BULGARIAN ACADEMY OF SCIENCES

INSTITUTE OF INFORMATION AND COMMUNICATION TECHNOLOGIES

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ABSTRACT OF PhD THESIS

Models and Methods for Decision Making and Process Management within ITIL (Information Technology Infrastructure Library)

for the acquisition of an educational and scientific degree "doctor"
doctoral program in informatics
Professional direction: 4.6. Informatics and Computer Science
Scientific specialty: 01.01.12 "Informatics"

Research supervisor:

Assoc. Prof. Dr. Leonid Kirilov

Sofia, 2024

The PhD thesis was discussed and allowed to be defended at an extended meeting of the "Information Processes and Decision-Making Systems" section of IIKT-BAS, held on 20.02.2024

The thesis contains 139 pages, in which 17 figures, 10 tables and 14 pages of literature, including 124 titles.

The defense of the PhD thesis will take place on 20.05.2024 at …….. time in hall ……. of block 2 of the IIKT-BAS at an open meeting of a scientific jury composed of:

1. Prof. Dr. Vasil Gulyashki
2. Prof. DSc. Stefka Fidanova
3. Prof. Dr. Evgenia Kovacheva
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And the following deputy members:

6. Prof. DSc. Daniela Borisova
7. Assoc. Prof. Dr. Alexander Iliev

The materials for the defense are available to those interested in room 215 of IIKT-BAS, "Acad. G. Bonchev", bl. 25A

General characteristics of the dissertation work

Relevance of the topic

Every single organization, regardless of its volume and subject of activity, is subject to the mass penetration of information technologies in order to support daily activities. More and more operations are being assisted by computer algorithms or are being fully automated. It has long been a fact that the classic system maintenance model is extremely inefficient. The complexity of digital solutions, as well as their key effect on the functioning of the business, separates the management of information technologies into a separate directorate with its own structure, budget and management system. As digitalization advances, the goals of this directorate are increasingly being reformulated to be directly part of the success of the organization's core product, instead of being solely focused on the support of the company's computer system and technology. There are various methodologies and standards supporting the functioning of the IT Directorate. Despite the fact that there are globally established ones (ISO standards, project management frameworks, business management frameworks, etc.), there is no universal standard or approach applicable to the overall management of this directorate. Deploying a management system of any of the above types is a complex process. It takes considerable time, resources and commitment from all parts of the organization. The decisions to be made for a successful implementation depend on many criteria and require considerable analysis. Organizations that have gone through such a change recognize the critical need for support in making such decisions. The need for hiring external consultants and building a structured decision-making system is undeniable - [8, 9, 10, 11, 12, 13, 14].

Overview of IT processes in organizations

There is a wealth of research in the field of information technology service management. Although they explore diverse aspects of the field, the repetition of the consideration of ITIL - Information Technologies Infrastructure Library is noticeable. Based on the review of research from different types of sources, covering a development period of more than 10 years, the following areas of IT process research can be systematized. For each of the areas, the results achieved in the world to date are described in the present work:

- Overview of IT processes in organizations
- Approaches in the initial implementation of ITIL Description of specific cases that were encountered during the projects. Contain results which of the originally achieved goals were met and what methods were used to do so. A significant part of these studies are of the "case studies" type.
- Approaches to the application of ITIL in everyday and routine tasks - a large part of the formulated problems in the field affect the subsequent development

in the use of ITIL due to the development of the main business activity, the need for optimization, the need to solve previously unforeseen tasks, etc. These studies represent a more in-depth analysis of the use of ITIL.

- Sharing ITIL with other frameworks and standards – this is an area of growing research interest. The reason is due to the current needs of the industry, which require in a real environment to simultaneously use several frameworks and standards for the management of projects in the organization, the production cycle, the quality, the storage of documents and personal data, and so on. These management frameworks cannot exist independently and must be linked.

For each of the areas described above, there is a rich set of methods that solve specific problems. There is a large body of research and at the same time the activity of scientific and scientific-applied activity in the field of service management related to IT is increasing. The almost complete absence of formal methods and**, in particular, of decision-making support methods is clearly noticeable**.

Aims and Task of the PhD Thesis

The subject area of the dissertation is related to service management processes related to the implementation, use and improvement of Information Technologies in organizations.

Based on the overview of the results in the field, the following **goal of the dissertation** was formulated. Namely, **to develop and apply formal models and methods to support decision-making in the implementation of the ITIL structural library (Information Technologies Infrastructure Library), at its various stages in large organizations - initial implementation, specifics when implementing specific services, linking with others infrastructure frameworks.**

For the fulfillment of the main goal of the dissertation, the following fundamental and logically related tasks have been formulated:

1) To create models and methods that support decision-making during the initial implementation of the structural framework ITIL in large organizations.
2) To create models and decision support methods for evaluating implementation, quality and performance and the related Key Performance Indicators (KPIs) in the process of managing IT-related services in organizations.
3) Creation of an operational model and method of integration of the most widely used frameworks for managing services and architectures related to IT: ITIL (Information Technologies Infrastructure Library) and TOGAF (The Open Group Architecture Framework). The goal is to join the logically related elements of the frameworks (processes, operations and roles), as well as to merge the overlapping elements (processes, operations and roles).

The following methodologies and standards are covered in detail:

- ITIL – Information Technologies Infrastructure Library
- TOGAF - The Open Group Architecture Framework

Content structure

The research on the topic of the dissertation is divided into six chapters, in which an introduction to the field of research, exposition of current problems on the topic and proposal of a solution and topics for subsequent development of the work were successively carried out. The chapters are structured as follows:

Chapter 1 - The infrastructure IT library ITIL and methods for its implementation and maintenance in organizations.

Chapter 2 – Model and methods for decision making and evaluation of ITIL implementation in large organizations.

Chapter 3 – Model and method for group decision support about KPI selection for IT service evaluation.

Chapter 4 - Using ITIL and TOGAF together.

Chapter 1 - The infrastructure IT library ITIL and methods for its implementation and maintenance in organizations

This chapter provides an overview of the ITIL structural framework and the problems it solves. The importance of this framework in managing IT services in large organizations is shown. The implementation and enforcement methods used are reviewed. The review is based on literature research and the official ITIL documentation.

1.1. ITIL (IT Infrastructure Library)

Over the past ten years, ITIL (Information Technology Infrastructure Library) [15] has been established as the most used process management framework for IT service management. It contains a complete set of recommended practices that are intended to help maintain an optimized information service.

ITIL provides a complete set of guidelines on how to deal with IT service maintenance scenarios. These guidelines are called recommended best practices and are based on the experience of many companies and enterprises. These practices ensure that the task is completed in the most efficient and cost-effective manner. This helps operations to be carried out in unison with the company's strategic objectives.

The core subject of the entire ITIL methodology is the Information Technology Service. All practices are directed to the management and maintenance of the Information Technology Service. The definition of a service given in the official introduction to ITIL, Service Lifecycle is:

"Service" is a means of providing added value to users by facilitating the results that users want to achieve without being responsible for specific costs and risks.

1.2. Key principles of ITIL

Many authors, cf. for example [17, 18, 19, 20] as well as the official ITIL documentation [21, 22 ,23 ,24, 25] states the main task of ITIL. It's about helping organizations achieve their core business goals by providing them with a cost-effective and high-performance IT environment. Following the context of this, basic principles of ITIL can be summarized as follows [26, 16]:

- Added value to the service
- Obtaining a high rating from users for the service provided
- More active application of skills and experience
- Improve user productivity
- Cost reduction

ITIL is designed as a framework, which means it only provides an overview of processes and does not require strict adherence to all of them. This general rule is also supported by the design of ITIL - it is structured in a way that allows companies

to use only the processes they find useful and applicable. All processes are designed in a way that allows them to be used alone or together [27].

1.3. ITIL tasks

The main task of ITIL is to provide IT managers, as well as the entire organization, with end-to-end processes to enable them to manage day-to-day IT operations [28]. These processes must be able to continuously improve the service of the organization and its users [29]. They must also support the implementation of their strategic objectives. This task can be divided into the following objectives:

- User satisfaction
- Optimized use of resources
- Workflow optimization
- Improved information security
- Clear accountability
- Clear definition of roles

1.4. ITIL integration approaches

Various studies have been reviewed that analyze and track ITIL implementation [31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41] Based on the overview, two possible approaches to integration can be summarized, with the division being provoked according to the type of organization. The first, rarely performed, describes the start-up company that decides to implement ITIL from the ground up. It is deployed as most organizations start out in a small footprint that does not require a complex environment management system. The second approach is used for most companies in the market - it covers all organizations in the market that already have at least several years of experience in the market and at least relatively established internal IT management processes. The decision to improve these processes is followed by the creation of an ITIL implementation project. In general, the implementation of this project takes years. It can be divided into four main stages:

1) Assessment of current IT service management processes
2) Create a tactical ITIL implementation plan
3) Implementation change management
4) Continuous service improvement

1.5. Organizations suitable for ITIL implementation

There is no formal definition or framework that says in what type of business processes ITIL can be successfully implemented in order to bring added value. This shows that the framework does not depend on the type of business of the organization. It is widely applicable because IT processes are universal and do not directly interfere with the main product of the business [44, 45, 40]. Of particular importance is the possibility and willingness of the organization to accept process-oriented work as part of its culture [46]. A rule of thumb can be introduced that larger

companies adopt ITIL more easily than smaller ones [47, 48]. The reason is mainly the lack of resources and the smaller scope for optimization. As stated in "Delivering Effective Support. Adopting ITIL to Fit Your IT Business Model" [49], after conducting qualitative research with a focus group of 30 companies: "Many companies feel that they have insufficient resources to implement such strict IT support standards such as ITIL.

