Abstract. IT outsourcing is a great chance for technological and economical growth of developing countries. Natural outsourcing vendors are small and medium enterprises. To obtain higher competitiveness in that sector, skilled engineers are required. Academic environment doesn’t provide students with enough experience with real-life problems. This article discusses the state of students’ knowledge in Croatia as demonstrated on the software engineering course which tries to place students in an environment similar to an industrial one.

Keywords. Information technology outsourcing, alliances, software engineering, academic environment, industrial environment.

1. Introduction

In today’s rapidly changing technological environment, fierce competition is putting companies under constant pressure to trim costs. One cost-effective solution that emerged as very popular during the recent years is outsourcing software development and maintenance activities. During the last few years outsourcing has become a major trend in the global IT market. Such practice boosted software industry in some developing countries and caused software export and production to take a significant role in their national economies.

Building alliances between firms is another approach to reduce costs. Alliances are nowadays one of the most important competitive strategies for technology companies [6]. It is also noted that the number of developing countries involved in international strategic alliances with the information technology content is rapidly growing. This implies major impact on their private IT enterprises and through them, to countries’ economies [11].

Potential candidates for outsourcing or alliances in smaller markets are small and medium companies since the nature of software development favors small companies with relatively low capital requirements [7]. For a market to be successful it is vital that small and medium companies lead in technology and development.

However, since start-up companies have a high failure rate, and IT sector is not an exception, a higher level of competitiveness from the start can mean a difference between success and failure. Small IT companies in Croatia are frequently created by the core of a few experienced professionals and a supporting team of engineers, often newly graduated. Since smaller companies usually cannot afford additional education of their staff, it is easy to conclude that the knowledge and practices of engineers acquired during their academic education will directly reflect to technical quality and performance of such companies. For any serious development of this sector, it is necessary to have a labour pool of skilled and capable engineers. Furthermore, the problem of a rising number of experienced IT professionals leaving the country adds up to the importance of the quality of engineering students’ knowledge acquired during education.

In this paper we shall present an analysis of the level of Croatian IT students’ knowledge at the end of their academic education and give an opinion on its impact on possible development of IT outsourcing in Croatia. The conclusions we made came from our experience through work with students in the course of software engineering at the University of Zagreb, Faculty of Electrical Engineering and Computing. Furthermore, common obstacles and challenges placed before a company in an outsourcing sector will be discussed.
2. Outsourcing and alliance benefits

For a (presumably) large company searching for outsourcing contractors, a worldwide market obviously has benefits allowing the company to find the financially most attractive contractor, to select among companies with a large scale of experiences, etc. It can be observed that several regions of the world had emerged as outsourcing oases, like India, Israel, and Ireland [3].

While large companies seek contractors to work on their projects, or just look for a way to cut costs by transferring development to contractors, for most of the firms in small markets of developing countries, outsourcing is the matter of survival. For any IT company in such an environment, seeking clients abroad is a necessity, since the local market is typically not developed enough to sustain a larger IT sector. Collaboration with foreign clients is often the only development strategy at choice for such firms [4]. Even further, most local companies in need of an IS have their own IT departments which are typically not outsourcing enthusiasts since most of the employees see it as a possible threat to their own jobs or positions. When working with an abroad client, outsourcing contractors often receive higher ratings in the local sector, which provides an interesting opportunity in increasing a company’s references.

A strategic alliance is defined as a web of agreements where two or more partners share the commitment to reach a common goal by pooling their resources and coordinating their activities [8]. This is meaningful when the parties involved have complementary strengths. Such partnerships usually do not require large capital investment, but require more integration of structures and practices instead [5]. An alliance between large and small companies is typically formed when a smaller company has niche market technology or products and when it needs larger company’s resources for further development. Since the small firm survival rates in IT sector are still lower, and at the same time startup rates are higher, small firms can often be forced to turn to large companies in need for finance. If strategic research partnerships are important to large corporations, they are even more important to small firms [1].

3. Common obstacles

When forming an alliance or an outsourcing relationship with a company abroad, obstacles may occur. Most common obstacles are:

- Communication problems,
- Language issues,
- Bureaucracy issues,
- Legal issues,
- Psychology issues.

Communication problems are partially linked to the fact that the project is most of the time led over considerable distances. Other sources in communication problems are closely connected to language and bureaucracy obstacles. Also, not to be neglected, a very important problem is different time zones between vendor and client.

Language poses a significant problem, even while English is globally recognized as the main language of the industry, it can be easily observed that the world’s leading outsourcing country – India – traditionally has a large English-speaking population. It has been noted that the language issue was a major barrier for development of outsourcing in some countries like Russia and China, which in spite of possessing vast human resources still have not reached India [3].

Bureaucracy gap comes from structural differences between large and small companies – large companies needing a chain of command while in small companies it is often implicit or even inexistent, with the responsibility shared between employees. It is often unimaginable to employees of a small company that such a layer of bureaucracy might stand between the detected problem (like a software bug) and a solution to the problem - which can cause a loss of faith in common interest.

