# Agent-mediated Academic Advising System: Nodal Approach on Knowledge Management System towards achieving Students' Graduate-on-Time

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## ABSTRACT

The administrative task of advising students has been part of the academicians' scope of work in some institutes of higher learning. Other than making sure that the students are registering the right courses every semester, the academicians' key performance index might include ensuring that the students graduate on time. This happens in a private university in Malaysia, in which this research is based on. Since the inception of agent-mediated personal knowledge management (PKM) concept in 2011, most research covered the area of education management, such as class management, social media in education, and academic quality management. Seeing the opportunity in applying the PKM concept to one of the most critical process in academic management, this paper presents an idea of agent-mediated academic advising system. The result presented in this paper includes the processes of academic advising, and how the knowledge agent could be deployed to advise both the advisor and students.

## CCS Concepts

**• Computing methodologies → Artificial intelligence → Knowledge representation and reasoning → Reasoning about belief and knowledge.**

**• Information systems→ Information systems applications → Decision support systems → Data analytics, Online analytical processing.**

## Keywords

Personal knowledge management; software agent; academic management; academic advising system; graduate-on-time.

## 1. INTRODUCTION

Ever since its formation, the city campus of a Malaysian university have adopted the academic advising system to ease the workload of the academic programme coordinators. Having an average of 30 students per intake for a programme every semester, with a range of seven Bachelor programmes and five Diploma programmes, it is highly critical to delegate the task of advising students to the active 100 academicians. Not until the academic year of 2010 that the university upgraded the advising system from manual to online.

However, the advising process is deemed lack of coordination and less manageable due to the teaching load that has been the core tasks of the academicians. The situation gets worse when the assigned academic advisor for a batch of students is from different background than the academic programme the students are registered for. In other words, the knowledge of the programme itself may not be of 'reach' to this advisor, what more if the programme is not of his or her interest. This has caused an inconsistency in the number of students who graduate on time from 2010 to 2015. Students who had the potential to graduate on time or earlier than the expected duration seemed to join the group of those who did not graduate on time.

Putting the social environment factor aside and viewing this situation from an academician's perspective, an opportunity to upgrade the current online system into an intelligent agent-mediated system is deemed necessary. Furthermore, the development of reasoning for the advising process is achievable if we look at the personal level of advising process commonly or expectedly performed by the individual academic advisors.

With this opportunity in mind, the objective is set for this paper to present knowledge representation for an agent-mediated academic advising system, in order to ensure that the students graduate on time according to their programme structure.

## 2. RELATED WORKS

Looking at the need to understand the background of this research from different angles, this section is divided into three: academic advising system; and personal knowledge management.

### 2.1 Concepts of Academic Advising System

Academic advising has been part of the supporting function in an academic management system, in which an exchange of information and knowledge is designed to facilitate students in reaching their educational and career goals. The task of advising is a shared responsibility between the advisor and the student he or she is assigned to. In the end, it is up to the student to take up the responsibility in making the decisions about his or her life goals based on the advice provided.

Academic advising takes place in situations when institutional representative, i.e. academic advisor, gives insight or direction to a student regarding the academic, social or personal matter [1]. The direction advised by the representative could be to "inform, suggest, counsel, discipline, coach, mentor or even teach" [1]. At some point of time, the advising process puts both the advisor and advisee into a dynamic relationship respectful of the student's


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concerns [2]. This is supported by Hendey [3] who stated that developmental advising, i.e. a part of academic advising, is "a systematic process based on a close student-advisor relationship indented to aid students in achieving educational, career, and personal goals through the use of the full range of institutional and community resources". In other words, it is expected that the institutes of higher learning to provide the resources and environments conducive to the advising processes.

In terms of role, the academic advisor serves as "a facilitator of communication, a coordinator of learning experience through course and career planning and academic progress review" [4]. For the scope of this paper, we look into the aspect of academic progress review, since it is within the internal environment of the university.

