

# Role Hierarchy based Access Control Student's Project Repository System for Education Institutes

Heramba Limaye, Bhavesh Dhake, Shraddha Shinde, Prof. Prita Patil

*Computer Engineering Department, Mumbai University, Vidyalankar Institute of Technology, Mumbai*

<sup>1</sup>heramba961@gmail.com, <sup>2</sup>bhaveshdhake4852@gmail.com, <sup>3</sup>shraddhadshine192@gmail.com,  
<sup>4</sup>prita.patil@gmail.com

**Abstract**— The design of suitable models for authorization and access control for electronic academic record is essential by in Educational Institutes. Managing and controlling the final year projects of students using manual or traditional process is a very tedious job. In this paper, we proposed role hierarchy-based access control student's project repository system whose major objective is to create an automated system for managing all the documents of student projects on online portal and manage their work on online portal. Proposed web-system is useful for students, project coordinator and project guide to manage project details smoothly for future reference. It offers functionality like project guide allocation; updating project details of each project group and common sharing point of project ideas, research papers etc. to serve as fruitful resource in the expansion of existing project ideas or to utilize past experience of similar type of projects.

**Keywords**— Automation, ICT, Role based model

## I. INTRODUCTION

The internet provides a variety of paths for exchanging data, data files, music, and video files, among other things. Being connected to the internet may provide access to certain routes. It's a collection of smaller domestic, academic, business, and government networks and websites that together contain a wide range of data and services. To put it another way, the internet is a network of networks. Information Communication Technology (ICT) refers to technologies that enable people to access information via telecommunications, with a focus on communication technologies such as the internet, wireless networks, cell phones, and other forms of communication. It can be used to automate a variety of daily procedures in a university. Managing a college is one of the most difficult tasks that educators confront these days. Educational process planning and implementation are critical components of any educational institute [1].

Previously, a file-based system was mostly utilized to store Projects and Research Papers that could be found at any university. The file system has become obsolete, volatile, and redundant since the internet's inception. Because of these factors, it is critical to transition from a file-based system to a web/internet-based repository system. Understanding the relevance and scope of the requirement, we have exercised our planned work as a real time solution at Vidyalankar Institute of Technology (VIT), Wadala, Mumbai, dubbed "Role-based Academic Repository System." The system's main notion is that it may be utilised as a platform in educational institutes for students and faculty members to fill out and manage details of projects and research papers, reducing iterative manual and paper-based labor. It also aids the upper user hierarchy in keeping track of administrative operations and evaluating performance in order to make more informed judgments. The suggested system creates a central data repository for keeping the institute's academic facts in one place, eliminating the need to check out segregated data in many locations and allowing the College Administrative System to make quick and informed judgments.

Choosing and assigning a mentor for a Project or a Research paper in offline mode might be a time-consuming operation, thus we've suggested an algorithm that assists in allocating mentors based on the Domains and preferences of the concerned Student/Faculty Member. In this work, we propose that Educational Institutes adopt an online web-based efficient, systematic, secured access, and sophisticated user-friendly automated system to manage their academic records and administrative

actions. We discussed the importance of automation and access control models, as well as the role of ICT in automation, in section II. In part III, the proposed system is discussed. Implementation and analysis are covered in Section IV. The simulation findings are presented in part V, and the recommended work is concluded in section VI.

## II. LITERATURE REVIEW

### A. Automation

An automation [1], is a replacement of manual operations with computer procedures and other machinery. An automation is required to increase productivity, reduce production time, increase manufacturing flexibility, reduce costs, eliminate human error, reduce labor shortage, high degree of accuracy, performing tasks that are beyond human capabilities of size, weight, speed, endurance, etc.

A Library Automation System implemented in University of Toronto Library in 1963-1972[1] and University of Illinois at Urbana-Champaign 1965-2000[2], Automated System for Educational Assessment developed in Nigeria, e-Learning System [3], Automated Project Grading and Instant Feedback System [4] are the well known examples of Automated Systems those have achieved automation in their manual processes and enhance their overall performance. An automation is achieved by converting paper based system into paperless system [5]. The popular models used in paperless systems are Single Copy model and Form oriented Model [5].

