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Comparative Study of Domain Driven Data Mining for It Infrastructure Suport

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Abstract— Information Technology (IT) is one of the most emerging fields in today's Internet world. IT can be defined in various ways, but is broadly considered to encompass the use of computers and telecommunications equipment to store, retrieve, transmit and manipulate data. Infrastructure is the base for everything. IT also has an infrastructure, which can be managed and maintained properly. For an organization's Information Technology, Infrastructure Management (IM) is the management of essential operation components, such as policies, processes, equipment, data, human resources and external contacts. This paper, propose a methodology to manage the IT Infrastructure in a better way. In the proposed methodology uses the tree-structure based architecture to manage the infrastructure with less manual power. To maintain such services, we have to set up an infrastructure and also provide essential steps to maintain and manage those kinds of services. This kind of management is termed as IT Infrastructure Management Services. While the user wants to use this kind of IT Services, the infrastructure paves way for this by providing proper responses for the requests made by the user. These responses are provided by the IT resource persons who are managing and maintaining the services. The proposed methodology deals with this by undertaking the requests from the user and providing proper responses for the requests. The response is provided by analyzing the requests and then redirecting the requests to the resource person who are considering that kind of request. Thus the proposed methodology provides proper services for the user by managing the work flow in the IT Infrastructure. This paper also compared with the other methods in the domain driven data mining area, to ensure that the proposed method is more efficient in terms of SLA service level agreement and methodology when compared to other methods.

Keywords- (IM) (IT).

I. INTRODUCTION

Domain-Driven Data Mining: A Practical Methodology One of the fundamental objectives of KDD is to discover knowledge of main interest to real business needs and user preference. However, this presents a big challenge to extant and future data mining research and applications. Before talking about actionable knowledge discovery, a prerequisite is about what is knowledge action ability. Then, further research can be on developing methodologies and facilities in order to support the discovery of actionable knowledge.

The following existing algorithm (Domain-Driven Data Mining: A Practical Methodology, *Longbing Cao*) on a Linux box with eight CPUs (Intel(R) Xeon(TM) MP CPU 2.00GHz) and 4GB memory.

The results indicate that parallel computing and efficient implementations can extremely accelerate the computation of data mining. However, in this case, eight CPUs make little difference from four CPUs.

This is probably due to the overhead from system and managing master and slave sub processes.

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II. ALGORITHM

The life cycle of DDID-PD is as follows, but be aware that the sequence is not rigid; some phases may be bypassed or moved back and forth in a real problem.

Every step of the DDID-PD process may involve domain knowledge and the assistance of domain experts.

P1. Problem understanding
P2. Constraints analysis
P3. Analytical objective definition, feature construction
P4. Data preprocessing
P5. Method selection and modeling or
P5'. In-depth modeling
P6. Initial generic results analysis and evaluation
P7. It is quite possible that each phase from P1 may be iteratively reviewed through analyzing constraints and interaction with domain experts in a back-and-forth manner or P7': In-depth mining on the initial generic results where applicable
P8. Actionability measurement and enhancement
P9. Back and forth between P7 and P8
P10. Results post-processing
P11. Reviewing phases from P1 may be required
P12. Deployment
P13. Knowledge delivery and report synthesis for smart decision making

The DDID-PD process highlights the following highly correlated ideas that are critical for the success of a data mining process in the real world.

Domain-driven Data Mining for IT Infrastructure Support (Girish Keshav Palshikar)

The author Girish Keshav Palshikar discussed in the paper regarding D3D algorithm with help of standard data mining algorithm. This approach which extract different types of knowledge from given historical data. But this variety has led to technology fatigue among end-users. First, there is no unified representation for the many different types of knowledge extracted (decision rules, clusters, associations etc.), making it difficult for users to relate extracted knowledge elements. Next, even the volume of extracted knowledge tends to be large, making it difficult for users to filter and use it.

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Research on knowledge filtering and knowledge selection using interestingness measures are useful, though the problem is far from solved. Lastly, there is a huge gap between the extracted knowledge and practical business goals of the user (e.g., the questions stated above). Extracted knowledge is not aligned to (and hence not directly usable for meeting) the users business goals. It becomes the users responsibility to understand and make use of the extracted knowledge to solve a business problem. This requires expertise in setting up appropriate data-mining experiments, selecting and understanding the extracted knowledge and applying it to solve the business problem. This demands data-mining expertise as well as domain expertise - a rare combination. In this paper, the authors attempt to bridge this gap by adopting a domain-driven data mining approach, increasing acceptance from end-users. As an example, the author also developed domain-driven data mining algorithms for workforce analytics in ITIS domain and also in customer and employee survey domain. Instead of trying to fit a data-mining technique to a business problem, the authors adopt a top-down approach where they begin with a business goal. The author has implemented their methods by introducing ITES domain. The following session illustrate the implementation of the existing methodology with sample data set.

