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Globalization and Socio-Technical Aspects of Information Systems Development

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1. Introduction

Globalization has reached the spheres including, economy and software development, making the approach known as Global Software Development (GSD) increasingly adopted. In that the physical, cultural and temporal distances are inherent. They can introduce advantages such as better use of resources in different places and thus stimulate cooperation for the software development. On the other hand, brings challenges related to communication, control and coordination of teams, which reflect in technical, social and cultural differences management.

According to Cukierman et al. (2007), is very common to deal social issues of software engineering as "non-technical"ones. So is assumed that most of the software engineering community believes thats is possible to divide the problems into "technical" and "non-technical". Laudon and Laudon (2011) suggest that project managers have to solve technical and non-technical problems by allocating people in the most effective way.

Currently, both the practice and research have shown, increasingly, that software engineering community must review projects considering both the technical as well as the social view point. So a more complete view of the context and impacts that these two points cause in the products generated are obtained. Further more, the GSD has features that making possible that the socio-technical aspects be considered in the overall development of information systems.

In the context of this chapter global development of information systems is the work that involves the collaboration of two or more organizations. These organizations may be in geographically dispersed locations, which can result in loading of cultural and techniques differences. So, find guidelines and best practices to support the management and also analyze the impact of socio-cultural and technical differences are crucial to achieving success in the global development of information systems.

This chapter is structured as following: Section 2 describes GSD emphasizing their advantages and challenges. The elements of sócio-technical view are presented in Section 3. Section 4 shows the socio-technical aspects involved in GSD. Section 5 brings an application example analysing the impact of the socio-technical factors considered in this chapter. Finally, Section 6 presents final considerations.

2. Global software development

In the last decade has been a great investment in the conversion of national markets into global ones, resulting new ways of competition and collaboration (Herbsleb *et al*., 2000). In this context, in search of competitive advantage, many organizations have chosen to distribute the software development process adopting Global Software Development (GSD).

GSD can be defined as a strategy for software development. This strategy uses teams in several geographical locations with the involvement of people of different nationalities and different organizational cultures. It has been mainly characterized by collaboration and cooperation among departments and organizations by creating groups of developers working together, but located in different cities or countries, physically distant and time zone (PRIKLADNICKI and AUDY, 2008). According to Carmel (1999), the GSD projects consist of teams that working together to achieve common goals in the same project, however scattered geographically.

In this strategy the process is accelerated due to: reduced costs, access to human resources improvements in infrastructure (Internet and development and integration tools); advantage of new markets, the rapid composition of virtual teams, and improving time to market, with the use of development "around the sun" (BEGEL and NAGAPAN, 2008).

However, this dispersion has added new challenges to the development mainly related to communication, coordination and control, which may adversely affect productivity and therefore the software quality. These factors influence the way in which the software is designed, developed, tested and delivered to customers, thereby affecting the corresponding stages of the life cycle of the software.

This configuration of software development, the GSD, added new factors to the process, such as temporal distance, geographic dispersion, socio-cultural differences, which extended some of the challenges in of software engineering are and also added new demands that challenge the processes of communication, coordination and control of projects (LAYMAN *et al*., 2006). According to ((Damian, 2002) (Herbsleb *et al.*, 2000) (Mockus and Herbsleb, 2001) (Sangwan *et al*., 2007)) these challenges, can be related to technical factors (problems with network connectivity and differences between development and test environments) and non-technical (trust, communication, conflict and culture).

The main challenges found in GSD are related to cultural differences, geographic dispersion, coordination and control, communication and team spirit. Cultural differences often exacerbate problems of communication which can lead to frustration, displeasure and even disagreement between the teams. Holmstrom *et al*. (2006), report that culture has a determining effect on how people interpret certain situations, and how they react to these ones. Cultural differences involve the organizational and national cultures, language, politics, individual motivation and ethic of distributed teams (CARMEL, 1999).

In GSD, the large geographical distances adversely affect communication. Eckhard (2007) points out that solving the problems of communication is a challenge because of the complexity of projects GSD. Then complexity is caused by (i) heterogeneity as people, source code, hardware and software, difficulting the integration of tools, (ii) dependency among these elements, and (iii) and the constant changes in development environments. In addition, communication affects coordination and control (CLERC, LAGO and VLIET, 2007).

Coordination is the act of integrating each activity with each organizational unit. Integration usually requires intense and constant communication. Control is the process of adherence to the objectives, policies, standards and quality levels. For Mockus and Herbsleb (2001), coordination becomes a problem because the processes of each distributed team are different, that is, there is not a uniform process. Communication is the mediating factor that directly affects the coordination and control, and is considered the essential component of all practices of collaboration in software development. It represents the exchange of unambiguous and complete information, that is, the sender and receiver can reach a common understanding. According to Herbsleb *et al*. (2000), informal communication plays a key role in the success of distributed teams. The lack of efficient communication in GSD environments can result in a low level of trust among the teams and the loss of visibility into the work progress (DAMIAN, 2002).

3. Socio-technical view

The software development is not just a set of technical objects. It is designed, built and used by people. The socio-technical perspective provides a deeper analysis on the relationship between the methods, techniques, tools, development environment and organizational structure. Damasevieius (2007) also highlights that it is difficult to dissociate the social aspects of technological one, because they are mutually interdependent.

In the socio-technical view approach the organizational structure is composed by social or organizational aspects and technical aspects. However, the vision goes beyond the socio-technical division between technical and social aspects in seeking to put both at the same level, none is privileged over another. The integration between the social and the technical can to ensure the success and its absence can lead to failure of projects. Motta and Cukierman (2009) report the failure of a large Brazilian company in the pursuit of the implementation of CMMI model motivated by non-technical and cultural issues.

