CMDB Reporting Introduction and Quality Improvement at a Given Hungarian Company

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Abstract: Configuration Management Database, also known as CMDB, with reliable and up-to-date data is one of the essential foundations for the efficient operation of IT systems. A leading company in Hungary (name withheld for confidentiality reasons) is committed to providing world-class telecommunications infrastructure services, and to achieve this goal, it is focusing on the implementation of a project to create reporting on its Configuration Management Database, which will allow for better visibility and more efficient maintenance. The development will follow ITIL principles, with a more detailed focus on the doctrines of Service Transition and Continual Service Improvement. In this study, the process of preparing the report is followed from the initial phase to the analysis of the resulting data visualizations, concluding with some recommendations for improvement.

Keywords: ITIL; service life cycle; service transition; continual service improvement; CMDB; reporting; database; Power BI

1 Introduction

IT systems are playing an increasingly important role in the lives of companies, making their efficient operation essential for successful operations. The Hungarian company in our study, as a major domestic IT player, is also facing the challenges of running its systems more efficiently. The company is committed to providing world-class telecom infrastructure services, so it is no coincidence that reliable and fast maintenance of IT systems is a top priority for them.

In order to achieve these goals, they want to create a project to create reporting on its configuration management database, which means it is focusing on implementing a system that will allow for better visibility and more effective maintenance. An exemplary definition of a CMDB emphasizes its role as a software-enabled capability facilitating the discovery, reconciliation, management, and optimization of IT service interdependencies, supported by multidimensional benefits and requiring attention to process, culture, communication, and technology, while its foundation comprises a management model guiding CI addition and CMDB management processes and a data model illustrating CI attributes and relationships [13]. The aim of this paper is to present the process of implementing CMDB reporting, its benefits and challenges at the company.

In doing so, the project will describe in detail the methods used to collect and analyze the data and interpret the results.

Creating the perfect CMDB is challenging as it dynamically evolves with company needs, requiring flexibility to accommodate unique Configuration Item identifications, adapt to changing project requirements, potentially growing large, and handling significant data volumes and multiple simultaneous requests to serve diverse employee needs [14].

However, the main objective of the study is to improve the quality of IT systems through the implementation of CMDB reporting and enabling a company to provide more reliable and efficient services to its customers. The results and conclusions of the work can help the company to identify further improvements.

2 ITIL Principles

In order to achieve the above objective, a guideline is needed that sets out and defines the path of development, providing direction for the work. Many international and domestic companies follow the principles of the standard described below.

2.1 The Creation of the ITIL Standard

ITIL stands for Information Technology Infrastructure Library, a library and framework for IT service management, also known as ITSM. ITIL first came into being in the late 1980s when the UK government was trying to organize IT services within the government sector. The IT services provided by organizations in this sector often suffered from a variety of problems, including interruptions, high costs and lack of process coordination.

Although the ITIL framework was originally designed for IT professionals working in the government sector, over the years it has become more widely adopted and has become one of the most common standard IT service management methodologies.

2.2 History of Development

ITIL took years to create and develop. The initial versions focused mainly on the operational details of IT service management, but over the years the framework has expanded significantly to cover a number of different IT service management areas.

In 2000, Microsoft used ITIL as the basis for the Microsoft Operations Framework. In 2001, version 2 of ITIL was released, based on the core publications Service Support and Service Delivery. Training courses on the new methodology have been organized worldwide and hundreds of thousands of people have participated, gaining the certification that has helped them manage IT-based services and environments and to advance their ITSM careers [1].

ITIL version 3 was released in 2007 and was updated in 2011. ITIL v3 is built around a service life cycle that included the following:

- Service strategy: defining IT services that meet business needs.
- Service design: creating new IT services and maintaining existing ones.
- Service transition: development, integration and testing of new IT services.
- Service operation: supporting the use of IT services.
- Continual service improvement: ensuring consistency between the IT service provided and the continuous evolution of business needs [2].

