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Online Class Scheduling and Faculty Loading System within a Decision Support Framework

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ABSTRACT

Developing course schedules to accommodate student enrollment needs has been a recurring and complicated task of the department heads each school term. To develop a course schedule connotes an assignment of time intervals for each course offering and optimization of available resources such as classrooms and computer laboratories and subsequently maximize the department faculty inventory and preferences. The study aimed to create a class scheduling and loading system which tackles academic department heads' responsibilities of establishing well-defined faculty teaching loads. A descriptive-developmental design was utilized using a researcher-made questionnaire and interview. The

scheduling and loading system is articulated to allow the defining of teaching assignments to the time slot system by applying knowledge-based approach, appropriate heuristic functions and rule sets to load correct courses to faculty; and allow a search for the best slot on multiple viable slots within the decision-support framework. Decision support framework facilitates administrative priorities to resolve conflicts on slots representing deviations from the assignment criteria. The result of the study indicated the reduction of time required for course scheduling and the results are more acceptable to faculty loads for the teachers. The study recommends embedding other parameters into the system and continuous improvement and maintenance should be done for the system, adding new constraints and requirements.

***Keywords*—** Information Systems, faculty loading, descriptive-developmental method, Philippines

INTRODUCTION

The academic department heads before each semester do the process of preparing the course or subject schedules. Developing course plans is a complex problem regularly faced by the department heads. To accommodate the student enrollment needs, program heads, deans, and chairpersons and even HR Director laid best goals to course offerings. These objectives take into account resources like the number of classrooms allocated according to class size, type of dedicated equipment and the human capital resources. Such resources are to be kept in mind so as to make use carefully and avoid wastage or under-utilized. The justice principle in the distribution of workloads, some may have greater qualifications or experience, while others will only work for part time or in their field of specialization. Other factors are also considered related to the policy such as the number of preparations, seniority, and demography.

Currently, in almost all educational institutes, rare exist a reliable, efficient, or intelligent timetabling system. The reality that all educational institutes ranging from small to large ones are following the manual system (Adriaen, De Causmaecker, Demeester & Vanden, 2006) which is very intricate and time-consuming that takes weeks of iterative repair (A. Jain, S. Jain, & Chande, 2010). The manual system has become a hot issue at the start of each semester for the department heads. As enrollment is increasing the pressure on course offerings, the need to meet human resources is also at stake. During scheduling,

department heads have to consider the instructor that can handle the course offered. In a college with a limited number of faculty members, one of the factors that needs to be considered is the matching of instructor's expertise/specialization. For the faculty expert handling a particular specialized course, a time slot has to be blocked-off. Some small colleges in a university share faculty members to maximize the human resources and minimize cost. Each educational system handles different class course faculty scheduling task; each professional teacher has different preferences on teaching time slots (Shih, Chao & Hsu, 2012).

Course scheduling allows instructors to visualize how their workloads should begin and when it is due. This proverbial plan gives them insight into the importance of their individual responsibility, which impacts their efficiency. Universities and colleges in the Philippines are mostly using a manual process in class scheduling that adds burden to the department heads in assigning or loading courses to the instructors, monitoring and updating schedules. The downside of the manual programming approach is that the scheduler cannot look at every combination of plans and evaluate which is best (Bellardo, 2010).The course scheduling process of the University of Cebu – Banilad Campus, Philippines starts with identifying the faculty and their expertise. All departments have the same set of General Education instructors. Thus, department heads need to coordinate with other department heads in their course offerings to ascertain the time schedules for a particular subject. For instance, there are four English 1 offerings in an 8:30 – 9:30 AM schedule and there are only 3 English teachers that can handle the subject. Due to the teacher's unavailability to hold the desired timeslot, one of the department heads has to give in for a change of plan.

Students' educational development may put to challenge when the teachers' needs are unfounded. Department heads need to see first the existing faculty load to check the availability of the teacher whenever a new course schedule created, especially for General Education courses. Framing a timetable provides a morally persuasive plan that can move a scheduler to make considerations including free periods for snacks and break-time, prevention of high workloads, long idle hours, personal and geographical factors of both the students and the instructors. The timetable is the second school clock, spark plug and mirror (Nirav, 2014) to keep the attention of their entire class and ensure their focus and interest (Cox, 2014) to the activities engaged in school. Inappropriate class schedule assignment could lead to ineffective teaching performance and inefficient utilization of department facilities and human resources, and biased class-course assignment (Shih, Chao, & Hsu, 2012).

