Software Business Education for Software Engineers: Towards an Integrated Curriculum

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Abstract

All software is developed to create value to its stakeholders. Software engineering decisions and business value are closely linked with each other: technical decisions may have a profound impact on the business potential of software. Yet, software engineering education usually does not provide students with sufficient knowledge on business-related issues. We believe that the general business education is too abstract and unfocused to address the specific characteristics of software business. This paper suggests specific areas of business competencies that should be integrated into the software engineering curriculum. In addition, we compare these topics with software business curricula in three Finnish universities.

1. Introduction

Software is a fundamental part of most businesses and organizations, often a critical part of the value chain of an organization. Value creation, or the business benefits, is the underlying and ultimate objective of software engineering. Regardless of this, software development has been primarily driven by technical objectives and criteria. The importance of considering value in engineering decisions has been widely recognized as an important, yet neglected driver in software engineering [3]. However, value creation is a necessary but not sufficient condition for continued, viable business. In addition to value creation, the software organization needs to be able to create and maintain a profitable business model and operations over time.

The unique characteristics of software as an engineering object make the value and business considerations particularly complex and challenging. More specifically, the complexity of software [4] makes it difficult to understand the value implications of engineering decisions; the conformity characteristic of software makes engineering of software more reactive and less stable, increasing the uncertainty in value estimates of software; the changeability of software results in continuous evolution of value implications of software; the invisibility of software makes it difficult to explicate and understand the characteristics of software and, hence, their implications on value; software is a digital good [9] and, consequently, the ease of copying, transfer, and durability influence many aspects of value; as software is an experience good [7], its value is realized through the interactions with the system, making value assessment a situation-dependent activity; and as software is a networked good [9], value assessments need to take into account the value networks that are created during the development, delivery and use of software. All these aspects make value considerations unique and challenging for software. Software development is also closely tied to the people, organization, and processes utilized to develop software [6]. Hence, the characteristics and capabilities of the software organization influence the characteristics of software and its ability to create value. Furthermore, as services related to software products often are a critical component in the overall value creation [5] and as services are strongly

linked to processes and capabilities of an organization, we view organizational capabilities and characteristics to be critical in value assessments of software-based organizations and products.

Despite the above, most of the software engineering curricula do not include business education to students. While the general business competence classes have been proposed in the IT context [2], we have not found papers or reports detailing business requirements for software engineering tasks. It has become a common practice for many students to select a business minor to complement their SE studies. We have found that generic business studies do not provide detailed enough knowledge to effectively apply it in the context of SE work: it is too indistinct and too abstract. More specifically, the general business education does not take into account the specific characteristics of software, as presented above, and the content of business curriculum is too generic to be easily applied in software engineering tasks. Furthermore, business topics and computer science, including software engineering, topics have traditionally been taught separately by different educational institutions or university departments. Hence, the link between management sciences and software engineering has remained scant.

Hence, more specific and detailed business training should be given to software engineers so that they would have better abilities to recognize, plan for, and create value through their software engineering activities. This paper uses the Software Engineering Body of Knowledge (SWEBOK) [1] as the framework to identify the main areas of software engineering. Given this framework, we have identified a set of business topics or competencies that should be taught to students in such context.

Table 1. Relevant knowledge areas and corresponding business competency requirements

Knowledge Areas		Required Business Competencies
Roadmapping and planning		Strategic management: technology foresight, technology strategy Marketing: industry and competitor analysis, societal infrastructure analysis, market selection, generic positioning strategies Product management: commercialization
Partnerships and outsourcing		Partnership management Legal: contract negotiations
Other general business management competencies		Entrepreneurial skills: establishing a firm, growing a business, business administration, accounting, financing, network creation International business: internationalization, legal, taxation Ethical values
SWEBOK-based	Software requirements	Marketing: customer feedback gathering and analysis; customer requirements foresight Domain understanding: customer operating domain Communication skills: information gathering
	Software design	Industry structures and markets: technology platforms Communication skills: collaboration and negotiation Organization and human resource management: team management
	Software construction	Organization and human resource management: team management Communication skills: individual communications
	Software maintenance	Customer relationship management: customer feedback gathering and analysis Domain understanding: customer operating domain Communication skills: information gathering
	Software engineering management	Organization, technology management, and project management Communication skills: cooperation and negotiation (value proposition, sales and contract) Human resource management: leadership Marketing: sales
	Software engineering process	Organization, technology management, and human resource management: process management skills, change management
	Software engineering tools and methods	Management science: decision analysis (tool and method evaluation and selection)
	Software quality	Organization and technology management: quality management, business and quality measurement

2. The Software Engineering Body of Knowledge

The Software Engineering Body of Knowledge defines software engineering as a discipline and provides a structure by which various areas of software engineering can be categorized [1]. The SWEBOK is divided into ten software engineering Knowledge Areas (KA) and additional KAs of strongly related disciplines are also addressed.