The socio-technical aspects involve the coordination of technology, organizations and persons who shall cooperate with each other and adjust to optimize the performance of the complete system. Thus, information systems can be considered a team effort, involving people with different technical, administrative and analytical skills (LAUDON and LAUDON, 2011).

Cukierman *et al.* (2007), consider that in the context of software engineering (SE), the social, cultural, and organizational policies are important. But, they do not receive addequated attention and recognition of their importance neither in literature and events of software engineering, and especially in practice. These are common questions referred to as "non-technical" by the SE community, which deals the division of problems into "technical" and "non-technical" ones.

Discussion on technical and non-technical elements in the development and management software are also covered by Fuggetta (2000) considering such elements as important to the success of projects. Cukierman et al. (2007) argue that to meet the growing challenges of software engineering is necessary break the barrier between "technical" and "non-technical" aspects. It is necessary deal they in a new design view, a new framework, a sócio-technical view, that consider both social and technical view concomitantly.

In seeking by physical and human resources shared,, the software development by distributed teams requires that the software project manager has new skills and concerns

associated with those common in the management such as: plan, lead, coordinate and monitoring. The challenges stemming from the collaborative work also include the integration of teams with different cultures that need to share ideas and knowledge.

The sharing of ideas and knowledge is possible by communication among the teams that need store the information for decision making and better control of activities. Cultural differences increase the need for better communication and coordination.

4. Socio-technical aspects in GSD

The software development process is an extremely complex activity involving several technical and non-technical factors. For many managers, the technical aspects of the project or any matter related to the programming language used, databases, tools or technology, are absolutely paramount. Thus, often the non-technical problems are left aside.

According to Pilatti *et al.* (2007), the non-technical knowledge involves social, cultural, behavioral, linguistic and political aspects. In the case of distributed software development, sometimes the socio-cultural aspects are much more evident, since teams located in different countries with, language and habits totally different, are forced to work at the same project.

Managers see their software project that was developed in distributed way fail. Sometimes it is due to non adequate a combination of social, political, linguistic and cultural issues (KIEL, 2003). According to Carmel (1999), cultural diversity is among the five major challenges for the GSD project manager, along with inefficient communication, lack of coordination, geographic dispersion and loss of team spirit.

In GSD projects may exist groups with differences in behavior between people due to their different cultures. This can lead to complications in work planning, decision-making process, in the style of argument, in conversation, inconsistent work practices, among others (OLSON and OLSON, 2003). In countries with continental extensions, such as Brazil, Russia, China, United States, among others, cultural differences can occur even with people of same country due to local customers (ENAMI *et al.*, 2006).

Moreover global development, elements such as language (Cibotto *et al.*, 2009), religion (Kotabe and Helsen, 1998), customs, prejudices (Aquino, 1998), rivalry (Brenner, 1990; Vidal 2005), lack of education and professional qualification (Kotabe and Helsen, 1998) stand out in conjunction with infrastructure problems (Rigolon, 1998), economic and political aspects, organizational culture (Schein, 2004), among others. So besides allocate the best team for the development of a project, these other elements should be considered to facilitate the proper working of the team.

The division between technical and non-technical can lead to a classification that takes the as primary and that nontechnical as secondary. Among several tasks in the software project management area is one that deals with people whose actions collaborate to integrate socio-technical aspects (CUKIERMAN *et al.*, 2007). (Enami *et al.*, 2006), (Trindade *et al.*, 2008), among others, present elements that contribute to the socio-technical approach such as the integration of communication Tools that make possible people to perform activities in distributed development environment.

The development of a system is not a purely technical, but social since it contemplates the organizational structure and culture. Social structures influence and determine behavior at work and generation of artifacts making it important throughout the development (DAMASEVIÈIUS, 2007).

The present socio-technical challenges in GSD will be stratified by subdividing them into categories, so it is easier to characterize them. According to Soares (2011) can be identified three categories: people, business and infrastructure. These categories were extended including technical factors that we think should also be considered when they turn as socio-technical. We divided in four groups (Figure 1):

- **Group 1** - Factors caused by people involved in the project, ie, the adversities that arise from different cultures, habits, ways of thinking and working of each one.
- **Group 2** - Factors caused by the structure and working style of the company.
- **Group 3** - Factors caused by issues outside the company, ie, due to characteristics of the environment where they are inserted.
- **Group 4** - Factors caused by technical factors.

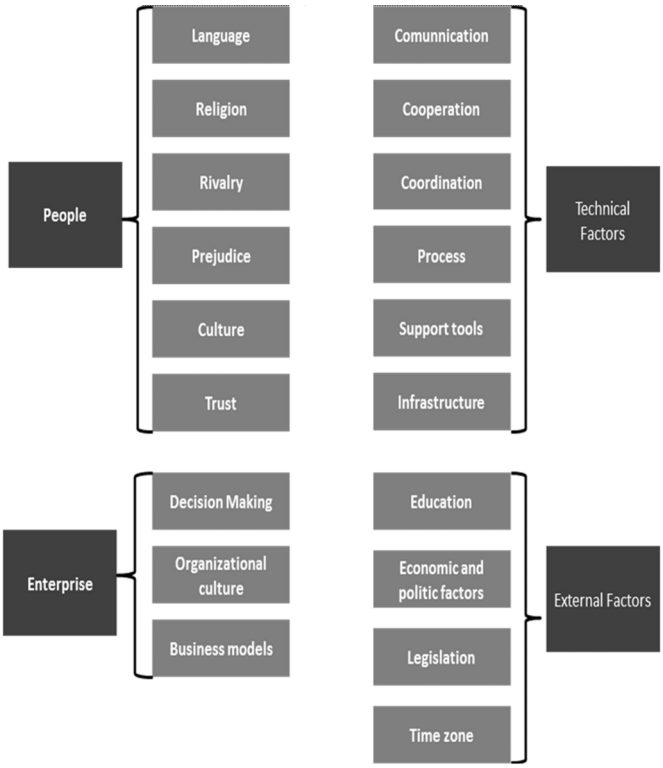

Fig. 1. Sociotechnical factors.