It is important to ensure proper time allocation for teachers to organize their schedules and to set the stage to communicate students what exactly are expected of them. The extreme importance of a school timetable allows the teacher to identify student behaviors that must directly teach him, which in turn, helps him develop greater student autonomy, responsibility, and self-control. With a clear class schedule, instructors will achieve satisfaction and better results. Clear class scheduling makes the work of an instructor structured and routine, well-planned, flexible, focused, and disciplined. Course schedules, ideally, shall serve the best interest of the students, teacher and the school itself. An optimal computer-aided class scheduling and faculty loading system can assists academic heads to better manage resources, increased productivity and efficiency in preparing class schedules.

FRAMEWORK

The eminent need to investigate and develop automated timetabling suitable for a university was exorbitant especially to shared resources across departments and colleges. The user acceptance of new Information Technology (IT) influential factors is of interest to stakeholders which are the pivotal needs to address the outset of technology development. The development must be viable, and utilization of the technology improves organizational performance and efficiency.

Integrating technological intervention and the development into a total system are some of the hardest tasks for the consultant to execute (Appelbaum, 1997). Anchoring on the Unified Theory of Acceptance and Use of Technology of Venkatesh, Morris, M. G. Davis and F. D. Davis (2003) states that the ability to predict individual's adoption of IT is dependent on the number of key determinants that include the user's decision about a measure of his intentions in terms of attitudes, subjective norms, performance expectancy, and perceived ease of use.

Implementing acceptable technology throughout the managed design process includes the Social-Technical Systems models using Control and Enhancement forces to emphasize a holistic view of the organizational impact of informatics. The valuable engagement of any technology hinges on the ability and willingness of users to employ IT for worthwhile activities. The Socio-Technical Systems approach had been pivotal in shifting technology design away from just financial and technical concerns that manifested in traditional software development models (such as the waterfall model of Boehm) towards a more user-centered

perspective. Approaches to design warranted soft-system methodology, the need underline the value and utility on any technical system as viewed by users, developers, or manager of users (Dillon & Morris, 1996). An allocation must be taken at the engineering level of the social dynamics or sub-unit within an organization when transforming inputs into outputs to jointly optimize both the social and technical attributes.

The Complexity Theory on Combinatorial Problems of Willemen (2002) states that a feasibility problem can be described by its input, decision variables, and a set of constraints must meet or satisfied. Dasgupta & Khazanchi (2005) viewed academic timetabling or course scheduling as a constraint satisfaction or feasibility problem where computational complexity and their decision variants are closely related. As the number of offerings in the department is rapidly increasing, the task of scheduling classes to fit into the timetable and existing facilities is much more complicated, tough and challenging especially when there is a diversity of constraints (Chiarandini, Birattari, Socha & Rossi-Doria, 2006). Burke, MacCarthy, Petrovic and Qu (2001) utilizes Attribute Graphs Approach that asserts the relations (constraints in the problems) between each pair of objects (courses in the problems) and found out a significant effect on the solution.

A timetable is a set of meeting in time designed to satisfy all requirements. A meeting is a combination of resources (such as rooms, people, and others). The aim is to schedule teachers and classes to utilize fully available resources (Jain, Jain & Chande, 2010). A timetable is feasible and may be realized by the institution. Furthermore, it is deemed to be satisfactory when it carries certain quality characteristics to a certain degree of users' satisfaction (Daskalaki, Birbas, & Housos, 2004).University course planning and scheduling are the processes of determining what courses to offer, how many sections are needed, the best term to offer, assigning the faculty member to instruct, and scheduling each to a timeslot to avoid conflicts. This process is typically broken down into three major phases: planning, assignment, and course scheduling (Bellardo, 2010).

Guiding administrative interventions at reducing the problem of underutilization with practical value for evaluating the system is through the development a timetable using models (Murray, Müller, & Rudová, 2007) of the user acceptance determinants. Apparently, the need for the timetabling community was crucial; influence the direction taken by research should high-quality, and practical solutions are produced (McCollum, Qu, Burke, Merlo & Lee, 2006).

