Development of a Knowledge-based Tool in Facilitating Course Exemption Process

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Abstract
Course exemption is an important phase in the enrollment process. It is done before a student being enrolled and accepted into a program such as diploma students enroll into degree programs. A knowledge-based tool is required to assist program leaders to provide exemption advice to students. The traditional approach requires much cumbersome manual iteration, making the process longer and error-prone. In order to overcome these problems, a knowledge-based tool is proposed and it contains knowledge-based engine that assist program leaders in generating course exemption advice report by using rule-based reasoning technique. The knowledge-based engine incorporates several features, including rules and requirements set by authorized regulatory board for standardization and compliance purposes. The course exemption process may vary from one university to another, and one faculty to another. In this paper, a case study is conducted at a business faculty at University A. It is hoped that by using the proposed tool, the business faculty being the largest faculty in University A will increase work efficiency. This tool is an exemption advice tool to assist program leaders in facilitating course exemption to students under categories of new students, returning students, transfer students and existing students. This paper presents the existing exemption process adopted by department Y, which parked under the business faculty.

Keywords: Course Exemption, Knowledge, Academic Knowledge, Organizational Knowledge and Program Leader

1. INTRODUCTION
Course exemption is one of the important enrollment processes to any institution of higher learning; as it helps students who wish to enroll into programs offered by institution of higher learning determine courses to be registered. The process is time-consuming and error-prone. Furthermore, even through when a course exemption is completed, it has to go through verification process. Many times, the entire process will go through duration of one week to one month to complete before students can proceed with course registration. Therefore, to ease the processes of course exemption, this paper presents a knowledge-based tool for program leaders, taking full advantages of Java and graphical user interface. The proposed tool is a computerized web-based solution, which will ease the work of program leaders and result in faster and more accurate course exemption compared to traditional approach. One of the valuable features of the proposed tool is it allows program leaders to verify the compliance according to the specified requirements and view the exempted courses statistics to ensure accuracy is in place.
The organization of the paper is as follows: section II discusses the importance of knowledge to an organization, the enrollment process at University A, problems encountered by program leaders during course exemption process and some related work. Section III presents the course exemption features and system architecture. Section IV discusses the application tool in University A. Section V concludes the paper.

2. BACKGROUND

Knowledge refers to insights, understandings, and practical know-how that we all possess, and it is the fundamental resources that allow us to function intelligently (Wiggs, 1996). Organizational knowledge refers to knowledge of the overall business of an institution: its strengths and weaknesses, the markets it serves, and the factors critical to organizational success (Coukos-Samuel, 2003). Academic knowledge is used to support teaching and learning whereas organizational knowledge is used to support educational administration. Organizational knowledge is now becoming an important resource in the organization (Theece, 1998). Therefore, there are much effort has been focusing on software application that capture and retrieve knowledge (Hahn & Subramani, 2000). In view of the importance of knowledge in higher education setting, a knowledge-based tool is proposed to support administrative task such as course exemption of a program leaders who are providing course exemption advice to students. The following sub-section will present the enrollment process at University A.

There are six important phases in enrollment process. The first phase is applying for admission and students need to submit application form either online or manual. The second phase is applying for financial aids and students need to fill up a form either scholarship or study loan application. The third phase is requesting for transcripts; students need to send the official transcripts from all previously attended universities or colleges to the admission and record office (in the context of this research it is called registrar office). These transcripts will be kept in students’ file and students will be exempted from some courses if the prior courses meet necessary criteria. This phase mainly incurs exemptions for transferring and returning students. Phase four involves English proficiency assessment and orientation. The fifth phase is student will register courses during orientation and final phase is student will pay fee according to selected courses. Figure 1 illustrates the different phases of student course exemption.

In this paper, third and fourth phases are focused, as the exemption process will take place in these phases. There are many types of students enroll into academic programs in the University, these students are: New students – who have never applied University A and have taken courses at other universities or colleges (complete phase 1 to 6). Transferring student – who have completed their course at other universities or colleges other than University A (complete phase 1 and 6). Returning student – who are returning and previously completed courses at University A and are returning after a lapse of time or enrollment at another universities or colleges (complete phase 1 to 6). Existing student – who have taken some equivalent professional courses or diploma courses at University A (complete phase 3 to 6).
Course exemptions are based on courses previously completed at colleges or universities level only. There are criteria in giving course exemption: students must have obtained a minimum grade of 50% at the college level in order to be eligible for the exemptions and the exemption credits given must not exceed 30% of the total credit hours of the selected program. Each student must submit a copy of college transcript, diploma and course materials as well as other supporting documents. The documents will be reviewed and written notification (i.e. exemption advice from) will be issued by the faculty. This form will then mail back to the students who are the applicants by the counselor. The exemption process is shown in the Figure 2.
3. METHODOLOGY

