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Project Sourcing for Capstone Course Experience from an Undergraduate Program

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Abstract

Capstone project courses give students experience solving a substantial problem using concepts that span several topic areas in the program of study. Having 280 students graduate every year, requires a substantial effort towards sourcing appropriate projects from the industry and academia that provide hands-on opportunity to apply IT solutions to problems. This paper presents two sourcing models for supporting the sourcing of capstone projects. For each model, the various project origination sources, the distinct attributes, the challenges and lessons learnt are discussed.

1. Background

Undergraduate students in computer science, information systems and information technology undertake a capstone project that integrates the specific knowledge and skills acquired during their studies. These capstone projects help students practice methods, techniques, and tools [1].

Research studies have addressed various aspects of a capstone project. For example, [2] proposes a hybrid project management method that combines waterfall and agile project management techniques when managing capstone computer and information systems projects. Another research study has identified six styles of supervising capstone projects. These include student alone, execution focused, global supervision, management focused, technological mentoring, and process focused [3]. A more recent study has examined the lessons learned across three different higher education institutions with regard to design, supervision and implementation of capstone project courses [4]. Other research studies have focused on team formation [5], and project types [6]. Though a lot of work has been done with regard to capstone projects, very little has been published with regard to sourcing capstone projects. The various mechanisms to source for projects are particularly important in programs that have a large cohort of students required to complete capstone courses every academic year. Traditionally, projects have been sourced internally, through faculty teaching in the program. However, this severely restricts the variety of projects that students can work on and therefore limiting the knowledge and skills that can be gained from the capstone project course. More recently, programs have emphasized the need to source projects from external agencies so that students gain “real world” exposure. These projects provide the opportunity for combining theory and practice for the benefit of external organizations [7]. This paper addresses the important topic of sourcing for capstone projects. Sourcing involves identifying a suitable project for student teams to work on. A good project is one that helps students gain competencies specified for the capstone course, has the right level of difficulty appropriate to the program, is capable of being completed within the course timeline, and provides the opportunity for students to apply knowledge and skills gained from other courses in the program. However, for a large program of about 280 students requires a steady supply of at

least 55 projects every academic year, assuming five students per project team. A major challenge is to provide adequate variety of projects in terms of technology used, business problems addressed, industry sectors, and client profiles.

The main contribution of this paper is to propose different sourcing models for ensuring continuous supply of problems for capstone projects. Section 2 describes the key attributes of the capstone project for the BSc Information Systems Management Program. In Section 3, the project sourcing models are discussed along with their attributes, challenges and lessons learnt. In the final section some of the issues faced during the implementation of the models are discussed and opportunities for future enhancements are presented.

2. BSc Information Systems Management Capstone Project Course

The capstone project is a compulsory core course requirement for all students graduating with the BSc Information Systems Management (ISM) degree at School of Information Systems (SIS). It is equivalent to one course credit. The project is undertaken in a team of four to five students.

Students are set a major task to complete over one term comprising fifteen weeks. Projects utilize authentic real-world challenges and have a client who sponsors the project. Students work together in teams to define a problem, develop a solution plan, produce and demonstrate an artifact that solves the problem, and present their work.

3. Capstone Sourcing Models

The sourcing for a good student project is difficult. The type of projects available largely depends on the maturity of the IT industry in the city where the institution is located. Singapore is a small island city but has a very mature IT industry and a developed economy. Therefore, for SIS, there is an abundance of project sponsors from both for-profit and not-for-profit sectors of the industry, community and government. At the outset, therefore, it was decided that student should be able tackle a diverse set of projects, which meet the course requirements and satisfy the competencies defined for the course.