Next each item is discussed.

4.1 People

Language

The language is considered as the major cultural distinction. Even if the groups involved in the development have different customs and beliefs, but they use a common language among them, they can develop the project with less difficult. Otherwise, if these groups do not adopt a common language to communicate, probably they will have more difficult to develop the project. According to Mockus and Herbsleb (2001), Even with common language the lack of proficiency of some members and cultural differences that may influence the interpretation semantics during communication, create problems that can lead to mistrust or disagreements about the need for respect for hierarchy or even for punctuality. However, GSD often the spoken language may be different from one location to another. So, establish an effective communication with a language that is not his natural language, can be tricky if not well managed. Therefore establish a training programming in a common language that will be used to develop a project, followed by a face meeting, and also in loco visit on different places, are good practices that could be adopted.

Religion

An interesting comment refers about the importance of neutrality on religion. Religion has influenced the politics, economy and also the traditions of a people. In some countries there is a constant change by government agencies establishing laws and guidelines that influence the public and private life of the population. As an example, there are countries where some professional activities can be performed only by men. The women are prevented from acting in their respective professions. Moreover, they are forced to cover their face completely when they walk by streets. In business terms, these countries often do not see positively the presence of women in leadership positions or meetings. However, women in leadership positions become increasingly common in Western countries in both public and private organizations. Therefore, where the religion has great influence , it has been used to allocate teams politically and geographically dispersed. The religious situation must be observed by managers to ensure that neither the team nor the projects are in risk.

Rivalry

The rivalry can occur at several levels: countries that compete one each other; rivalries arising from sporting activities, territorial disputes, religious conflicts, among others. In the management of virtual teams, the rivalry issue becomes relevant because often leads to conflicts between the teams, ie, rivalry goes beyond the limits and starts to affect not only the development of daily tasks by team members but also their behaviour.

Sometimes the rivalry creates a team spirit among people who share the same opinions. It results the same type of behavior toward certain situations in which they have to decide or solve problems.

Prejudice

Another factor that has influenced the development of team activities in projects is the behavior prejudiced against the differences that there are among people. Prejudices such as racism, homophobia, anti-semitism, gender, among others, if not properly managed in the team result in conflicts among the people involved. A project manager who acts from the

socio-technical perspective should certainly observe the characteristics of his/her team. Anyway it comes to patrolling the ideas expressed, but is important to be aware of the respect that should exist between people and the differences identified. Prejudice and discrimination lead to acts of violence both physically and psychologically, which configures in intolerance in relationship among people.

Some countries have different laws and opposing positions about criminal acts and prejudice as well as that related with to the tolerance and encouragement of these types of discriminatory acts. The project manager need much skills to deal with this kind of differences. He must always act without discriminate the people. The project manager that takes discriminatory positioning of any kind can put at risk the team's activities and, in the case of geographically dispersed teams this situation becomes quite complex as they are added elements from the religious faith and morals.

Trust

Teams are fragile social units, that can easily be broken. When problems such as distance, cultural differences and time zones appear, the synergistic effect that makes the team a cohesive unit, is often compromised. Trust is essential when people depend on each other to achieve common goals. Thus, according to Carmel (1999), trust is based on the individual to believe in the character, ability, strength and confidence of someone else. Therefore, a team without trust can not meet their commitments effectively.

Trust in an organizational environment is defined as "faith in each one of intentions and behaviors: trust builds trust, distrust leads to distrust." The importance of trust has become increasingly recognized as a critical element in the success of operations in organizations and, specifically, business, professional work and relationships. Trust is the basis of successful cooperation among individuals within and among organizations. It is essential to the functioning of an organization and the operating units within it. High level of trust within an organization improves performance, efficiency, productivity, creativity, and consequently the results obtained.

Trust is a recurring problem in GSD teams due to geographical, temporal, organizational, cultural and political differences. It is crucial to all business relationships since it enables a more open communication, increases performance to deliver better quality products, and greater satisfaction in the decision making process. Virtual teams with low cohesion require face to face interactions and synchronous ways to build trust and relationships and also to share views. An Indian experience has shown 'Customer references', 'Experience in outsourcing', 'Reputation', 'Client visits', 'Investment', 'Processes', 'Communication', 'Performance', 'Honesty', 'Commitment', 'Confidentiality', 'Cooperation', 'Understanding' 'Creditability', 'Capabilities', 'Pilot project performance', 'Personal visits', 'Investment' are important factors to establish the initial trust between customers and suppliers.

While developing offshore/nearshore can exist trust and good relationships. However it can be continued if the trust between the staff of involved organizations is broken. This can result in not a non-cooperative behavior in which e-mails are used to attack one each other. As a result, instead of working as a whole, begin to work discrediting the work of others, every opportunity being used to obstruct and denigrate colleagues. As a result the projects fail to meet specifications, over budget, late delivery occurs, and worse, resulting in delivery of low quality products.

Also, when starting a new project, the goals, objectives, definition of teams that will be involved and what will be done at each location must be communicated to all involved. Such information must be documented and provided and so obtain the commitments that everybody understood and so avoid misunderstandings from part of members (LINGS *et al.*, 2007). A leader to foster trust and commitment among members must be defined.

Culture

Culture can be defined as values and beliefs shared that are historically situated, and also emerging. They are constantly interpreted and negotiated in social relationships and interactions of a group of people within a particular socio-cultural context. The development of Information System is embedded in a socio-cultural and multi-level complex environment. It generate cultural diversity since the globally distributed team members have several cultural experiences: national, organizational and professional. Cultural difference can promote creativity and innovation that are important for knowledge intensive work. The other hand it can become a barrier to sharing and knowledge transfer.