In an overview, academic advising has been cited as [5]:

- a planning process that helps students to approach their education in an organised and meaningful way;
- a process of teaching students how to become responsible consumers of their own educations, involving teaching them how to make viable decisions;
- a process of giving students guidance, support and encouragement;
- a process of helping students diminish the confusion that comes with a new environment, clarify their goals and get the most out of their education;
- an interactive process, in which the advisor helps the student set and achieve academic goals, acquire relevant information and services, and make responsible decisions consistent with interests, goals, abilities and degree requirements.

It is stated as part of the guideline to the students in Rutgers, the State University of New Jersey [6], that they are expected to accept responsibility for making their own plans and decisions with the advice provided by the advisor, and to define a primary plan to achieve their own goals but also have an acceptable alternative. On the other hand, the advisors' responsibilities include providing assistance in helping a student to learn how to make practical academic plans and decisions, how to discover a range of options available to the student, based on the student's stated goals, and how to think through the consequences of the student's own choices [6]. In the end, the expected outcome of the academic advising system would be having the students who will know how and where to access accurate information about policies, procedures and requirements, on top of being encouraged to make decisions that support their goals, abilities and aspirations [6].

## 2.2 Online Academic Advising System

An empirical study of advising system in Muscat, Oman, conducted on 375 respondents, has shown a significant positive correlation between training/orientation on advising and perceived quickness in solving students' problems [7]. It is recommended for institutions to understand various key aspects such as advising style, website and online experience, proper orientation on advising, support and help needed, so that higher scores can be secured on student satisfaction with the advising system. The advising system consists of a host of different resources and people that students will access at different points of time during their academic years.

Hingorani and Danesh [8] described that an Advisement System is designed to mitigate the issues of an out-of-the-box implementation at a southeastern university to help improve retention and graduation. According to these authors, the system is a very simple advisement system that provides all data required by advisor and allows the advisor to enter the gist of advisement session with the students. This system, developed using ASP.NET and Access database, provides a one-page view of the whole advisement process and allows the user to plan for three semesters in advance; it also allows the advisor to email from the page, and view the records from the RFID attendance system. Lastly, it provides a control system that would allow the administrator to monitor the quality of advisement and the retention and graduation rates [8].

There is a rule-based advising system developed to support university students. Engin et al.'s [9] case study has proven that advising system is able to emulate the decision making process of a human. Students are able to understand and get clear guideline from this system. The development used logical connectors "and" and "or" to establish logical connection between a course and its prerequisites, and the system associates one entity with another entity through the "exists" command.

In another case example, Postgraduate Advising System (PAS) provides accurate advices to the students and directs them to the essential processes in King Abdul Aziz University [10]. PAS system was tested by comparing previous proposed plans for students who had taken the advice from their advisors. The result was as expected, where most of the suggested plans by PAS were identical to the faculty advisors plans.

Parget [11] interpreted the theory of Hale, Graham and Johnson's [12] study and had similar findings. It was clear from the information received that the relationship a student had with his or her advisor did have an effect on students' development. This study indicates that the more the discussion is made between the advisor and student on possible career options and courses to take, the more the student positively develops. Academic advising was a contributor for 93 percent of students' satisfaction with their college experience.

On a more advance level, Gatus [13] proposed an expert system to perform validation of transferees, advises students what courses to enroll and allow students to do self-evaluation. It proved to be very useful in delivering valuable information to the students within or outside campus in terms of academic evaluation.

In general, most online academic advising systems are focusing on course and programme selection for the students. This process is commonly performed in the beginning of the students' life in campus during programme registration, and beginning of new semesters during their years of study in campus. There is no proof found on any system that fully mediate the tasks of an academic advisor throughout a semester and continuously monitors the students' academic progress throughout the semester and between semesters.

## 2.3 Agent-mediated Personal Knowledge Management (PKM)

Recent research on agent-mediated personal knowledge management (PKM) suggested that 'knowledge' can be managed by intelligent software agents with learning ability, by mediating the tasks of individual knowledge workers. In other words, an individual's personal knowledge can be managed within an agent environment or system, provided that the knowledge representation of what and when to do the tasks are defined for the agents to refer to and learn from.