This is a qualitative research and the type of qualitative research used is interview. Interview is particularly useful for getting the story behind a participant’s experience (McNamara, 1999). The interview protocol is posing questions to the interviewees who are program leaders and counselors who manage course exemption process. Two program leaders who have had at least one-year experience in granting course exemption and one counselor who helps to facilitate course exemption are involved in this study. The interview was conducted one time only for half an hour each interview session. The purpose of interview is to find out problems encounter by program leaders and counselors during course exemption process. Data analysis technique used in this research is content analysis and identifies phrases, keywords, sentences and phrases to come up with results.
4. RESULTS

4.1 Problems Encountered by Program Leader and Counselor

The main objective of this study is identifying problems encountered particularly by program leaders in granting course exemption to the applicants. Once the problems are identified, proposed solutions could be given to minimize the problems.

In this study, program leaders who are also course exemption advisors are staff appointed to lead or manage a specific academic program. In the context of this study, it is called program leaders and/or head of departments. Associate dean is responsible for verifying and approving the documents. This section surveys the problems encountered by program leaders during course exemption process. The focus of this study is on enrollment to IT programs; new, returning, existing and transferring students.

When counselor received a new course exemption application from students, the student needs to provide their transcript to counselor for course exemption. The entire process can be completed within one week provided students submit a complete set of materials to counselor. According to counselors, if the materials submitted by students are incomplete, the entire process might be completed in one month. However, the duration given for the entire process is 15 working days. Based on an interview conducted to a program leader, there are many factors cause delay, and the factors are: incomplete materials, key staffs are unavailable and timing of the exemption period. Furthermore, certain subjects such as co-operative placement exemption requires students to provide former employment letter and this serves as additional materials that may require longer time to prepare such documents. If this situation happened, it will prolong the entire exemption process.

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Another problem is during certain peak period where students’ intake is heavy and the exemption requests are high, program leaders might require longer time to complete this task. Due to the heavy workload of the program leaders, this task using traditional approach is time consuming and error-prone. This results in affecting work efficiency, and also indirectly affecting student in doing course registration. One more problem is lack of standardization of exempted courses. Due to human error, there might be discrepancy in granting course exemption by two different program leaders to the same student. This problem requires a rule-based knowledge engine with intelligent components to overcome it.
In summary, the said problems are grouped into three categories:

1) **Documents needed for exemption**
   In order to process course exemption, the required documents are transcripts and course syllabi; if these documents provided are incomplete, program leaders are unable to process the course exemption application. A delay will be incurred if tedious manual process is needed (refer figure 2 and 3).

2) **Type of student**
   Students who are applicants could be existing, returning, transferring or new students and they come with various academic qualifications for course exemption application. The manual process is time consuming due to handling various groups of applicants.

3) **Time of processing application**
   The normal time in processing course exemption at university level is 15 working days. The manual process usually take more than the stipulated time due to the incomplete documents provided or additional documents needed to support the application.

4.2 **Method for Knowledge Inference Engine**

   Artificial intelligent components are essential to facilitate course exemption process in the proposed tool. Artificial Intelligence (AI) is usually defined as the science of making computers do things that require intelligence when done by humans (Copeland, 2000). Negnevitsky (2005) commented that an intelligence system process knowledge in the form of rules and use symbolic reasoning to solve problems. Now, it has many intelligence tools to make system smarter or intelligent to solve problem as human being. The inference engine of proposed tool will be designed by using a theory of Bayesian network to process knowledge.

   Bayesian network is a graphical model used to represent a set of random variables and conditional dependencies for probabilistic. Over last decade, the Bayesian network has become a popular representation for encoding uncertain expert knowledge in expert (AI) system (Heckerman, 1995). The researchers use Bayesian network for a solution of reasoning, planning, learning, perception and robotics problems. For solving the narrow problems in each different domain, there have many different theories and algorithms to support it. The proposed reasoning inference engine is used to decide the rate of similar courses matching. In Bayesian network applications, the algorithms and theories based on Bayesian reasoning that can filter, predict, smooth and find explanations of data streams for helping perception system to analyze the processes (Nashad, 2010). The algorithms and theories which are defined and developed based on Bayesian network used to solve the problem and there are as follows:

   Bayesian inference is an approach to statistics in which all forms of uncertainty are expressed in terms of probability (Radford, 1998). It is a method of statistical inference, which is used to determine the probability of a particular hypothesis given some observed evidence by using prior probability. Expectation-Maximization (EM) Algorithm was given its name in a paper written by Dempster, Laird, and Rubin in the Journal of the Royal Statistical Society (Dempster et. al., 1977). The EM algorithm is an efficient iterative procedure to compute the Maximum Likelihood (ML) estimate in the presence of missing or hidden data. In ML estimation, we wish to estimate the model parameter(s) for which the observed data
are the most likely (Borman, 2009). Decision theory is a theory that used to help decision maker to choose a proper decision from the condition of certainty or uncertainty for relevant questions or issues with an analytical techniques (Mendoza & Guitierrez-Pena, 2009). Dynamic Bayesian network is a Bayesian network that models a temporal process Hidden Markov Models and Kalman filters can be considered as dynamic Bayesian network in many standard time-series methods. (Heckerman 1995;West & Harrison, 1997)

For the proposed tool, decision theory is used for creating inference engine. The rules are created in inference engine is based on decision theory that is used to estimate the external condition match to existed data in the database, the comparison of each with exists in the database, and give system user a recommended result. The inference engine and function module combine the agents that work together to process case in proposed tool. Each agent has its own ability and collaborates to process tasks. The following subsection discusses software agent and how it is applied in the proposed tool.

4.3 Software Agent and Multi-Agent

Agent is referred to a component of software and/or hardware which is capable of acting exactly in order to accomplish tasks on behalf of its user (Hyacinth, 1996). Jennings and Wooldridge (1996) characterized the capability of problem-solving of agents. Some of the characteristics of agents are autonomy, persistence, possesses social ability and reactivity.

With the ability and capability of the agent, the proposed tool is capable to perform course exemption task automatically without human intervention. During the exemption process, the agents are designed for different purpose and each agent will perform their task continuously step by step and collaboratively work with other agents until goals are achieved successfully. Based on the literature study, software agents embedded in this tool are necessary and useful in automating course exemption task.

Few agents are designed to process different tasks for different purposes in the proposed tool. Each agent in the proposed tool has its own ability to solve a part of problems of a task, and every agent collaborative work is to complete a task. The function modules in the agents are composed of code that used to process requests. The function modules have its own ability to process data for different purpose of the requests and it uses rule-based technique to process data. The detail of rule-based technique will be discussed in the following sub-sections.

4.4 Rule-based Techniques

Rule based system are often used in artificial intelligence application and related research. Conventional computer program in problem-solving area were used well-defined algorithm, reasoning strategy and data structure to find solution, and conventional rule-based expert system were used to solve real-world problems that required by human intelligence (Ajith, 2005). In the proposed tool, the inference engine is designed based on defined rule for processing constant requests from client side. Rule-based reasoning will be used in development of knowledge engine and inference engine that to compare the applied and current courses. Knowledge manager and the people who are knowledgeable about the course exemption such as program leader can set particular rule for course exemption. The knowledge and inference engine will compare each element of course exemption application
to database for matching and mapping the goal. After the knowledge engine generates results, program leader can adjust result such as change exempted course selected by tool if necessary when the result is not suitable for current case. The changes are recorded in the data repository when solution of new case for future exemption.

4.5 The Proposed Knowledge-based Tool

The architecture of proposed tool will be designed based on the MVC (Model-View-Controller) model. This model is used to isolate logic process from user interface, reduce complexity in architecture design and improves maintainability of code for developing an application. Figure 4 illustrates the three-layer system framework. Referring to the proposed framework in figure 4, client presentation layer A being the first layer (view layer) of the framework of the proposed tool that used to accept user inputs, operation and present the result of exemption. It will send data to the agents or function modules for process data rather than process data in the user interface. It provides interface for users to input data such as exam grade, course title, names of the university and credit hours.

Business logic control B contains knowledge engine, inference engine, function module and agents that collaborative work together for processing the user requirements. In this layer, the components may analyze the data from user input and send data to next step for the purposes, compare student subjects with database repository according to user request. Controller layer C processes the request where was sent from the view layer. The components in controller intercept the request and process it with appropriate actions, and it determines what data direct to view layer or process. Data control layer C is responsible for manipulating the data for serving controller. It is a layer that contains SQL statement, data store procedure, data transaction that used to access data to database.
4.6 The Proposed System Architecture

Figure 5 presents internal components in the business logic layer B in the proposed tool. Service Agent (SA) is a portal for receiving the request from user presentation layer. It is responsible for analyzing the user request, and directs the data (request) to appropriate agent. When user executes a command, SA will receive the command and acquire the data. SA identifies the received command, and acquires the data from user. Then, it starts to manipulate data as needed format and send data to next step in context. Normal function module is responsible for basic service in the system such as registration service and user verification. Information Distribution Agent (IDA) receives data from SA via different interface to identify purpose. An interface can receive several different types of variables from outbound at the same time. For example, when IDA received a command from SA about course exemption, one variable may named as “course exemption” for command and other variables may contain course name and course id in database. Internal modules of IDA decompose these data to useful format, and encapsulate data to an appropriate packet such as compose two variables into one text string and send it to knowledge assistant agent (KAA) or Task Agent (TA).