### B. Access Control Methods

As automation provides various advantageous features, we need to take care of data privacy and confidentiality. An Access Control mechanism is an effective security policy that provides verifiable system to guarantee the protection of information from unauthorized access. Usually Access Control Models are categorized into four types [6] as- i) Mandatory Access Control (MAC), ii) Discretionary Access Control (DAC), iii) Role-Based Access Control (RBAC), iv) Domain Type Enforcement (DTE). After comparing the access control models, we found that Role Based Access

Control Model (RBAC) is suitable for proposed system.

The various implementations of RBAC are discussed as BASE Model for RBAC [7] focuses on role of user and assigning the access control to the users. Role Hierarchies in RBAC [7] on the implementation of user hierarchy and assigning the access control based on senior and junior roles. Constraint based Model in RBAC [7] centers around the enforcing constraints on the roles, user session to provide access control. Management Model in RBAC [7] helps in managing and assigning the access rights by the administrative person of the organization. In Induced Role Hierarchies with Attribute-Based Model in RBAC [8] an enterprise defines the set of rules that are triggered to automatically assign access control to the user roles. Administration of a Hybrid Role Hierarchy in RBAC [9] uses decomposition of hybrid role hierarchy or inference rule to manage administration of Hybrid Role in the Organization. Contextual RBAC Authorization Model successfully implemented in Electronic Patient Record (EPR) [10]. The integration of rules based on contextual information gives more flexibility and expressive power to specification of EPR access policy using RBAC authorizations. The proposed work on Workflow Access Control from Role Engineering to Task Engineering focuses on Constraint Satisfaction Problem (CSP) based approach to achieve task engineering in Workflow access of the System [11]. Also elaborated the importance of Task Engineering with Role Engineering

### C. Information Communication Technology

ICT refers to technologies that provide access to information through telecommunications. It is similar to Information Technology (IT), but focuses primarily on communication technologies. This includes the Internet, wireless networks, cell phones, and other communication media. In the past few decades, information and communication technologies have provided society with a vast array of new communication capabilities. For example, people can communicate in real-time with others in

different countries using technologies such as instant messaging, voice over IP (VoIP), and video-conferencing. A social networking website like Facebook allow users from all over the world to remain in contact and communicate on a regular basis.

We know we need a system to understand the number of users, job responsibilities (roles), their division and hierarchy, and the access control privileges associated with each user based on the aforementioned study. It should concentrate on administrative roles done by users in the company, so that administrative decisions can be made more swiftly and actions can be taken more promptly. As a result of our understanding of the need, we presented a new model for managing student academic projects called Role Hierarchy based Access Control Student’s Project Repository System

### III. PROPOSED WORK

Our proposed model extends approach of RBAC, Hierarchies in RBAC, Management Model and Task Engineering approach without violating the role hierarchy and their access right policies in an organization.

Our proposed model (TEATRHBAC) follows the following steps :

- A. *User creation and functionality assignments as per their user role type*
- B. *Formation of user role hierarchy*
- C. *Formation of Administrative Role based Access Control*
- D. *Division of work task using task engineering approach*

#### A. *User creation and functionality assignments as per their user role type :*

In this step, proposed model focuses on Users (U) and their roles (R) and association of User Creation (UC) follows the rule,  $UC \Rightarrow U \times R$ . Each user role type plays specific functions in an organization and by understanding the functionality of each role our proposed system provides access to the

functionality. The type of user roles in our system are Admin, Director, Principal, Head Of the Department (HOD) are assigned to Senior role , Staff, Student to junior role.

#### B. *Formation of type role user hierarchy :* [12]

Permission for accessing the resources is highly dependent on the hierarchy present in an organization. While providing access control services to the users using type role hierarchy, we have satisfied following requirements like : It supports the principal of strict least privilege, supports the delegation of authority, reflects the reporting structure, allows for slight differences between positions, enforces separation of duty control principles etc. [12]. User Role hierarchy consists of different types of roles that are associated with each other. A distinction is made between organizational roles, task roles, private roles, job roles and junior or senior role. Position in the User Role Hierarchy can be formed as

$$U_{RH} \Rightarrow U_{org} \cup U_{job} \cup U_{pri} \cup U_{task}$$

Where,

$U_{org} \Rightarrow$  represents user roles that relate to the hierarchy in an organization,

$U_{job} \Rightarrow$  represents user roles that broadly define a person’s job. Examples can be found in general terminology, such as HOD, Principal, Director, etc.