Quoting from the previous research on agent level personal knowledge management, the PKM processes include get knowledge, understand knowledge, share knowledge, and connect to knowledge source [14]. This is deemed possible since the software agents are expected to be able to engage in dialogs to coordinate [15], carry out some sets of operations on behalf of a user or another program with some degree of independence or autonomy, and in doing so employing some knowledge or representation of the user's goals and desires [16], and perform flexible action in the environment in order to meet its design objectives [17].

In fulfilling the need to design an agent-mediated system, a nodal approach is introduced to illustrate how an agent mediates the task on behalf of its human counterpart, or knowledge worker [18]. A node, $N$, is specified as follows: a knowledge worker, $KW$; all functions of the knowledge worker, $f_i$, one or more agents, $A_j$; and all functions of agents, $f_{jk}$. In other words, a node is a four-tuple structure [19]:

$$N = < KW, f_i, A_j, f_{jk} > \quad (1)$$

where $f_i \in KW$, $f_{jk} \in A_j$, and $i, j, k \geq 1$.

# 3. RESEARCH SETTINGS

The case university consists of 12 campuses all over West Malaysia, but this paper only covers one campus located in the main campus as case study. The campus offers seven Bachelor programmes and five Diploma programmes, for undergraduate studies. Although the campus offers postgraduate programmes, this research is only deemed fit for undergraduate studies, due to the number of students that is at average of 2,000 students being active in campus in a semester.

As introduced in the Introduction, the academic advising tasks in this case university is assigned to academicians or lecturers, to assist the programme coordinators in monitoring an average of 30 students per intake per advisor. This number has increased in recent scenario, when the Diploma programmes are no longer offered (i.e. no more intakes since September 2016) and the number of intakes for Bachelor programmes have been doubled up.

This research started off by analysing an academician's way of managing the advising tasks since the beginning of a semester until the end of the semester. Even though the sample case covers the whole duration of a student's academic life in a Bachelor programme, this paper only takes into account the processes that are performed during a semester. The details of this analysis process is presented in the next section.

# 4. RESULTS AND FINDINGS

According to the rule-of-thumb, the basic knowledge that is needed to start an analysis could be from the 5WHs: what, where, when, who, how. In a simple manner, the knowledge processes that involve 'what', 'when' and 'who' are presented. This is followed by the conceptual overview of how the software agents would be deployed in the virtual environment to mediate the tasks based on the processes defined.

## 4.1 Knowledge Management Processes

Table 1 shows the personal knowledge management processes that are performed at three substantial phases in an academic semester: beginning of semester; middle of semester; and end of semester.

**Table 1. Knowledge Requirement in Academic Advising**

| When | What | Who |
|---|---|---|
| Beginning of semester | Create or update student' profile, which include updated grade for each course taken in previous semesters | Advisor |
| | Calculate the average grade for courses taken | Advisor / Student |
| | Set CGPA target for current semester, based on needs and capabilities | Advisor / Student |
| | Calculate a must-achieve GPA for current semester | Advisor / Student |
| | Advise on the minimum grade to target for each current course, based on capabilities | Advisor |
| Mid of semester | Monitor students' coursework - through mid-semester results | Advisor |
| | Further consultation and motivation in the second half semester | Advisor |
| End of semester | Compare final result of current semester with expected GPA and CGPA | Advisor / Student |
| | Plan corrective action for next semester | Advisor / Student |
| | Advise student before next semester starts | Advisor |

As shown in Table 1, the 'who' attribute is assigned to the human responsible of the relevant processes. In most cases, academic advisor plays quite a number of roles, since the success of performing the advising tasks are the determinant of their key performance index for each semester.

The results from Table 1 is translated into a timeline view for further analysis, as shown in Figure 1.