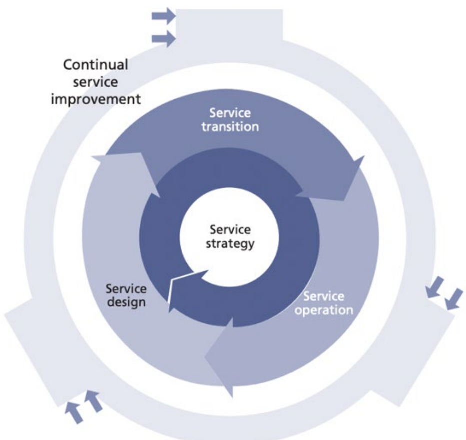

Figure 1
Service lifecycle [4]

The latest version of ITIL is ITIL 4, released in 2019. ITIL V4 also includes guidance on how to adapt Agile, DevOps and Lean methodologies to the service management domain as emerging developments in software development and IT operations.

2.3 About ITIL in General

ITIL provides a set of practical recommendations and procedures for designing, implementing and supporting IT services. The framework is a set of "best practices" aimed at making IT services run more efficiently [4].

ITIL's approach to service management is based on the recognition that IT services cover many different areas, each of which can affect customer satisfaction. ITIL's practical recommendations cover the entire lifecycle of IT services, including design, development, operation and repair.

Phase	Process
Service strategy	1. Strategy management for IT Services 2. Service portfolio management 3. Financial management for IT services 4. Demand management 5. Business relationship management
Service design	1. Design coordination 2. Service catalogue management 3. Service-level management 4. Availability management 5. Capacity management 6. IT service continuity management 7. Security management 8. Supplier management
Service transition	1. Transition planning and support 2. Change management 3. Service asset and configuration management 4. Release and deployment management 5. Service validation and testing 6. Change evaluation 7. Knowledge management
Service operation	1. Event Management 2. Access Management 3. Request Fulfillment 4. Problem Management 5. Incident Management
Continual service improvement	1. The seven-step improvement process

Figure 2

ITIL v3 [3]

Each process sets out in detail the practical recommendations for the area covered.

2.4 Identifying the ITIL Recommendations Required for the Project

The company in our focus is one of the companies that are determined to operate according to ITIL principles because they operate critical infrastructure. Among the ITIL recommendations presented earlier, we will apply in this project the guidelines of service transition and continuous service improvement. The reasons for this are explained in detail below.

Service transition involves the design and development of services so that they can be deployed in a live environment. Some key elements are listed below:

- Managing Service Devices and Configurations: this process deals with managing the devices and configurations associated with the IT infrastructure. The purpose is to track, document and manage the devices and configurations associated with the services and their components, including the relationships between them. SACM is a combined process consisting of two separate and implicit processes:
- ITIL Asset Management: this process manages the assets used to deliver IT services. Asset management is an important process that must be carried out by a company in managing its assets effectively and efficiently [15].
- ITIL Configuration Management: this process keeps track of the configurations of the different components (configuration items) and their relationships between the different IT services [5].

The other ITIL principle is continuous service improvement, which we try to apply in our ongoing work.

Continuous Service Improvement (CSI) is concerned with the continuous assessment and improvement of the quality of services and the overall maturity of the ITSM service lifecycle and underlying processes to maintain value. CSI combines the principles, practices and methods of quality management, change management and capability development. It also seeks to improve each stage of the service lifecycle, as well as current services, processes, related activities and technologies. CSI is not a new concept, but for most organizations the concept is not yet beyond the discussion stage. For many organizations, CSI becomes a project when something has failed and has severely affected the business. When the problem is solved, the concept is immediately forgotten until the next major failure occurs. There is still a need for discrete, time-bound projects, but to be successful, CSI must become embedded in the organizational culture and become a routine activity [6].

The seven-step development process aims to define and manage the steps required to identify, define, collect, process, analyze, present and implement improvements. The stages in the seven-step improvement process are [3]:

- Plan:
  1. Define a development strategy
  2. Determine what you will measure
- Implementation:
  3. Collect data
  4. Process the data
- Verification

5. Analyze information and data
6. Presentation and use of information

- Action:

7. Perform development

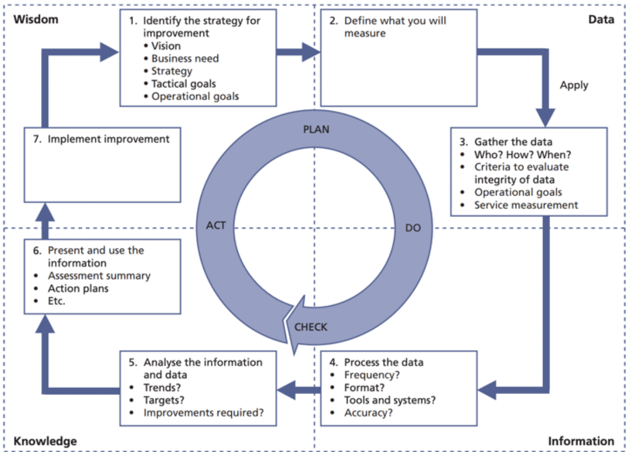

Figure 3
The seven-step development process [3]

So, the ultimate goal of Continual Service Improvement is to reach a state where service and process efficiency is achieved and cost improvements are possible. This is achieved by ensuring that improvement opportunities are identified throughout the service lifecycle [3].