When sourcing for projects, the following four criteria are applied. The first criterion is business domain. SIS BSc (ISM) program trains students in application of technology in a business context. Hence projects from different business domains are sourced. For example in the last three academic years, projects were sourced in the domains of finance, healthcare, insurance, manufacturing, bioinformatics, education, retail, and logistics. The second criterion is exposure to a variety of technologies. These can include open source technologies, enterprise technologies and different programming languages. In some instances projects also require students to develop embedded systems that require dedicated hardware. The third criterion is exposure to different types of organizations. This helps students gain valuable professional skills and knowledge of business processes and working culture specific to an organization type. Currently, projects include operational business units, research and development departments, not-for-profit organizations, small and medium sized organization, multinationals, government organizations and startup companies. The fourth criterion is the project focus. These include proof of concept prototype, complete product development and marketing, software design and deployment in a production environment, and research experiments and prototype. The project management processes, techniques and tools vary according to the project focus.

Two sourcing models are presented namely internal sourcing and external sourcing. Internal sourcing refers to project ideas that originate within the SMU community. External sourcing refers to project ideas that originate outside the SMU community.

The following briefly describes the different sourcing models and for each model, the lessons learnt are presented.

3.1 Internal Sourcing Model

This group of projects comes from within the university. These projects originate from SMU business units and research units. Those that originate from the business units are predominantly focused on building operational systems. For example, a project sponsored by the SMU retail shop to develop an online system for selling university branded products such as T-shirts and mugs. The operations manager for the business unit drives these projects and they require students to work through the entire life-cycle, from defining requirements to testing and deploying the system. Students learn a lot about requirements gathering and dealing with end users. Since most of these projects address automation of manual tasks. This helps students gain a better understanding of real world end-to-end business processes. The Intellectual Property (IP) is very flexible and allows the student to reuse the code for other purposes. Since these units have very little funding, students are expected to build systems from scratch using open source software and tools. The success of these projects is measured in terms of how the system deployed is perceived by the end users. An important criterion is the end user evaluation.

Research faculty drives projects that originate from research units. The focus here is to get the students to build a prototype to test a research hypothesis. These projects are highly iterative in nature and require students to build an incremental prototype. The Intellectual Property (IP) is very stringent and requires all members of the team to sign a Non Disclosure Agreement (NDA). The students work with research tools to build the prototype system. Usually students who have a research interest and are keen to pursue further career in research or higher studies choose these projects. The success of this project is measured in terms of how the system helps to measure the research hypothesis. The success or failure of the hypothesis does not impact the student project. An important criterion is the evaluation done by the faculty sponsoring the project.

3.1.1. Lessons learnt: Internally sourced projects are easier to manage with the university resources and support. The main challenge with projects funded by the research units is to ensure that students satisfy the requirements of the capstone project and gain the competencies listed for this course. Some of the research faculty and research engineers lack an understanding of real world software engineering life-cycle. Therefore, in some instances, the projects turn out to be more deep research and very little implementation. Such projects therefore fail to satisfy the course learning outcomes of the capstone, and are better suited for independent study, which is another course within the ISM program. It is also observed some of the research driven projects tend to be more mathematical in nature and require students to have good math skills. In order to overcome these drawbacks, the course manager has to work closely with the sponsor to educate them on the requirements for the capstone project. One way to educate is to get the research faculty involved in supervising projects sponsored by external organizations.

3.2 External Sourcing Model

This group of projects comes from outside the university. These projects can originate from a number of sources namely not-for-profit organizations (NGOs), small and medium sized enterprises (SMEs), multinational companies (MNCs), and student start-up.

The NGOs can be either charities or government agencies. Projects proposed by SMEs and NGOs tend to be requirements for developing operational systems. Most of the NGOs focus on automating their manual processes with a few trying to improve their outreach projects. NGO

projects appeal to teams with altruistic motivation. Some of the projects are basic IS automation while the more IT savvy NGOs leverage emerging technologies such as mobility applications. For example, using mobile devices and maps to show how donor's money is helping the various causes. The senior manager or IT head drives these projects. The students are required to work through the entire life-cycle, from defining requirements to testing and deploying the system. Students learn a lot about requirements gathering and dealing with end users. Most projects under this model address the need for automating manual tasks in order to enhance process efficiency within a NGO. The Intellectual Property (IP) is very flexible and allows the student to reuse the code for other purposes. The government agencies are big organizations that use projects to improve their operations. However, very rarely require full implementation and deployment. Student teams working on government projects understand the complex processes in an efficiently run government. For SME and government projects, the software tools required are entry level enterprise software and usually stipulated by the organization, whereas for NGOs, students are expected to build systems from scratch using open source software and tools.

