A CBR-based Approach to ITIL-based Service Desk

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ABSTRACT

During the last 20 years ITIL (IT Infrastructure Library) has been evolving with the latest version published in 2007. Incident Management and Problem Management are two main activities of ITIL service operation framework which handles incidents and their root causes respectively. Service Desk systems are software tools that help IT organizations in handling incidents and problems. On the other hand since Knowledge Management emerged, many corporates adopted Knowledge Management. By adding a Knowledge Management structure to the ITIL framework in 2007 the path of utilization Knowledge Management in Service Desk system is smoothed, however, the number of Service Desk systems that have adopted a Knowledge Management structure is few and the adoption is not practical in many cases. In this paper we try to address this issue and focus on Knowledge Management structure utilization in Service Desk systems by integrating Case-based Reasoning and Service Desk structure.

Keywords: Incident Management, Problem Management, Service Desk, Knowledge management, Case-based Reasoning

1. INTRODUCTION

In general, the Knowledge Management Service Desk have attracted attention over last years and by adding Knowledge Management to the ITIL version 3 in 2007 the importance of considering Knowledge Management in IT organizations is observed more than ever.[1] Service Desk facilitates the accessibility and availability of IT organization’s services in supporting the agreed IT service provision by adopting various techniques. By using Service Desk the reception, response and troubleshooting of end-users’ issues regarding organization’s services are handled. [2], [3]

Service desks have a prominent and vital role, especially in IT organizations that provide services to their customers and as they are engaged with a lot of data and information, the usage of Knowledge Management concept in service desk systems is inevitable. During the last decade, researches were conducted on the subject and some real world problems have been exemplified, however, there are so many problems to be solved and improvements are possible. One of the main problems in Service Desk topic is the acquisition of the knowledge about information technologies supported by Service Desk. In order to solve a reported incident, technicians must have the knowledge of information technologies engaged in the incident; however, the information technologies are increasing rapidly [4]. According to Gartner Group that conducted a study on Service Desk systems, the average of the information technologies that are supported by Service Desks had increased from 25 to 2000 from 1996 to 2001[5]. So imagine how big the number might be these days!

One of the other problems is, finding proper solution when technicians do not possess the knowledge over domain to find the solution, if it was not found on the first encounter. It is also mentioned by Jäntti and Kalliokoski [6] in 2010 that search for the proper solution and related incidents is time consuming; more there is no effective method to search for the solution in databases.

Knowledge Management is a technology that increases our understandings and helps the organizations to make decisions and solve problems more effectively by providing strategy, process and technology to spread information and experiences [7]. Accordingly applying Knowledge Management concepts on Service Desk is on the increase and some research and commercial applications adopted Knowledge Management in creating an effective Service Desk, but still there is much to do.

The Knowledge Management technique that this paper proposes is Case-based Reasoning (CBR). From a Service Desk point of view, managing incidents and problems related to the IT organization is the main goal, nevertheless a framework is needed. The Service Desk structure deployed in this paper is based on ITIL v3; hence the Incident Manager and Problem Manager activities are considered a part to it. ITIL v3 is chosen because it is the most used framework in IT Service Management. According to Mauricio Marrone [8] the impact of ITSM frameworks on the IT organizations among the US IT companies which had adopted ITSM frameworks; ITIL has the highest rate of adoption in 2009 with 24%.

There are many sources that describe ITIL; this paper sheds the light on, the Incident Management and Problem Management chapters of ITIL; with Knowledge Management techniques harnessed and a proposed system provided.

2. INCIDENT MANAGEMENT IN ITIL FRAMEWORK

Jan van Bon defined an “incident” in his book as [9]:
"Any event which is not part of standard operation of a service and which causes, or may cause, an interruption to, or a reduction in the quality of a service"

By building on the definition of incident, the goal of Incident Management is understood as restoring the normal operation of services as quickly as possible with the minimization of the incident’s impact on business and customer satisfaction according to the Service Level Agreement (SLA) agreed-upon with the customer [10].

Other activities like escalation (which needs the line of support classification) or assignment parameters like priority, urgency and impact should be considered in Incident Management workflow, however, generally the activity line of Incident Management is as in figure-1 [2], [9], [11].