Knowledge Assistant Agent (KAA) contains knowledge engine and inference engine components. Knowledge engine in KAA is used to transmit data into knowledge by defining rule, and recording the knowledge in database. Inference engine in KAA works for knowledge engine, it reasoning the request and calculate the data by define formula for course matching, comparison and finding. For example, when there is a request for course exemption from user, knowledge engine will find out the records which have same university name or same major when it is captured and stored in database before rather than other similar data. This process may find out done cases by searching university name, and query records from database which related to name. KAA received set of records from database, and analyze each part of the set which are course name, exam grade, credit hours, course materials by using inference engine. In the event that exam grade is lower than required requirements or the total exempted credit hours is greater than requirements set, the tool will automatically filter the courses, and KAA will decide which courses are suitable. In fact, this is a time saving procedure as it helps program leader to handle routine course exemption.

Action Control Module (ACM) executes the commands of actions for KAA. It allocates each command for different action, and connects to data control layer for retrieving, storing, getting data for KAA using. For example, ACM calls SQL statement in data control layer C for retrieving results based on university name from database. Task Agent (TA) is responsible for analysis, matching the constant inputs of course based on rules set such as compare subject with existing subjects in database and exam grade. It processes elements of course with well-defined rule by knowledge manager. Constant Content Analysis Module (CCAM) inside of Task Agent (TA) is to find out matched name of course and university A’s courses for exemption. Content Agent (CA) is responsible for rate calculation of content of course and find out which existed course in database is similar to user applied. The rate calculation is defined based on decision theory of Bayesian Network, CA will compare the content of user applied with existing content of course in database, and find out which are matched for course exemption. The Proposed System Architecture

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In summary, the features of the proposed tool are: (1) automated matching of courses’ content; (2) automated checking of exam grade for applied courses (3) automated credit calculation of exempted courses; (4) report generation.
4.7 Application of The Proposed Knowledge-based Tool

The proposed knowledge-based tool is used by program leaders in issuing exemption advice for students before course registration takes place. Using traditional approach, program leaders need to perform subject matching manually by referring to course materials provided by the students. However, the proposed tool provides a simple and user friendly interface with numerous functions that user can select to display necessary information for course exemption. This paper only presents the proposed architecture of the tool and implementation phase will take place at the later stage. Once the proposed tool is developed, it will be used by Department Y at University A. The tool will be used to grant course exemption fulfilling the requirements set by Malaysian education regulatory body and University. Without the support of the proposed tool, the update of the requirements with respect to both University and National regulatory board would be interminable; using the proposed tool the program leaders saved the time that they usually spend tackling such a task, subsequently human error will be significantly reduced. The proposed tool also helps program leaders in screening supporting documents or materials required for course exemption purpose. The tool will pre-screen the materials if it is sufficient to proceed to the next stage. This step has been introduced to save time compared to manual screening. Later, subject matching will take place. The program leaders only need to navigate the report generated by the tool, to check and make recommendation if necessary.

Furthermore, the proposed tool has imposed good practices among all the program leaders as it helps to generate standardized exemption report across the faculty. In the event of one personnel is unavailable, another personnel is authorized to perform the task. On one hand it avoids unneeded delay; on the other hand it imposed standardization as the tool recommends exemption cases which captured in knowledge engine. Every single case is captured as and it can be referred by the other authorized personnel, this feature is meant to capture tacit knowledge of the workers and training time for successor will be significantly reduced; subsequently reduce human error. Comparing with traditional approach, the approval process has been reduced. Four steps have been reduced to three steps instead as counselor no longer need to go through faculty administrator for document passing. Since one step is eliminated, time has been saved by reducing one step. Furthermore, the verification and approval process in step 4 (figure 2) has been automated by introducing online approval functionality.
5. CONCLUSION

Course exemption is one of the importance phases in the enrollment process. Nevertheless, using traditional approach in performing this task is time consuming and error-prone. This paper has presented a knowledge-based tool to facilitate course exemption process. It also serves as a tool to support and assist program leaders in granting course exemption to students. Although the proposed course exemption tool is mainly used by program leaders for department Y, it also offers other features such as alerting program leaders if the deadline is approaching and allow program leaders to authorize another personnel to continue the task. Future work is to tackle more challenging issue: granting course exemption for programs in other department.
6. REFERENCES