Negative attitudes centered on standards are too much stress on the organization, too expensive, or simply not important enough to invest time in."

1.6. Benefits of ITIL integration

The following benefits of using ITIL can be summarized: improved service quality [52, 53, 54, 33, 25], higher customer satisfaction [37, 38], higher productivity [55, 56, 25, 52], improved response time to customer requests from the provider [55, 53], and more efficient use of IT resources [57, 55, 53].

1.7. Structure of ITIL v.3

Between 2007 and 2011 (two editions) the third major version of ITIL was launched. It provides more consistent solutions addressing rapid advances in IT technology, as well as modern business needs and the outsourced support model. Version 3 of ITIL is systematized in 5 volumes. There is another one that is often overlooked because it is an introductory book with a broad overview. It is called ITIL Complementary Guidance The other five are:

- ITIL Service Strategy
- ITIL Service Design
- ITIL Service Transition
- ITIL Continual Service Improvement

1.8. Other governance frameworks and standards

1.8.1. TOGAF

TOGAF is a standard for managing and maintaining enterprise system architecture. It is one of the most frequently used standards among enterprises, and in most cases it is actively supplemented with ITIL. This is because the scopes of ITIL and TOGAF do not overlap.

1.8.2. Other management frameworks applicable in IT

The list below indicates the main frameworks that support in whole or in part the management of IT environments, and they can be a complementary or a substitute unit of ITIL, depending on the objectives and the subject of activity of the particular enterprise.

- **CobiT** – a methodology that focuses on how the management of the IT department should be done.
- **CMMI** – This is a framework that focuses on software development. It aims to optimize the entire process of creating a software product, improve its quality and optimize the price.
- **ISO9001** – standard describing the general levels of quality management.
- **PMP** (Project Management Professional) – this is the most common standard for project management. It can be applied regardless of industry and project size. Its real capabilities unfold when leading large projects, due to the full range of operations it manages. This method is known as the so-called name "waterfall" method because the result is delivered at the end of the project.
- **SCRUM** – this is a project management method that aims to break down the entire task into many simple tasks to be performed sequentially and quickly, each of which guarantees a result. The main strength of the method is in the implementation of non-scale projects with a total duration of less than one year.
- **Kanban** - is a framework for managing the production of various products, which mainly seeks to balance the work flows so that we can deliver the ordered product in the agreed time without affecting its pre-planned cost.

1.9. Positions responsible for decision-making

There are 14 different types of roles in Service Design, with one defined for each process. We will discuss their role in decision-making tasks in Chapter 3. Below is a complete list of Service Design roles:

- Applications Analyst
- Availability Manager
- Capacity Manager
- Compliance Manager
- Enterprise Architect
- Information Security Manager
- IT Service Continuity Manager
- Risk Manager
- Service Catalogue Manager
- Service Design Manager
- Service Level Manager
- Service Owner
- Supplier Manager
- Technical Analyst

1.10. Approaches to integration of ITIL

The integration of ITIL requires a clear understanding of the organization's goals, as well as a detailed familiarization of the board of directors with the current trends for

managing an IT directorate. Due to the dynamically changing business environment, the deeper penetration of IT technologies into daily activities, as well as the increasing costs of owning IT systems, the nature of IT departments and their functions are evolving. The rate of these changes is higher than the frequency of ITIL version updates. This determines the need for the use of external support from business analysts, experts in the management of IT organizations, to help make strategic decisions concerning the IT department. We can conclude that the framework as well as the necessary information for making these decisions is absent in the ITIL Service Design chapter. It is provided by the above business analysts and should be implemented once a specific integration scheme is chosen. Four different models/approaches can be specified for ITIL integration. These approaches are purely practical and intuitive. They have appeared and developed since 2011 and until now. They have arisen in chronological order, assuming that each subsequent one is more effective for the business than the previous ones. To date, three of these four models are current and used across industries. The specific choice of model depends on the specific needs of the organization as well as the maturity it has reached. The models are described in detail by Gartner Inc., a leading research and consulting company - [39]. In [39], the development of these models, the frequency of their use, as well as the results of their application are traced. The article provides valuable guidance on which model to choose.
The main models, principles and integration schemes are given in chronological order:

1. An optimizing model.
2. Model optimizing processes.
3. Model optimizing the service
4. A model optimizing the value of the service

Although there are guidelines for choosing an appropriate model - [78], according to the specific functions of the organization, its commercial activity and its existing internal management methods, there is a risk of incorrect self-assessment and choosing the wrong model for subsequent development. The reason is that decisions are made subjectively, with no clear metrics available to assess the current situation.

1.11. Conclusion

This overview chapter analyzes the ITIL infrastructure IT library as well as existing ITIL integration methods. The processes that ITIL offers are reviewed. Based on this and the studied ITIL company documentation, as well as scientific research in this area, the following more important conclusions can be drawn:
1) the infrastructure IT library ITIL is the most commonly used library of best practices and processes for managing IT services;
2) The ITIL library is universal, there is no analogue, it can be applied in organizations of different sizes and subject of activity.
3) The advantages of the ITIL library are very clearly expressed in large organizations, where there are opportunities to optimize complex processes
4) Implementing and maintaining ITIL involves making complex decisions. Such are, for example, the Service Strategy and Service Design chapters.

5) The ITIL library does not explicitly address decision-making issues regarding its integration into organizations.
6) The ITIL library is implemented and supported massively by using generally accepted elementary (naïve) decision-making methods such as brainstorming, voting, game methods, etc. Decisions are made subjectively, albeit at an expert level. There are often no clear metrics available to assess the current situation.
7) In the theory and practice of the ITIL library, modern decision-making methods are not applied so far. Therefore, the creation and use of such methods would significantly assist ITIL experts and users in integrating and applying the framework.

Chapter 2 - Model and methods for decision making and evaluation of ITIL implementation in large organizations

This chapter offers a model and two decision-making methods for evaluating and implementing the ITIL framework in large organizations. The model is in matrix form. The method used to make the decision is based on the median score. The second is a structural process-oriented method for integrating ITIL. The suggested model and methods does not require knowledge or experience in implementing IT management frameworks.

2.1. Formulation of the problem

The decision to integrate the ITIL IT environment management framework requires a thorough study of the current environment, the appointment of new roles, the hiring of consultants, etc. Therefore, the main decision is the result of a large series of decisions about the use of resources, the determination of roles etc. This sequence requires a significant budget and time to be invested in such a project. All these changes lead to a risk for the normal functioning of the company, as well as its revenues [26].

Unfortunately, the ITIL framework does not provide a detailed approach to follow to achieve successful integration. No clear approach is given on how to choose which processes to integrate and which not. Only checklists are provided to track that all necessary operations are performed. Only in the chapters "Service Design" and "Service Transition" describes in detail how the service is designed and integrated.

Another risk for the company is frequent service interruptions during operation. It is assumed that this is due to poorly executed routine maintenance There is a need for a clear methodology on which to prove the success of the integration. **The two methods we propose in this chapter are a step in that direction.**

One of the main objectives of implementing such a framework is to increase the quality of service. Its interruption can lead to significant losses for the company, as well as discrediting the brand. To be able to fulfill the company's business objectives, the framework to be integrated must be strictly customized according to the set strategic and tactical business objectives. Applying redundant processes (unnecessary to the organization and its work) that do not support the achievement of the main business goals would only lead to increased costs and bureaucracy. This always affects the business product.

2.2. Approaches to solving the problem

ITIL management has not used mathematical decision-making methods so far. On the other hand, sufficiently complex decisions have to be made, and their effective achievement needs modern decision-making tools. The approaches described below use completed scorecards that measure various parameters of the environment before and after ITIL integration. Their advantages are mainly related to the fact that

the organization is evaluated before the transition, and then the progress and success of the implemented changes can be easily tracked. It is important to note that such approaches are not explicitly described in the ITIL documentation.