III. EXAMPLE DATASET

When using an IT resource, the users sometimes face errors, faults, difficulties or special situations that need attention (and solution) from experts in the ITIS function. A *ticket* is created for each complaint faced by a user (or *client*). This ticket is assigned to a *resolver* who obtains more information about the problem and then fixes it. The ticket is *closed* after the problem is resolved. There is usually a complex business process for systematically handling the tickets, wherein a ticket may change its state several times. Additional states are needed to accomodate reassignment of the ticket to another resolver, waiting for external inputs (e.g., spare parts), change in problem data etc. *Service time (ST)* of a ticket is the actual amount of time that the resolver spent on solving the problem (i.e., on resolving that ticket). ST for a ticket is obtained either by carefully excluding the time that the ticket spent in ”non-productive” states (e.g.,*waiting*) or in some databases, it is manually specified by the resolver who handled the ticket. The historical data of past tickets can provide insights for designing improvements to the ticket handling business process. For illustration, this author consider a real-life database of tickets handled in the ITIS function of a company. Each ticket has the attributes shown in Table I. The database contains 15538 tickets created over a period of 89 days (with status = ’Closed’), all of which were handled at level L1. In ITIS terminology, simple problems are handled at level L1, problems requiring expertise and special skills are escalated to and handled at level L2. The hardest problems requiring complex solutions are handled at level L3. Summary statistics for various quantities is shown in Table II, where Q1, Q2 and Q3 are the first, second and third quartiles. The ST histogram in Fig. 1(a) shows peaks at the left and right ends, implying that a noticeable fractions of tickets have either short ST (< 30 minutes) or large ST (> 240 minutes). The peak on the right end is really an aggregation of the long tail on the right. Fig. 1(b) shows a histogram of the *experience* levels among the 66 resolvers for this 3 month window, as measured by the number of tickets handled by them. The resolvers’ experience before this period is not taken into account here. The peaks at the left and right ends clearly show noticeable fractions of the resolvers having either little experience (< 50 tickets) or sizeable experience (> 400 tickets), thereby implying a team with mixed experience levels (high, medium, low)

Table I
COLUMNS IN THE SAMPLE TICKETS DATASET.

Column Name	Description	#distinct values
Ticket_id	Unique ID for each ticket	15530
Client_id	Unique ID of the end user who is facing the problem denoted in a ticket	8022
Client_location	Unique ID of the office location or business unit to which the client belongs	25
Severity	Degree of severity of the problem	2
Priority	Priority with which the ticket was requested to be processed	3
Problem_type	Broad area of the problem; e.g., Hardware, Software, Networking, Messaging, Security etc.	10
Problem_item	Problem sub-area; e.g., for problem_type='Networking', these are: Access rights, DNS, Proxy, Router, ISDN, Dialup, Wireless etc.	44
Problem_subitem	Further details about the problem; e.g., for problem_type = 'Networking' and problem_item = 'Access rights' these are: Home folder access, Project folder access, Server access etc.	103
Resolver_id	Unique ID for the person who resolved the ticket	66
Resolver_location	ID of the group or location to which the resolver belongs	24
Create_dt	Datetime stamp when the ticket was created by the end-user (client)	
Solve_dt	Datetime stamp when the ticket was finally resolved	
ST	Estimated total service time spent in resolving the ticket (in minutes)	

Table II
. SUMMARY STATISTICS FOR VARIOUS QUANTITIES FOR THE EXAMPLE TICKETS DATASET.

Quantity	Average	STDEV	Q1	Q2	Q3
ST (minutes)	360	4797	21	72	169
Number of tickets arriving per day	172.6	111.7	23	217	251
Total no. of tickets handled by a resolver	235.3	176.5	84	245	335
Team size per day (no. of resolvers who closed at least 1 ticket on a day)	27.5	16.5	7	36	41
Resolver productivity (no. of tickets resolved per resolver per day)	5.94	4.33	3	5	8
Resolver efficiency (average ST per ticket for a resolver)	2862.0	19705	136	212	387

Table III
JUSTIFICATIONS FOR EXAMPLE TICKET TYPES CANDIDATES FOR AUTOMATION.