$U_{pri} \Rightarrow$  represents user’s private roles, i.e., roles where the permissions are not inherited upwards.

$U_{task} \Rightarrow$  represents the roles that relate to specific tasks, it the building block of organizational workflows.

Creation of User Role Hierarchy involves following steps :

- i) Vertical organization partitioning
- ii) Horizontal partitioning
- iii) Define organization positions
- iv) Define private roles
- v) Define task based roles

- vi) Assign Users
- vii) Assign Permissions

*i) Vertical organization partitioning :*

In this step, we have done vertical partitioning by considering division of an organization into number of departments that are grouped together using higher level unit.

*ii) Horizontal partitioning:*

Each vertical partition is partitioned horizontally according to the types of role performed by each user. These roles may be related to each other through a generalization relationship.

*iii) Define organization positions (UR<sub>org</sub>) :*

Many times for each role in the organization, there exists many different people that fulfill single role. For example, many users having same post HOD, staff, for different department. During this step the different users are created for same roles in the different departments.

*iv) Define private roles (UR<sub>pri</sub>) :*

Each user may require a private role. For example, in our proposed system each user from senior to junior having rights of uploading their research work documents in common knowledge sharing point. Every users are able to share documents but the updation or deletion permission is only given to the user that uploads the documents even he is the junior no such permissions are inherited to senior authority provision of such facility gives appearance of assigning private role to the user.

*v) Define task based roles (UR<sub>task</sub>) :*

After analyzing the existing system, we built task based roles in the hierarchy to complete different tasks and accomplish the workflow of the system. If the permission assigned to the task role should be inherited upward, the task role should be linked to a job role. Finally, if the task should only be done by a specific role, it should be linked to a private role of the job.

if (UR<sub>task</sub> && Inherits Permission (UR<sub>Senior</sub>))

```

{
    URtask => URjob
}
else
{
    {
        URtask => URpri
    }
}
    
```

}

Where UR<sub>Senior</sub> => represents senior user role in the user hierarchy.

*vi) Assign Users :*

Users are assigned to the highest possible role ur<sub>i</sub> where ur<sub>i</sub> ∈ UR<sub>org</sub> ∪ UR<sub>job</sub> ∪ UR<sub>pri</sub> ∪ UR<sub>task</sub> if he satisfies this equation in the organization. Accordingly, Admin, Director, Principal users belonging from topmost hierarchy whereas Staff, and Student occupies bottommost post in the hierarchy and HOD users occupies middle position in the hierarchy.

*vii) Assign Permissions:*

In this step, permission is assigned to each user in order to access the appropriate resources. In our proposed, we have created separate platforms for each user by understanding their UR<sub>org</sub>, UR<sub>job</sub>, UR<sub>pri</sub> and UR<sub>task</sub>.

*C. Formation of Administrative Role based Access Control Hierarchy:*

This step focuses on Administration in an organization. It forms the hierarchy of all the users that plays important role in Administration. Managing the security policies and access control becomes difficult as the number of users associated with the users get increased. To overcome this situation, our proposed system forms the Access Control Hierarchy of Administrative users that perform the administrative actions in effective and efficient manner.

The benefits offered by this proposed technique are:

- Formation of user hierarchy in the organization using task division approach that reduces overall user creation time
- Provides authorized user permissions to access appropriate resources
- Manages change in role of user in the Role Based Hierarchy
- Manage and verify completion of task from the user to whom they are controlling

- Removal of central administrative action by single person.

Hence formation of Administrative Role based Access Control Hierarchy is essential for the division of administration activity and enhance the overall workflow of the system to complete the task in fastest way under secured access control.

#### *D. Division of work set using Task Engineering approach:*

In our proposed system, we have achieved combined effect of Task engineering along with Role Engineering without conflicting their role access controls in three different ways:

- i) Using 'Duplicate User Role Creation by Administrative User Hierarchy' technique to achieve Task Engineering.
- ii) Completion of multiple tasks by Single User with Multiple Role Types using Task Engineering (creating separate platform of resources associated with the user role type)
- iii) Division of work set into multiple task sets to achieve parallelism.