- Brainstorming
- Voting
- Hire a consulting agency

2.3. ITIL integration method

Based on the analysis of ITIL Service design, as well as the existing IT process integration models in, it can be concluded that the ITIL Service design chapter does not provide sufficiently comprehensive information when processes must be built from scratch. Only a general framework is presented. The ITIL integration scheme is given in Figure 1.1.

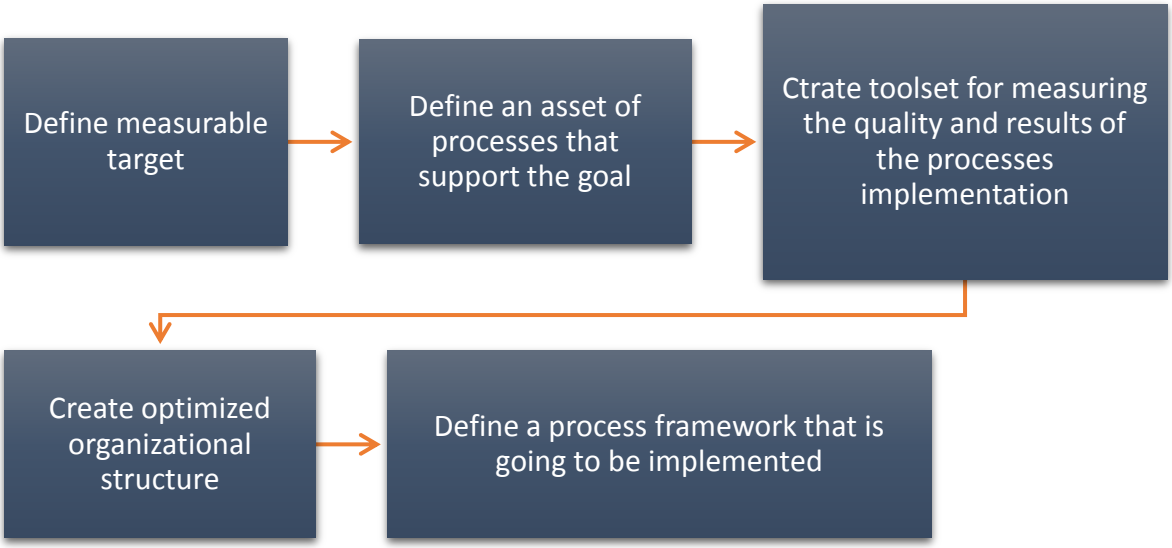


Figure 1.1. ITIL Integration Scheme

After implementing the steps outlined in the outline, the organization has generated the necessary knowledge and process base to begin implementing ITIL. The organization has a governing body to make informed decisions, measure progress and quality of implementation, and have a clearly defined goal to follow.
The next step is implementing ITIL. It is described with the processes from the ITIL Service Strategy chapter.
It should be said that the ideas of [87, 88, 78] by which optimal implementation is pursued are process oriented. In other words, we are talking about the implementation of a specific IT service (case study). However, there is no common implementation methodology. On this basis, we propose the following ITIL integration method. It offers a series of steps, the consistent application of which ensures the effective implementation of ITIL in any IT service:
a. Assessment of current service management processes

b. Create a detailed ITIL integration plan.
c. Management of ITIL implementation activities
d. Periodic improvement of the service.

Assessment of current service management processes. The activities here mainly include interviews with IT departments and experts in the given area. The results of these meetings (interviews) are documented in various checklists and design documents.
Create a detailed ITIL integration plan. This step includes the ITIL implementation decision process, where it must be decided which "best practices" will be implemented. **Management of ITIL implementation activities.** To effectively carry out the tasks to be realized during the transition, the company can use different project management frameworks such as: Six Sigma, PRINCE2, etc. It includes activities such as training staff on new approaches and a set of tools, creating new documentation, assigning new roles in teams, communicating with selected suppliers.
Periodic improvement of the service. Regular audits throughout the company's life cycle are recommended to maintain effective processes serving core business objectives. Most of these audits are conducted on a 6-monthly or annual basis.

1.12. A group decision-making method for optimal ITIL integration selection.

Considering the above method, it can be seen that the decision-making process is mainly concentrated in Step 2 "Create a detailed ITIL integration plan. This is a critical part for the success of the implementation, since almost all decisions are made in time of this part It is important to note that no one-size-fits-all plan can be used in this step. At this point, we will propose a decision-making method for the optimal choice of ITIL integration. For ease of presentation, we will describe it by solving a real case study – a healthcare company based in the UK that successfully implemented ITIL some time ago (see Table 1) using a conventional method.

The healthcare company we are looking at adopted ITIL 18 months ago. Its headquarters are in Great Britain, but its IT services management is in Bulgaria. The IT environment consists of about 220 servers, switches, backup tape libraries, etc. All servers are in the data centers of an external service provider. A detailed profile of the organization is described in Table 2.1.
ITIL integration was done in this company according to the method we developed. For this purpose, an independent group of experts with experience in creating, maintaining and/or consulting the information service using ITIL has been created. Most of these experts are certified in the implementation of ITIL, and one of them is the head of the IT directorate.

Table 2.1. Profile of the researched organization

Company type	A public company based in Great Britain, 23 mil. Euro capitalization in 2013
Areas of activity	Global distribution of medicines in over 60,000 pharmacies; hospital equipment;

	integrated solutions for home treatment
Regions of activity	Europe
Employees	~ 16 000
Employees in the IT Directorate	~ 115
Number of configurable units	~ 850 of which 220 are servers
IT strategic goals	Cloud first service selection strategy Automation by optimizing processes and introducing artificial intelligence Introduction of hybrid roles Direct use of IT technologies to solve medical problems Reducing the number of service interruptions, significantly reducing the number of contacts with technical support personnel. Transforming the IT department as a profit center
Experience with management processes	As the company grew, it implemented its own business processes. Subsequently, different processes from ITIL were integrated on a campaign basis, without following a set strategy. Acquired companies have used a wide range of process frameworks and, to date, they have not been harmonized with the parent company's processes.

Our first step is to collect data about the company to be summarized and presented to the experts. This includes:
• a set of data for applications and systems that are used in the company's information environment.
• a set of data about the infrastructure environment that hosts the information systems; • organizational structure of the IT Directorate.
• a set of data on existing processes in the management of the IT directorate.
The second step is creating a questionnaire. It gives the individual chapters of ITIL. Each expert should indicate which ITIL processes would add value to the quality of the IT service. At the time of scoring the questionnaires, the experts were not aware of the actual ITIL integration solution that had been implemented. The group of experts familiarizes themselves within a week with the project documents and requirements provided by the company. The documentation is from the stage where the company has not yet implemented ITIL integration [91]. The answers to the questionnaire are summarized in table 2.1. As can be seen from the table we have used the rule of thumb that an ITIL sub-section is the smallest structural unit that can be integrated. Each expert must assess how well each sub-unit is suitable for the company and would contribute to supporting the main business objective. For this purpose, we have chosen a 5-point scale, where 1 means completely irrelevant and 5 means completely relevant - see Table 2.2:

Table 2 2 Description of the possible evaluations by the experts

Assessment	1	2	3	4	5
Importance of assessment	Completely irrelevant process	Not recommended process	I can not decide	Recommended process	A highly recommended process

In general, there is a general understanding that implementing as much of ITIL as possible in a company should ensure better IT management and achieve better results. But this is not the best scenario and should be avoided. The collected completed questionnaires are presented in Table 2.3.
For better visibility and analysis of the data, the headings of the chapters and their subsections are replaced by numerical indices. In this way, **a matrix model for Group Decision Making for the implementation of ITIL** was obtained - see Table 2.3. The experts' ratings for each indivisible unit of ITIL are presented in turn. The indivisible logical units of ITIL are given by pillars. The numbers of the logical units indicate the order of their integration. A unit with a smaller number integrates before a unit with a larger number, but not vice versa. To solve the problem, we will accept the assumption that the subhead is the smallest logically indivisible structural unit that can be independently implemented. The total number of these units is 33. The solution of the above group decision-making model consists in the following: based on the expert judgments made, select a set of logically indivisible units from ITIL for integration. One obvious solution is to select all 33 units.
This means **detailed implementation of ITIL in the organization**. But as already mentioned, this would not give an optimal result. In rare cases, an optimal budget can be guaranteed. But managing additional processes that would not improve the quality of the IT service can lead to unnecessary complications. Any other selection of some sub-string of these 33 items (at least 1 item must be selected) is also a decision (implementation of ITIL) that is specific.

