

Towards a Globalized Software Industry

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Abstract: Software Engineering (SE) represents a remarkable share of the Information and Communication Technology (ICT) industry, which is an important feature of modern well-developed societies. Its importance can be seen on two levels: the industry itself and its indirect consequences for other industries. Although the SE industry represents a reasonably small share of employment (in the home country of the author, 2-3%), the indirect effects raise its economic importance to a much higher level. The role of the ICT industry is also used as one of the Information Society (IS) metrics in country comparisons. One of the leading trends of modern SE is globalization: employees represent different national cultures and the organizations are distributed across several countries. This paper opens the discussion on the topics worth considering when making globalization decisions. The basic hypothesis is that decisions are mainly based on economic factors. The organizational and cultural factors connected to these decisions are not well understood. At the beginning of the paper some background is introduced and the results of related studies are listed. The paper introduces a framework that is useful in planning the globalization of an organization. This paper focuses on the Finnish software industry; however, the same principles are applicable independent of the country or nation.

Keywords: cross-cultural, multicultural, software engineering (SE), cultural sensitivity, global software development, information and communication technology (ICT), globalization, global software development (GSD)

1 Introduction

1.1 The Economic Value of the Software Industry

The software industry is an important business sector – both on a worldwide scale and in the Finnish dimension. The total value of the global software market has been projected at EUR 238 Billion [1, 2]. The figures for Finland are as follows:

- In 2008 software product business revenues (composed of the software product business and related services) accounted for EUR 2.32 billion; about one-third of it from international business.

- The latest statistics show an 8.7% annual growth in business volume; the software industry tends to be reasonably independent of economic trends.
- The number of Information and Communication Technology (ICT) companies in Finland is 8 800 [3]; they employ 51 000 people, 33 000 of which are in the software industry.
- According to a recent report [4], two-thirds of software companies employ less than 20 employees; 72% of companies have an annual revenue of below EUR 20 million. The average revenue per employee is EUR 100,000.

However, the figures above do not tell the whole story, because the analysis is of the ICT industry in its narrowest sense. It does not cover the companies developing products controlled by embedded computers and software. More than pure software products, these represent the leading edge of the Finnish ICT industry. This product category includes instrumentation, telecommunications, and machine engineering products, among others. Typical examples of this category are mobile phones and harvesters. Nokia has reported that the development costs of mobile phone software represent approximately 80% of the total. A harvester used to harvest timber in forests is a high-tech product controlled by close to ten computers interacting with each other. The total size of the software in these products is in the range of millions of lines of code, representing a reasonably wide variety of software types, from very typical administrative applications to complex real time and telecommunications software.

Software engineering (SE) is demanding expert work. Typical of this kind of work is its indirect effect on employment. According to statistics, a software engineer typically employs 2-3 people in related jobs. In summary, the total employment effect of the software industry can be calculated more likely as 10% of employment rather than of a few percentage points only.

The importance of the software industry is also important on an indirect level. It is one of the information society metrics in country comparisons. The home country of the author is ranked high in international comparisons, which means that the information technology-based infrastructure is well developed and the industrial structure is highly dependent on the welfare of the ICT industry. For the sectors utilizing ICT-related products, the proximity of the ICT industry itself is crucial.

1.2 The Software Industry is Globalizing

One of the trends that is changing the characteristics of the software industry very strongly is *globalization*. The driving forces are manifold and cover the factors derived from business goals, characteristics of the products, and changes in the software engineering development process. The factors connected to the *software business* are motivated by growth, access to wider markets, and the availability/price of the resources required. The current *software* products are

more products than individual artifacts. They are modular, adaptive, and based on *industrial* development methods. As a consequence, the distribution of work has become a natural part of the *development process*. Because of the “industrial overhead,” software products are also growing in size and complexity as components of the *complex systems of systems*; as a result, their development and maintenance are based on distributed responsibilities. Even the traditions in the development culture are breaking down; the productivity of the traditional plan-oriented development has been impugned and an alternative approach is provided by the Agile approach (see e.g. [5]). In addition to traditional software (based on ownership of the product or licenses), different kinds of service-based solutions are overwhelming the market (e.g. SOA-based solutions, ASP- and SaaS-based services).