Different cultural factors co-exist at different interaction levels and together produce different environments and group dynamics. The culturally diverse work groups are faced with difficulties in communication and interpersonal conflicts that may become less pronounced with synchronous and face to face interactions. The face to face interactions enhance the ability of team members to work with the spatial and cultural differences.

Culture has a deep impact on communication styles. Someone prefer direct communication while others prefer indirect communication. Thus, for example, German engineers have a communication style direct and assertive whereas the Indians have an indirect communication style and are reluctant to say "no". Often due to cultural differences the silence is established as a result of conversational style, that can generating misunderstanding. The knowledge acquired during the project development can support Information Technology professionals to develop strategies to achieve greater collaboration between people.

Another point to consider is that the ‘compromise’ is culturally different in India. When an Indian software developer says "yes" to a certain deadline, this usually means "yes I'll try that" instead of "yes I can do it." Punctuality is also taken very seriously by the Indians. If you have a meeting scheduled for 9:00 pm they usually get 5 minutes before and not 10 or even 20 minutes later as with the Americans.

Other cultural factors such as masculinity versus femininity, and individualism are covered by Evaristo (2004). The creation of a code of ethics to be practiced by all partners can help reduce the impact of these factors.

Cultural prejudices about punctuality, perfectionism, ethics, teamwork, quality and interaction can affect design decisions. Therefore, the effective management of cultural diversity is critical to success in the practices of global development.

4.2 Enterprise

Decision Making

Employees can often feel frustrated when they realize that organizational decisions, workflow, project and infrastructure among others are always centered and coming from

a specific location. This occurs regardless if the teams are in the same group or organization working together on a project or performing some activities due the fact they are partners. To minimize this kind of feeling could be established a participatory process stimulating the motivation, cooperation and also promoting opportunities to release the creative potential of staff. In this way could leading to greater engagement and also sharing responsibility.

The determination of the authorities, responsibilities within the organization setting who does what within the project allows to establish the correct leadership, avoids omissions and prevent recriminations. It is also important to provide practitioners the opportunity to reflect and share their tacit knowledge acquired in practice.

Organizational culture

Organizational culture has apparent and adjacent features. According to Moscovici (1993) the apparent features are characterized by formality and documentation standard established by the organization. The issues surrounding these aspects are considered informal or hidden, but can influence the project development and team performance. For example, consider an organization that has clear rules for use of information technology, which indicate the shape and levels of access to equipment, the proper use of the Internet and computers. This organization need perfectly disseminate these rules and so they reflect the behavior of people in the organization.

However, sometimes people have friends outside the organizational structure. These include, the team of football, members who profess the same religious faith, among others, that although are in locations outside of the work environment, there they also can discuss problems related with the organization. This indicates that they may take similar stances on the problems or to support in performing the activities. Thus, it is sometimes given another format for the rules. In this context change simple rules as maintain confidentiality about individual password to access equipment becomes commonplace, since some people share their passwords with other when they help one each other in case of some faults or problems.

This simple example clearly shows the categorization of organizational culture in terms of formal and informal. While the rules are clear when is considered the formal aspects, when is considered informal aspects, sometimes the password that should be keep confidential, because it was informed in confidence, is not. It can generate problems with involved people.

In addition to these formal and informal aspects there is another view of the organizational culture that determines the behavior and ways to develop activities in the organization. Some companies have rules and customs that no there are overtime, appreciate people who participate in community activities, the use of company products, among other attitudes that become part of everyday life of organizational members.

The geographical dispersion understand that the organizational culture in each place becomes a challenge for project managers. While there is a specific local culture, there is also built-in organizational culture that reflects the behavior of individuals. Moreover the local culture is part of national culture, in the case of geographic dispersion of teams from different countries.

Managers would aware and trained to deal with cultural differences when they are to sent or brought from another country. According to Prikladnicki, Audy and Evaristo (2003), the definition of design patterns that can be adopted by the teams involved, help decrease arguments concerning the way of solving some problems. The use of standards, processes and certifications are also useful for the standardization of quality in different locations. When standardization is not possible, local conditions and concepts can make use of ontology to prevent confusion at the project level (LINGS *et al.*, 2007).

Business models

In a GSD environment the distribution can take some configurations, according to the distance between the teams and organizations involved in the project. Regarding the geographical distribution of the units involved in a project, when they are located in more than one country is called offshore distribution, if all they are in the same country has the distribution onshore. Considering the relationship established among the companies, there is the outsourcing scenario in which a company delegates the control of one or more activities to an external company which hired the service, and insourcing, when companies create their own software development centers. From these distribution these settings there are four business models, as are shown on Figure 2 and discussed as follow:

- *onshore insourcing*: in this business model there is a department within the company or a subsidiary in the same country (onshore), which provides software development service through internal projects (insourcing);
- *onshore outsourcing*: this business model indicates the hiring of a third company (outsourcing) for the development of certain software products or services to a company. The third company is located in the same country of the contracting company (onshore);
- *offshore outsourcing* or *offshoring*: this business model indicates hiring a third party (outsourcing) for the development of certain software products or services, and the third party is necessarily located in an other country than the contractor (offshore);
- *offshore insourcing* or internal *offshoring*: the latter business model indicates the creation of a subsidiary own company to provide software development services (insourcing). This subsidiary is necessarily located in a country different from the parent company, or contractor (offshore).

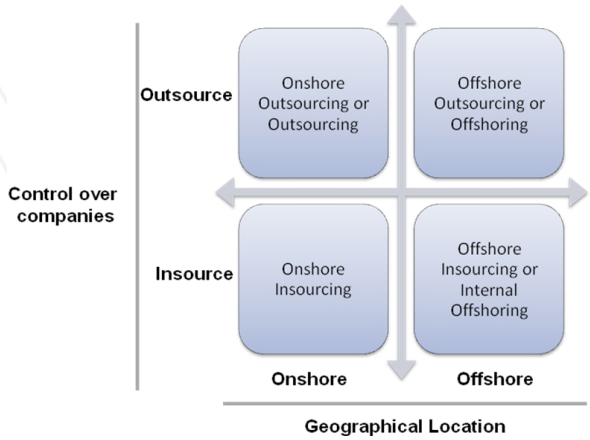

Fig. 2. Models of Distribution.