- **Incidents acceptance and recording**: In this phase an incident record is created upon the users call or any other way like email.
- **Classification and initial support**: The type, impact, urgency and priority of the incident are mentioned in the report and a solution (even if it is temporary) is given to the user.
- **Service Request initiated**: If the user asks for a service request the procedure is started.
- **Matching**: Searching the database for a solution for the incident.
- **Resolution and Recovery**: Solving the incident upon finding the solution.
- **Closure**: The case is closed upon the satisfaction of the user.

### 3. Problem Management in ITIL Framework

The definition of “problem” according to ITIL [9]:

“A problem is a cause of one or more incidents. The cause is not usually known at the time a problem record is created, and the problem management process is responsible for further investigation.”

Considering the problem definition, the key objective of Problem Management would be preventing problems from happening and minimize the impact of incidents.

![Figure 1: Incident Management Activity Line based on ITIL framework](image-url)
without proper solutions. The workflow of Problem Management is illustrated in Figure-2 [12].

Two following concepts in Problem Management could save the organization a lot of time and resources [12], [13], [9]:

**Problem identification and recording:** Although in principal any incident with unknown cause should be identified as a problem, if you identify any incident as problem there will be chaos in the Problem Management and technical teams will be bombarded with many unnecessary problems. Consequently, allocating incidents with the high impact on business or recurring incidents should be considered.

**Problem investigation and diagnosis:** There is a contrast between Problem investigation and incidents solving, problem investigation is considered an iterative phase. With each turn you get closer and closer to the desired solution; in some cases you might need to reproduce the incident to see the result by yourself for the sake of comprehending the incident and eventually the problem root. Sometimes the root cause is not recognizable, not cost-effective or more investigations may be needed to reach the final resolution; in such cases a temporary fix is offered to keep the impact of the problem at the minimum size.

4. KNOWLEDGE MANAGEMENT APPROACH

We can simply define Knowledge Management as doing what is needed to get the most out of knowledge resources [14]. Utilizing Knowledge Management has been increasing with in the past decades among organizations as a result of the promotion in creation, sharing and leveraging of the organization, which Knowledge Management can provide. With the increase of domain complexity, accelerating market volatility, intensified speed of responsiveness and diminishing individual experience, the integration of Knowledge Management concepts and technologies is inevitable these days [14].

Numerous techniques abide within Knowledge Management literature; the determining factor is the

![Figure 2: Problem Management Activity Line based on ITIL framework](http://www.cisjournal.org)
domain characteristics. This approach adopts **Case-based Reasoning** as the underlying method; nevertheless, there are some other methods as below [14]:

- **Frame-based Reasoning**: The main concept of the Frame-Based Reasoning is about questioning and answering. For each object in the systems a frame (contains all attributes related to it) is created and in order to find information about a particular attribute a question is asked directly or indirectly by using inheritance form the parent frame. Frame-based Reasoning usually is used to increase the performance of other reasoning methods and rarely used individually.

- **Rule-based Reasoning (RBR)**: Rule-based Reasoning is more complex and formalized rather than Frame-based Reasoning. In RBR the problem is solved based on a set of rules provided previously; it has two methods: Backward reasoning and Forward reasoning. The process can be started either with problems and ended with the right solution or the other way. In the RBR finding the right rules can be a real challenge.

In Case-based Reasoning new problems are solved according to previous experiences and each solved problem serves as a new case which can be helpful in solving incoming problems. The lifecycle of CBR [16] is illustrated in Figure-3.

By considering Figure-3 it can be observed that every Case-Based Reasoning system should consist of [14]:

- A **Case Library** which is a repository for the previous cases and consists of knowledge created in the happened and solved problems.
- In order to find a solution the system needs a method to search the case library and retrieve similar cases.
- **Adding new solved problems to the case library also needs a method.**

These other methods are not to be underestimated, for that the rationale behind the approach is related to the domain and system design. With Problem and Incident Management, CBR seems to be a sound and practical choice for the reasons above and because of the disadvantageous and advantageous attributes associated with other methods and CBR, respectively and as enumerated below.

**RBR disadvantages** [14]:

- Results can vary according which expert’s knowledge is considered as each expert has his own perspective on domain.
- Absorbed knowledge by knowledge engineers form an expert can be transformed incorrectly although the expert has the right knowledge.
- Too many rules are needed to cover the entire needs of the domain.

