrm{mín}(\mathrm{NP}_i), \tag{6}$$

This result is the best possible sequence in the set of IT procedures selected by the organization. Calculations obtained by Rubio Sánchez (Rubio Sánchez 2021) were returning the best set of procedures and tasks of all the IT possible procedures, however, this is not always what the organizations are looking for. The method proposed in this paper returns the best set of tasks or procedures considering a limited set of candidates. The strategy is similar to those followed by other authors (Miller 2017; Calvo-Manzano et al. 2015; Pastuszak et al. 2012; Marrone et al. 2014). In these cases, a small set of IT procedures is taken into account to determine the best sequence.

4.5. Steps to Determine the Ordered List of Processes

In this section, we show the required steps to obtain the optimal sequence by applying the optimization formula given by Equation (6) (Pseudo code can be found in Appendix B)

- Fill the database with data (level of implementation and characteristics of organizations) gathered through the survey. These data are required by the next steps
- Get data about the level of IT tasks and procedures adopted, and also about its characteristics for the company that wants to adopt ITIL.
- Build the list of tasks S_IT, excluding those ones already implemented
- Create an empty set SCHOSEN = {}
- Eliminate the excluded tasks and procedures S_IT-S_Excluded

- Define the criteria used to calculate the optimal result by fixing α_j, γ_j. Typical values are: $\alpha_j = 1$, $\gamma_j = 0$
- Calculate the parameter NP for each element in S_IT
- Select procCHOSEN and add it to SCHOSEN
- Delete procCHOSEN from S_IT
- If S_IT still has elements go to 7
- The solution is contained in SCHOSEN.

Return SCHOSEN as the optimal set of procedures or tasks.

To summarize, the methodology presented compares the position of a company (in terms of IT processes implementation) versus other companies with specific (selectable) characteristics and returns an optimal set of IT processes to get closer to those companies. This new method also improves the efficiency of the method taken as a basis (Rubio Sánchez 2021). In order to validate the sequence obtained, we finally compared the result versus the initial result obtained by Rubio Sánchez 2021, and versus the results obtained by different authors.

5. Conclusions

In this study, an improved method to properly manage IT processes in the hospitality industry has been exposed. We have applied it to a representative case in a company that belongs to the tourism industry. This method provides the optimal sequence (based on an optimization algorithm) of the IT processes for an organization to satisfy the requirements and objectives established. An information survey collected in a database, and the beforehand mentioned requirements, are used to optimize the formula for the optimized sequence of the management processes. The innovation hereby is the obtainment of an optimal sequence, as it has the potential of excluding procedures, or tasks, from the calculations. Hence, for the final set of IT procedures, not only criteria for optimization have been used, we have also included a list of nonselectable procedures and tasks.

Compared to other alternatives, this improved methodology returns a result completely adapted to the organization that desires to adopt ITIL. The company gets a unique set of ITIL procedures (or processes) for its own objectives.

Other methodologies or algorithms that have been used in the past are not based on an equations schema. The use of a mathematical basis enhances the set of selected processes to satisfy the needs of the organization, as they are either based on experts' opinions or empirical observations. In those cases, no equation model is supporting the sequences, as ours does. The methodology of the presented study is also open to the public and can be used by any company that desires an ITIL implementation. To provide an example for this, we presented a sequence proposal for a representative tourism and hospitality industry company: it can also be applied to any other business.

As explained above in the Section 4.4, by focusing only on the company-important IT procedures, the initial methodology to sequence the IT procedures could be improved. It now overcomes problems where a company does not want to include a specific process because of its cost or time of implementation and is therefore more efficient.

Future studies will allow for improving even more items such as adoption (or adaptation) cost, implementation time, or other items to obtain the most specific lists of tasks or procedures for a representative standard tourism industry company. The optimization function might be improved by considering costs, times, or difficulties related to the adoption of every procedure or task. This means that an equation-based model could be developed to consider the difficulty to adopt procedures and tasks, e.g., the infrastructure-access control task. This could be useful in the case of a geographically distributed business without a unified access system. Contemplating these topics will improve the results of the method proposed in this article.

Including a greater number of companies and characteristics could also help to enhance the methodology, as it would certainly improve the quality of the proposed sequences and overall will help to obtain even better results.

Supplementary Materials: The following supporting information can be downloaded at https://doi.org/10.5281/zenodo.6470763: 1. Web app to generate the ITIL sequence; 2. Data was gathered from the survey to be used in the algorithm.