Globalization has meaningful consequences for the software industry:

- software companies are establishing branch offices abroad;
- software companies are offshoring their processes, outsourcing their work, and subcontracting abroad;
- ownership of companies is becoming global; therefore several Finnish software companies are today under foreign ownership and Finnish companies own companies abroad.

These factors require the easy flow of workforce over geographical borders and also meaningful changes in software organizations, which are becoming *multicultural*. Globalization may be a success or a failure.

This paper is based on an ongoing research project. The project has just started and its goal is to identify the factors that have an effect on successful globalization, as well as to find the factors behind failures. The focus is set on the development process, its consequences in the organization, management, and division of work, taking cultural aspects into account. However, product viewpoints (usability, localization, user aspects) are excluded. In sub-chapter 1.3 we start with two “real life” cases.

1.3 Two Scenarios

Scenario 1: A Finnish company (A) is establishing a branch office in China. The decision was based on the calculations of the salaries and availability of a skilled workforce. The purpose is to offshore a part of the software development to China (i.e. moving work from Finland to a cheaper country). The management of the company were not familiar with Chinese culture and lifestyle, but they expect to manage this problem because of their previous experience in international business. One of the experienced members of the higher management was relocated to China to establish the branch office – his responsibility was to build

up the infrastructure and recruit the first employees. Plans to distribute the project responsibilities were available and the organization has experience in intra-organizational distributed work culture. However, the opening of the office in Beijing was delayed by half a year due to the problems with *bureaucracy* and *local policy*. The banking system does not support free money transmissions. Additionally the first Chinese employees were not totally committed to the company and left after three months because of a better offer from an American company. After three years the organization was operative, but its costs exceeded the costs of the Finnish part of the company – the salary level was 80% of the salary paid in Finland. Additionally regular quality problems exist in the products developed in China – the processes applied in Finland do not fit Chinese working culture. Company (A) is considering closing the branch office in China because the availability of the workforce in Finland has also become easier and China is not a promising market area for the products of company (A).

Scenario 2: A Finnish company (B) was profitable as an important subcontractor of software and its main client was a big Finnish globally-operated company (D). Part of the work was done in collaboration with an Indian subcontractor (C), which also collaborated with D. Thus, the organization has been used to collaborating in cross-cultural teams. The Indian company (C) is a large one (30,000 employees) and operates in diversified fields of business, software development being only one of them. C offered to buy the Finnish company (B); after six months of consultation, the agreement was finalized and the Indian company C became the owner of B; a part of the agreement covered the willingness to continue and extend operations in Finland. After purchase, some Indian experts were moved to the Finnish offices of B. Finnish management is continuing but the budget and growth expectations are set by Indian head office – at a far too demanding level in Finnish circumstances, which are not familiar to the Indian management. After two years, a part of the operations that had been under the responsibility of the Finnish part of the joint organization (B+C) was moved to India and half of the employees were faced with two alternatives - either to move to India or leave the company.

1.4 Study Problem

The scenarios above provide a rather pessimistic view of globalization. Apart from some negative experiences, most cases are, however, more or less successful – some great successes and some leading to an acceptable final state. This paper is based on the background ideas of a research project (called STEP) recently started by the author and his research group. Its *primary goal* is to deepen the understanding of the globalization process of software organizations. The cultural aspects are mental and not easy to anticipate. The study covers two viewpoints: (1) a *Finnish company* that is extending its activities to foreign cultures or (2) is as a

result of acquisition, now under the ownership of a company representing a foreign culture. The study is based on the following hypothesis:

- 1 Globalization decisions are made on economic grounds and prior knowledge of the foreign culture is usually poor when the globalization decision is made.
- 2 The elements of successful globalization vary according to the organizational characteristics, direction of globalization, the role of the owner in the global collaborative network, and the globalized artifact.
- 3 The culture-based stereotypes recognized by Hofstede (the selected framework of this study) are helpful in managing cultural aspects but need additional interpretation in order to be used in the context of the software industry.