Ticket type	#Tickets	#Non-outlier tickets	ST Avg.	ST STDEV	#Tickets with low ST	% Tickets with low ST
problem_type = 'TCS Global Domain' ∧ problem_item='Account Management' ∧ problem_subitem='Unlock account'	751	734	47	65	505	68.8
problem_type = 'Audio and Video Conferencing' ∧ problem_item = 'Audio' ∧ problem_subitem = 'Audio Conference Request'	577	558	39	107	460	79.7

Table IV
HEAVY HITTER TICKET TYPES.

Ticket Type	#Tickets	ST Avg.	ST STDEV	ST %	Tickets %	Cost
problem_type = 'Global Messaging Support (Lotus Notes)' ∧ problem_item = 'Messaging Support' ∧ problem_subitem = 'Archiving Problems'	63	567	2127	0.64	0.41	1.57
problem_type = 'Global Messaging Support (Lotus Notes)' ∧ problem_item = 'Messaging Support' ∧ problem_subitem = 'Lotus Client Configuration'	470	510	991.47	4.29	3.03	1.42

Table V
TICKET TYPES HAVING UNUSUALLY HIGH SLA NON-COMPLIANCE.

Ticket type	#SLA non-compliant tickets	#Tickets	% SLA non-compliance
problem_item='Messaging Support' ∧ problem_subitem='Account Lockout'	19	584	3.25
problem_item='Leased Line' ∧ problem_subitem='Leased Line Link Down'	10	47	21.3
problem_item='Messaging Support' ∧ problem_subitem='Group or Functional Id Creation Deletion and Modif'	8	30	26.7
problem_item='Installation' ∧ problem_subitem='Analog Phone Installation'	2	31	6.5

The following tables 1, 2, 3, 4, 5 are used as sample data set to implement the existing algorithm proposed by the author [Girish Keshav Palshikar]

IV. ALGORITHM

algorithm heavy_hitters
input D {tickets table containing N tickets; $N = |D|$}
input T_0 {total ST spent on all tickets in D}
input $A = \{A_1, \ldots, A_m\}$ {set of m problem columns}
input n_0 {min. no. of tickets a selector must have}
input P {max. no. of columns in selector; default=$min(3, m)$}
input k {desired no. of heavy hitters (default = 10)}
output O {heavy hitter ticket types (selectors)}
$O = \emptyset$ {initially empty}
for all $j = P \ldots 1$ **do**
  empty statement
  for all subsets $B \subseteq A$ containing j columns **do**
    X := set of all selectors using columns in B and their costs obtained using following query
    select $B_1, \ldots, B_j$, ((1.0 * sum(ST))/(1.0 * T_0))/((1.0 * count(*))/(1.0 * N)) from T group by $B_1, \ldots, B_j$ having count(*) >= n_0
    Let Y = subset of selectors in X using an outlier method
    Let $O = O \cup Y$ {add Y to set O}
    if $|O| \geq k$ **then** {done}
    retain top k selectors in O in order of cost
    return O
    end if
  end for
end for
return O

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V.RESULT

In most support processes there is a specified time deadline for each type of problem, called *Service Level Agreement (SLA)*, which is a specified time limit within which any ticket of that problem is required to be processed. A ticket may have different SLAs for different actions; e.g.,SLA for first response, SLA for final resolution etc. As a result, tickets datasets often include columns called service quality flag(s), which indicate whether that ticket met the specified SLA or not (can also include SLA limit).

In most support processes are monitored for SLA compliance levels. All problems are supposed to restrict the such problems are often of interest (and focus area) for improving SLA compliance, each ticket includes a Boolean column called customer_resolve_sla, which indicates whether or not the ticket met the SLA. One approach is to adopt the subgroup discovery algorithm given earlier to examine selectors formed using the given set of problem attributes and identify those selectors for which the ratio of number of SLA non-compliant tickets to the total number of tickets is above the global average. The author have also used a standard classification approach to solve this problem. They treat the column customer_resolve_sla as a class label and then apply a statistical classification algorithm, such as decision tree or classification-based on association (CBA), to discover classification rules. For example, each path from the root to a leaf node labeled customer_resolve_sla = 0 (excluding the leaf node itself) in the decision tree learned from such a training dataset characterizes one subset of tickets. They can compute the fraction of SLA non-compliant tickets in each such subset and select those for whom this fraction is above the overall (global) average. In the example dataset, 15548 tickets (99.5%) have met the SLA and 80 tickets (0.5%) have missed the SLA. Table V shows some ticket types discovered by the CBA algorithm, which have unusually high SLA non-compliance (much more than the global average of 0.5.