*i) Using 'Duplicate User Role Creation by Administrative User Hierarchy' technique to achieve Task Engineering :*

A Task Engineering Approach is achieved by proposing a new technique known as 'Duplicate User Role Creation by Administrative User Hierarchy'. By understanding the importance of work completion in short time span or to handle complex situation like managing a department or an organization in the absence of senior user e.g. HOD for department and Principal or Director for college 'Duplicate User Role Creation by Administrative User Hierarchy' technique is introduced. With the proposed technique, users are able to create similar duplicate users in the organization with proper user authentication and will provide access control permission by assigning appropriate user role. Creation of duplicate user and assigning the appropriate role is under the control of Administrative user Hierarchy. Again creation of duplicate user is bounded to Administrative User

Role Hierarchy. Steps involved in our proposed technique are :

Step 1 -: Create Duplicate user by Administrative User as per the real time demand.

Step 2 -: Assign Role to Duplicate user by Administrative User as per the real time demand.

Step 3 -: Acquire all the access control permissions same as that of Actual User (as per the role).

Step 4 -: Complete the task associated with user role type

Step 5 -: Delete duplicate user after completing the task

The major goals of proposed techniques are removal of person dependency in the work, completion of task in short period, mitigate the urgent task completion situation, division of similar task among multiple users to complete the task in fastest way.

The major challenge with this implementation is keeping track of Actual User and Duplicate User, which is overcome in our proposed system by assigning separate user id to each user in the system even their role is same. Thus, if any, misuse occurs, we can easily track the responsible user for given task. In this way, our proposed system takes care about security violation.

*ii) Completion of multiple tasks by the Single User with Multiple Role Types using Task Engineering:*

A single user can perform multiple roles in an organization so work responsibility associated with each role type is different. For example, HOD user can be a 'Project In-charge' and 'Staff' too. So he need to get access and activate multiple roles simultaneously to complete the task associated with individual role. In addition to complete the individual task, he would like to have independence in the working platform to feel the privacy. To complete multiple tasks simultaneously, we have created separate resource platform associated with each user role type, which he is able to activate simultaneously by providing appropriate authentication in terms of user id and password associated with the role.

iii) *Division of work set into multiple task sets to achieve parallelism :*

In order to achieve parallelism in the work flow of the system, we have divided each resource platform into multiple resource units and each resource unit is further divided into smaller sub units. Here each unit and sub unit can be completed in parallel. So that entire work can be done in fastest way.

Various steps in Proposed model, Task Engineering with Administrative Type Role Hierarchy based Access Control (TEATRHBAC) are given as:

Step 1-: Start

Step 2 -: Decide the Roles for the users.

Step 3-: Perform the User Creation with rule User Creation (UC) follows the rule  $UC \Rightarrow U \times R$ .

Step 4 -: Form the User Role hierarchy as  $URH \Rightarrow UR_{org} \cup UR_{job} \cup UR_{pri} \cup UR_{task}$  and execution of sub steps as: i)Vertical organization partitioning , ii)Horizontal partitioning, iii) Define organization positions, iv)Define private roles,v)Define task based roles, vi)Assign Users and vii)Assign Permissions

Step 5 -: Decide the Roles for the Administrative users

Step 6 -: Form the Administrative Role Based Access Control Hierarchy same as that of Step-3

Step 7 -: Divide work set to achieve Task Engineering using approaches like

- i) 'Duplicate User Role Creation by Administrative User Hierarchy' technique (creating duplicate user of same role type)
- ii) Completion of multiple tasks by the Single User with Multiple Role Types (creating separate platform of resources associated with the user role type)
- iii) Division of work set into multiple task set to achieve parallelism in the work set

Step 8 -: Stop

#### IV. IMPLEMENTATION AND ANALYSIS

The proposed model is implemented on three tier architecture in which the client interface is simply a web browser , XAMPP is configured as a web server, PHP is used as scripting language, MySQL Database connectivity.

An implementation of proposed model aims to satisfy the access control requirement of student project details in any Educaitional Institutes. After successful execution of above steps mentioned in proposed technique, we are able to achieve the following aspects related to access control in any organization:

- *Strict least privilege in the system:*

User belongs to a superior role is a necessary condition to assign the task to the user. For example, unless HOD user will not assign blank format of academic details to 'Staff' user. He/she is not able to view the academic details associated with him/her. However, the permissions granted to the user will only be determined by the task role associated with the task, not the roles that the user may assume. For example Mr. X and Mr. Y are the two 'Staff' users, but only Mr.X can guide Final Year B.E. Project and Mr. Y not then access to Project related academic details is given to the Mr. X not Mr. Y even they are having same Role type.