The research is focused on *organizational and process issues* (how the global collaboration is organized and how aspects derived from the multicultural characteristics of the organization are taken into consideration). The viewpoints of product localization and user experience in different cultures are excluded.

The work is just in its initial stages and it is too early to provide any results in this paper. The study itself contains two phases of interviews: the first phase (target group is selected experts in the field) is to set the focus of the second phase (target group is a statistically meaningful set of software companies) interview to the right scope. In addition, a relevant literature survey has been executed to become acquainted with the existing findings. Surprisingly, there are not very many reported results available on the topic. The interview results will be analyzed using the framework introduced in this paper. At the moment the first interview phase and literature survey is ongoing. This paper concentrates on the current findings and introduces the methodology applied in the analysis.

1.5 Structure of the Paper

The purpose of this paper is to analyze the factors related to software engineering in a cross-cultural and also in most cases in a distributed environment. Section 2 introduces the frameworks developed to recognize cultural differences. Section 3 lists the findings of related studies, mainly based on real cases analyzed and reported in SE journals and conferences. Section 4 introduces the analysis model that is used to simplify the complexity of the problems related to cross-cultural software engineering in globally operated organizations. The last section concludes the paper and lists activities for future work.

2 Analyzing the Cultural Differences

Terminology within the multicultural and cross-cultural communication field seems to be inconsistent. The concepts relevant to this study are defined below. The terminology is a part of a wider glossary of relevant terminology [6]:

Culture is a collective phenomenon. It is shared with people who live or have lived within the same social environment, which is where it was learned. Culture consists of the unwritten rules of the social game. It is the collective programming of the mind that separates the member of one group or category of people from others [7, 8].

Cross-cultural describes comparative knowledge and studies of a limited number of cultures [9].

Multicultural describes comparative knowledge and studies of relating to, or including several cultures [9].

According to [7, 8] cultures can be considered on several levels: national, organizational, sub-organizational, professional, domain, project, team and task cultures (see e.g. [10], [11]). In this paper, the focus is on *multicultural* organizations and on the analysis of the role of *national cultures* in multicultural software organizations.

There are two frameworks of the analysis of the differences of national cultures that are widely used and applied. The most referred to is the work of Hofstede [7, 8, 13]. The framework (summary in Table 1) recognizes five properties that separate cultures from each other (see the figure enclosed [12]). *Individualism/Collectivism* (IND) describes the extent to which a society emphasizes the individual or the group. *Power Distance* (PDI) describes the extent to which a society accepts that power is distributed unequally. *Masculinity/Femininity* (MAS) refers to the values to be held in a society. *Uncertainty avoidance* (UAI) refers to the extent that individuals in a culture are comfortable (or uncomfortable) with unstructured situations. *Long-term/Short-term orientation* (LTO) refers to the extent to which a culture programs its members to accept delayed gratification of their needs.

Hofstede's www-page [7] includes a useful tool to compare cultural differences. It provides an opportunity to study the characteristics of individual cultures or to analyze differences between two (or more) cultures (Figure 1).

Table 1
Hofstede's Cultural Dimensions [12]

Dimension	Description of the dimension
Individualism/ Collectivism IDV	Individualism/Collectivism describes the extent to which a society emphasizes the individual or the group. Individualistic societies encourage their members to be independent and look out for themselves. Collectivistic societies emphasize the group's responsibility for each individual.
Power distance PDI	Power distance describes the extent to which a society accepts that power is distributed unequally. When the power distance is high, individuals prefer little consultation between superiors and subordinates. When the power distance is low, individuals prefer consultative styles of leadership.
Masculinity/ Femininity MAS	Masculinity/Femininity refers to the values more likely to be held in a society. Masculine societies are characterized by an emphasis on money and things. Feminine cultures are characterized by concerns for relationships, nurturing, and quality of life.
Uncertainty avoidance UAI	Uncertainty avoidance refers to the extent that individuals in a culture are comfortable (or uncomfortable) with unstructured situations. Societies with high uncertainty avoidance prefer stability, structure, and precise managerial direction. In low uncertainty avoidance societies, people are comfortable with ambiguity, unstructured situations, and broad managerial guidance.
Long-term/ Short-term orientation LTO	Long-term/Short-term orientation refers to the extent to which a culture programs its members to accept delayed gratification of their material, social, and emotional needs. Business people in long-term oriented cultures are accustomed to working toward building strong positions in their markets and do not expect immediate results. In short-term oriented cultures the "bottom line" (the results of the past month, quarter, or year) is a major concern. Control systems are focused on it and managers are constantly judged by it.