After a deeper understanding of the ITIL recommendations, it is clear that a project can be achieved by applying the two processes, Service Transition and Continual Service Improvement, together. The goal remains to implement CMDB reporting and through this to achieve quality improvement.

3 About the CMDB

The acronym CMDB is used not only in the title of this thesis but also in the previous chapters, so it is timely to introduce and clarify the term.

The Configuration Management Database, abbreviated CMDB, is a part of the Service Asset and Configuration Management element of the Service Transition process.

The CMDB is a database that stores the devices, configurations, attributes and relationships associated with IT services and their components. When a new service is designed and implemented, it is important to document the system components and resources required for it, one of the tools used is the Configuration Management Database.

The CMDB helps to track, document and manage IT infrastructure and applications, their interrelationships and changes. This contributes to more accurate change management, problem solving and planning of IT services.

With the CMDB, the IT team can record and track which components are undergoing changes and how they are related to other components or services. Keeping configurations, resources and relationships up to date helps you understand the impact of the change on the system as a whole and allows you to identify potential problems or incidents early. This facilitates efficient planning and implementation, and reduces risks and opportunities for failure, minimizing service outages. In addition, a well-maintained CMDB also helps in decision making, for example, in authorizing a change.

In general, a configuration management database can help ITIL's Continual Service Improvement element to provide more accurate information about current services and where changes are needed. As this is a methodological recommendation, there is no universally accepted and recommended software for CMDB management. Companies make their own decisions to develop their own systems, as a well-specified CMDB can lead to greater service stability.

Our company purchased the Conclusion software framework developed by Czech Eller and adapted it to its own needs. It is an end-to-end enterprise process management solution, including a configuration management database. The Conclusion software is used by all employees on a daily basis, making it a key tool in the company's day-to-day activities. To avoid downtime, a test version is also available, which allows you to try and test Conclusion framework enhancements before they are implemented.

4 Description of the Database

Although the graphical interfaces of Conclusion visually display the CMDB content, it is clearly stored in a background database.

4.1 Database Management System and Development Tool

The underlying database of the Conclusion software is based on PostgreSQL, a popular open-source relational database management system developed by

Postgres Global Development Group. Within the company's Hungarian rights, this is accessed via a mirror database, so only data of interest in the Hungarian context is displayed in the form of views.

In addition to the Postgre database management system, it is also worth using a separate database development tool, currently provided by DBeaver. This is a free tool, also open source, which allows the management, querying and analysis of databases. DBeaver supports a wide range of database systems, including PostgreSQL, so that together they work ideally to serve and support the day-to-day work of the company. So, PostgreSQL is responsible for the permanent storage and management of data, while DBeaver is a tool for working with databases, helping you to communicate with them, execute queries and analyze data.

4.2 Description of the Necessary Views

The Hungarian views are available within the public schema, these are tagged with hun_view tags to distinguish them from Bulgarian or Serbian data, so that only the information relevant to us is displayed and an extra filtering step is avoided.

The CMDB data for this project are contained in the sd_components_hun_view, the sd_componenttypes_ hun_view and the sd_componentssubtypes_ hun_view. In addition to these, the sd_lov_hun_view, the sd_customers_hun_view and the sd_users_hun_view will be needed during the report generation process, as they provide valuable information about the state of the CMDB.

5 Report Development

After describing the PostgreSQL backend database, the next step in the project is to create reports using Power BI. In this phase, the goal is to integrate the data stored in the database into the Power BI Desktop application and then create visualizations and reports based on that data. The analysis of the work produced will help the company to operate a more stable system, which is the objective of this thesis.

Efficient and valuable analysis of data is essential for strategic decision making and for optimizing the performance of IT systems. The reporting application chosen in this context has a significant impact on the process of data analysis and access to corporate information.