- *Delegation of authority :*

In our proposed system, we have achieved delegation of authority by creating private task based role so that even the user is performing lower role in an hierarchy, the permission rights will not be inherited upwards.

- *Reflection of the reporting structure :*

The association of position of the roles with one another allows for defining a "supervision" relation.

- *Allows for slight differences between positions:*

Position in the role hierarchy inherits permissions from their corresponding job role. For Example, in our proposed System HOD user is Staff User and can be "Project charge" too. In such cases HOD is positional role from his job

responsibility but again he need to have different permissions for performing role of ‘Staff’ user and Project In charge too.

• *Enforces separation of duty control principles :*

We have achieved the separation of duty by providing the permissions as per the task role approach. By providing different resource interface as per the user’s role and completion of task. Therefore, even HOD user is performing three roles- HOD, Staff and Project In Charge in the organization he has feel of performing separate independent duties associated with the task assigned to the respective roles.

• *Streamlining process of Mentor Assigning :*

We have implemented an automated mentor-assignment system to ease the load of manually doing that work. The General User specifies his/her choice of Domain and submits three preferences of potential mentors belonging to the respective domains. The client university has to first specify that how many projects/papers can a mentor handle at a time at most. Then according to the data fed by the university, the algorithm works to first shortlist available mentors from selected domains and then choose an appropriate choice of a mentor who has got the least amount of Projects at that time and is on higher-end of the preference list submitted by the general user. The chosen mentor is then finalized by the Admin.

• *Task Engineering approach speed up the process:* Implementation of task engineering approach removes the single person dependency. Task engineering approach in Administration reduces the overall burden in managing the organization and its various departments, helps in completing various tasks simultaneously. Each step while performing task engineering takes care of not violating the permissions and access control associated with the Role Engineering.

V. RESULTS AND DISCUSSION

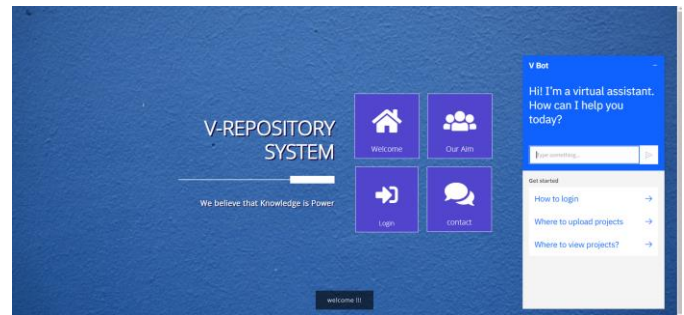


Fig. 1. Top level user’s details’ view

BE Teams and Project Details														
Domain	Project Title	Department	Year	Guide/Mentor	Member 1 (Leader)	Member 2	Member 3	Member 4	Member 5	Member 6	Summary	Synopsis	Presentation	Report
Image processing	start	comp	2019	Prof. Swapnil Sonawane	A.B.C. 18102A003	d-1	e-2	f-3	g-4	h-5	gh	Download Synopsis	Download PPT	Download Report
Image processing	start	comp	2020	Prof. Swapnil Sonawane	teacher a	Prof. Swapnil Sonawane	Prof. Prita Patil	Prof. Swapnil Sonawane	Prof. Swapnil Sonawane	Prof. Swapnil Sonawane	This is final project sample final teacher dashboard	Download Synopsis	Download PPT	Download Report
machine learning	start	comp	2019	Prof. Pritish Deshpande	A.B.C.	d-1	e-2	f-3	g-4	h-5	check without test 1	Download Synopsis	Download PPT	Download Report
algorithms	start	comp	2019	Prof. Swapnil Sonawane	A.B.C.	d-1	e-2	f-3	g-4	h-5	check without test 1	Download Synopsis	Download PPT	Download Report
Image processing	start	kit	2020	Prof. Pritish Deshpande	teacher a	Prof. Swapnil Sonawane	Prof. Prita Patil	Prof. Swapnil Sonawane	Prof. Swapnil Sonawane	Prof. Swapnil Sonawane	gh	Download Synopsis	Download PPT	Download Report