In Finland the most promising reference cultures are China and India as the most feasible goals for offshoring/outsourcing. Figure 1 shows the differences between the cultures – the facts that must be taken into account in organizing the work and in management of a multicultural organization. Finns are used to working in low democratic organizations (low PDI value) as individuals (high IDV value), whereas Chinese and Indians respect the power and status based on the hierarchy – this has direct consequences e.g. in decision making and in liability; they are also used to acting as a member of social groups both in work and private life. Finnish culture is family-oriented and feministic, whereas Chinese and Indian values are categorized as more masculine (MAS; money, property). This has reasonable high consequence on the factors motivating people to work. Finns accept higher uncertainty (UAI) than the reference cultures, in which "losing face" is not acceptable. Indian and Chinese cultures are typical examples of long-term orientation – the ability to wait for the results of the work is high. This metrics value is not available for Finland, but an example of short-term orientation is the USA.

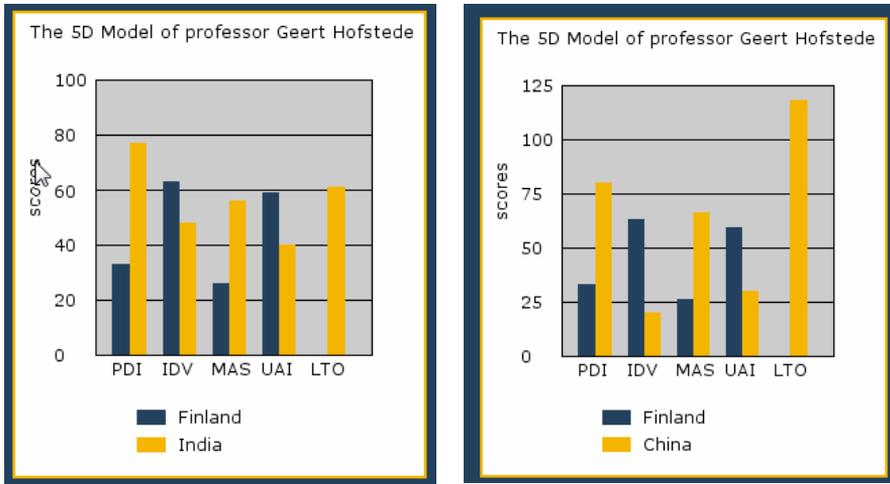


Figure 1

Comparison of Finland to China and India according to Hofstede's model

Another widely used model to analyze national cultures is the Lewis Model [9]. It focuses more on communication and interaction skills, and cultures can be classified into three main categories: a *Linear-active culture* is task-oriented and value is given to technical competence; a *Multi-active culture* is extrovert and human force is seen as an inspirational factor; a *Reactive culture* is people-oriented and dominated by knowledge, patience and quiet control. National cultures are located on the sides of the triangle having the three above-mentioned stereotypes as the corners [14]. The people representing *linear-active* cultures are communicative, but not too much. They concentrate on one activity at a time and are used to working step-by-step. They are polite but direct, job-oriented and are grounded on facts. *Multi-active* cultures talk all the time, used to the concept that parallel activities and plans provide more outlines than rules. They respect feelings more than facts and their "truth" is flexible. People from *reactive* cultures are listeners and activated as a reaction to the partner's action. They are indirect and diplomatic, and very people-oriented.