**CBR advantages** [14]:

- Knowledge acquisition process will be simple.
- Learning ability of the CBR greatly facilitates knowledge maintenance.
- It would be easier to be implemented in organizations that their experts do not possess a deep understanding of the domain.

5. **NEW APPROACH**

In this section of the paper each part of the new approach is described separately.

5.1 **Categorizing**

In the new method we need to categorize the organization’s services or products precisely otherwise the
performance of the system would not be acceptable. To categorize the services or products, an inheritance should be considered and each category has its own parent and subcategories. To clarify the category tree, figure-4 is illustrated in a hypothetical organization that provides solutions for any computer related matters. Any other method that is used in this article will be explained base on this tree.

5.2 Shared Path

Some parts of the tree can link to another tree. Considering the network tree, some of the problems and incidents related to the network problem are related to the Internet issues and as we have another tree for Internet problems, the problems and incidents related to the Internet that were reported under network category by preliminary investigation, are forwarded to the Internet tree.

This method reduces the amount of the data we need to save in database and accordingly the search and retrieve will be faster. This shared path could be like Internet tree that contains a whole tree or like Printer tree that only shares part of its tree with Network as Network Printers.

5.3 CBR Workflow

Upon designing and categorizing the organization’s services the new CBR workflow will be applicable as Figure-5.

In case the solution is not found on the first search a method of Adaptation is needed in CBR technology. To fulfill this, the Case Library is searched according to a set of rules prepared before, based on the domain expert’s knowledge. Rules Library contains how the values of each attributes can be replaced by each other to get a new set of solutions which has the highest likelihood of solving current incident.

Figure 4: A part of the category tree provided to clarify the category and shared path concepts – for the implementation, the complete tree is used.
For instance, by considering figure-4 when it goes on the model layer you might be able to change the models of certain Access Points and still be able to find a proper solution for current incident and the new solution set is applicable on the incident in hand. By considering this, a rule must be defined in the Rule Library that values of the fifth level can be replaced by each other as the automatic adaptation. In this case the models value should be change if the solution was not found on the first normal search. So the value of the Access Point’s model is replaced by its nearest neighbor-another model of the same Access Point producer- to find nearest solutions.

5.4 Learning

As new solved cases are added to the Case Library, it is becoming more effective and less time is needed to solve incoming problems and incidents, however, there are some problems in adding cases and solutions to the database of the system. The first problem might arise from too many cases with little diversity and the second, is inconsistency between solution and incident. It means problems and incidents in the same area of problems space must have solutions in the same area in the solution space. If this rule is not considered in the Knowledge Management based system it causes inconsistency in the system. [14]

In order to regulate the learning system an administrative, supervisor or a team of supervisors who have a deep understanding of the system and domain are needed to approve each created case or solution. Each new solution is added to the solution library upon the approval of the supervisor.

5.5 Mapping Knowledge Management Process

Since the Knowledge Management concepts are proposed there have been some models for Knowledge Management [15], however, the model that is the most proper one for our approach are as below:

- Capturing information
- Storing information
- Transforming information in to knowledge
- Dissemination and Utilization of knowledge

By considering our new approach, Incident Management and Problem Management activity line, Table-1 shows the mapped process.

Table 1: Mapped Process of Incident & Problem Management and Knowledge Management

<table>
<thead>
<tr>
<th>Knowledge Management</th>
<th>Incident Management</th>
<th>Problem Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capturing Information</td>
<td>Recording and Diagnosing</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>Storing Information</td>
<td>Closing Incident</td>
<td>Reporting and Control</td>
</tr>
<tr>
<td>Transformation</td>
<td>Work around and Solving</td>
<td>Problem Resolution</td>
</tr>
<tr>
<td>Dissemination and Utilization</td>
<td>Investigation</td>
<td>Problem determination, Workaround &amp; Recovery</td>
</tr>
</tbody>
</table>
6. IMPLEMENTATION

The Application made to cover the Incident Management and Problem Management procedures has 3 major parts:

- **Incident Manager:** In Incident Manager technicians can choose to create new incident ticket or solve previously created and escalated incident tickets. An incident ticket is created by entering related information; as a result, a list of existed solutions for the selected category is shown. If solution could not be found within the list, the adaptation comes in. There are two ways of adaptation as:
  - Automatic adaptation
  - Manual adaptation

They are described in the CBR workflow section thoroughly and the related screenshots of the application are figure-7 and 8.