4.3 External factors

Education

The different business models allow participants from different places constituting the development teams. The geographical dispersion may, refer to two situations: in first one identify the professional expertise that will contribute greatly to generate a software product with higher quality. On the other hand one can identify professionals who are less expensive. Often these professionals cost less, can have a lot of willpower, but may not have availabity to participate as a team member or don't have the necessary skill or knowledge to perform project activities. In this case would be interesting that organizations offer the necessary training to these people whether at undergraduate, graduate or training.

Thus, companies located in places that do not have institutions that can offer the appropriate courses should encourage employees with opportunities for this qualification. One solution would be, for example, avail himself of the physical dispersion and look for other sites to establish an exchange in which a given employee could spend a certain period of time learning and after his return become the disseminator element. This person could offer training courses on site an thus offer for a large number of people in the company, the opportunity for a recycling.

Economic and politic factors

When considering the organization as an open system should be checked all the connections that exist among they and their surroundings. Figure 3 presents the various actors that are related to the organization, both directly and indirectly. Can be directly included suppliers, customers, employees. Can be cited as indirectly related the government and non-governmental organizations that do not determine the activities, but may influence the is which activities are carried out. Often, the need to reconcile the laws of different countries, especially when it comes to GSD, can impact the progress of a project. This may require adaptations for dealing with the human and material resources involved in the project.

Fig. 3. Organization in its environment. Adapted from Tait and Pacheco(2001).

The adjustments in software products can result from changes in legislation or changes in procedures to incorporate the new rules at the government level. To make the adjustments necessary to formalize the new procedure can result in higher costs and reallocation of staff.

In thinking about political and economic factors in a distributed environment, it is necessary to must identify factors in each site which can compromise the project. Countries with high economic instability and political instability are considered unsafe for the installation or maintenance of existing companies. The insistence into remain in unstable places can put at risk the security of project teams.

The political and economic factors are part of the organization's external environment and, in principle, should not have influence on internal activities. However, organizations depend on these factors to maintain their activities. Thus, it is more over challenge for software project managers to perform the planning and monitoring of projects developed by geographically dispersed teams.

Legislation

The legal aspect is one of the main problems between different locations. Groups may be subject to different laws, be they commercial, civil, labor, etc. This diversity affects the development of several ways. For example, in some countries it is forbidden to import hardware, while some others countries have reciprocal trade agreements and require that a company spends part of the revenue in the nation’s economy where it is located. Other countries prohibit to transfer data to out of their national boundary or have government restrictions regarding access to the internet.

The laws of each country vary in many ways and in many cases, significantly. Each team must know the laws of the country in which it is installed. It should be noted that even in a single country, there may be substantial differences in taxes in different regions. In addition to general legislation, it is essential to know the labor laws under which the team is governed. Detailed knowledge of the laws allows each group, when necessary, take action in accordance with the regulations that surround them, avoiding legal problems and allowing the group to take the advantages offered in this local. A good legal advice can help the organization complies with the laws.

Another aspect of the legislation of each place is related to documents stored in electronic and optical media, which should be reviewed by each team. Just as the general law must be observed and can present diversity from place to place, there is a category of specific laws dealing with intellectual property, which may be different in each country that can often hinder the development of the software. It should be analyzed to see how the organization can guard against the theft of design information and source code of programs.

In an environment where there are several participants from different countries working is essential that the project manager worries about the issue of copyright and intellectual property of software or part thereof. It should be interesting seek legal advice and always be alert to changes in local laws involved with software development.

Besides being able to apply the penalties provided by law, managers can and should be aware to the sanctions for which employees must comply with in case of misuse of internal

information or use of them outside the company. This action contributes to awareness of employees regarding the content of the projects developed by them or by third parties.

The software source code and its corresponding documentation is an intellectual resource that should receive the protection of law. It is the creation that should be protected, it is an intangible property whose owner has a right of ownership over it, and therefore an intellectual property right.

The intangibles resources are the fruit of intellectual creation that have high economic importance. Legal protection for resources is to ensure the creativity, to protect and to encourage the creativity and intellectual work to safeguard the rights of the creator from economic exploitation.

In Brazil, intellectual property can be guaranteed by copyright. The copyright protection ensures a work and have externalized the idea. It does not require registration, but it brings greater guarantees. However, copyright is not permanent, the lifetime for the author, parents, children and wife and other heirs lasts up to 60 years. The copy for purposes of comment, criticism, research and teaching is permitted, but in Europe, most countries recognize the moral character of the copyright while in the U.S. it does not. In order to have protection in other countries is necessary to search a signatory to the convention on the subject, and verify the effectiveness to guarantee those rights. The defense is made under penalty of copyright, it is necessary proof that the accused could not have access to the software so that it is possible condemnation. Another important aspect is that the software that was developed in the company belongs to the employer.

Therefore, access to products developed should be preserved only to those who need them to perform their tasks. Another branch of intellectual property is the industrial property in which the protection is effected to ensure of patents and trademark registration among others. The patent provides a monopoly on the creation, however, in Brazil is not recognized on the software. Even in the industrial property the trademark registration protect the merchant's goods and distinguishing them from others. In software the only protection is on the program (source code).

Time zone

Due to restrictions on working hours and, as well as of time zone, because they are in different locations, members of virtual teams may not be available for certain tasks or even to a synchronous communication with other members. There are also two other types of unavailability that are specifically related to the local context: one due to local holidays and other socially oriented. In addition to national holidays such as Christmas, Republic Day, Independence Day, there are also religious holidays. In this case, as there are diversity of religions in some country, it is also the larger the amount of holidays. In India, for example, they practice the Hindu, Islam, Christianity, Sikhism.