In the previous existing algorithm the tickets are labeled automatically by assigning ticket number as per queue fashion FIFO. The remark in the existing algorithm take more time to process the customer request as per the ticket number, for that it is essential to develop on efficient solution for IT management services based on issues in ticket processing.

In this paper proposed algorithm is developed to process the service as per the status of issues [Domain Driven Data Mining: An Efficient Solution for IT Management Services on Issues in Ticket Processing]

The objective of the proposed algorithm to perform the complex functions required in the IT field. The modern Information Technology would use many things such as computers, servers, database management systems and cryptography. It would also made up of several System Administrators, Database Administrators and IT Manager. With the help of these resources, the IT Management Services would be most efficient and powerful. The most popular IT Skills at the moment are:

- Computer Networking
- Information Security
- IT Governance
- Business Intelligence
- Project Management

Information Technology Departments will be increasingly concerned with data storage and management, and will find that information security will continue to be at the top of the list. To lead in this trend this paper focuses the Implementation of Domain Driven Data mining in IT Management service in Order to Provide better efficiency.

In this paper, we implement the Domain-Driven Data Mining in IT Management services in order to reduce the work flow in the organization, and to analysis the issues occurred in the ticket, handling the issues and then fix the issues through proper methodology. The proposed methodology experimentally verified in order to check for the efficiency of the proposed algorithm.

Proposed Method

The aim of the paper is to propose a methodology to fix the issues raised in the ticket submitted by the user in order to process the request, and to improve the customer satisfaction. The summary of the proposed methodology is as follows: The IT Organization comprises of several levels of industrial patterns, to manage and maintain the infrastructure. Each level performs its own functions depending upon the organizational structure. Domain-Driven Data Mining extends organizational toolbox and borrows from well-known industry patterns. Organizational patterns that the domain-driven data mining lays out are that there are solutions for every level of detail in the system.

In this paper, the IT Infrastructure management can be carried out in Domain-Driven Data Mining in order to provide a generalized solution in any kinds of domain, that we can be implemented. The initial step is to receive the tickets from the user to process. Upon receiving the tickets from the user, the tickets can be classified into categories based on the concern. Since the tickets has been processed based on these categories.

Upon classifying the tickets into categories, the next step is to check for any issues or errors arised in the submitted tickets. If so, then the issues are analyzed in order to verify whether the occurred issues are relevant to each other. After analyzing the issues, the next process is to find the ticket with high issue rate. The found ticket is then undergoes for the process. Then RCA is applied on the ticket.

RCA (Root Cause Analysis) is a method of problem solving that tries to identify the root causes of faults or problems that cause operating events. The RCA is applied on the tickets with issues. The result is then obtained and then analysis the result to get the ticket with high issue rate. The ticket with high issue rate is identified and then analyzed the cause for the issue. Upon analyzing the cause, the next step is to verify whether there is any option to fix the issue. If so, the next step is to apply CI on that issue.

CI (Continuous Improvement) is a method to improve the status of the tickets with issues through continuous periodic improvement to overcome the issues. The CI can be applied on the ticket in the category, to find the solution. The identified solution can be applied on every ticket in the category and analyze whether the solution reduces the number of tickets causing the issue. If so, we can fix the solution to improve the customer satisfaction by reducing the number of tickets.

Thus, with the help of RCA, we can analysis the cause for the issue and through CI, we can fix the issue and to reduce the number of tickets causing the issue.

Through the proposed methodology, we can gain more advantages which are as discussed below:

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- Reduce the number of issues.
- Increase the customer satisfaction

No. of Tickets	Tickets with Issues	Processing Rate %(in Existing System)	Processing Rate %(in Proposed System)
10	3	75	95
20	12	50	98
50	32	43	99
75	45	33	99
100	78	31	99.9

- Increase the number of customer requirements
- No need to wait for SLA
- Efficient way to fix the issue.

The proposed methodology provides a better solution to manage the issues arise in the IT field.

VI. PROPOSED ALGORITHM

Begin
Get the tickets from the user
Categorize the tickets based on the concern
For i in 1 to n categories
If issues on tickets = true then
ICat = category(i)
End if
Next
Apply RCA on ICat
Cause = Identify the root cause for the issue using RCA
If Cause possible to solve then
Apply CI on the tickets
Solution = Identify the solution using CI
End if
If Solution minimize the issue then
Apply Solution to fix the issue
End if
End

Comparing these two periods, the proposed framework seemed to be performing well and the request has been processed successfully and efficiently.
The sample data related to banking information is shown in the following table-1 to table-6.