Legal issues may arise from the fact that intellectual property laws may be different, or differently enforced, often less rigorously in developing countries.

Psychology – if outsourcing is considered as a reduction of costs in a large company, an employee of such a company might find himself or herself obsolete by some foreign company working on the project. Following that way of thinking, some individuals might believe that their jobs are threatened. A typical reaction would be to somehow affect the project to show his or hers own value.
4. Other obstacles

Like any other form of cooperation, or even in-house development, outsourcing and alliances are vulnerable to deficiencies such as:
- Poor or incomplete project specifications,
- Poor project or distance management,
- Inappropriate communication methods or communication frequency.

Poor or incomplete project specifications are a common source of project delays or failures. The distance problem, which is commonly related to outsourcing, greatly increases the impact of project specification and project management to the overall project success. Distance management must obviously include arrangement of appropriate communication methods and strategies – which challenges the management. Without physical contact, the question of progress reporting and project visibility through reports and documentation, respectively, becomes more important than in a tight, single-site environment. These problems are common to any distributed project development. However, for two companies, working on the first project together, this can be a major obstacle. Proper project management on both sides should try to reduce the stress put on the development teams on both sides. When dealing with companies that considerably differ in size and management experience, establishing a trusty relationship between both sides involved can be a lengthy process.

5. IT market in Croatia

Currently, Croatia has great potential to create an IT economy. It owns both an excellent telecommunication infrastructure and well-educated labour force to use it [2]. Since Croatia is a developing country, it is reasonable to see a chance to boost its economy through the development of the IT sector. Unfortunately, these advantages are still not very well used and there is plenty of room for expansion.

As it can be seen from Table 1, most of IT companies in Croatia are smaller firms, with more than 85 percent with less than 10 employees. Also, smaller firms employ the majority of around 7600 workers. Most of the IT industry firms are clustered in the area near the capital of Zagreb which has about 56 percent of total employees in IT sector, but draws 74 percent of total profit [10].

However, the majority of these companies are involved in hardware redistribution and assembling, and there are less than expected companies engaged in software development, system integration, or manufacturing. During the last three years, things started to get more prosperous in the field of software development, mainly because of foreign companies, especially German, opening their offices in Zagreb and employing a significant number of people to develop software [2]. Unfortunately, this process was slowed down because of the worldwide IT recession.

The labour force in Croatia is very well educated. Still, employers report that graduates possess good academic skills, but need to be trained on the specific applications related to their job [2]. This slows down the process of adapting to the company’s environment and if the employer is a small company, it can put a strain on its usually tight budget.

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<th>Table 1. IT companies in Croatia according to the number of employees and revenue, 1999-2000 [10]</th>
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6. Software engineering in academic and industrial environments

Software engineering deals with a somewhat different set of problems when placed in an academic environment, which tends to be more relaxed, without constant pressure of success. Typical academic projects are led by experienced researchers and scientists, with supporting students who work distributed and on their own schedule. Teamwork is often loosely coupled with clearly defined modules for each student to implement. Academic problems are typically well-structured, with clearly defined goals and contents. Such an approach essentially teaches students to assume there is a correct solution to the problem and that they should be able to deduce such a solution from the problem itself.

Industrial environments have to face problems that have a changing set of goals, contexts and obstacles, with constantly changing influences to problem-solving approaches. To be successful, future engineers need to have practical experience with such problems. Because of that, companies want to hire engineers with good team-working skills, with entrepreneurial attitude, engineers who can adopt a company culture quickly, develop engineering solutions to industrial problems, collect the information and data for problem solving, and sell their ideas to different levels of people within the organization [9].

A major company can easily invest in educating students, like telecommunications companies in Croatia do. The IT sector is mostly comprised of SME companies who do not have ample resources to spend on education of students. Improving the academic courses to include experiences in practical problem solving can directly help the development of SME companies. In a small, developing market the skills of newly graduated engineers are highly important.

Software engineering is introduced to the students in an introductory course – Software Engineering – Selected topics.

At the start of the course, students are given a short questionnaire in which they are required to express their current and desired level of knowledge. This questionnaire is later used to form teams and assign team leaders. We have used this questionnaire to provide an overview of what students think of their skills. Students are generally content with their knowledge of programming languages and base technologies (C/C++, Java, Web – HTML, MS Windows and Linux platforms or databases), with some improvements from 2001/2002 generation to 2002/2003 generation. Students were also polled about their knowledge of advanced technologies, grouped into four groups – web technologies (HTML, XML, PHP, JSP), wireless technologies (WAP, SMS, Bluetooth), distributed architectures (EJB, CORBA) and integrated architectures (Smartcards, J2ME and security). The results show a high level of interest in new and high-profile technologies (wireless and integrated architectures), but somewhat reduced enthusiasm for established topics like web and distributed architectures. A large number of students did not express their will to learn such technologies either.