The primordial objective was to provide up-to-date information in the generation of robust timetable with flexible techniques that performs well after some degree of modifications which can cope with complexities experienced during implementation in real world scenarios. Dillon and Morris (1996) pointed out the degree of fuzziness, or the likelihood of deviations from idealized planned usage to the actual usage is small. However, the acceptance theory essence was the deviations were not significant; the user acceptance process for intended purposes can be modeled and predicted for any IT.

Decision Support System (DSS) comprises software systems that assist humans in making the complex decision in real-life problem domains. Decision-making is characterized by complex, unstructured nature of problem areas, and unpredictable outcome of the actions that are apt to the basic dynamic of problems and information, and the potential risks associated with making an inaccurate decision. Over the last few decades, DSS software applications have been used to support many problems (structured, unstructured) in planning (strategic, investment, enterprise, management (stock portfolio, human resources),case-based reasoning and help desk automation (Dasgupta & Khazanchi, 2005).

The set of components overarching DSS which includes knowledge management systems, model management systems, and data management have shaped up humans in making better decisions by incorporating previous data and information about the domain. Making the correct decisions attributed to solving a constraint satisfaction problem given (MirHassani & Habibi, 2013) the relevant historical data and a set of parameters describing the current environment. Intelligent Agent Enabled Decision Support (IAEDS) system architecture combined the advantages from the domains of software agent enabled computing and decision support systems. Augmenting decision support systems with software agents gave the human user and machine the facility to go together historical information with the background knowledge acquired from real-time environmental data and decision rules. Academic course scheduling software provided adaptive-intelligent DSS (Dasgupta & Khazanchi, 2005).

The Decision Support Systems for University Course Scheduling centered on the development of a tool that would support the human-user to key-in required data and to run reports to view information in a tabular format, but it would not replace the decision maker. However, a few peculiar circumstances like the lack of expert knowledge, or the inconvenience to encode (Salwani & Turabieh, 2008) caused complications in the development of the Decision Support System (DSS) and due to the conditions; the system was unable to detect scheduling conflicts.

Several software products were already available in the market, and couples of them reviewed. However, with the undying methodology used in each package, the possible solutions to the scheduling problem (Bellardo, 2010) were taxing to comprehend. The package implementations were suited and designed for specific cases of an organization timetabling (Chiarandini, Birattari, Socha & Rossi-Doria, 2006). Based on the theories and related studies presented, the researchers were motivated to conduct the study to ease the burden of every semester in scheduling classes and assigning subjects to the teachers. The automated system provides an advancing tool for administrators to assert the likelihood of successful class scheduling and faculty loading, and proactively design the needed programs.

OBJECTIVE OF THE STUDY

The study aimed to develop an online class scheduling and faculty loading system within a decision support framework for the University of Cebu– Banilad Campus, Cebu City. Specifically, to: 1) Determine the processes and constraints that are needed in creating course schedules;2) The instructor's specializations;3) Determine the instructors' preferences as to number of preparations; days of the week; time of the day; and other preferences; and 4) Determine how the system will be analyzed and designed.

METHODOLOGY

The study utilized the descriptive-developmental design with the use of researcher-made questionnaire as the key instrument in gathering the data and interview to supplement the data gathered. Interview was conducted to identify the standard procedure in preparing class schedules. A trial survey was conducted to validate the questionnaire and the interview guide was reviewed by the research director and selected department heads from the other campus of University of Cebu. The design and development of the online class scheduling and faculty loading system used the Incremental Life Cycle Model. Incremental Life Cycle Model has four (4) phases (Saleh, 2011): requirements, design and implementation, testing, and operation. Requirements phase is the first step of the model where gathering of requirements from the end users will be done. In this phase, the proponent conducted a survey from the faculty in terms of their qualification and preferences. Interview was also conducted with the academic department heads in the class scheduling process in order to gather

the functional and non-functional requirements of the system. During design and implementation phase, data gathered from academic department heads, faculty and human resource director were used in the construction of the domain database. Within this stage, the proponent implemented the first increment or prototype of the software. In the testing phase, the proponent conducted a series of unit testing of the modules implemented in the first prototype. Academic department heads were requested to try the software for possible comments and recommendations. Operation phase is the step in which the first prototype is deployed and used officially by the users. Testing and evaluation results from the users were gathered so that it can be implemented in the next increments. In this stage, the academic department heads officially used the class scheduling software and provided recommendations for the improvement of the system.