Recently, the Hungarian company has turned its attention towards the Power BI application, in which a number of factors have played a role in the decision-making process. Below is a summary of why the company chose Power BI and how this application fits with the company's objectives and needs.

These benefits include tight integration with the Microsoft ecosystem, enabling efficient collaboration with Office 365, Excel and Azure. All these integrations are already based on artificial intelligence [16]. With a wide range of data connectors, Power BI provides the ability to easily import and combine data from different sources. It also offers interactive elements and dynamic visualizations so users can perform deeper analysis when interacting with data. Power BI has both cloud-based and on-premise versions, so companies can choose the version that best suits their needs. There is also the option to tightly control data access through security and privilege management features. Regular feature updates ensure that users always benefit from the latest technologies and developments [7].

In the case of the examined company, the Power BI Service application collects reports within a workspace on a web interface, but due to built-in rights management, decision makers only have access to the files that are relevant to them. The resulting file is called CMDB report, which is a descriptive name that helps to quickly identify the content.

The internal structure of Power BI Desktop is divided into the Power Query section, the Model View, the Table View and the Report View. The application is built along these layers, ensuring full functionality and efficient processes from data import to reporting. These layers work together in an integrated way, creating a harmonized and intuitive environment for data visualization and analysis.

5.1 Power Query

Power BI and Power Query are tightly coupled, so using them together allows you to import, cleanse, and transform data. Power Query is a flexible tool for formatting and manipulating your data, using a query language (M) developed by Microsoft. We use it to load data into the visualization layer from the PostgreSQL database we learned earlier.

5.2 Model View

Data modelling is a key step in Power BI, which is to display data in a structured and efficiently linked way, so it is necessary to create relationships between loaded tables following data transformations. In addition, relationships allow filtering between different visualizations, so that reports can be more dynamic and interactive.

In order to correctly set up the relationships between tables, a mapping table [Figure 4] has also been created, which now clearly contains the type of relationships, helping to set up the correct relationship within Power BI.

from_table	from_attribute	to_table	to_attribute	type
components_hun_view	customer	customer_hun_view	guid	many:one
components_hun_view	kind	componenttypes_hun_view	componentkind	many:one
components_hun_view	subtype	componentssubtypes_hun_view	guid	many:one

Figure 4
Mapping table

The final version of the Model layer is illustrated in Figure 5. Here, the relationships defined above are illustrated with lines and arrows, making it easy to understand how the data communicate with each other. Each line represents a relationship and its direction indicates whether the relationship is unidirectional or bidirectional. The relational diagram thus illustrates the complexity of the relationships that are formed and how data flows between tables. In relation to the direction of the arrows, the relationships can be simple, i.e. one-to-one relationships, or more complex, more-to-one relationships.

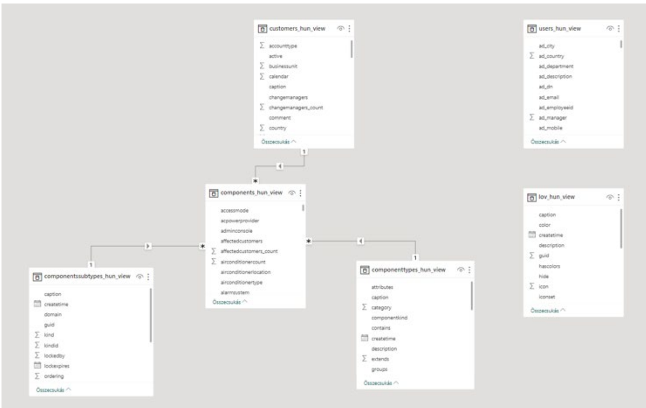

Figure 5
Relationships between tables within Power BI

Data from additional views is not accessed by setting additional connections within Power BI, but by using DAX functions. In this case, more complex logic can be decoded to optimize runtime. This method is usually used to decode different IDs, in other words, to resolve them, creating a new column in the data set. This is also the reason in Figure 5 no relationship with the additional tables is shown for log and users.

These codes no longer use the Power Query coding language, but a so-called DAX, called Data Analysis Expressions, which is a set of formulas and expressions for Power BI, Excel Power Pivot and SQL Server Analysis Service. The DAX functions are used in a next layer within Power BI, which is described below.

5.3 Table View

In Power BI Desktop, after creating the model view, the next step is to create the tabular view layer, which displays the data in a structured format. This layer allows you to filter the data and further fine-tune it before creating visualizations.