Table – 1: Resource Person List (rplist)

RP ID	Status
RP1001	Free
RP1002	Allocated
RP1003	Allocated
RP1004	Free
RP1005	Free
RP1006	Free
RP1007	Free

Table – 2: Tickets

Ticket No	User Name	Request
T101	ABC	Account Creation
T102	XYZ	Net Banking Request
T103	SKV	Recover Password
T104	MNP	Senior Citizen FD Details
T105	VND	Account Details Updation
T106	SSD	Account Information
T107	PQR	Online Transfer

Table – 3: Priority Setting

Ticket No	Time Bound	Priority
T101	30 – 40	Low
T102	45 – 50	Low
T103	10 – 15	High
T104	10 – 15	High
T105	20 – 25	Medium
T106	10 – 15	High
T107	25 – 30	Medium

Table – 4: Queue-1 (with High Priority)

Ticket No	Status
T103	RP1001 (Processing)
T104	RP1004 (Processing)
T106	RP1005 (Processing)

Table – 5: Queue – 2 (with Medium Priority)

Ticket No	Status
T105	RP1007 (Processing)
T107	Waiting (until RP free)

Table – 6: Queue – 3 (with Low Priority)

Ticket No	Status
T101	Waiting (until RP free)
T102	Waiting (until RP free)

These tables' shows the proposed framework by splitting the request from the main queue into sub-queues based on time bound. Thus the proposed framework performs well and the aim of the paper has been successfully implemented in this paper.
The experiment is taken out in banking sector in order to verify the efficiency of our proposed method. In that banking sector, we undergo an experiment with two sections. First, we test the result of processing the tickets without implementing the proposed methodology. Also, each ticket is processed independently and so the time consumption to process the ticket becomes more. Secondly, we implement the proposed methodology to verify the result.
In This paper the proposed methodology, the tickets have been categorized and then it undergoes for processing. So the time consumption becomes less. Also the issues arise in the tickets has been processed efficiently in the proposed method than the existing method. The comparison has to be made between these two sectors and the resultant shows that the proposed method provides better solution in solving the tickets with issues in a much better way with the help of RCA and CI methods.

Table.7 Comparison Data

The comparison result is shown below:

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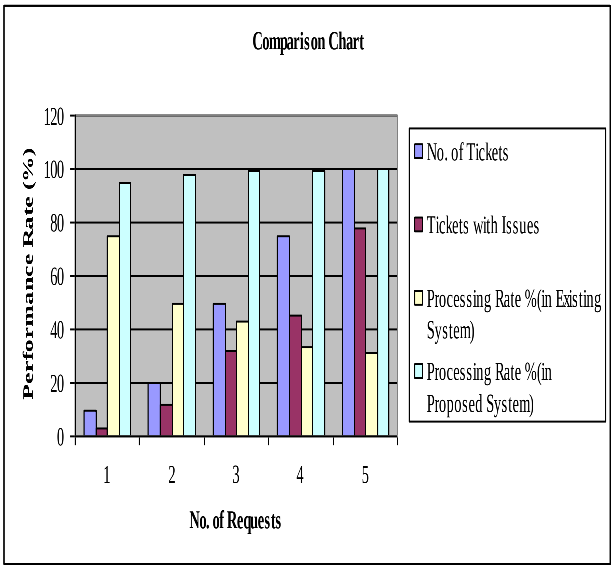


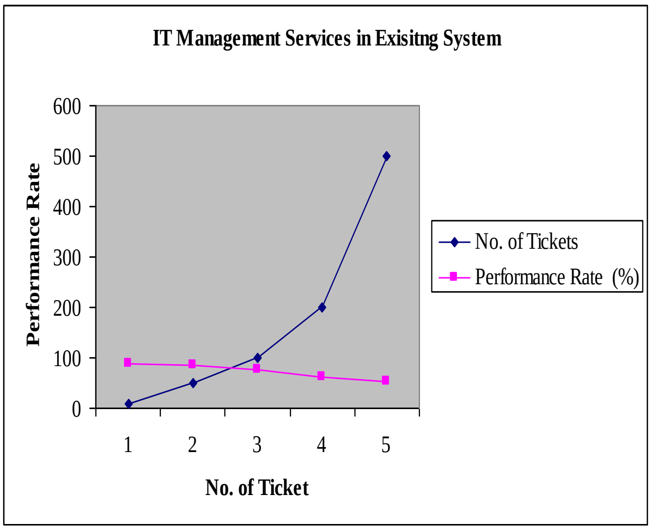
Fig.7 Comparison Chart

From the comparison chart, it is clear that when the number of tickets and the issues increases, the performance of the existing system becomes low compared to the proposed methodology. Thus, our proposed system performs well in solving and processing the tickets.