Research Site

The University of Cebu –Banilad is a non-stock and non-profit corporation duly registered with the Securities Exchange Commission. It is a private educational institution that provides quality education at low tuition fee. It is is one of the four (4) campuses of the University of Cebu located at Gov. Cuenco Ave., Banilad, Cebu City. The university offers various academic programs such as: Juris Doctor, Bachelor of Science (BS) in Accountancy, Accounting Technology, Information Technology, Information Systems, Computer Engineering, Electronics Engineering, Secondary Education, Elementary Education, Criminology, Electronics Engineering, Hotel and Restaurant Management, Tourism. To date, the class scheduling and faculty loading system of the university are done manually.

Participants

The participants were the 48 faculty members and seven (7) academic heads (deans and chairpersons of various departments). Universal sampling was used in selecting the academic heads for there were only seven departments in the campus at the conduct of the study. Purposive sampling was used in selecting the faculty-participants to ensure collective information. They were chosen based on status of employment (full-time or part-time), qualifications and tenurity and faculty with special arrangements in terms of number of teaching loads, work days and time.

Research Instrument

The study utilized the researcher-made questionnaire for data collection. This tool was accomplished by the academic heads and selected faculty members. An interview guide was also used to gather information as to the process and preferences in creating class schedules and faculty loads.

Procedure

Before administering the questionnaire, the researchers requested permission to conduct the study from the Campus Director of UC-Banilad and also from the academic heads. Once approved, the participants were oriented as to the questions and how to answer the questionnaire to ensure accuracy and validity of the responses. The researchers explained the objectives of conducting the study and address whatever queries or clarifications that arose during the data gathering. Interviews were made further to supply the necessary data needed.

Based on the constructed questionnaire, the gathered data were processed, analyzed, interpreted and treated using frequencies and percentages.

RESULTS AND DISCUSSION

Processes in creating course schedules

Course offerings are planned in a fashion that offerings are made available to the greatest number of students and allow the best match between the faculty member's instructional needs and the existing policies. The process of creating course schedules starts with the Dean/Chair preparing a class schedule for a particular subject based on the curriculum. This includes the subject code, time start and time end, and days identified and schedules made per section.

The following identified the processes in creating course schedules: Regular offerings made first (see Figure 1). For highly specialized subjects, the Dean/Chair checks first the availability of the teacher that can handle to single out the specified time and days. For subjects with shared laboratories, the Dean/Chair forwards a list of the schedules to the particular college for confirmation of available laboratory. In the case of unavailability, the Dean/Chair changes the time block, accordingly. Laboratory supervisors found out that some schedules have no prior verification for availability, which cause schedule conflicts. Problems exist when the said schedules are already posted, and students are already enrolled. After preparing the class schedules, the Deans/Chairs meet with the Academic Director for pre-loading of subject to a particular faculty.

During loading, teachers were identified whether full- time or part-time. After which, they were categorically grouped according to specialization and qualification. Loading is done per subject. For instance, Engl 1 was checked first. Each dean would present the schedule in Engl 1 and the Academic Director checks if there is an available teacher for the time or days specified. If there is no available, the Dean/Chair changes the affected subject schedule. The process will be repeated until all are checked for the available teacher. Faculty qualification and preferences and number of preparations are considered during loading. In cases where the Dean/Chair offers new schedules, the in-charge who was appointed by the Academic Director is obliged to check the schedule to verify the availability of teachers before posting.