5.4 Report View

The table view layer provides the raw data, while the report view puts it into an interpretable form. The dynamic views make it easy to understand the state of system components within the CMDB. These visualizations make it easy to analyze what changes are needed to keep the configuration management database accurate and up-to-date.

The visualizations will be created in two tabs during the project and are described below. What they have in common is that they both filter out deprecated, components, as it is unnecessary to examine them, so that only active and relevant data is used in the visualizations.

6 Analysis of the Results

Once published, the report can be viewed in the workspace of the given title. Web access allows easy access for all those involved within the company, as well as automated daily updates of the reports, so that up-to-date reports are always available.

Although the CMDB report has two separate pages, they are identical in content and data set. The first tab is intended to provide a more complex view of the gaps in the configuration management database, while the second tab is intended to provide a more visual representation.

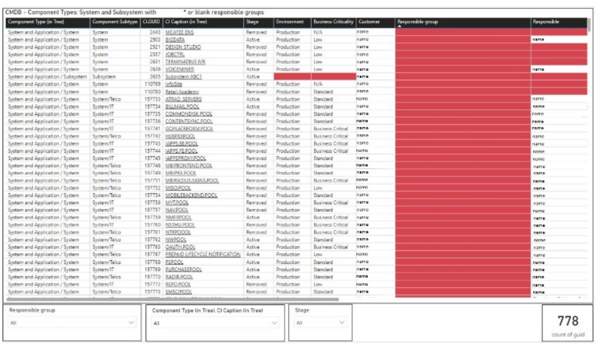

Figure 6
CMDB Report tab displayed, 1st detail

Figure 7
CMDB Report tab displayed, 2nd detail

Figure 8
CMDB Diagram tab displayed

The various visual elements help to speed up comprehension, as they work easier and faster in the human brain compared to textual data. A well-chosen graph or chart conveys information much more effectively than a long table. Recognizing relationships and patterns between data is also easier, even for those without a technical background. Visualizations enhance communication, enabling business messages and results to be conveyed more effectively, as people are more likely to remember and remember visual, visual information. In addition, visualizations also offer interactivity, which not only enhances the user experience, but also allows the data set to be analyzed at a deeper level, thereby complementing and expanding what tables cannot fully show [8].

For these arguments, we will use the visualizations in the CMDB Diagrams tab to perform an analysis of the configuration management database precedence. In the menu in the right corner of each visualization element, it is possible to zoom in on them, so that the data can be read in a larger and airier interface.

The clustered diagram on the left side of the report is designed to show, as solution clusters, which business-critical elements each team is responsible for. Four different values are shown, three of which represent the type of business criticality possible, and while the last value marked N/A refers to the missing data. The coloring of the signal explanation follows the doctrine of human intuition, with the most critical condition being indicated in red and the generally unsafe in green. The diagram is arranged in descending order from left to right, so that at first glance, users can see the data for the groups responsible for most system components, helping them to make quick conclusions. Based on the current CMDB state, the Customer Facing IT Operation Office group is responsible for most of the high and low business criticality systems, so keeping these elements up to date and accurate in their completeness is of paramount importance. There is only one case where this attribute has not been completed, but it is worth completing in the near future.

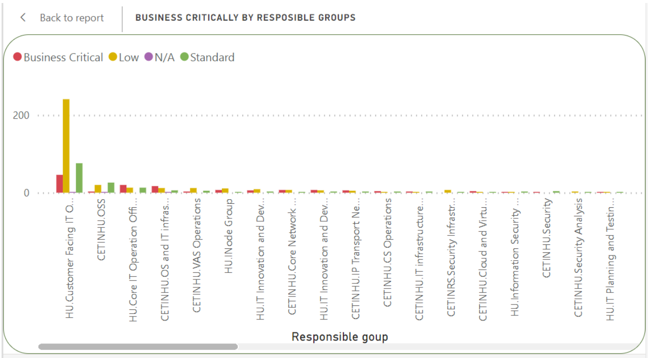

Figure 9

Visualisation of different business criticality systems

The two pie chart visualizations in the middle of the report show the dominance of systems and subsystems. The system components account for 93.63% of the total diagram, while the subsystems account for only 6.38% of the total. The same logic is further broken down in the second pie chart, where the categorization of the individual systems, if any, is also shown. For the most part, the type of system is not further specified, as Systems dominate more than 70% of the diagram.