The socially oriented unavailability is due to needs of family and social obligations. Among the social obligations is, for example, the legal liability. The unavailability is a social concept culturally embedded. For example, China and India are countries focused on relationships, and norms. They care for elders at home, which requires a greater commitment to family.

However, it is possible to have flexible availability with accommodation of availability, in order to facilitate the temporal coordination in GSD. The flexible availability can be

understood as the availability outside of working hours. In India, for example, there is a well defined boundary between work and private life, and plans can be changed flexibly to meet different demands. This can lead to situations where a person may not be available when it was expected, but that may be available when he/she would not be. In India, the work seems to never end, people even outside of work hours are availabe to compensate for holidays. Recently the flexible availability has been adopted as a way to gain advantages in competitive environments. On the other hand, in the United States, the balance between work and personal life is better balanced.

The accommodation of availability refers to the predisposition to shift work hours so that an overlay is established to encourage greater interaction among team member at these times of synchronous activities. Thus, if a meeting is scheduled for 8:00 am in the morning hours in Central America, corresponds to 9:00 pm in Beijing the same day. But for the Chinese team, it means that their working day will end only around 11:00 pm. Only after this time is that they go to home by train or bus, which might reflect on issues of personal safety. Thus, accommodate the meeting time to 7:00 pm in in Central America would correspond to 8:00 am the next day. This illustrates the accommodations that are negotiated based on the contextual needs.

Thus, GSD teams are exposed to challenges arising from these differences. The project manager should take it into consideration when distributing the activities of a project and also be tolerant and understanding when absences occur. Note, therefore it is necessary to care that this does not reflect a delay in a project schedule and budget no overflows. When the difference in time is small, has no major effect on quality, but the quality drops as the time difference increases.

4.4 Technical factors

Comunnication

Effective communication is vital in any organization. However due to the involvement of different places it is a great source of problems in GSD. Frequent communication is important to provide a constant confirmation that the members are still here and still working. The frequency and predictability of communication and the extent with that they are provided with feedback improves the effectiveness of communication leading to greater confidence and improving team performance. Inexperienced teams may experience anxiety and low confidence due to negative interpretations associated with silence or delay associated with the dispersion time.

Several practices have been proposed to mitigate the challenges related to communication: regular meetings, whether ad hoc or planned, or video conference organized as weekly sessions. Communication can be kept flowing swiftly through the use of wiki to document the discussions and decisions. These regular meetings can improve project definition, makes better socialization, increase trust, enhance respect among members and enhance the electronic communication subsequent.

The face to face meetings are crucial when the projects begin, because it offers the chance to answer important and urgent doubts. Teams can communicate using different tools, from cell phones, fax, chat, video conference, e-mail and groupware applications. These practices

are used to support the communication needs in GSD: troubleshooting, reporting and monitoring, relationship building, decision making and coordination. However, success depends on the predisposition to adopt them and also of the project elaborated. Still, it is important that the tools are synchronized. For example, despite tools availability, if individuals forget to report changes or updates made during the day to other members it results in rework and lost time.

The trust and motivation have a direct impact on the level, content of communication and effective communication, and also about the use of tools. In general, when the software development occurs in the offsite model, communication is kept to a minimum, calls are not returned and emails are not getting answered. So many questions remain unanswered. When there is a direct communication, the speech is short and aggressive. This may indicate that online communication was being used as a means to limit and control the quantity and quality of information that was shared, which ultimately limit the establishment of personal relationships. It is easier to ignore someone that you do not know if he (she) is particularly one competitor.

Cooperation

Cooperation among team members is essential for the successful of virtual teams. The distance has a negative impact on the interaction intensity established among remote colleagues working collaboratively and effectively as a team (HERBSLEB AND MOCKUS, 2003). Yet, it is known, that it is not easy to successfully integrate geographically remote and culturally diverse individuals or groups into a single team (BATTIN *et al.,* 2001). Add the impact of fear and it is easy to understand why in these circumstances problems can and do arise.

In GSD environment to facilitate collaboration and cooperation among team members it is necessary that trust to be established. It is possible by knowing and building relationships between individual team members. When this is successfully achieved the results can be a motivated and cohesive team with a common purpose and shared goals and objectives.

The fear by itself undermines and inhibits the development of cooperation and trust. The studies have shown that in offsite software development, the local engineers mistrusted of offsite engineers. They see them as a potential threat for their future employment. In this instance trust was never established. Then, it results in communication problems, knowledge transfer limited, uncooperative behavior, and ultimately the failure of offsite strategy (CASEY and RICHARDSON, 2004); (CASEY and RICHARDSON, 2008).

Coordination

Malone and Crowston (1994) defined coordination as the management of dependencies between activities. The software development process, especially large scale systems development, is usually characterized as highly ambiguous, uncertain, and interdependent. Therefore, effective communication and coordination are critical to the success of software development projects, especially when they are globally distributed.

Espinosa *et al.* (2007) identified three major types of coordination needs in distributed software development, technical coordination, temporal coordination, and software process coordination. Temporal coordination refers to the mechanisms to schedule software

development tasks, synchronize activities, and allocate resources in order to use optimally distributed resources and adhere to scheduled timelines (Espinosa *et al.*, 2007; Massey *et al.*, 2003; McGrath 1990). Herbsleb (2007) pointed out that the absence or disruption of many mechanisms (such as formal and informal communication) used to coordinate the work in co-located settings is the fundamental problem of globally distributed software development (SANGWAN et al., 2007). Regarding temporal coordination mechanisms, temporal separation restricts the synchronous communication, immediate information exchange, on-demand support, and real-time problem solving (CUMMING *et al.*, 2007). Temporal separation may cause problems in the workflow of globally distributed projects. So the time to deal with some problem can be longer, causing with this delay for coordination (ESPINOSA and CARMEL, 2003).