MNC projects tend to cover a range of industries such as financial services, manufacturing, retail and health care. The project provides a wealth of knowledge in the industry domain. This coupled with motivation for students to learn and possibly get a job in the sponsoring organization or with that industry, makes this group of projects highly in demand. These projects have strict NDA requirements and IP eventually belongs to the sponsoring organization. The projects are mostly proof of concept that is very unlikely to be immediately deployed for real use. MNCs use the project results to understand the feasibility of an idea, and in some instance to use the experience gained to write proposals for obtaining vendor quotes. While working on these projects students gain hands-on experience using advance enterprise software such as SAP ERP, Salesforce CRM and Oracle financials. This experience and the industry domain knowledge that is gained make these projects very valuable. As most of these projects are proof of concepts, it is hard to judge the success unlike those that are based on the deployed usage of the system. However, the projects can be assessed in terms of the technical complexity and stakeholder management, which are usually more challenging in the MNC projects.

A number of projects are also driven by student startups. A member of the team or the entire team is involved in starting a new business. The business idea drives the requirement for the project. The IP is very flexible since the students own the IP. The startup projects are usually experimental ideas and extend from requirements definition to prototype development. Very rarely, they lead to full-scale deployment and evaluation. To avoid IP issues, these projects tend to use open source tools for implementation.

3.2.1. Lessons learnt: Sourcing projects from MNCs is very difficult since the organizations are very large and there is not a specific person who is able to collate and manage the collaboration between the student teams and the stakeholder. In order to overcome this challenge the school has established strategic partnerships with a few MNCs. In these collaborative partnerships, the MNCs are required to invest resources to manage the projects. Usually, a technology or innovation lab is set up. The funding for the lab is co-shared between the school and the MNC. The lab has at least one representative from the MNC and one from the school. The main role of MNC representative is to work with the business units in the MNC and source for projects. Once the project is identified, the school representative works with the student team to further refine the requirements and clearly define the project scope, timeline and deliverable. The MNC and school representative collaborate with the project team and the project supervisor to ensure the projects is successful from both the perspectives of the course requirements and those of the MNC's business unit. Every successful project strengthens the collaboration and paves way for further project ideas. Currently, the school has exclusive

collaboration labs with two MNCs one from the financial industry and one from the health industry.

For student startup projects, having the students to act both as client and project team member leads to situations where the requirements are manipulated to suit the team's interest and pace of work. This leads to projects which underperform. To avoid this, a solution is to enforce all student startup projects to have a mentor who is not a student and is not part of the project team. This mentor plays the role of a client and ensures that requirements are not changed in an ad hoc manner.

5. Conclusions and Future Work

This paper presented two models for sourcing capstone projects. The internal sourcing model relies on sources within the university such as the operational business units, research institutes and centers. The external sourcing model relies on sources outside the university such as NGOs, SMEs, MNCs and student start-up.

With the internal sourcing model, a major challenge is to get a continuous flow of project ideas. We have observed that there is a lack of initial inertia to suggest project ideas that develop operational systems, but once a few projects are successfully implemented, new project requests keep coming in. However, this requires the university management to drive productivity and process improvements. With the external sourcing model, a key challenge is to ensure the school's reputation is maintained. Any project that fails to deliver affects the project pipeline. Therefore, it is very important to establish clear lines of communication between the student team, supervisor and the external sponsor. All parties must fully understand the course objectives and agree on the specific requirements of the project. In situations where the school has an existing agreement or memorandum of understanding (MOU) with the external entity, it is vital that the capstone project operates within the scope of the MOU.

Future work will be directed towards two studies. The first study will focus on investigating the relationship between the sourcing model and project success. The second study will be aimed at collecting student perceptions of the different sourcing models.

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