Author Contributions: Conceptualization, R.S.J.L.; methodology, R.S.J.L., M.M.O. and G.R.M.R.; software, R.S.J.L.; validation, M.M.O. and G.R.M.R.; formal analysis, R.S.J.L., M.M.O. and G.R.M.R.; investigation, M.M.O. and G.R.M.R.; resources, M.M.O. and G.R.M.R.; data curation, M.M.O. and G.R.M.R.; writing—original draft preparation, R.S.J.L.; and writing—review and editing, R.S.J.L., M.M.O. and G.R.M.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data supporting the reported results can be found in the Supplementary Materials.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Proposed sequence of processes in a generic hospitality organization.

Number.Process
1.Handling of incidences
2.Administration of continuous enhancements
3.Handling of validation and approval tests
4.Requesting government
5.Transition-on-production scheduling
6.Supply administration
7.Deployment and version control
8.Phisical and logical security management
9.Capacities handling
10.Infrastructure-access control
11.Asset and config. government
12.Service level agreement control
13.Administration of continuous enhancements
14.Demand control
15.Availability handling
16.Change management
17.Service portfolio control in ICT
18.Service catalogue control

Table A2. Questions in the poll about ITIL procedures and tasks.

Task Information **Question (Assign 1 to 3 for . . .)**
Strategic administration of Information and Communication Technologies (ICT)
Service portfolio control in ICT
Finance administration
Demand control
Administration of business relations
Coordination for design service
Service catalogue control
Availability handling
Service level agreement control
Business-continuity administration
Physical and logical security management
Supply administration
Capacities handling
Transition-on-production scheduling
Change management
Deployment and version control
Handling of validation and approval tests
Asset and config. government
Change evaluation
Knowledge storing
Control of problems flow
Handling of incidences
Infrastructure-access control
Handling/Tracking of events
Requesting government
Administration of continuous enhancements

Appendix B

```
procedure ordered_seq_processes ()
{
    #Input data, implementation degree, restrictions/limitations and
    #aims/desires for the #organization XX. Calculate difference to max
    #implementation level
    #
    # Iniatially values for charact. of organization XX are needed
    for every charact.
        input (ch[jj]) #for XX

    #For XX, require data about the implementation of every process_p
    # Initialization not needed
    for every InfTechInfLib_proc p_ii
        {
        input (diff[p_ii]); #for organization XX
        #once entered, then assign
        Value[p_ii] = MAXIMUM_VAL–diff[p_ii];
        }

    #Set array of possible processes
    Scand_list = {}
    #Builds an array of tasks not considered
    for all InfTechInfLib_proc p_ii
        require (excluded[jj]) #for organization

    for all InfTechInfLib_task p_ii
        {
```

```
        #eliminate those already in the organization
        if (diff[p_i] not equal to MAXIMUM_VAL ) and
           (¬ excluded[p_ii])
           Scand_list = Scand_list U {proc p_ii}
        }

    #Generate the list SCHOSEN_list = {}. It is a list of
    processes_p with 0 elements
    SCHOSEN_list = {}

    # Arrays array_t and array_T from the data stored
    for all InfTechInfLib_proc p_ii in Spossible
    {
    #Explore all characteristics
        for all charac ch[jj]
        {
           #Search all possible values
           for all possible value of ch[jj]
              {
              #Finally calculate
              calculus of array_t[ii][jj][kk]; #optimization expression
              array_T[ii][jj][kk]= MAXIMUM_VAL-array_t[ii][jj][kk];
              }
        }
    }

    #Set the criteria for optimization:
    #delj = 0 for the chrtss will not be present in optimization
    #1 ≥ alfj > 0 to ponderate the parameters in the formulae
    for all chrts ch[jj]
    {
        input (int del[jj]); # del[jj] = 0 or del[jj] = 1
        input (float alf[jj]); # 1 ≥ alf[jj] > zero
    }

    In case SSEL_list <> {}
    {
        #Evaluate NP for every_task in Spossible; select the
        #minimum result
        #
        #Starting, NP_minimum is task number 1
        NP_minimum = NP[Scand_list [1]];
        pCHOSEN = 1; #Task with NP_minimum
        #review all procs
        for ii== 2 to {total procs in Scand_list}
            {
            #evaluate
            calculate NP[Scand [ii]]; #calculate formula to optimize
            #compare
            if NP[Scand_list [ii]] < NP_min
                NP_ minimum = NP[Φcand [ii]] # lowest parameter
                pCHOSEN = ii; # Add proc minimizing NP_minimum parameter
            }

        #Choose the task pCHOSEN and include it in the list SCHOSEN_list.
        SCHOSEN_list = SCHOSEN_list U {Scand_list [pCHOSEN]} #including in
SCHOSEN list
```

```
            #exclude from candidate list
            Scand_list = Scand_list − {Scand [pCHOSEN]}#erase in Scand_list
        }

        #The best list is determined by SCHOSEN_list.
        show SCHOSEN_list
}.
```

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