Table 2-3 Group decision-making model for ITIL integration

	1					2								3							4									5			
	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	3.1	3.2	3.3	3.4	3.5	3.6	3.7	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.1	5.2	5.3	5.4
Expert 1	3	4	5	3	4	2	3	5	5	5	4	4	3	2	4	3	2	2	2	5	2	5	5	5	3	3	3	4	3	3	3	2	2
Expert 2	2	4	3	2	1	2	4	4	3	5	3	5	3	3	4	3	4	4	4	3	4	5	4	5	4	4	5	4	3	4	4	4	4
Expert 3	2	2	2	4	3	3	2	4	5	5	5	5	4	3	5	5	4	5	3	4	4	5	5	5	5	4	3	5	4	3	3	2	2
Expert 4	4	4	5	4	5	5	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5	3	5	5	5
Expert 5	3	2	3	2	2	4	4	3	5	4	3	3	3	3	5	2	4	5	4	4	3	4	5	4	5	3	4	4	3	2	4	4	4
Expert 6	3	4	3	3	1	3	3	2	5	4	4	4	4	4	5	4	4	5	3	5	4	5	5	4	5	4	4	5	4	5	5	3	3
Expert 7	4	1	5	3	5	5	5	4	5	5	5	5	5	3	5	4	4	4	3	3	3	5	5	5	3	4	5	5	3	3	3	4	4
Expert 8	5	4	3	2	4	3	2	2	4	4	4	4	3	2	4	2	4	2	2	3	4	5	5	5	5	4	3	3	5	3	3	3	3
Expert 9	2	2	2	3	3	2	3	4	4	4	4	3	3	4	5	3	4	3	3	3	4	4	4	4	5	5	3	5	3	5	4	4	5
Expert 10	2	1	5	3	3	4	5	3	5	4	5	4	2	2	4	4	5	5	4	4	2	5	4	5	5	4	2	5	5	3	3	2	3
Expert 11	5	5	3	2	4	4	3	4	5	5	5	5	3	5	4	5	4	4	3	3	4	5	5	5	4	4	4	5	5	3	4	3	3
Expert 12	3	4	2	3	1	4	2	5	5	3	3	4	3	3	5	3	5	4	5	3	4	5	4	5	4	4	4	4	2	4	5	3	3

We assume that the person who makes the final decision (DM - decision maker) is one person. In this case, it is the project manager. So how to solve the above pattern. For this purpose, we propose **a statistical method based on the median score** of each logically indivisible unit of ITIL. The solution to the task is presented in Table 2.4, where "1" means that the referenced subchapter is accepted for implementation, and "0" means that it is not accepted. The selection is based on the calculation of the medians m(i),(i=1,...,33), of the distribution of the experts' evaluations for the i-th

logical unit. In our case, if m(i)≥4 (according to the rating scale from 1 to 5), then the i-th sub-chapter is recommended for implementation (value "1" in the second row of Table 4). Medians m are calculated using the following equation:

$$m = m_l + \frac{\frac{N}{2} - F_l}{f_m}.c$$

where:
m_l- lower limit of the median class;
N- total frequency;
F_l- previous cumulative frequency corresponding to m_l;
f_m- frequency of the median class;
c – median class width.

Table 2 4 Group decision model solution

ITIL unit	1_1	1_2	1_3	1_4	1_5	2_1	2_2	2_3	2_4	2_5	2_6	2_7	2_8	3_1	3_2	3_3	3_4	3_5	3_6	3_7	4_1	4_2	4_3	4_4	4_5	4_6	4_7	4_8	4_9	5_1	5_2	5_3	5_4
Median	3	4	3	3	3	3,5	3	4	5	4,5	4	4	3	3	5	3,5	4	4	3	3,5	4	5	5	5	5	4	4	5	3,5	3	4	3	3
Solution	0	1	0	0	0	0	0	1	1	1	1	1	0	0	1	0	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	0	0

It is interesting to see what the number |Ω| is of all possible options Ω for ITIL implementation (solutions) of the proposed model. It can be seen that this is the sum of all possible combinations without repetitions of length k, for k=1,…,33,

$$|\Omega| = \sum_{i=1}^{33} \binom{33}{i}$$

The solution obtained from the proposed method is compared with what has already been implemented in practice by a conventional method by experts and is selected as a conditional benchmark. It turns out that the two solutions are close. In the actual implementation of ITIL in the first 18 months, the company has found that it is more appropriate to start using an extended solution, but in less depth where applicable.

2.5. Conclusion

The following results were obtained in this chapter:

1. A structural process-oriented method for ITIL integration is proposed. The method does not require knowledge or experience in implementing management frameworks.

2. A group decision-making model is proposed for selecting an optimal set of ITIL processes to be integrated.

3. A method for solving the group decision-making model for selecting an optimal set of processes is proposed. The method is statistical and is based on the median assessment of expert opinions.

4. The model and method for group decision-making are demonstrated in a real example of an international company from the healthcare sector. The proposed model and method give great flexibility to decision makers to manage their experts' proposals. The results obtained can be used as suggestions to other decision-makers

and as justification data that can be used before the company's board of directors as well as external auditors.

Chapter 3 - Model and method for group decision support about KPI selection for IT service evaluation.

3.1. Description of the e-mail service

In this chapter, we will show the entire process of formulating KPI indicators, compiling formulas for their calculation, defining intervals and threshold values for their evaluation with the aim of optimizing the implemented service. We will also show how they are used in the implementation of the particular service. Since the number of IT services is large, each of them requires a specific set of KPI indicators, we will do this for a specific service (Case Study). As such a service, we choose the e-mail service.

The Service Level Agreement (SLA) is one of the important topics that must be addressed in the processes that are part of ITIL Service Design. This agreement describes the performance parameters that the service must provide to ensure smooth operation of the employees. The service level agreement (SLA) is of key importance to the organization, and it should be done with the active involvement of the board of directors in the organization – [41]. The goal is to gain support from management and be closely related to the organization's goals. An important part of the service level agreement (SLA) are the KPIs. These metrics describe the service level agreement (SLA) qualitatively and quantitatively. The creation of the Service Level Agreement (SLA) will cover KPIs that serve ITIL Service Operations. Our scenario includes cases where the e-mail service is already integrated and running in a routine mode of operation, and there is no part of it that has been moved to a cloud service (Office 365). The parameters of the Service Level Agreement (SLA) described by KPIs are typically reviewed and analyzed at certain time intervals (daily, weekly, monthly), but in recent years there has been a trend to monitor this data live and compare with historical data [96, 97, 21]. The monitoring of this data is subject to strong automation.

A Service Level Agreement can be entirely created and monitored using the ITIL framework. This is also the case that is chosen and discussed in this chapter because of its universal applicability. When performing Service Design, the processes through which the service is designed are first created by a Service Level Agreement (SLA).

This is a task of great importance for the quality of the service in the future, the resolution of disputes and the description of requirements in accordance with the expectations of the customer. Service levels are expressed using KPIs that describe quantitatively and qualitatively what is required and accepted for good service and expected from the service provider.

Customer feedback is based on a predetermined rating system. Another study by Al. Tsenov et al. - [103] proposes a method for examining customer satisfaction with wireless services by measuring various provider metrics.

- The correct selection of the appropriate KPI indicators can be divided into the following 2 tasks:

- **Selection of an appropriate set of KPI indicators** - since there is a very wide variety of KPI indicators, as well as the possibility of creating completely specific ones that can describe the properties of the service, the first task is to define those indicators that can represent the client's expectations and priorities. A common problem is choosing the wrong KPIs to track. This leads to a waste of resources (commitments to non-essential tasks that do not add significant value to the overall quality of the service and/or neglect of other important activities).
- Setting values for the selected KPIs – the next task after choosing a set of service quality indicators is to set measurable values that can describe these indicators. It is common practice to also set change intervals to describe a given level of quality (eg: if between 95% and 100% of all requests are completed on time, then quality is excellent, if this value is between 85% and 95 %, then the quality is alarming and improvement actions are needed, etc.).

3.2. Service relationships

The e-mail server and thus the service it provides depend on the different technologies in the IT environment [104]. This means that the e-mail service may be affected by various technologies that interact with it. These can be physical or virtual servers, data storage arrays, network connectivity, electrical power. In organizations with 500 or more users, there are various engineering positions and/or teams responsible for these technologies. Following this scenario, ITIL best practice is to define different KPIs for each service-related technology.

To solve the problem described above, the following "good practice" can be applied. Namely, application of cascading of threshold values. Accordingly, all KPI indicators of services supporting the functions of the e-mail service should have higher values. This means that if the parent service for the email server is running at a minimum KPI value, the corresponding email server will still be able to meet the expected performance level as shown in Figure 3.2.