At the bottom of the report is the so-called line and cluster bar chart, which helps to measure the average elapsed time between the last validation and the present one for each stage state, if the former attribute is filled in precisely. To check this, the green panel on the right has been created and is described below. The chart has a double y-axis, with the left side measuring the number of system components and the right side the number of months elapsed. Regular validation, that is, maintenance every six months, would be crucial for systems in an acute state, but as the diagram shows, the number of months elapsed is well above the six-month threshold.

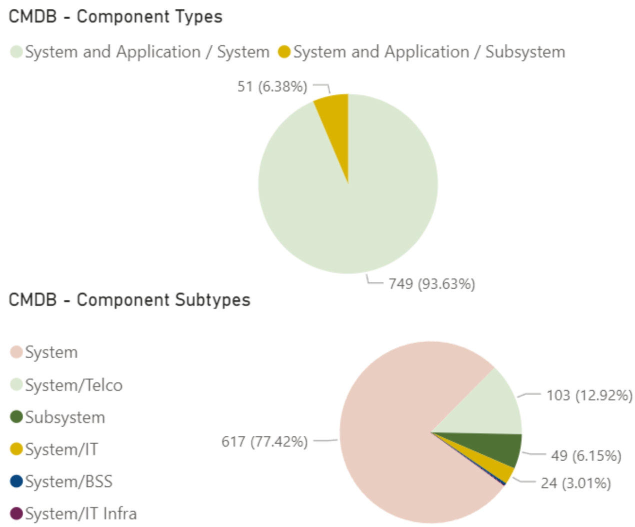

Figure 10
Visualisation breakdown of different types of systems

On average, a validation is carried out every 16 months, which should be improved in the future. Although the graph may look out of line for systems that have been removed and those that are not in use, their values can be ignored from an operational point of view.

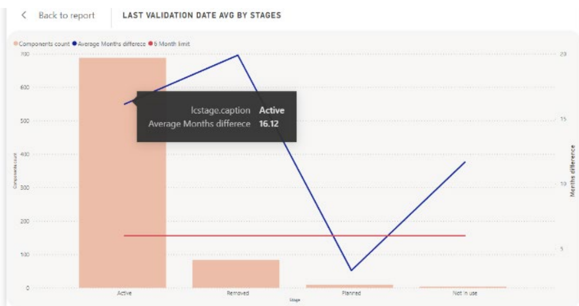

Figure 11
Average monthly difference visualisation by system status

The final visualization element of the page is the green panel on the right, which represents the fill rate of each attribute. It examines the same columns as those highlighted in red on the first tab of the report, but here the data are presented in a completely different context. The panel is built up from percentage visualizations in meter type and card format, so the same data set is presented in multiple formats. The meter visualizations have a target value, which in all cases is 800, as this is the number of systems currently included in the configuration management database. The value displayed inside the semicircle shows how many configuration records have been filled for that attribute. In all other cases, except the Last validation column, the number of non-empty values is displayed, while the 6-month limit is also checked for the former. On the report tab, it is possible to set two types of filters, you can filter your dataset by solver group or by component type, so the fill rate panel will always change depending on the settings. With this dynamic, it is easy to check which component types are worth correcting and replacing, and which solver groups need to make their system properties more accurate and precise.

Figure 12
Visualisation of fill rates

In Figure 12, the dataset displays the current CMDB fill rate in its entirety, without applying any filters. It is easy to see that the system environment is the most accurately populated data, with only seven records missing. In addition, business criticality performs similarly, barely missing its metric. Among the most inaccurate columns are the date of last validation, which has come up many times, and the time the device was installed. These two date values are missing for a lot of configuration records, so replacing them is highly recommended.

7 Development Proposals

Based on the parts highlighted in the analysis, some suggestions for improvement can be made, which should be implemented to ensure that the Hungarian company can continue to provide world-class service through an accurate CMDB. The above-mentioned programming and visual methodologies and data analysis for configuration management have a wide range of applications. Examples of this have been given by many experts in the field of algorithmisation [9], pseudo-detection [10] modular learning support systems [11] and IoT Data Collection [12]. In this process, the concept of ITIL Continual Service Improvement, or CSI, becomes highly relevant. The goal of improvements in these areas is to continuously progress, optimize services and improve the customer experience. Considering the suggestions for improvement outlined below may be worthwhile for your company.