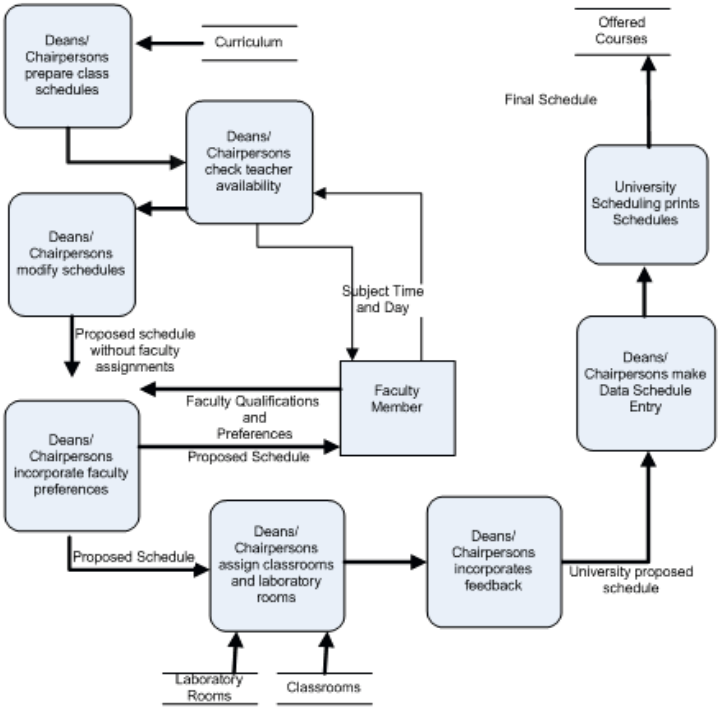

Figure 1. Course Schedule Process Flow

Constraints in creating course schedules

The following identified constraints in creating class schedules: 1) No class can be in more than two rooms on the same period; 2) No subject allocated to a time inconvenient for a faculty member; 3) A faculty member cannot take a lecture in two different classes at a time; 4) There should be an allocated break time after three straight lectures; 5) A workload should be acceptable according to the basic tenets of demography (i.e., age, marital status, educational attainment and discipline, geographical distance, tenure, seniority, and rank) and 5) No subject will be allocated to a time that does not demand faculty qualification.

Instructors' specializations

Fifty-six percent or 27 of the participants hold master's degree, 38% or 18 earned bachelor's degree and six percent, or three are post-graduate degree holders. The study conducted by Croninger, Rice, Rathbun and Nishio (2007) found out that there is no effect on certification status, but there is a positive impact on teachers' degree type and experience on reading achievement. Student achievement has potential contextual effects of teachers' qualifications, demonstrating higher levels in reading and mathematics where higher levels of coursework emphasis in these subject areas (Croniger et al., 2007).

From the data gathered regarding the subjects taught and specialization, all teachers are aligned to their qualification. According to Hoy (2000), the development of teacher efficacy influences on the mastery experiences during student teaching and the induction year. Bandura's theory of self-efficacy suggests that most malleable in learning are the first years of teaching where it could be critical to the long-term development of teaching efficacy.

Instructors' Preferences

In the article of Nirav (2014), the teacher has to set the motion of the programmed activities inside the classroom with due attention. To avoid the allotment of an unbalanced workload of any teacher, the instructors' preferences are according to the number of preparations, days of the week, time of the day, and others.

Regarding the preferred number of preparations, 38% or18 respondents preferred to have 3-subject preparations only. The respondents prefer to have less for them to have more time to focus on the subjects handled. Thirty-five percent or 17 preferred 4-subject and twelve 12% reply that it was well with them to have more than 5-subject and 15%, or seven preferred to have five subject

preparations. The researcher interviewed some of the respondents to verify their responses, especially those who answered more than five. According to them, they accepted more than five (5) should there be sufficient books or resource materials available for a particular subject.

Regarding preference on days, 67% preferred the schedules from Mondays to Saturdays. Only 23% holds Monday-Wednesday-Friday (MWF), and 10% responded that it is all right to have classes on Tuesday and Thursday only.

With regards to the preferred time of the day; 56% of the faculty preferred to start their classes at 7:30AM to 8:30 AM; 36% preferred to have classes until 6:30PM to 7:30PM; 31%favored to start their classes at 9:00AM to 9:30 AM and ends at 3:30PM to 4:30PM; 6%preferred to start at 1:00 PM to 2:00 PM and only 10% desired to have classes until 9:30PM. Departments are strongly encouraged to consider the particular pressures that individual faculty may face outside the work setting (University of Michigan, 2012).

During the researchers' interview with the deans/chairs, most subjects in the evening were given to or handled by part-time teachers whose availability is in the evening.

Other Preferences

Based on the gathered data, some faculty members considered accepting teaching loads if there were available books and reference materials on the given subject. Another consideration is the location of the room and the subject assigned.