Global teams can adopt some tatics to minimize the effects of time separation and to facilitate coordination, such as: (i) sequencing or structuring activities for troubleshooting; (ii) using modular design to assign work to different locations in order to reduce the dependencies between tasks, and thus facilitate the needs of inter-local coordination; (iii) making working hours more flexible in order to create or expanding overlapping time, and thereby facilitating the synchronous communication. Similarly the distributed team members can rearrange their daily workflow, allocating the independent tasks on time slices overlapping and the dependent tasks in time slices without overlapping.

Process

The software process is the set of policies, organizational structures, technologies, procedures and artifacts needed to design, develop, deploy and maintain a software product (FUGGETTA, 2000). It involves steps consisting of a set of activities, methods, practices and technologies that are used throught development to maintenance and also either related products.

The process should enable the improvement of quality of service, engineering and design, reducing costs by increasing predictability and ability to mitigate risks and improve the efficiency and productivity of the organization.

In GSD environment a common process is essential. It directly assists all team members providing them with a common nomenclature for tasks and activities, and a common set of expectations. In GSD the variables and risks increase if there is not an appropriate methodology for the development process and so increasing chances of not meeting the initial planning.

A common process improves communication between teams and can minimize the ambiguity of artifacts. It provides support to the processes of communication, coordination and control by using a common nomenclature in the case of disciplines, roles, activities and artifacts to involve everybody.

However, more recently, due to the different business models present in GSD can be observed that participating organizations can have different process models. In order to meet this peculiarity, the software engineering area, particularly of collaborative systems have attempted to define techniques, mechanisms and strategies that provide the necessary support to make process more flexible during software development. An example of such mechanism could be a process engine that manages expertise of the different participating

organizations with regard to the generation of artifacts during the development process. Still, the formal specification of tests can minimize the problems of ambiguity and also reduces the needs for communication (MULLICK et al., 2006), (AVRITZER et al., 2007) and (AVRITZER et al., 2008)).

Support tools

The geographic distribution and inter-organizational software development created the need for tools and techniques for coordination and cooperation in teams. In order to meet this need effort have been made to construct Distributed Software Development Environments (DSDE).

The DSDE have common requirements, such as integration, data management and process. However, it should be highlighted the need to provide appropriate support to enable cooperation among team members and an efficient allocation of resources. There are several approaches explored in the literature to define coordination and cooperation in DSDE: access control, information sharing, monitoring, support for communication board meeting (LIMA REIS, REIS, NUNES, 1998).

Since team members are geographically distributed, syncronous and assyncronous tools can be used by them to establish the effective communiction during activities development. So, chat, video conference are examples of synchronous tools. E-mails, discussin foruns and blogs are examples of asynchronous tools. Thus, the project activity developed by team members will determine the convenience and necessity to use one or other tool type.

The data generated from chats, forun or discussion list show the communication that there are among team members. Information concerned with coordination among team members in GSD can be obtained from tasks list and bugtracker. The cooperation that could be established among team members can be extracted from blogs or control version system logs. Nowadays effort have been made aiming at develop tools to storage and also to explore socio-technical information from organization repository. With this the idea is to offer an adequate support for an effective and efficient decision making by project manager and so turn the organization more competitive in a world so globalized.

Infrastructure

Technological advances have enabled an increasing number of people to have access to a large volume of information, whether textual, graphic or audio. To this end, it is not enough that tools to support different stages of development are available. It is necessary also made available a whole support infrastructure, including network infrastructure, availability of electricity, and adequate physical facilities.

The network infrastructure in some situations may include local or traditional underground cables or not. But it is also increasingly common to provide wireless networks. The continuous availability of electricity is of fundamental importance for the smooth progress of work, including interaction between the participants through different communication tools and / or interaction as mentioned above and also in situations where long transactions need to be processed. However, in some places, it may happen that in the workplace or business energy supplier interrupt or rationing energy. This can often lead to instability or even unsafe. In these cases should be, as far as possible,

provide alternative ways such as a generator to ensure delivery and avoid situations that can often mean chaos.

Regarding to adequate physical facilities, it is expected that besides the size, the space has good lighting, ventilation and adequate furniture. The furniture associated with inadequate or incorrect posture can lead people to diseases that depart from the work.

It is worth noting, also, that when you try to maintain a standard technology infrastructure and operational in all units, suitable for carrying out the work, it is important to establish the collaboration, perform an effective control of documentation and version control of artifacts.

5. Example

Organizations in the search for better solutions and highly skilled professionals starts to expand their activities and partnerships with other companies around the world. Thus in its structure, organizations allocate their teams for projects considering skills and competencies.

Take the example of a team working on project development in the area of control earthquakes and volcanic inspections. This team is geographically distributed in three countries: Brazil, Japan and India. The project will be deployed in Japan.

In this scenario, the following solutions listed by Soares (2011), identifies some differences among the three countries regarding the development team. We highlight the local culture, and organizational culture as there are many differences among the three countries and local culture can influence the behavior of people working in organizations.

Thus, solutions must be sought to reduce the impact that differences could cause on project to be developed. The three elements outlined in Table 1, are socio-cultural, independent of the technical elements, which can impact the success or failure of the project if not properly managed. At managerial level, allocation of human resources in the distributed team must also be considered, the risks and the lack of integration and commitment of staff and additional costs arising from the creation of reporting structures and performance of training meetings must be reduced.

Regarding to education, specifically in the information technology area, it is expected that human resources allocated to the projects have the necessary training if team members are distributed in different places. Therefore, when access the selection process of human resources, the project manager must know the instituition where the people made undergraduate and graduate courses and verify how good is that education of students and future professionals.