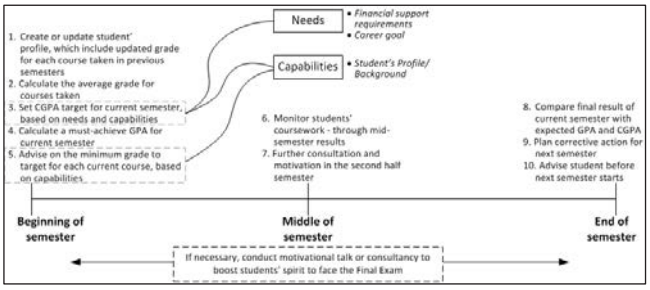


**Figure 1. Timeline view of the personal knowledge management process in academic advising task.**

From the timeline view (Figure 1), it is depicted that there is a need to refer to external sources other than the tacit knowledge of a human academic advisor. These sources would be the storage of information that could facilitate the advisor in understanding the needs and capabilities of the student. If the student is under a financial support contract, then there is a need to refer to the requirements of the contract, e.g. minimum CGPA of 2.5 in every semester. In addition to that, the student's career goal could be an indicator for the needs, in setting the target grades. In terms of capabilities of the student, the student's basic profile and background could be retrieved from the existing academic database. The information include the courses taken in previous

programme (e.g. Diploma, Certificate, Matriculation, or any certification before entering Bachelor programme), grades in previous programme, credit transferred from previous programme, and such.

## 4.2 Nodal Approach of the System

Based on the findings presented in Table 1 and Figure 1, the 'who' attribute is illustrated in the human nodes of Human Academic Advisor and Human Student, in a nodal approach view (as shown in Figure 2). The 'when' attribute is separated and delegated into three different agents: $A_P$, Profiling Agent that performs the five tasks in the beginning of semester; $A_M$, Monitoring Agent that performs the two tasks throughout the semester or mostly in the middle of semester; and $A_C$, Controlling Agent that performs the final three tasks at the end of the semester. On the student's side, the basic agents are assigned to delegate the tasks of retrieving knowledge ($A_R$) and analysing knowledge ($A_A$) shared by the advisor's agents.

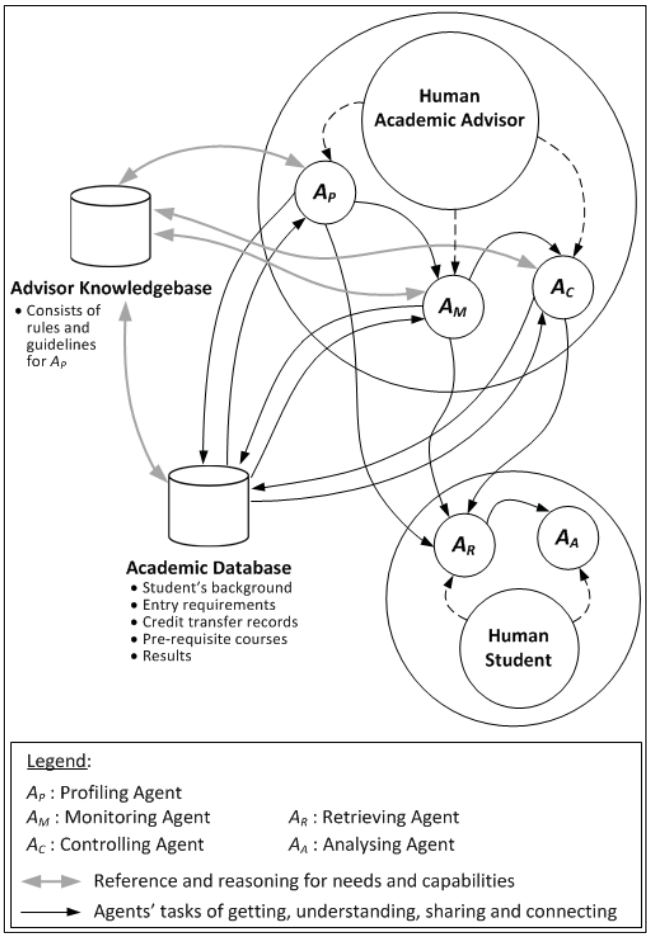


**Figure 2. Overview of the nodal approach for the agent-mediated Academic Advising System.**

Based on the illustration in Figure 2, the agents' tasks are deployed into the following manner, with specific PKM processes defined.