The frameworks have been widely criticized – especially by researchers in social sciences. It is clear that the analysis based on the wide material collected by means of interviews is not the final truth. It is also true that every culture is a set of individuals and not a homogenous one. However, the stereotypes identified by the models help to recognize some basic rules on how to organize the work of a culturally heterogeneous group of people. Organizing the work, dividing the activities, adapting the management to take into account the cultural differences are examples of multicultural leadership and management culture.

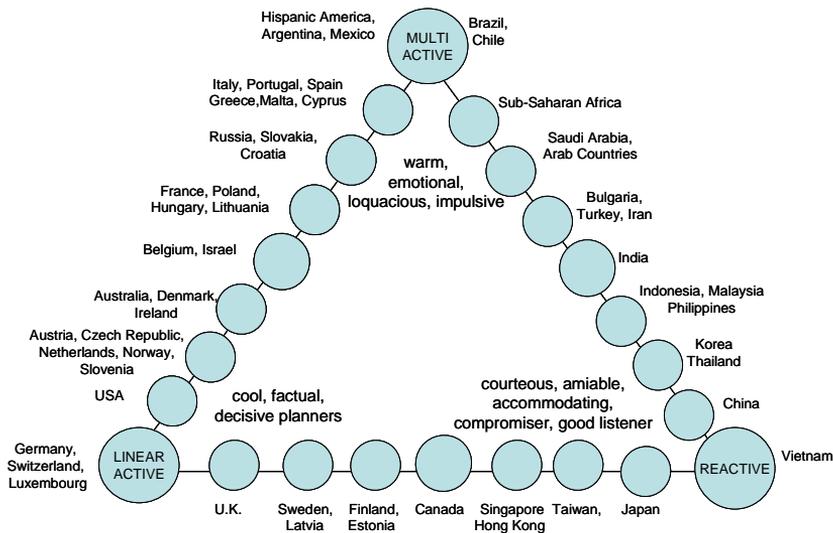


Figure 2
Cultural Types by Lewis

3 Multicultural Software Engineering – Current Findings

In spite of the fast-growing tendency towards globally distributed collaborative multicultural organizations in SE, there are just a few objective reports publicly available. Relevant sources are available from SE journals (ACM, IEEE, Springer, etc.) and conferences (e.g. ICSE – International Conference in Software Engineering and ICGSE – International Conference on Global Software Engineering, among others). The most commonly applied reference model is Hofstede's model. The findings (see Table 2) cover the differences found and provide recommendations in the area of practices related to software life cycle management, contracting, attitude to working time, mental mode (attitude to bureaucracy, authorities, the role of values and norms), meeting practices, team work, feedback practices, expectations in communication, division of work, importance of specifications, risk management, product management. Additionally, the papers cover recommendations of how to take multicultural aspects into account in SE education.