Fig. 2. Graphical view of Database

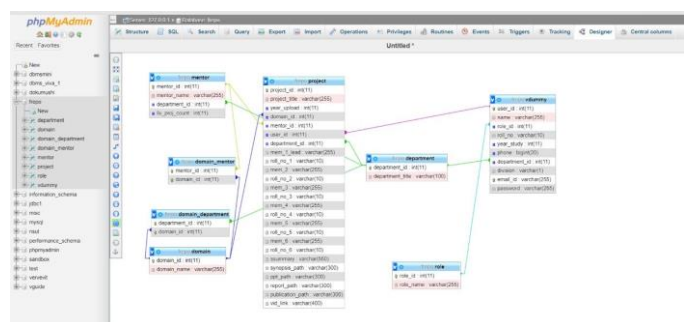


Fig. 3. Admin Role User Hierarchy

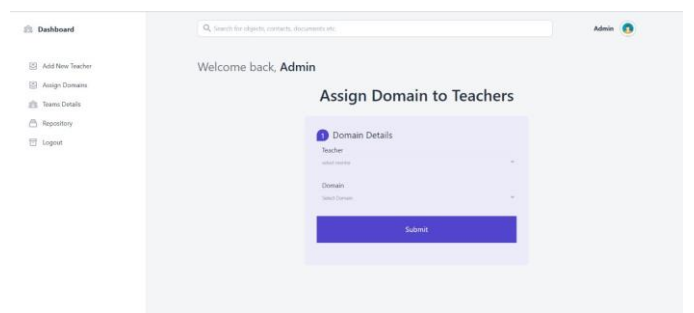


Fig.4. User Role Hierarchy

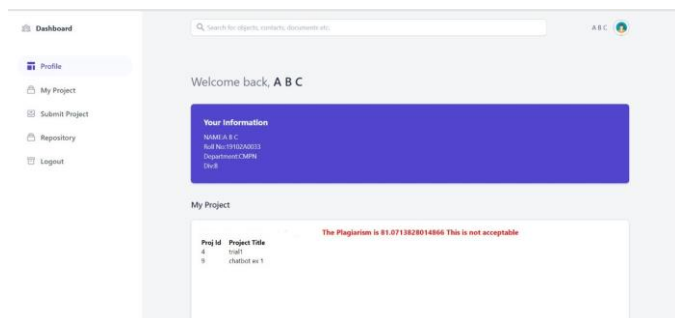


Fig. 5 Repository Page

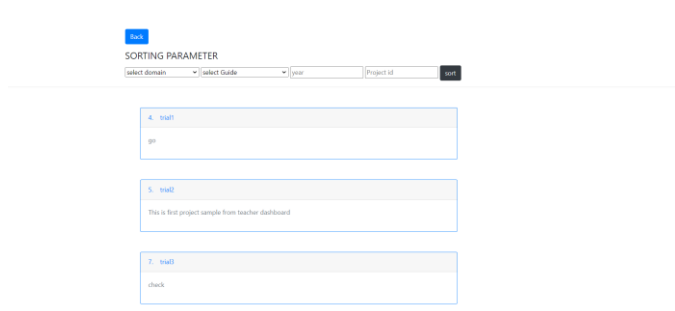


Fig. 6. Duplicate User Login

From Fig.5 and Fig.6 , we can say that our proposed system tracks the each and every action performed by Duplicate and Real use in terms of Created By field the database. Hence security violation in the role responsibilities can be easily track in the system.

## VI. CONCLUSION

In this paper, a suitable access controlled authorization model for student project record is proposed which is implemented as Live application in Vidyalkar Institute Of Technology, Wadala , Mumbai. The proposed work describes an integrated automated web based paperless system that converts manual filling of data into online System, by providing controlled access to the online resources by understanding users, their job responsibilities(role) and present hierarchy in the organization. The work also focuses on the importance of Task Engineering in the Role Engineering whose implementation is achieved without disturbing role hierarchy and their access rights policy in the organization. We have also considered the importance of administrative actions performed in the organization. Our system has divided the Administrative actions by forming the

hierarchy of the Administrative Users based on their role, task, position. The concept of task engineering is implemented by creating and monitoring the tasks by Duplicate User Creation, completion of multiple tasks by providing separate resource platforms and division of task sets into sub tasks to achieve parallelism in the work. Therefore the resultant web based automated system provides improvement in terms of controlled access on the online resources, making administrative decisions and performing administrative actions in fastest way and implements task engineering approach that enhances the overall performance and efficiency in the workflow.

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