We use the term business competency to refer to "behaviors that employees must have, or must acquire, to input into a situation in order to achieve high levels of performance" [8]. These competencies have been identified on two levels using the format *<area of business knowledge>: <specific skill>*, i.e., we have identified the competency on a higher level, using the main categories of business and management discipline and then identified the more specific skill that defines the competency in more detail. Most of the required business competences are based on the SWEBOK KAs but we have added three, as they are critical tasks relevant for most software organizations: Roadmapping and planning, Partnerships and outsourcing, and Other general business management competencies. As we did not identify any specific business competencies for SWEBOK KAs Software testing and Software configuration management, they are not included in the table. The right-most column in Table 1 contains the proposed business competencies required by each of the knowledge areas.

3. Review of Software Engineering Curricula for Business Requirements

In this section we review the curricula of three Finnish universities that offer education in software engineering. The purpose of this review was to compare how well our proposed requirements correspond to the course offering available now under software engineering curricula in order to identify differences and analyze the reasons for them. This information will be used to elaborate and refine the proposed list of business competency requirements for software engineers. We selected and grouped competencies from Table 1, reflecting more business competences that usually are not found in normal SE curricula. The results of this review are presented in Table 2.

In addition to the courses described in Table 2, the universities offering IT/SWE curricula also offer varyingly general courses and minor subject studies in marketing, management, organization, logistics, accounting, financing, entrepreneurship, and business law that can form a part of a software business curriculum, but are not software or high-tech specific.

4. Conclusions

As Bassellier and Benbasat [2] note, IT professionals should better understand the general business, interpersonal, and management domains in order to cooperate successfully with their customers. On the other hand, even this understanding is not sufficient if IT professionals are running their own software company, as this imposes further requirements on how to conduct the software business itself. In this paper we listed required business competencies for software engineering education and compared the requirements with the topics lectured in three software business curricula. On this basis it seems evident that there exists a major body of knowledge in the intersection of software engineering and business management that is beyond these two generic disciplines and thus specific to software business. Further work is needed to elaborate this knowledge and modularize it on top of appropriate curricula structures (e.g., ACM Computer Curricula, MSIS etc.).

Table 2. Software business specific education on business topics in the selected universities

Required business competencies	Helsinki University of Technology	University of Oulu	University of Jyväskylä (SW Business)
Strategic management	- Software product and service offering and models - Strategies and business models - Value networks - Horizontal vs. vertical software markets	- Planning SW business - Case-studies in SW business	- Business models and strategies for SW companies - Competing with software products and standards
Product management	- Requirements engineering & requirements elicitation	- New product development in SW business	- Requirements management and systems engineering
Entrepreneurial skills	- Software entrepreneurship - Creating and evaluation new business opportunities	- New dimensions in SW entrepreneurship - Creating SW business opportunities	- LaunchPad for start-up high-tech entrepreneurs
International business	- Internationalization of software companies - Internationalization models	- International SW business	- Business networks - International SW product distribution channels
Managerial issues	- Software project management - Risk management in software companies - Growth management	- Managing SW business	- Organizing and managing SW business and services - Risk management
Marketing and sales	- Pricing and positioning of software - Sales channels	- Sales management in SW business	- SW distribution channels
Organizational issues	- Organizing software development - Scalable organizational capabilities - Life-cycle models	- Organization, human resources and development	- Knowledge sharing in SWB
Partnerships	- Trust in outsourcing - Partnership management	- International SW company	- SWB partnerships - Business networks - Software and services sourcing
Technology management	- Software development methods - Software processes - traditional software engineering	- Case-studies in SW business - ICT standardization	- Information technology management and foresight
Legal issues	- Law in network society - Legal aspects of electronic commerce - Legal issues in computing	- Legal issues of digital knowledge - Information security and law	- Legal and Risk Considerations in Global SWB - Contract Agreements Related to International SWB
Communication skills			- Knowledge sharing in SWB companies
Management science	- Risk management and decision making under uncertainty		
Ethics		- Ethics of information technology	- Computers, ethics and society

5. References

[1]   A.Abran, J.W.Moore, P.Bourque, and R.Dupuis, *Guide to the Software Engineering Body of Knowledge -- SWEBOK,* IEEE Computer Society, 2004.

[2]   G.Bassellier and I.Benbasat, 'Business Competence of Information Technology Professionals: Conceptual Development and Influence on IT-Business Partnerships', *MIS Quarterly,* **28**, 673-694, (2004).

[3]   S.Biffl, A.Aurum, B.W.Boehm, H.Erdogmus, and P.Grünbacher, *Value-Based Software Engineering,* Springer Verlag, 2005.

[4]   F.P.Brooks jr., 'No Silver Bullet: Essence and Accident of software Engineering', *IEEE Computer,* 10-19, (1987).

[5]   M.A.Cusumano, *The Business of Software: What Every Manager, Programmer, and Entrepreneur Must Know to Thrive and Survive in Good Times and Bad,* Free Press, 2004.

[6]   W.S.Humphrey, *Managing the Software Process,* Addison-Wesley, 1989.

[7]   D.G.Messerschmitt and C.Szyperski, *Software Ecosystem: Understanding an Indispensable Technology and Industry,* MIT Press, 2003.

[8]   L.Miller, N.Rankin, and F.Neathy, *Competency frameworks in UK organisations: key issues in employers' use of competencies,* Chartered Institute of Personnel and Development, 2001.

[9]   C.Shapiro and H.R.Varian, *Information Rules: A Strategic Guide to the Network Economy,* Harvard Business School Press, 1998.