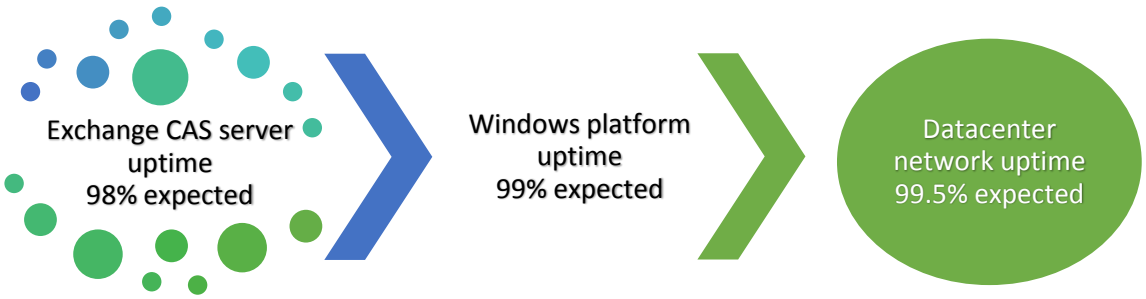


Figure 3 1 Cascade in determining the KPI indicators for the Exchange server of the e-mail service.

According to Figure 3.2, the Exchange CAS Server (CAS – Client Access Service) is installed on Windows and is responsible for fulfilling all client access requests to the Exchange e-mail server. It is essential that the e-mail service works, but this service depends on the Windows Server platform on which it is installed. The Exchange CAS role cannot be performed until the Windows platform is functional. That's why we define Exchange CAS Server KPIs as leaders. The Windows Server operating platform may have other server applications installed and therefore cannot deliver the service it is intended for if it does not have proper network connectivity. In this case, we must make sure that the fastest possible time access to the server room is provided. Usually, different servers are located in the same premises and any instability in the network connectivity would affect many more services than just the e-mail service. Below we list the technologies and services that support the e-mail service and are necessary for its operation:

- Server platform
- Network connectivity
- Backups

3.3. Existing solution approaches

The main approaches currently being used by companies to solve the above formulated problems are described below: [31]
• Applying an existing set of KPI
• Set appropriate metrics for selected KPIs in practice, the above approaches are not applied according to the needs of the client.
Instead, each vendor sets higher KPI values driven by market trends and competition to offer better solutions.

3.4. ITIL processes responsible for creating and maintaining KPIs

We will briefly discuss the ITIL processes through which the Service Level Agreement (SLA) and KPI indicators are created and negotiated.

3.4.1. Service strategy

This is a group of activities that must be performed before the service is integrated. They define the strategic tasks of the service, as well as its short-term and long-term goals. Service strategy is not a one-time activity, but a process that recommends various activities throughout the service life cycle.

3.4.2. Service design

Once the service strategy is clarified, concrete processes describing the service design are to be created. These processes are described in another ITIL chapter called "Service Design". This stage begins with an assessment of the current IT

environment and processes, if any. During this evaluation, it is decided what will be kept and what will be changed. Some of the following important decisions are made during this cycle of processes: • Catalog with the exact technologies that will be used; the details of their implementation - their design, the stages of implementation, as well as their deadlines. • Description, structure and plan for the training/hiring of the staff who will perform the transition to ongoing support thereafter. • The necessary ITIL roles required to maintain the environment from a process perspective • KPIs that will be used to measure the effectiveness of IT processes and the environment.

3.4.3. Service transition

This group of processes is used after the design has been specified. It offers a set of good practices on how to introduce the service in the enterprise in an effective way - with optimized costs and without causing a disturbance in the daily tasks of employees. This can be a new installation of a service that did not exist until now or a change to an existing service (for example, installing a new module to a system, updating the software version, replacing hardware, etc.).

3.4.4. Service operations

These processes [43] help maintain the service when all design and implementation projects are completed and a stable environment requiring routine maintenance is established. This means that the IT environment is installed, tested and made available for use by the business. For the e-mail service we're exploring in this chapter, this means that e-mail messages are forwarded through the Exchange 2012 environment, as we've chosen in this example for ease of description. The KPIs we explore in this chapter are oriented towards Service operations and measure the performance of the e-mail service during this product life cycle.

3.5. Compilation of KPI indicators for the e-mail service

In this point, we will offer a comprehensive set of KPI indicators for the e-mail service, and the way of their formation was presented in the previous points and will be completed here - [106]. In the context of the ITIL framework, there are several main steps (see Figure 3-3) that need to be considered, respectively KPI indicators should be grouped with this in mind. It usually starts with defining the most widely used KPIs that successfully allow the level of service to be measured. Depending on the needs of the business, only a few KPIs can be selected. But specific ones can also be added. In some of the companies, it is extremely important to have a high level of personal data protection (banking institutions, military institutions, etc.). In other companies, the reliability of the service and the lack of interruptions (in the field of logistics and sales, for example) are put first. So, there are different business requirements for e-mail service in different fields of activity. This also leads to the use of different KPI indicators to successfully measure the level of service. It is important to note that there are also different groups of KPI indicators for the different stages of implementing the ITIL.

- Availability of the service
    - o Service availability – the time during which the service is available to all users, expressed as a percentage of the entire month.
    - o Number of unplanned service interruptions caused by a technical problem or human error.
    - o Number of partial service interruptions.
- Processing of customer requests
    - o Average time to process customer requests during the month
    - o Percentage of customer requests processed within the agreed time interval.
    - o Percentage of customer requests processed in one iteration - represents requests that were not sought clarification from the guarantor and were not returned for corrections.
    - o Percentage of complaints - describes the set of requests where there was a complaint about the accuracy of execution.
- Incident handling
    - o Average time to launch work on a customer incident. It is measured by averaging the times between the creation of an incident and the initiation of work on it by a maintenance worker.
    - o Average Incident Resolution Time – measured as the average value between creation (or detection by the monitoring system) and restoration of service.
    - o Percentage of all incidents resolved within agreed timeframes.
    - o Percent of Incidents Handled in One Iteration - represents requests that were not sought clarification from the guarantor and were not returned for corrections. o Percentage of incidents whose initial maintenance level 1 assessment was performed according to procedure instructions.
    - o Complaint rate
- Changes made midway
    - o Percentage of successfully implemented changes implemented according to plan.
    - o Number of failed changes in the middle.
    - o Number of unauthorized changes in the middle.
- Resource capacity
    - o Consumed disk space per user
    - o Number of users supported by the equivalent of one employee – the number of users that can be supported for a given service by the equivalent of one employee.

3.6. Group decision-making in the selection and evaluation of KPI indicators for the e-mail service

At this point, we will propose a model and a solution where, with the help of a group of experts, the adequacy of the proposed KPI indicators for the e-mail service is evaluated. This will help process integrators to compare and determine the relevant KPIs and their desired values for each specific case.

For a more convenient presentation, the presentation will be made with the help of a real example (Case Study). Namely, implementation of the e-mail service in a large national University. Solving the above task will be done in two main steps:

I. The panel of experts compiles a list of all key performance indicators that can potentially be included in the Service Level Agreement (SLA) for the specific case, as they are relevant.
II. The group of experts evaluates the feasibility of the collected indicators one by one.

Based on the proposed list of KPI indicators, experts can decide whether it is necessary to add more indicators or whether the current set is sufficient. In our case, the set of 18 KPI indicators grouped into 5 groups, which was proposed in the above point, is used.

3.6.1. Model

On the basis of this submitted information, the experts evaluate with 1 to 10 points each KPI indicator according to the three selected aspects - whether it will support the accessibility of the service: user satisfaction and user productivity. – see Table 3.2.

Table 0-1 Expert's KPI evaluation with grades 1-10

	Service availability KPI			Service request management KPI				Incident management KPIs						Change management			Capacity SLA	
	• Uptime percentage of the service	• Count of complete unplanned service outages	• Count of service degradation events	• Average time for completing the service requests	• Percentage of service requests completed within the agreed SLA	• Percentage of service requests completed within one shot	• Percentage of complaints	• Average time for starting work on case	• Average time for resolution	• Percentage of incidents resolved within the SLA timeframes	• Percentage of incidents completed within one shot	• Percentage of incidents with proper initial assessment	• Percentage of complaints	• Percentage of successful changes	• Number of failed changes	• Number of unauthorized changes	• Consumed disc storage per user	• Supported users per FTE
Will support the service uptime																		
IT Director	10	10	7	3	4	4	6	4	7	9	8	6	8	8	7	10	8	10
SLA Manager	7	9	9	5	4	4	3	7	4	6	4	4	8	6	8	9	6	8
Incident Manager	9	6	7	4	5	5	6	6	3	10	6	8	4	7	9	9	2	4
Problem Manager	10	6	7	2	3	1	3	7	8	9	8	8	6	8	8	8	4	6
Change manager	9	9	6	2	3	2	4	8	4	8	6	7	5	10	8	7	6	4
Will support the end user satisfaction																		
IT Director	8	8	9	8	7	9	10	7	7	6	10	7	9	7	7	3	3	1
SLA Manager	10	6	5	8	5	7	8	3	6	5	7	4	8	4	5	1	2	3
Incident Manager	8	7	6	9	7	8	9	5	8	7	8	5	10	6	6	2	1	3
Problem Manager	8	9	6	7	6	9	8	4	4	6	5	2	7	5	4	1	3	2
Change manager	9	6	6	7	5	5	8	3	5	5	7	3	7	7	7	4	4	1
Will support the end user productivity																		
IT Director	10	9	8	7	4	2	4	8	8	8	5	3	5	5	5	2	7	3
SLA Manager	8	9	8	6	4	2	5	7	6	7	5	4	4	3	3	3	2	2
Incident Manager	9	6	6	5	6	2	3	4	9	9	3	5	6	4	3	1	1	2
Problem Manager	8	8	6	3	3	3	3	4	6	4	3	2	7	7	7	3	3	3
Change manager	9	9	5	4	6	3	1	5	7	6	1	1	3	5	4	6	2	5