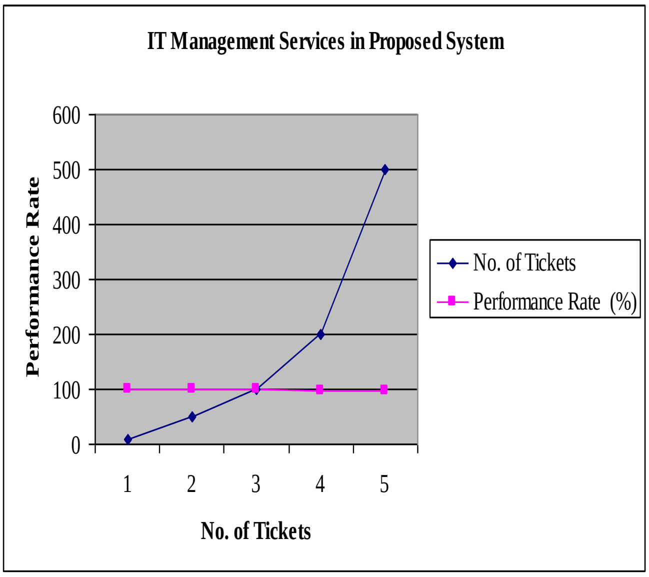
EXPERIMENT-1: IT MANAGEMENT SERVICES IN EXISTING SYSTEM:

No. of Tickets	Performance Rate (%)
10	89
50	84
100	75
200	63
500	53

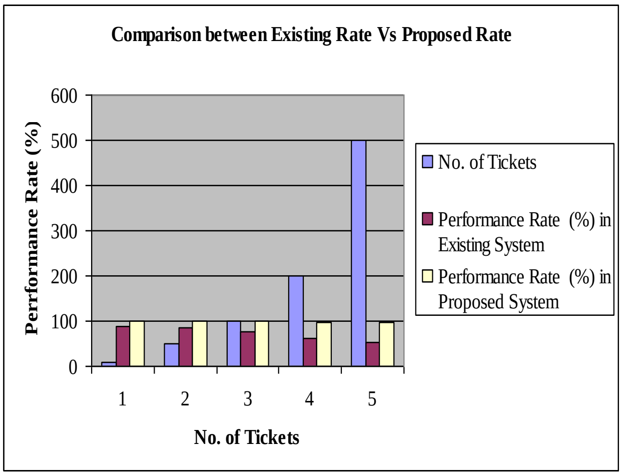
No. of Tickets	Performance Rate (%)
10	100
50	99.9
100	99
200	98.5
500	98



EXPERIMENT-2:IT MANAGEMENT SERVICES IN PROPOSED SYSTEM:



EXPERIMENT-3: COMPARISON BETWEEN IT MANAGEMENT SERVICES IN EXISTING SYSTEM Vs PROPOSED SYSTEM:



EXPERIMENT-4: PROCESSING OF TICKETS BASED ON QUEUE MANAGEMENT:

No. of Tickets	Time to process without Queue Management	Time to process with Queue Management
10	20	5
50	100	25
100	300	40
200	450	45
500	980	50

No. of Tickets	Performance Rate (%) in Existing System	Performance Rate (%) in Proposed System
10	89	100
50	84	99.9
100	75	99
200	63	98.5
500	53	98