Table 2
Summary of the results of the selected studies in multicultural SE

Source	Reference model	Main findings
[15]	Hofstede	<i>Cultures:</i> Indians and Non-Indians <i>Findings:</i> Different practices and attitude in software life cycle management and contents of the life cycles. The main findings focus in contracting, organizing the life cycle phases, attitude to working time, meeting practices, team work, feedback practices, expectations in communication and risk management.
[16]	Bloom's taxonomy [17]	<i>Cultures:</i> General <i>Findings:</i> Analysis of the the requirements set by multicultural context for university.
[18]	Hofstede	<i>Cultures:</i> Japan, India; America <i>Findings:</i> PDI, UAI, IDV indices in focus. Analyzing the meaning of the differences recognized in attitude to work, software architecture, division of work, product management
[19]	No	<i>Cultures:</i> General <i>Findings:</i> More focused generally on distributed software development. Requirements for SE education are from distributed and multicultural character of the organizations. Architecture and modular structure in focus.
[11]	Nonaka & Takeuchi Spiral	<i>Cultures:</i> General study of the role of cultures <i>Findings:</i> Cultural aspects in SE – views in development and education. Cultural aspects are seen as a context (among others). Analysis of different levels of cultures and application of Knowledge Creation Spiral by [20] to analyze the structure of SE and SE education.
[21]	Nonaka & Takeuchi Spiral; Boehm Spiral	<i>Cultures:</i> General study of the role of cultures <i>Findings:</i> Three-layer model (development process, knowledge & context, multicultural services) to manage the complexity of multi cultural SE (seen as knowledge work).
[12]	Hofstede Lewis	<i>Cultures:</i> General study of the role of cultures <i>Findings:</i> An overview of applicable frameworks in cross-cultural software development environment and synthesis of the existing research findings. Three factors: distribution, cultural differences and ownership of the network.
[22]	Hofstede	<i>Cultures:</i> US, India, Western Europe, Japan <i>Findings:</i> Analysis of real outsourcing cases. Difference in agreement culture, level of expected documentation and in the mental mode of the cultures (attitude to bureaucracy, authorities, the role of values and norms etc.). The problems arising inside cross-cultural teams are different than those arising inside teams representing the same nationalities / cultures / language groups. The beneficial use of "bridging teams" was seen as important, as well, to unify the organizational culture in the long term.
[23]	Hofstede	<i>Cultures:</i> General <i>Findings:</i> Culture has an important role in the successful adoption

		of Total Quality Management (TQM) in an organization. The result is a framework that can be used for further analysis.
[24]	No	<i>Cultures:</i> Several – not specified. <i>Findings:</i> Results of a case study, in which the cultural mix of SE design teams was analyzed. The members of the teams were undergraduate students of a university-level IT curriculum. The main finding is that in teams, the cultural strengths of some members support the weaknesses of the others.
[25]	Structurational analyses, Hofstede;	<i>Cultures:</i> Jamaica, India (Case studies) <i>Findings:</i> A theoretical framework for cross-cultural aspects in SE. The paper reports two case studies, one from Jamaica and one from India. The framework is based on a structurational analysis method, which is compared to Hofstede's model and the findings of two offshoring cases.
[26]	Pattern approach	<i>Cultures:</i> General <i>Findings:</i> Recognized project patterns to be applied in global software development projects. Applicable patterns and a pattern language are introduced.

The studies published are introductory rather than the analysis of existing cases. There has been no effort to generalize the results and by comparisons to find some common phenomena to act as a guideline for planning globalization activities. In our studies, as a part of an ongoing research project, we have recognized the complexity of the problem and tried to find ways to structuralize it. This framework is explained in Section 4.

4 Five Factor Model for Analyzing Multicultural SE

The Five Factor Model (FFM) is based on the factors of globalization introduced in [12]. These factors are considered to be important in analyzing the data collected through interviews. The five-dimensional space provides a means to classify the data and find differences/similarities between the categories recognized.

The relevant factors of the FFM are:

- 1 Organizational characteristics of distribution and globalization (Table 3);
- 2 Frameworks of cultural differences – existing knowledge of cultural differences (Section 2 of this paper);
- 3 Direction of the globalization (classification factor);
- 4 Ownership of the global organization/process (classification factor);
- 5 Artifact: product, process, service (classification factor).

Table 3
Organizational dimension

A. Outside	Broker	Broker Network	Broker Offshoring	Broker Outsourcing	Traditional Subcontracting
B. Inter-Organizational	Virtual Organization	Distributed Virtual Organization	Traditional Offshore	Traditional Outsourcing	NULL
C. Intra-Organizational	Traditional	Distributed Traditional	Concern based Offshore	NULL	NULL
	1. One site	2. Multiple sites	3. Offshore	4. Outsource	5. Subcontract

The model will be used to classify the findings that will be collected from the globalization experiences of Finnish software companies.

Organizational characteristics of the global organization are classified according to Table 3 (Globalization Grid). The left-to-right dimension lists the type of distribution and the down-to-up dimension the characteristics of the organization. In the figure, the companies inside the “marked” area are the focus of the project related to this paper; the 42 companies representing different categories have been selected and will be interviewed as part of the project. The article of Herbsleb and Moitra [27] handles briefly the role of distribution in global software development. They point out that SE requires a lot of communication – both formal and informal. The former needs a clear well-understood interface. However, the role of informal communication is emphasized especially when uncertainty increases in the projects. Outsourcing and offshoring typically decrease the opportunity for this kind of communication, if it is not especially taken into account by providing tools to support it.