The resulting model is in the form of a two-dimensional matrix. Pillars correspond to KPIs. The rows correspond to the experts/decision makers (DMPs): DMP1 = IT Director, DMP2 = SLA Manager, etc. The values in cell (i, j) of the matrix indicate the i-th expert's assessment of the j-th KPI. The larger the value, the more the given indicator is preferred.

3.6.2. Model verification

We will solve the model thus formulated using a group decision-making method proposed by Don Krapohl - [47]. The method is simple and effective. It is based on statistical approaches. It provides structured and transparent decision-making within a given criterion according to a set template - see table 6. The core of the method is the so-called weighted decision matrix. For each expert, a weighting factor representing the level of knowledge about the area to which a given KPI indicator applies is calculated. The solution process consists of three stages:

- I Identification of the group factor;
- II – Individual assessment;
- III Calculation of final result.

Data entry and analysis are consolidated. The result includes the following information: "heat map" type tables reflecting levels of disagreement and agreement; Points of contention; Optimistic/pessimistic disagreement and Optimistic/pessimistic support of the bottom line - see Table 3.3.

Table 3-2 Top 5 evaluated KPI indicators: Levels of agreement and disagreement

	Relative strength of disagreement				Disagreement Heat Map				Agreement Heat Map				Top 5 scored		
	Weight	Will support the service uptime Score	Will support the end user satisfaction Score	Will support the end user productivity Score	Weight	Will support the service uptime Score	Will support the end user satisfaction Score	Will support the end user productivity Score	Weight	Will support the service uptime Score	Will support the end user satisfaction Score	Will support the end user productivity Score	Will support the service uptime Score	Will support the end user satisfaction Score	Will support the end user productivity Score
• Uptime percentage of the service					0.7	0.5	0.8	0.7	0.6	0.7	0.6	0.6	394	351	360
• Count of complete unplanned service outages					0.9	1.7	1.2	1.2	0.5	0.4	0.5	0.5	314	292	324
• Count of service degradation events					0.9	1.0	1.4	1.2	0.5	0.5	0.4	0.5	287	257	263
• Average time for completing the service requests					0.8	1.2	0.7	1.4	0.6	0.5	0.6	0.4	107	258	170
• Percentage of service requests completed within the agree					0.8	0.7	0.9	1.2	0.6	0.6	0.5	0.5	126	199	150
• Percentage of service requests completed within one shot					0.8	1.5	1.5	0.5	0.6	0.4	0.4	0.7	108	253	78
• Percentage of complaints					0.8	1.4	0.8	1.3	0.6	0.4	0.6	0.4	147	286	109
• Average time for starting work on case					1.0	1.4	1.5	1.6	0.5	0.4	0.4	0.4	261	183	225
• Average time for resolution					1.0	1.9	1.4	1.2	0.5	0.3	0.4	0.5	210	250	300
• Percentage of incidents resolved within the SLA timeframes					1.0	1.4	0.7	1.7	0.5	0.4	0.6	0.4	350	241	283
• Percentage of incidents completed within one shot					1.0	1.5	1.6	1.5	0.5	0.4	0.4	0.4	264	305	137
• Percentage of incidents with proper initial assessment					1.0	1.5	1.7	1.4	0.5	0.4	0.4	0.4	276	174	126
• Percentage of complaints					1.0	1.6	1.2	1.4	0.5	0.4	0.5	0.4	248	340	208
• Percentage of successful changes					1.5	1.3	1.2	1.3	0.4	0.4	0.5	0.4	296	220	177
• Number of failed changes					1.5	0.6	1.2	1.5	0.4	0.6	0.5	0.4	294	221	161
• Number of unauthorized changes					1.5	1.0	1.2	1.7	0.4	0.5	0.5	0.4	315	89	121
• Consumed disc storage per user					1.5	2.0	1.0	2.1	0.4	0.3	0.5	0.3	202	102	114
• Supported users per FTE					1.5	2.3	0.9	1.1	0.4	0.3	0.5	0.5	236	69	118

From the table, we can see the first 5 most highly rated KPI indicators for each of the three objectives of the session: availability (service uptime) of the service; supporting end user satisfaction; end user productivity support. We can also see the level of agreement and disagreement between experts on the applicability of a particular KPI according to the heatmaps. A more intense color means a high level of agreement (disagreement) between experts and vice versa.

It can also be seen from the results that the service uptime indicators (the first three columns of the input table) have a high importance for the three decision objectives/aspects. This is also consistent with the high level of agreement between experts. It can also be seen that the level of disagreement between experts is relatively high for the first 5 selected KPIs for measuring productivity and end-user satisfaction (see Table 6, last two pillars).

This means we can confidently confirm which KPIs are not relevant. Namely:

• For "Will support service availability time", the indicators are not appropriate: Percentage of service requests completed within the agreed SLA; Average time to satisfy the service request; Average time to start work on a request;

• For "Will support end-user satisfaction" the indicators are not appropriate: Number of unauthorized changes; Average disk space consumed per user; Supported users of the equivalent of one employee.

• For "Will support end-user performance" metrics are not appropriate: Percentage of client requests processed in one iteration; FTE (full time equivalent) users supported; Percentage of service requests completed within the agreed timeframes.

3.7.Conclusion

In this chapter, we looked in detail at the process of defining KPI indicators for a given IT service according to the ITIL framework. A detailed set of 18 KPI indicators for the e-mail service, grouped into five groups, is proposed. A methodology using group decision-making is proposed to assess the appropriateness of the proposed KPI indicators. This methodology is demonstrated on a real example (Case Study). The proposed methodology will allow the management department in large organizations to have a structured approach to select appropriate KPI indicators to measure their business goals.

Chapter 4 - Using ITIL and TOGAF Together

4.1. Complexity in integration of frameworks

Market research [48] shows a permanent trend for the increase in the volume of outsourcing services in information technology. In turn, the trend towards the increasing complexity of information systems provokes the creation and effective use of established management frameworks in the industry, so that many reputable service providers can share a common protocol for monitoring quality and managing the service. These frameworks and standards are described in chapter one of the dissertation. This chapter proposes a methodology to enable the joint use of ITIL and TOGAF as management frameworks. The choice of aligning ITIL and TOGAF is motivated by the following:

- **wide use in industry.**
- **the need for a common protocol for the joint use of both frameworks.**

So, we will explore the TOGAF IT Service Management Framework because it complements ITIL from an architectural perspective. In business organizations, a variety of management frameworks exist simultaneously to cover different areas and aspects of a given IT service. Although these frameworks are designed to be compatible with each other and yet applicable across a wide range of industries, there are points of overlap that need to be explored. Also, the points of interaction, which can be called interfaces, **are not universal and do not follow a common protocol**. This also applies to the integration of two of the most implemented frameworks in information systems, namely ITIL and TOGAF. Two main types of problems can be formulated:

- Task 1: The same operations are described by both frameworks. This can lead to duplication of duties, conflicts and inefficient use of resources in the organization.
- Task 2: There is no relationship between TOGAF and ITIL processes.

For example, participants in the same directorate dealing with different types of operations may experience difficulties due to the undefined communication framework and protocol. As a result of the increasingly frequent use of the combination of the ITIL and TOGAF frameworks, it is increasingly likely that organizations, and in particular IT departments, will experience more and more difficulties in reconciling the two frameworks. Although an organization may decide to manage its architectural environments (when we have an overlapping case) from only one of the two frameworks - ITIL or TOGAF, the question of overlapping will still be present. It is expressed in the need for an interface for communication between the two frameworks – defining communication points, unifying terminology, as well as consensus (creation of a communication protocol).