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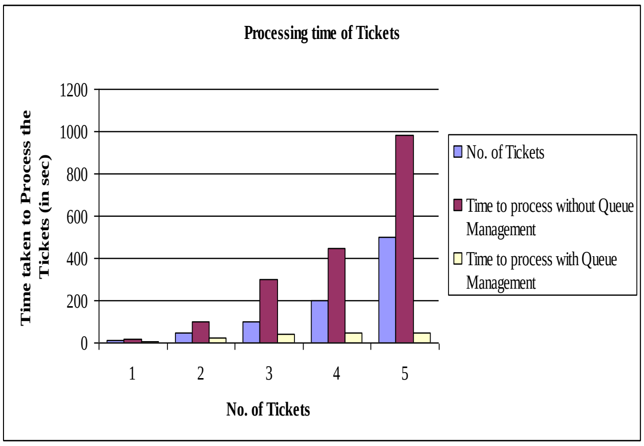
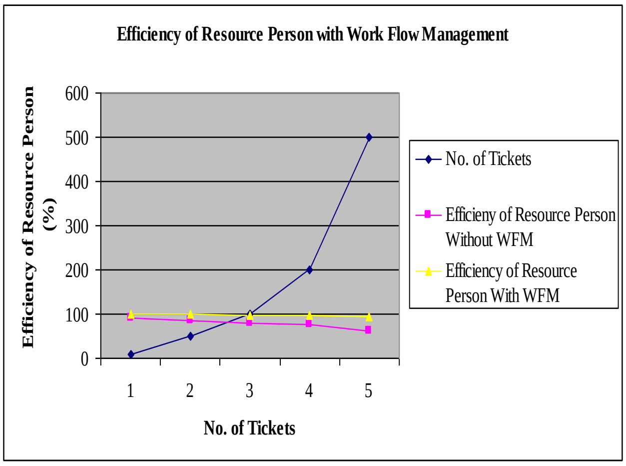


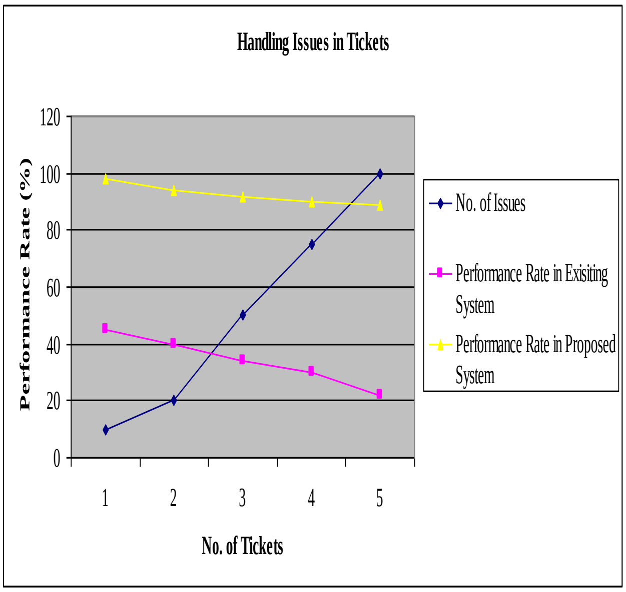
EXPERIMENT-5: EFFICIENCY OF RESOURCE PERSON BASED ON WORK FLOW MANAGEMENT:

No. of Tickets	Efficieny of Resource Person Without WFM	Efficiency of Resource Person With WFM
10	90	100
50	86	99
100	80	97
200	75	96
500	63	94



EXPERIMENT-6: HANDLING ISSUES IN EXISTING SYSTEM Vs PROPOSED SYSTEM:

No. of Issues	Performance Rate in Exisiting System	Performance Rate in Proposed System
10	45	98
20	40	94
50	34	92
75	30	90
100	22	89



VII. CONCLUSION

In all other papers they were tried to reduce the time to solve the tickets. But, we have proposed the method to identify the complicated area, and then, by using our new method called CI, we will bring down the ticket count to very low and the time taken to solve the ticket will be automatically reduced.

To conclude, IT infrastructure management and services offered by it have become increasingly complex. Most have a wide diversity of platforms, operating systems, and applications. New systems are being implemented that integrate end-to-end business processes across Web servers, application servers, ERP applications, legacy applications, and even partner and supplier systems. Managing this infrastructure and pinpointing failure points in the process spanning multiple systems is a difficult task. All these difficult task has been successfully implemented by proposing suitable methodologies, in this research work. Also, the proposed methodologies have been experimentally verified and compared with the existing methodologies, in order to prove that the research work provide successful results.

Thus, by implementing our proposed methodology in an IT organization, everything becomes easy and can able to provide better result to the customer. The process involved in the IT organization, providing reliable services to it and managing the infrastructure becomes easiest through our research work.

REFERENCES

1. Girish Keshav Palshikar, Harrick M. Vin, Mohammed Mudassar, Maitreya Natu, *Tata Research Development and Design Centre, Tata Consultancy Service Limited, Pune, India,* "Domain-driven Data Mining for IT Infrastructure Support", Data Mining Workshops (ICDMW), IEEE International conference, Dec (2010).
2. ERIK BEULEN, Tilburg University, PAUL VAN FENEMA, Erasmus University, Rotterdam, WENDY CURRIE, Warwick Business School, "From Application Outsourcing to Infrastructure Management: Extending the Offshore Outsourcing Service Portfolio", European Management Journal Vol. 23, No. 2, pp. 133–144, April (2005).
3. Borja Sotomayor, Rub´en S. Montero, Ignacio M. Llorente, and Ian Foster, "An Open Source Solution for Virtual Infrastructure Management in Private and Hybrid Clouds", IEEE Internet Computing, Special Issue on Cloud Computing, July 7, (2009).