There is a possibility that technicians come up with a new solution for the incident in hand. In this case the concepts described in the learning section are used. We cannot simply add each new solution to the database and each new solution is added to the database as a temporary solution.

- **Case Manager:** As it is mentioned in the Learning section of the main project report each temporary solution must be approved by admin team in order to avoid escalation in solutions. In order to fulfill this purpose the Case Manager section is designed and developed to handle the new solutions. Each solution can be used after the approval of the admin team.

- **Problem Manager:** In this section technicians can look for the incidents based on the category they are selecting and create a problem ticket. The solutions found in the problem management procedures are marked as root-cause solution so the technician will know which existing solution can solve the root problem of the incident in hand.

Figure 6: Relational Diagram depicting the major tables of the system
The next steps of implementation are as below:

- **Relational Diagram:** The Relational Diagram of the system is shown in the Figure-6.
- **Interface Design:** Although the application has many parts; the only necessary section for this paper is the Incident Manager, because the new Adaptation method and Shared Path are mostly used in this section. The Figure-7 and 8 show the Incident Manager Interface.

7. **EMPIRICAL TESTING**

In order to test the application a dataset comprising of hardware and software problems was gathered. The dataset has more than 850 records and solutions gathered form FAQ and Knowledge database of service providers and producers’ websites. The solved issues found in official forums of producers also were considered. By using the dataset to functionally test the application, the below findings were observed:

- Thanks to categorizing method the search over database takes less time and the result are shown almost instant.
- Because only the solutions related to the incident in hand are shown, the number of solution that technicians must go through to find the solution is diminished dramatically in comparison with conventional methods.
- The shared path technique not only reduces the database size but also the time to fill the database.
- If the Rule Library used for the automatically adaptation technique be created carefully and with proper knowledge of the domain, it is effective to find the nearest neighbor of the current incident.

![Image of Incident Manager Interface](image-url)

**Figure 7:** Incident Manager Interface- the requester section screenshot

**Figure 8:** Incident Manager Interface- the category and solutions section
The new system also has some limitations like:

- Finding solution still depends on the solved cases and it cannot be useful for completely new incidents.
- Adaptation is limited to our technique and although other techniques can be effective under certain condition, this might lead to unnecessary algorithmic confusion and technician might not feel transparency.

8. CONCLUSION

Service Desk systems are widely used in any organization’s customer service and technical support department and providing a convenient and fast method is crucial. In this paper the Incident and Problem Management of ITIL framework are described and used as the underlying structure of Service Desk. Then the Knowledge Management techniques -CBR and RBR- are analyzed; based on a conducted comparison, CBR is selected for the main implementation technique.

We provide a new method for Case-based Reasoning to tackle current problems and concerns in Service Desk systems. Shared path and new adaptation method are provided; both of these methods are based on a comprehensive category tree. Thanks to the category tree, the solutions shown to technicians are filtered and only the most related cases are listed, so time and efforts that might be needed to find the solution for the incident in hand diminish dramatically. All products or services of the organization must be scrutinized prior to implementing shared path and adaptation. The shared path is helpful in reducing the size of the solutions’ database and new adaptation method is used to augment effectiveness of searching, in case the solution could not be found on the first encounter. In adaptation method values of a specific level of category tree are replaced by each other to list a new set of solutions which have the highest possibility of solving the incident.

Based on the theoretical part of the paper an application is designed and tested. The relational diagram and screenshots of the application are also provided and the benefits and limitations of the new method are listed based on the conducted tests. A comprehensive and fully narrowed category and new adaptation method are inseparable and without a proper category system the result would not be acceptable. The Learning process also has a very essential role in our system and needs proper attention to add new solved cases to the solution library to avoid escalation.

This paper tries to work on a new perspective about adopting Knowledge Management techniques with Service Desk systems. This would not be the ultimate CBR integration with Service Desk system and the adaptation method can be improved in many ways. Future research in the application of Knowledge Management techniques in Service Desk applications is recommended.

REFERENCES

[12] Problem Management process guide