The rivalry in the example cited, is not perceived in the three countries. So, when is considered Brazil and Japan remains the appreciation of Japanese immigration which results in both commercial and cultural exchanges. It is possible to see the influences of food, dancing, and miscegenation in the Brazilian states from Japanese immigrants. On the Indian religiosity it attracts Brazilian and therefore there is no apparent dispute between the two countries. There is, for most Brazilians, a mystical vision of India that is associated with the

strong religiosity. In the Japan-India relationship does not detect rivalries that may impact the development of activities performed by team members.

	Brazil	Japan	India	Solution proposed (Adapted by Soares (2011)))
Language	Portuguese	Japanese	Indian	Standardization of language. Preference in hiring employees who are fluent in the languages involved. Courses and foreign language training within the company
Religion	Catholic Evangelical	Buddhism	Muslim	Instructions on the religious customs to other members. Respect for all religions of those involved in the project. Educate teams in order to avoid arguments and religious affairs.
Customs	Mixture of races and ethnicities. Strong regional customs.	Rigidity. Demand for high level behavior.	Devaluation of women. Strong family. Respect for animals.	Exchange of staff. Meetings and gatherings whenever possible.
Organizatinal culture	Relaxation Many holidays	Stiffness in the treatment. Stiffness in the schedule compliance.	Does not accept women in negotiations. Flexibility of hours.	Training and standardization.
Infrastructure	Continental country with large regional differences. Government programs to bridge gaps (broadband, telephony etc.). Problems in network infrastructure and energy.	Cutting-edge technology. Environment prone to seismic and climatic variations, which can cause problems in organizations.	Infrastructure problems that reflects the use of energy, and telephony networks. Bad roads.	Knowledge of reality to minimize impacts when problems occur.

Table 1. Differences among countries.

6. Final considerations

The growing search for greater competitiveness has led companies to adopt increasingly the GSD. Besides the physical distribution of teams, cultural differences, language, time zone, among others, increase the complexity of communication, coordination and control during software development process.

Software processes and their artifacts present perspectives: technological, social, psychological and others. The socio-technical perspective allows a deeper analysis on the relationship among methods, techniques, tools, development environment and organizational structure. The results of this type of analysis can be used to educate team members, disseminate best practices, improve process performance and quality of generated artifacts (DAMASEVIÈIUS, 2007).

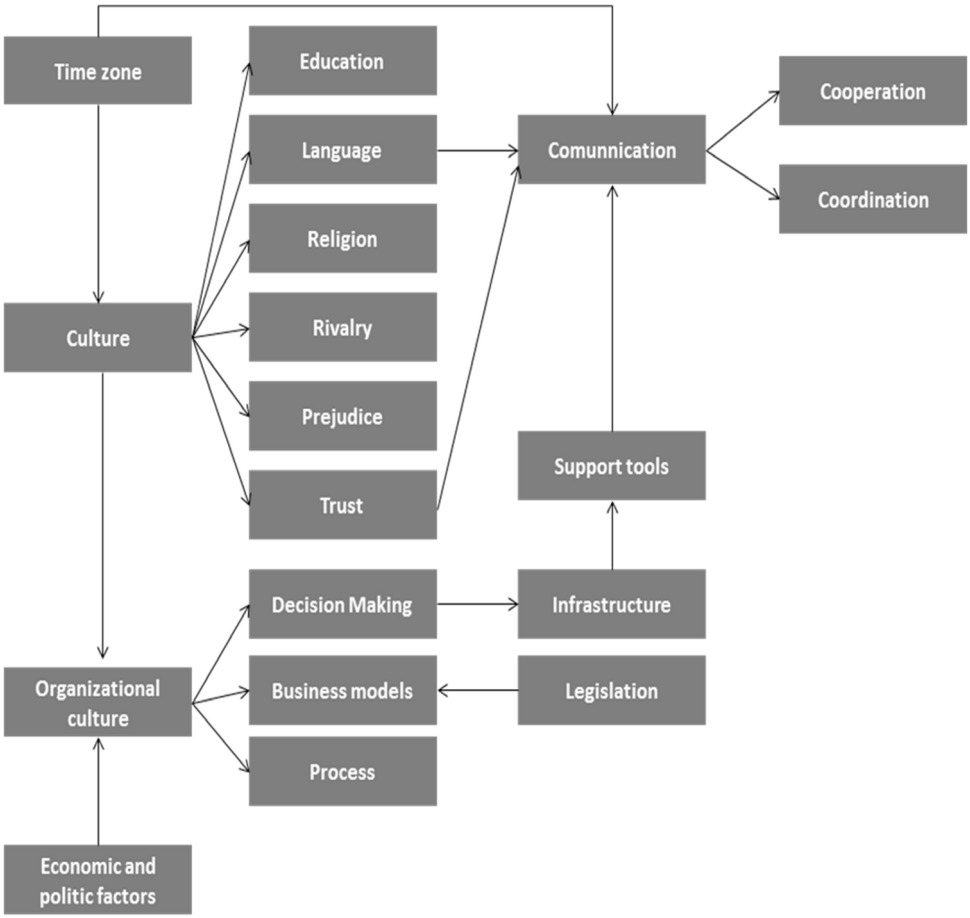

Fig. 4. Factors and relations.

The growing need to develop systems that meet the most different levels of decision making generate different types of information systems. Still, adoption of GSD makes increasingly clear that the differences caused by physical distance, social and time can affect the behavior of team members participating in the software development. The use of video conferencing and social networks as a means to improve communication are already increasingly popular. On the other hand data mining techniques have been increasingly exploited to improve the generation and knowledge sharing.

Thus, this chapter cast and discussed a set of elements stratified in people, organization, external factors and technical factors that constitute guidelines for better management of cultural, social and technical factors present in the global information systems development. Figure 4 present these factors and their relationship.

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