4.2. Applying ITIL with other management frameworks and standards

In most practice scenarios, companies use different frameworks and standardizations that interact with each other. This is necessary to provide a tool for

all operations required for the particular IT infrastructure. There are no restrictions on ITIL being used in parallel with other frameworks, as it only offers best practices without being mandatory. There are various studies that investigate the joint use of ITIL with other management frameworks [113, 114, 115, 116, 21, 24, 35, 51]. Another one [21] explores the coexistence of four widely used frameworks and standardizations:

- ITIL for IT service support
- CobiT
- ISO9001

The common existence of these frameworks and standards is described in the graphic in Figure 4.1 [21]:

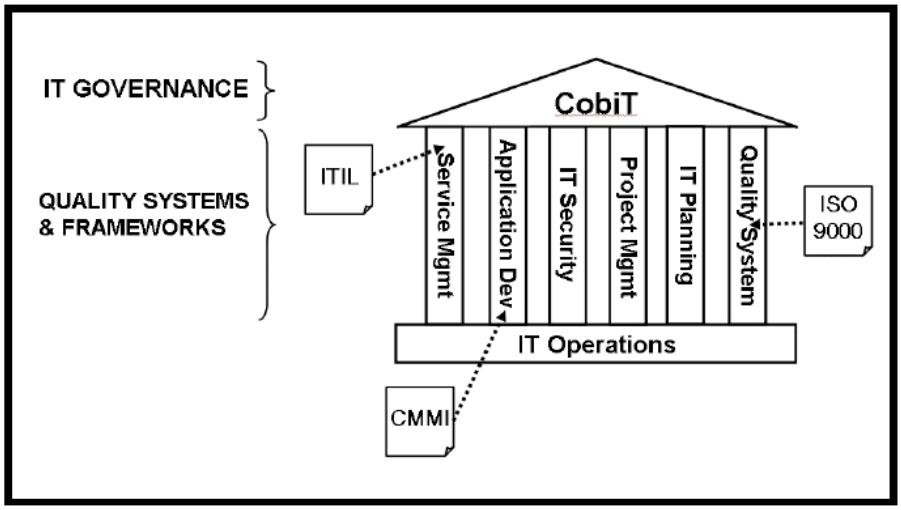


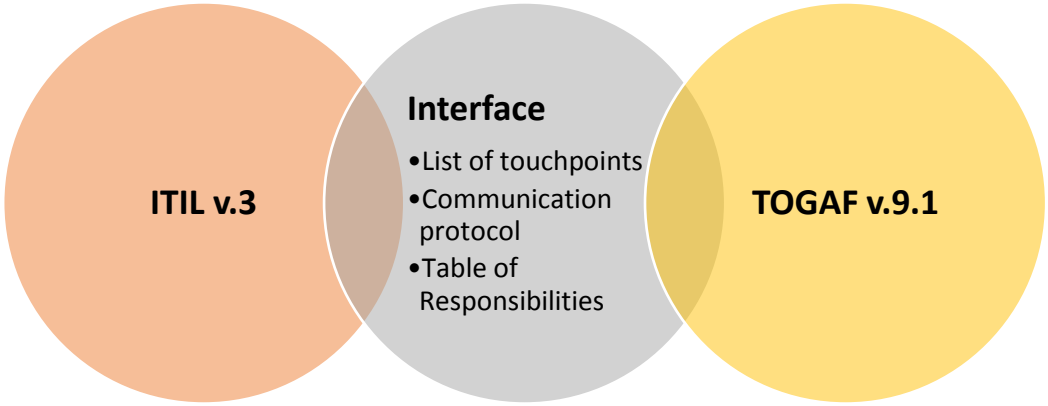
Figure 4-1 Interaction between 4 IT governance frameworks [21]

Figure 4-1 depicts a real scenario in an organization that has a wide range of IT services: hardware and software assets developed in-house or used off-the-shelf to provide a full set of tools to support day-to-day business operations. As a foundation, we have the day-to-day IT operations that support the day-to-day work of employees. Another study investigated the collaboration between ITIL, COBIT and ISO27002 [113]. The authors analyze the strengths of the three frameworks and propose a model in which the joint use of the frameworks leads to an improved outcome because of their complementarity. Other authors [114] make an integration between COBIT and ISO27002 to achieve a model in which the levels of information security are increased, and the costs of these activities are optimized using the distinct advantages of the two frameworks.

4.3. Method for identification and integration of ITIL and TOGAF structural frameworks

First, we will propose an operational model, on the basis of which the points of contact and overlap between ITIL and TOGAF will be defined - see Figure 4 2, on the

basis of which the integration is actually carried out. Duties will be allocated for implementation through ITIL or TOGAF through a table of responsibilities (RACI - Responsible, Accountable, Consulted, Informed) - [49]. The method is two-step for reasons of clarity. Each of the two stages can be performed independently or in combination: 1. identification of points of contact; 2. creating communication at the points of contact between ITIL and TOGAF.



Фигура 0-1 Integrational model between ITIL and TOGAF.

Version v.3 of ITIL and version v.9.1 of TOGAF are used to build the model.

4.3.1. First stage - identification of points of contact

At this stage, we will identify the points of contact at the level of a general structure (processes).

After analyzing the structures of ITIL and TOGAF, a relationship between ITIL and the ADM (Architecture Development Method) cycle for TOGAF is derived, which defines the points of contact. They are shown in Table 4.1 - a total of 9 in number. Table 4 1 Points of contact between the TOGAF ADM cycle and the main chapters of ITIL

TOGAF phases of ADM	**ITIL**
Preliminary phase	Service strategy
Architecture vision	Service design
Business architecture	Service design
Information system architecture	Service design
Technology architecture	Service design
Opportunities and Solutions	Service design, service transition
Migration Planning	Service transition
Implementation governance	Service transition
Architecture change management	Service transition

We will consider each of the links in turn, taking TOGAF's ADM model as a starting point of comparison.

Preliminary Phase – This is the preliminary phase of TOGAF, aimed at identifying the business requirements of the organization/enterprise, formulating the goal, creating a governance structure and describing the principles of the architecture. On the part of ITIL, the Service strategy section mainly aims to define the set of services that will be needed by the organization, to determine a budget and to identify the units/specialists **that should implement these services.**

Architecture Vision, as well as the next steps of **ADM - Business Architecture, Information System Architecture and Technology architecture** mainly aim at shaping the architecture of the environment. It starts from common requirements and standard design for the industry and reaches a customized design for the specific organization. A comparison with the functions that the processes of the ITIL Service Design section perform shows that the ITIL Service Design section can functionally interact with the above-mentioned TOGAF phases.

Opportunities and solutions are a phase of TOGAF that is responsible for considering the different options for achieving the target (final) architecture; divide the project into phases and identify recurring elements (tasks, parts of tasks); to plan specific changes in the information environment of the organization/enterprise and to examine their impact on the routine work of employees; to explore different implementation options. On the part of ITIL, these actions are represented in two sections - Service design and Service transition.

The Migration Planning phase, together with the next two - **Implementation Governance and Architecture Change Management**, perform functions on planning, implementation and product renewal. From the perspective of the ITIL framework, an IT service also needs these steps in its life cycle. According to the analysis, they are implemented by the Service Transition chapter. The above reasoning can be verified on a particular case only for ITIL – [50].

4.3.2. Second stage - communication in the identified touch points

To make communication protocols between duties in the two frameworks, role-level touchpoints between the two frameworks will first be defined. The determination was made by means of an analysis of the sources: - TOGAF version 9.1 documentation. It contains a description of the roles in the framework, as well as their duties and levels of competence for each; - documentation of ITIL version v.4. It contains duties of the individual roles in the framework, systematized by chapter. The analysis itself was carried out based on the established points of contact between the TOGAF ADM cycle and the main chapters (processes) of ITIL - see front point. We will demonstrate this approach at the first touch point:

Preliminary phase (TOGAF)	Service strategy (ITIL)

For the purposes of the analysis, we will use the TOGAF and ITIL definitions of responsible roles/activities, as well as the requirements of The Open Group, an

organization that created and maintains TOGAF [The Open Group - TOGAF. http://www.opengroup.org/] – see Table 4.2.

Table 4 2 Skill levels required for each role according to The Open Group - [http://www.opengroup.org/]

© The Open Group Roles	Architecture Board Member	Architecture Sponsor	Enterprise Architecture Manager	Enterprise Architecture Technology	Enterprise Architecture Data	Enterprise Architecture Applications	Enterprise Architecture Business	Program/ Project Manager	IT Designer
Generic Skills									
Leadership	4	4	4	3	3	3	3	4	1
Teamwork	3	3	4	4	4	4	4	4	2
Inter-personal	4	4	4	4	4	4	4	4	2
Oral Communications	3	3	4	4	4	4	4	4	2
Written Communications	3	3	4	4	4	4	4	3	3
Logical Analysis	2	2	4	4	4	4	4	3	3
Stakeholder Management	4	3	4	3	3	3	3	4	2
Risk Management	3	3	4	3	3	3	3	4	1

Service Strategy

- Business relationship manager

The role has no overlapping responsibilities with TOGAF roles, due to the definition that TOGAF supports the creation of the information architecture. For this ITIL role, we find that there is no need to develop a communication protocol.