In so doing, the advisor's agents are consistently referring to the Advisor Knowledgebase, especially in understanding the rules and guidelines, and mostly on the student's needs and capabilities. The knowledge from this source is vital in calculating the must-achieve GPA and CGPA, and setting the target fit for individual students.

**Table 2. Delegation of Agents' Tasks**

| Agent | Task | PKM Process |
|---|---|---|
| $A_P$ | Create or update student' profile, which include updated grade for each course taken in previous semesters | Connect to database, Get, Understand |
| | Calculate the average grade for courses taken | Understand |
| | Set CGPA target for current semester, based on needs and capabilities | Understand |
| | Calculate a must-achieve GPA for current semester | Understand |
| | Advise on the minimum grade to target for each current course, based on capabilities | Share, Connect to $A_R$ |
| $A_M$ | Monitor students' coursework - through mid-semester results | Connect to database, Get, Understand |
| | Further consultation and motivation in the second half semester | Share, Connect to $A_R$ |
| $A_C$ | Compare final result of current semester with expected GPA and CGPA | Connect to database, Get, Understand |
| | Plan corrective action for next semester | Understand |
| | Advise student before next semester starts | Share, Connect to $A_R$ |
| $A_R$ | Retrieve knowledge from $A_P$, $A_M$ and $A_C$ | Get |
| $A_A$ | Analyse knowledge retrieved and present in a format easily understood by the Human Student | Understand |

# 5. DISCUSSIONS

As stated in the beginning, this research only takes into account the scenario in a running semester with active students in campus, i.e. students in the semesters from semester 2 to 7. For new intake (i.e. students in the semester 1), the $A_P$ will have a more tasks to do, including teaching the students on how to follow, manipulate and make full use of programme structure, in order to set a 3-year target of their studied programme. The best practice is to train the students into planning for their study completion in 3-years, with targeted grades for each semester, so that they will have a buffer of one or two semesters. This is part of a preventive action, which will be beneficial for the university in order to trace the students for graduate-on-time from day one.

This additional task is often performed by the programme coordinator, but for consistency purpose and not to have possibilities of leaving out minor details, it is recommended to be embedded in this proposed system.

In addition to this, there is a form of tacit knowledge that could be included in the system, as shown in Figure 1. Apart from the three main phases of the system (i.e. beginning of semester, middle of semester, and end of semester), tacit knowledge could be shared by the advisor to the students in between the phases or throughout the timeline of a semester. Among the knowledge to be shared include motivational talk, personal consultancy, and share of tips and tricks to face the final exam. This could be a form of preventive action at semester level, to avoid the students being discouraged or unmotivated towards the end of the semester, due to the mid semester results that could be not as good as expected. On another note, this aspect could be a way to develop an agent-mediated self-regulated learning, in which the students would be exposed with knowledge throughout the semester on how well they are using the university learning management system (LMS) or virtual learning environment (VLE) specifically and social media in general [19].

## 6. CONCLUSION

This paper has presented the possibility of deploying software agents to mediate the task of an academic advisor in a current setting of a university. It does not only benefit the university and the advisor but also the students whom the advisor advises. It is anticipated that this knowledge management based system could be implemented for the overall benefit of the university's key performance on students' graduate-on-time, that would further benefit the students career life, the industry's needs in graduates, and the development of the nation. With an intelligent system as suggested, the education system in general could be improved in facing the future needs. Furthermore, it would be a unique intelligent system that covers continuous monitoring of students' academic progress throughout semesters, not on programmes or courses to choose in the beginning of semesters.

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