In our work the Hofstede Model is used as the *framework for cultural analysis* (because of its frequency in related studies, despite knowing the *critique against it*). The aim is to test the validity of the recognized stereotypes in the SE industry.

The globalization direction is an important factor. It tests the similarities/differences in the case where a Finnish company (or employee) is going into a foreign culture and vice versa. The expectation is that the same rules will not apply in both cases.

The ownership factor tests the ruling mechanism in the global network – this has consequences in adaption mechanisms either for the national culture or the owner’s culture – two approaches, permissive (adaptation into one culture) and non-permissive (unification into one culture) in adaptation is studied.

The *artifact factor* studies the differences in the globalization of product development, processes (process over cultural borders) and services (over cultural borders). A sixth dimension – not included here – could be added to study the differences in the *organizational status* of the employees (expert, project management, higher management).

Conclusions and the Future Work

Based on the first phase interviews, some common findings are available. In the reflection of an organization and national cultures we have recognized two approaches – *adaptive* and *permissive*. In practice, we either have to adapt processes or people. Especially in big firms, the employees are recruited as individuals, not as members of certain national cultures. The adaptive approach is used and new staff members have to adapt to the *company culture*. Their career is also culture-independent. The main benefit of this approach is that the same operative processes are applicable all over the company and the employees are easily transferrable from one organizational part to another. In the case of competition of a skilled workforce, this approach will increase the loyalty of employees to the company and bind them more tightly to the organization than in the case of the permissive approach (i.e. employees’ cultural background is taken into account and the processes are adapted to it). Experience also shows that employees who do not like the “company way” will leave the company quite soon. The disadvantage of the adaptive approach is that the strengths of the cultural background are not benefited from.

The cases analyzed to date all relate to a situation where a Finnish organization has established activities in lower labor-cost countries (China). The differences in the economic situation between Finland (high standard of living; *mature culture*) and the target country (lower standard of living, lower salary level; *emerging culture*) causes differences in work motivation: the marginal benefit of extra work in the emerging culture (Hofstede’s masculine values) is higher than in the mature culture (where feministic values are ranked higher). Independently, the motivation factors seem to remain the same because the surrounding society does not change as much as the company culture.

Experiences show that the direct cost difference is only a temporary benefit. In a few years, the salaries in lower labor-cost countries tends to approach the level valid in the host country. It may also mean that people are ready to move to the target country without extra benefits (e.g. extra financial support for moving from Finland to China to work in the “China office”).

There are also scenarios that discuss the division of the work between higher and lower salary countries. One of the potential futures is that the importance of the first phases (front-end engineering processes) of the software development life cycle will grow. It means that the division of work in a globally distributed organization leaves front-end processes (requirements elicitation and specification, design) in host (higher salary) countries and the back-end processes are the responsibility of the outsourced parts of the organization located in lower salary countries. Partly, this is already the situation today. There are also opposite examples that are based on good experiences in product conceptualization and product design e.g. in China.

This field of study has not yet been widely researched and the results available are mainly non-generalized experience reports. Multicultural working is demanding and, to manage the related problems, it covers topics in organizational studies, management (person, organization, project and team), and the social environment. As a study topic on the one hand it is challenging, but on the other hand it provides a new understanding of complicated social collaborative networks. Globalization studies are also culture-dependent – studies concerning Finnish organizations are not yet available. In the project related to this paper the aim is to produce new knowledge directly applicable to the Finnish software industry. Our expectation is that the results will also be applicable to other cultures, if the cultural differences are recognized and understood. This project will also open new research questions for further studies and provide a forum for permanent cross-cultural researcher networks. The findings will also be integrated into the SE curriculum – first in the applicant’s own organization, but also probably on a wider scale.

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