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Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

4. DIIMITRIOS GEORGAKOPOULOS AND MARK HORNICK, AMIT SHETH, University of Georgia, "An Overview of Workflow Management: From Process Modeling to Workflow Automation Infrastructure", Distributed and Parallel Databases, 3, 119-153 (1995).
5. Jie ZHANG, William Chandra TJHI, Bu Sung LEE, Kee Khoon LEE, Julita VASSILEVA & Chee Kit LOOI, "A Framework of User-Driven Data Analytics in the Cloud for Course Management", S. L. Wong et al. (Eds.) Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education, (2010).
6. Mahmoud R. HalfawyA, David PyzohaB, and Taymour El-HosseinyB, A Department of Civil Engineering, University of British Columbia, Canada, B EMH&T, Inc., 170 Mill Street, Gahanna, Ohio 43230, USA, "AN INTEGRATED FRAMEWORK FOR GIS-BASED CIVIL INFRASTRUCTURE MANAGEMENT SYSTEMS", Annual Conference of the Canadian Society for Civil Engineering, June 5-8, (2002).
7. Pablo L. Durango-Cohen, Department of Civil and Environmental Engineering and Transportation Center, Northwestern University, US, "A time series analysis framework for transportation infrastructure management", Received 2 June 2005; accepted 29 August 2006.
8. K. Keahey, I. Foster, T. Freeman, and X. Zhang, "Virtual workspaces: Achieving quality of service and quality of life on the grid," Scientific Programming, vol. 13, no. 4, pp. 265–276, (2005).
9. D. Nurmi, R. Wolski, C. Grzegorczyk, G. Obertelli, S. Soman, L. Youseff, and D. Zagorodnov, "The eucalyptus open-source cloudcomputing system," in Cloud Computing and Applications 2008 (CCA08), (2008).
10. R. Medina-Mora, T. Winograd, and R. Flores, "ActionWorkflow as the Enterprise Integration Technology," Bulletin of the Technical Committee on Data Engineering, IEEE Computer Society, Vol. 16, No.2, June, (1993).
11. I. Foster, C. Kesselman, C. Lee, R. Lindell, K. Nahrstedt, and A. Roy, "A distributed resource management architecture that supports advance reservations and co-allocation," in Proceedings of the International Workshop on Quality of Service, 1999.
12. W. Smith, I. Foster, and V. Taylor, "Scheduling with advanced reservations," in IPDPS '00: Proceedings of the 14th International Symposium on Parallel and Distributed Processing. IEEE Computer Society, 2000, p. 127.
13. Q. Snell, M. J. Clement, D. B. Jackson, and C. Gregory, "The performance impact of advance reservation meta-scheduling," in IPDPS '00/JSSPP '00: Proceedings of the Workshop on Job Scheduling Strategies for Parallel Processing. London, UK: Springer-Verlag, 2000, pp. 137–153.
14. B. Sotomayor, K. Keahey, I. Foster, and T. Freeman, "Enabling cost-effective resource leases with virtual machines," in Hot Topics session in ACM/IEEE International Symposium on High Performance Distributed Computing 2007 (HPDC 2007), 2007.
15. B. Sotomayor, K. Keahey, and I. Foster, "Combining batch execution and leasing using virtual machines," in HPDC '08: Proceedings of the 17th International Symposium on High Performance Distributed Computing. ACM, 2008, pp. 87–96.
16. R. Medina-Mora, T. Winograd, and R. Flores, "ActionWorkflow as the Enterprise Integration Technology," Bulletin of the Technical Committee on Data Engineering, IEEE Computer Society, Vol. 16, No.2, June, 1993.
17. T. Smith, "The Future of Work flow Software," INFORM, April 1993.
18. D. Black, "Workflow Software: A Layman's Handbook, Part I," INFORM, April 1994
19. S. McCready, "There is more than one kind of Work-flow Software," Computerworld, November 2, 1992.
20. Michael Alan Smith, Sabyasachi Mitra, Sridhar Narasimhan, USA, "Offshore outsourcing of software development and maintenance: A framework for issues", Information Management 31, 1996, 165-175.

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