![Figure 1: Results of the questionnaire for academic year 2001/2002](image)

Some differences between two generations can also be noted. While the first generation expresses willingness to learn all provided topics, the second generation chooses to focus on new and somewhat trendy technologies. During the course, students are split into teams of 5-10 people and placed before a customer (a role played by the teacher) who has just a general idea of what he wants, but is very specific that the project must be finished by the end of the semester.

The students are rewarded for the success of the project with grades. This simulates a real-world environment and students are required to manage relations with the customer and within their own team – teams are selected based on the
questionnaire. Experience with students' reveals the following conclusions.

Knowledge of English does not pose a problem – even if a minority of students finds their knowledge of English unsatisfactory, the overall awareness of a need for fluent English is very high. However, a higher level of knowledge of technical language is still to be desired – with an overall trend of introducing Croatian terms to the industry, the English originals still remain a primary reference.

When placed before the challenge of teamwork, a typical student response is to form minimal teams of two to three persons, based on personal preference, friendships and the like. Such small teams are also encouraged by the structure of the courses of the Faculty and students often work with the same persons throughout their entire academic education. This forms strong bonds in those micro-teams, but also reduces the teamwork experience that the students gather during their education. If a larger team is formed for a project during some course, especially if teams are selected based on student's experience and knowledge level (not their own preference), students generally demonstrate a lack of team mentality and teamwork experience – usually a small group of students carries most of the responsibilities of the whole team, while the rest deals with minor details. However, the awareness of teamwork experience importance is very high, and students are willing to learn on the subject - in a real company environment, with proper guidance, teamwork should not pose a significant problem.

The structure of educational process in Croatia can be considered traditional – the emphasis is on broad education, rather than the in-depth study of the field – at least not until the start of the graduation process. The range of technologies taught at the faculty is constantly changing and new technologies are embraced every few years. Broad education has benefits, of course – students easily adopt and understand different technologies encountered in senior years, and are not bound to single technology, development approach or mentality. The education cost for companies hiring such students is higher, but comparable to the cost of education for a technology significantly different than the one taught at the faculty. Such an approach on behalf of the faculty yields highly praised engineers, but only after significant time spent on self-education – this could be reduced if the students were offered a range of seminars, and an initiative for such seminars is very strong at the faculty, and many have been held to date.

Aside from the knowledge of technologies, the documenting process is not familiar to most of the students. The routine of writing comments to the code is mostly regarded as unnecessary and time consuming, even while most admit that comments are necessary for understanding of even one's own code after a while. Writing any significant documentation to the code itself is generally considered a lowest priority task, and a matter of personal choice and not common practice. Coding standards are usually agreed upon only in aforementioned micro-teams. When changing an already existing system, students tend to follow the coding standard, but not thoroughly. Students are not familiar with documentation standards, and the level of produced documentation varies greatly between teams.

Open source style of development is highly appreciated in the academic environment, as expected, but understanding of the need for distance development routine (e.g. usage of version control systems, such as cvs) is not nearly as high. The whole of the team's tasks are usually split to completely separate modules and then distributed over students or micro-teams – thus reducing the need to cooperate on the source level. It can be estimated that while the level of students' projects' complexity grows in the future, so will the distributed development methodology acceptance.
Overall, students exhibit great flexibility and a lack of knowledge of practices common for their future employers. This is due to a lack of cooperation between the university and the IT industry. By increasing the level of cooperation, the initial education required for newly employed graduates (or even students working part time) would reduce and the dependency on proper guidance (through management or colleagues) would become much less significant.

7. Conclusion

In today's global economy it is very easy for a smaller country to find itself falling behind if it does not succeed to use technology age benefits effectively. For Croatia, and probably for any other similar small country, the key to development is through planned help and incentives of the government. This could manifest through reducing trade barriers, offering tax and financial incentives to assist small and medium sized firms in training their workers, as well as investing in secondary education and related university programs. In this paper we have tried to show the importance of the latter aspect, by presenting state and structure of typical Croatian students' knowledge in the field of software engineering. Though most of them have strong coding skills and willingness to learn, it can be noted that the students are lacking practical knowledge of the field of software engineering, especially in project management and documenting process. An obvious solution to advance and deepen students' knowledge would be by strengthening the collaboration between university and IT industry, thus providing the students with the way to earn practical experience. In Croatia, this area is still underdeveloped. Again, the government should take the key role here by supporting such actions of SME sector and by investing in research and development.

It would be naïve to expect for any smaller country to reach India's enormous success, but development of IT industry through outsourcing and strategic alliances is by all means a great opportunity. Although it contains problems and possible pitfalls, and some can view it as a form of exploitation of theirs country cheap labour force, it is still potential engine of economical growth. However, without the help of country's government, there is no reason to expect any explosive growth in that field, no matter of the potentials of human resources.

8. References

[1] Audretsch DB. Strategic Research and Small Firms; Proceedings from an NSF workshop; http://www.nsf.gov/sbe/srs/nsf01336/p1s5.htm [03/14/2003]