Online Class Scheduling and Faculty Loading System

The proponent implemented the first increment (prototype) of the software. Below are sample screen shots of the system:

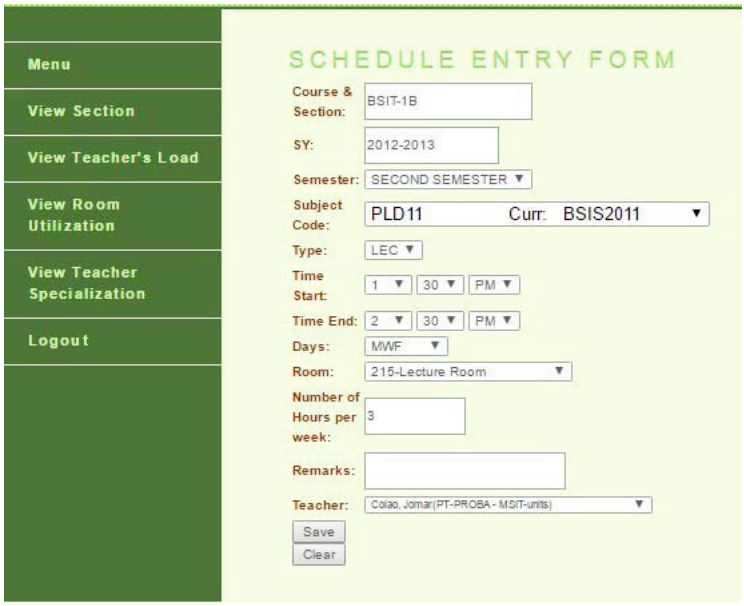

Figure 2. Class Scheduling Data Entry Form

Figure 2 shows the class scheduling data entry form that allows the department head to create a particular course schedule. During selection of a particular room, the system will check whether the room selected is available or not on the specified time schedule (see Figure 3). Upon assigning a teacher to handle the course created, the system corroborates the faculty availability in terms of qualifications and preferences. The system alerts the department head if there are time conflicts, qualifications and preferences mismatch, based from the rule sets defined in the system (see Figure 4).

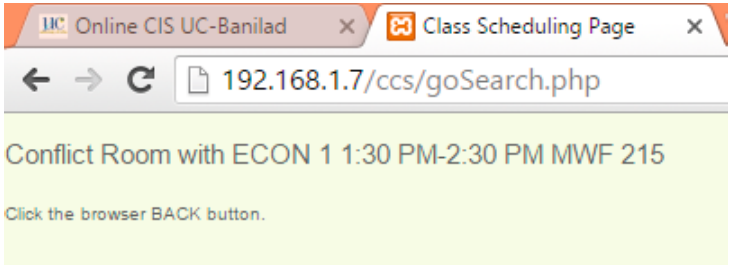

Figure 3. System Alert Notification – Room Not Available

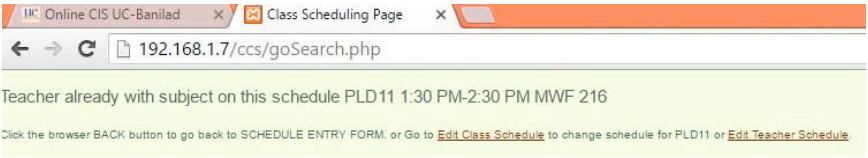

Figure 4. System Alert Notification – Teacher Not Available

CONCLUSIONS

The researchers concluded that it is feasible to develop an online class scheduling and faculty loading system that is accessible to all academic heads for efficient utilization of shared resources needed in preparing their course schedules. Teacher qualification, specializations, preferences, academic heads and HR requirements can also be embedded into the system to ensure that the requirements are executed for easy verification and approval and subtle in the decision-making process. The researchers concluded that the online class scheduling and faculty loading must be implemented and other parameters in course scheduling will be embedded into the system, and a continuous improvement and maintenance will be done placing new constraints, procedures, and requirements.

TRANSLATIONAL RESEARCH

The outcome of the study entitled "Development of an Online Class Scheduling and Faculty Loading System" had been translated into a working Web system used by the Electronic Data Processing Center of the University of Cebu-Banilad Campus. The system effectively managed and deployed under local area network and can run in all types of web-browsers. The online system for a class scheduling and faculty loading gave academic heads the look at every combination of plans and evaluate which is best for better resources management, increased productivity and efficiency, cost savings, and a crystal communication channel to stay afloat.

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