- Demand Manager

Based on an analysis of the requirements for this role, we postulate that the Demand manager must communicate with the following TOGAF roles to process architectural needs: Enterprise architect manager, Enterprise architect technology, Enterprise architect applications.

- Financial manager

There is no specific duplicative role on the part of TOGAF. Budget management is overseen by the Project/Program Manager, while each role within TOGAF has a high level of responsibility for budget definition and control. For its part, ITIL recommends that the financial manager should be aware of the financial implications of the architectural decision and be able to provide input during the architectural decision-making process.

- IT Steering group

This represents a group of roles and employees who are responsible for creating the strategy for the development of the information environment in the company. In addition, the group reviews the information objectives to confirm that they support the company's business objectives. This definition covers much of TOGAF's objectives. Therefore, it is at this interrelationship of processes that the overlap is greatest. Therefore, there is the highest risk of duplication of tasks, and/or difficulty in making decisions. Since this is a large group of roles, we recommend merging them as an effective solution to the problem. On the TOGAF side, the overlapping duties/roles are: Architecture board member, Architecture sponsor, Enterprise architecture

manager, Enterprise architect data, Enterprise architect applications, Enterprise architect business.

- Service Portfolio Manager
TOGAF does not address the topic of the methodology by which a service will be supported and therefore there is no significant risk for the Service Portfolio Manager to have overlapping duties with any of the other TOGAF roles. However, we recommend that Service Portfolio Manager catalog creation be supported by Enterprise Architect Technology, Enterprise Architect Data, and Enterprise Architect Applications.

- Service Strategy Manager
TOGAF does not address the topic of the methodology by which a service will be supported and therefore there is no significant risk for the Service Portfolio Manager to have overlapping duties with any of the other TOGAF roles. However, we recommend that Service Portfolio Manager catalog creation be supported by Enterprise Architect Technology, Enterprise Architect Data, and Enterprise Architect Applications.

ITIL	**TOGAF**	**Risk of overlapping obligations**
Business relationship manager	No overlap exists	There is no
Demand Manager	Enterprise architect manager, Enterprise architect technology, Enterprise architect applications	Low
Financial Manager	Project/Program Manager	Average
IT Steering group	Architecture board member, Architecture sponsor, Enterprise architecture manager, Enterprise architect data, Enterprise architect applications, Enterprise architect business	High
Service Portfolio Manager	Enterprise Architect Technology, Enterprise Architect Data и Enterprise Architect Applications	Average
Service Strategy Manager	Enterprise Architecture Manager	High

4.7 Conclusion

In the fourth chapter, the possibilities of integration of the structural IT library ITIL with other structural frameworks are considered. The TOGAF structural framework was chosen for this purpose, as it is the most frequently used combination in practice. While ITIL is concerned with offering good practices for maintaining a system service, TOGAF offers a standard to support the system architecture providing that service.

An operational model is proposed, based on which the points of contact and overlap between ITIL and TOGAF, through which the integration takes place, are defined. ITIL version v.3 and TOGAF version v.9.1 are used in the model.

A method for the integration of the two frameworks ITIL and TOGAF in their joint use in organizations is proposed. The method is two-step. At the first stage, the points of contact of the two frameworks at the process level are identified. In the second stage, the communication is done at the touch points at the role level. For each touchpoint, a specific communication protocol is made for each role. The proposed method is universal and can be used for integration of other structural IT frameworks. Using this method prevents the risks of overlapping duties where, as a result of insufficient communication, certain tasks can be duplicated (two people doing the same task without knowing about each other).

The proposed integration method is demonstrated for a first level one touch point between ITIL and TOGAF:

Preliminary phase (TOGAF)	Service strategy (ITIL)

For this point, 6 roles in ITIL and 8 roles in TOGAF have been established, for which corresponding communication protocols have been made. The extent of the risk of overlap is established in these protocols. The duties of the individual roles are allocated for implementation through ITIL or TOGAF through a table of responsibilities RACI (Responsible, Accountable, Consulted, Informed).

Conclusion

The dissertation examines the main issues related to the implementation and exploitation of the most used framework for the implementation and exploitation of IT services - ITIL.

First, it is the task of initial implementation of ITIL in organizations. As is known, there are no recommendations and approaches for this in the ITIL documentation. At the same time, in large organizations, this implementation is not a trivial task, which is also complicated by the fact that the work process should not be disturbed. All this makes the issue of proper selection and planning of ITIL components very important. This issue cannot be resolved effectively without the use of modern decision support methods. A group decision-making model and method for selecting an optimal set of ITIL processes are proposed.

Secondly, it is the task of the implementation, quality and performance and related Key Performance Indicators (KPI) of the service management processes related to IT in the organizations. A detailed set of 18 KPI indicators (criteria) for a selected service (e-mail) grouped into five groups is proposed. A methodology using group decision-making is proposed to assess the appropriateness of the proposed KPI indicators. This methodology is demonstrated on a real example (Case Study). The proposed methodology will allow the management department in large organizations to have a structured approach to select appropriate KPI indicators to measure their business goals.

Thirdly, it is the task of stacking the most used structural framework ITIL with other structural frameworks. The most used combinations of information environment management frameworks are ITIL - TOGAF. The two frameworks cannot be integrated through existing processes. There is a lack of integration methods, which leads to their inefficient joint use. An operational model is proposed, on the basis of which the points of contact and overlap between ITIL and TOGAF, through which the integration takes place, are defined. ITIL version v.3 and TOGAF version v.9.1 are used in the model. A method for the integration of the two frameworks ITIL and TOGAF in their joint use in organizations is proposed. The method is two-step. At the first stage, the points of contact of the two frameworks at the process level are identified. In the second stage, the communication is done at the touch points at the role level. For each touchpoint, a specific communication protocol is made for each role.

Scientific and applied contributions

Scientific contributions:

1) An analysis of ITIL was made including related tasks; significance; implementation approaches in organizations and the role of decision-making methods in this whole process.

2) A structural process-oriented method for ITIL integration is proposed. The method does not require knowledge or experience in implementing management frameworks.

3) A model and method for group decision-making in the initial implementation of the ITIL structure library/framework in large organizations is proposed. The model is in the form of a two-dimensional matrix. In it, the individual components of ITIL are represented as a string of binary variables. Panel of experts presents individual ratings on a selected scale for each component of the library. The method is based on the median evaluation of the evaluations of the individual experts.

4) Following the principles of ITIL, a comprehensive set of 18 criteria (Key Performance Indicators - KPI) has been proposed, united in 5 groups to evaluate the implementation, quality and performance of the e-mail service. A group decision-making model for implementing the e-mail service in organizations is proposed.

5) An operational model and a method for the integration between ITIL and TOGAF are proposed. ITIL version v.3 and TOGAF version v.9.1 are used in the model. The method is two-step. At the first stage, the interface is at process level. In the second stage, the communication is done at role level.

Scientific and applied contributions:

6) Group decision-making model for the implementation of the e-mail service in organizations is proposed. It uses user-friendly statistical method developed by Don(ald) Krapohl, 2010, USA.

7) The ITIL-TOGAF library coupling communication method has been implemented/demonstrated for the first level: in one touch point (Preliminary phase (TOGAF) – Service strategy (ITIL)) and for 6 ITIL roles for level 2 touch points. The duties of the individual roles are split between ITIL or TOGAF through a table of responsibilities RACI (Responsible, Accountable, Consulted, Informed).

8) The proposed model and method for the initial implementation of ITIL in an organization is demonstrated on a real example of modernizing IT services in a large pharmaceutical distribution company from Great Britain (Case study), in which the PhD student took part within their commissioned project of Hewlett-Packard (Service Center), Bulgaria.

9) The proposed model and a set of KPIs are demonstrated on a real example of a large educational organization (Case study)in a project implemented by Hewlett-Packard, Bulgaria (Service Center), in which the PhD student took part within their commissioned project of Hewlett-Packard (Service Center), Bulgaria.

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Full list of author's publications

As of January 2024. the PhD student has a total of **10 printed journal publications** and international conference papers to date. To date, a total of **13 citations** to these publications have been found, as described in the next paragraph.

1. Mitev, Y.; Kirilov, L. Using IT Management Processes for Achieving Better Efficiency in the IT Service. In: Proceedings of the ICEST 2014, Niš, Serbia, 25–27 June 2014; Volume 1, pp. 247–250, ISBN 978-86-6125-108-5. Available online: http://www.icestconf.org/(accessed on 31 May 2018).
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