The first and most obvious recommendation is to fill in the missing data, as the report has highlighted the critical need for this. The lack of attribute values not only compromises the accuracy of the CMDB, but also reduces analytical and decision-making capabilities. The replacement process should be a priority, and to this end a method should be introduced to encourage or oblige users to record this data. In addition, it is recommended to organize targeted user training or information on the importance of data and how to record it correctly.

Identifying and optimizing the sources of any missing or inaccurate data is also a recommended step. If the data come from different systems, it may be worth reviewing integrations and improving synchronization.

There is also a strong case for proposing more frequent validation, the importance of which has been mentioned several times during the project. Active systems are validated every 16 months on average, so it would be worth optimizing this period, preferably bringing it closer to the optimal limit of 6 months.

To check all these suggestions, it is worth using the report produced, which is updated daily, so that in all cases the changes and quality improvements can be monitored. In the future, this report may need to be further developed and supplemented as needs arise. One possible direction for this is to implement more complex detailing, for example to expand the visualization for business criticality and system type analysis. For example, if there is a system type that falls into a highly critical category, a more specific examination of the components and subsystems associated with it could help to identify, address and prevent potential problems.

7.1 ITIL Continual Service Improvement

Continual Service Improvement, or CSI, is a pillar of the ITIL framework, which aims at continuous improvement and optimization of services. The above suggestions and areas for improvement are related to the ITIL CSI concept in the following ways.

The ITIL methodology emphasizes the importance of data quality and integrity. The proposed data validation mechanisms and advice for filling in missing data are in line with the objectives of the ITIL CSI. Continuous service improvement encourages organizations to define and monitor KPIs, i.e. measurement indicators to assess the performance and quality of services. The visualizations and metrics such as completion rates or validation frequencies that are created and presented serve a similar purpose. The ITIL CSI encourages regular review and continuous improvement. The analyses and improvement recommendations reflect this spirit of continuous improvement, particularly in the areas of data accuracy and system performance optimization. Both the Continual Service Improvement and the filters for the visualizations produced highlight the importance of dynamic service management.

Dynamic analytics and user interactivity allow for fast and customized evaluation of services and systems. So the concepts and practical application of ITIL CSI are closely intertwined with the development proposals we have outlined. Both focus on continuous improvement and adaptation of services and IT infrastructure to enable the company to provide a higher quality service to its customers.

It is easy to see that one of the means of implementing ITIL CSI as described in subsection II/D, the seven-step improvement process has been completed at all points during the project, thus forming a complete cycle. In the planning phase, the development strategy was defined, that is, the company decided that it would like to create a report to track the current state of the configuration management database. It was then determined what kind of measurement would be needed in order for the project to achieve its ultimate goal, i.e., to improve the quality of the IT systems. In this case, this is served by measuring the accuracy of the system components. During the third stage, the CMDB data was collected and the necessary database views were presented. Subsequently, the dataset was filtered and transformed in order to be prepared for the reporting step. The analysis and presentation of the completed reports was used to identify critical needs for improvement in the configuration management database. By using these and the suggestions made, the company can achieve the goal set at the beginning of the project.

The processes described above represent a single cycle of the CSI's seven-step development process. It is recommended to repeat them as many times as possible in order to continuously improve the efficiency of the IT infrastructure and services.

Conclusions

This study focused on the development and management of a leader Hungarian company's IT systems, with a particular focus on improving the efficiency and accuracy of the configuration management database, also known as CMDB. By applying the ITIL principles and using the reporting process implemented, the objective was to achieve quality improvement and to facilitate long-term development.

During the project, the CMDB was subjected to a detailed analysis, presenting the current state of the CMDB and highlighting areas for regular optimization. From the design of the improvement to the formulation of corrective recommendations, each step was developed in detail, keeping in mind the objectives and ITIL principles. Among other things, the Postgre-based backend database was introduced and the data it contains was transformed to provide the right format for the report. A report view was developed on the resulting dataset using dynamic visualizations. The Power BI-based reporting process implemented has achieved its objective, making a significant contribution to increasing data accuracy and improving system performance.

The results show that reporting on the configuration management database has a positive impact on data accuracy and IT systems performance. The information provided by the reports helps to ensure the stability of the systems and determine the long-term improvement strategy. By presenting the proposed improvements and optimizations, the thesis identifies further directions for the further development of the CMDB and the reporting process.

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