

Mika Hartio

MANAGING COMPLEXITY IN GLOBAL IT PROJECTS



JYVÄSKYLÄN YLIOPISTO
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ABSTRACT

Hartio, Mika

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Project management includes a large amount of different areas which need considering by project managers and other higher level personnel in the beginning of a project and during it. However, the complexity of a project rises to a very high level when talking about global IT projects. There exists a great number of areas in this kind of projects, which can critically affect their success rate. This thesis focuses on observing what the complexity consists of in the case of a global IT project, how it is linked to complexity theory, and how this complexity can be managed. This research is conducted as a literature review. The literature has been collected from the libraries, and by using databases that collect academic journals such as IEEE explore. One of the most interesting findings was that the areas (dimensions) of global IT projects are straightly connected to each other, leading to a conclusion that organization's management should focus on the management of each of the dimensions with same amount of effort. The management methods of each reviewed dimension were observed, reviewed, and the optimal solutions regarding the management of complexity were sought.

Keywords: complexity, IT project, management, multicultural, dimension, organization, agile methods

TIIVISTELMÄ

Hartio, Mika

Kompleksisuuden hallinta globaaleissa IT-projekteissa

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Projektien hallintaan kuuluu paljon erilaisia osa-alueita, joita projektipäällikön ja korkeamman tason henkilöstön tulee ottaa huomioon ennen projektin alkua ja sen aikana. Projektin kompleksisuus nousee kuitenkin erittäin korkealle tasolle, kun kyseessä on kansainvälinen IT-projekti. Tämän kaltaisissa projekteissa on useita osa-alueita, jotka voivat vaikuttaa kriittisesti niiden onnistumiseen. Tämä tutkimus keskittyy havainnoimaan, mistä asioista kompleksisuus koostuu globaalien IT-projektien tapauksessa, miten se linkittyy kompleksisuusteoriaan ja miten tätä kompleksisuutta kyetään hallitsemaan. Tekotapana tässä tutkimuksessa on kirjallisuuskatsaus. Kirjallisuus on kerätty kirjastoista, sekä alan kirjallisuutta kokoavista tietokannoista, kuten IEEE Exploresta. Yksi mielenkiintoisimmista löydöksistä oli kuinka globaalien IT-projektien eri osa-alueet (dimensiot) ovat suorasti vaikutuksessa toisiinsa, jonka vuoksi organisaation johdon tulisi keskittyä jokaisen dimension hallintaan yhtäläisellä tarkkuudella. Jokaisen läpikäydyn dimension hallintamenetelmiä tarkasteltiin, arvioitiin ja pyrittiin löytämään kompleksisuuden hallinnan kannalta optimaaliset menetelmät.

Asiasanat: kompleksisuus, IT-projekti, hallinta, monikulttuurinen, dimensio, organisaatio, ketterät menetelmät

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1 Introduction

The corporate world is filled with projects that reach across borders. Organizations operating globally often have employees from all around the world from different backgrounds. These employees might share different cultural values, speak in different languages, and have accustomed to different working habits, which makes the task of project management more than telling people what to do and when.

Project management has been reviewed from many angles and based on these researches, many frameworks and methodologies have been created to ease the task (Binder, 2007). Regardless, Managing projects goes into a whole new complex level when it needs to be done to a massive global totality. This paper dives deeper into the complex of global IT projects in a form of a literature review. In IT projects, complexity is formed from multiple elements such as employees and technology, and basic rule could be made that '*the more complex a project is, the harder it is to manage*' (Anderson, 1999).

Because of high level of complex surrounding the topic, it is meaningful to first have a look at theories that have been made about complexity. After the complexity theories have been reviewed, the case of managing global IT projects is cut into pieces. These pieces, or so called *dimensions*, open the opportunity to detect and join together the best methodologies of each dimension. Intelligent management of these methods decrease the total amount of overall complex (Binder, 2007). For this reason, it is justified to research and review the complexity of global IT projects through a set of dimensions.

This literature review focuses on analyzing different methods and methodologies to manage complexity in global IT projects and each of the dimensions. Literature was obtained through libraries, general research article search engines (Google Scholar), and databases such as IEEE Explore. The analyzed dimensions include:

- *Cultures*
- *Languages*
- *Global teams*

- *Knowledge and data*
- *Information security*

Each complexity dimension represents one area of global IT projects. The justifications to these dimensions are given later, on the chapter that deals with them in detail (subchapter 2.2.1). The main focus will be in the threats of each dimension and how to overcome them. The dimensions are also looked into as resources. It is important to note that the positive points of each dimension are also part of the complexion and are critical to projects success. The research problem is stated as: *“How to manage complexity and complexity’s dimensions in global IT projects?”* This research problem is meaningful, because there is no earlier studies that observe IT projects from the view of complexity and its management.

After reviewing the literature, it was noticed that each of these dimensions are highly influenced by each other. By choosing a less complex management method, the total amount of complexion will be lower, even though this does not automatically mean it is a better choice in every case. Complexity theory’s way of thinking was noticed resemble greatly the one of *“agile development”* (Agile development stands for methods, which use self-organizing teams and the project details are very lightly planned ahead (Bourque & Fairley, 2014)). It was also found that none of the dimensions should be underestimated, because the connections to each other can easily create negative reactions. Along with these, multiple potential management methods and methodologies for each dimension were found and the positive and negative sides of those were analyzed.

The results should make global project managers and other high level managers aware of the importance of each of the dimensions in global IT projects. Managers could use this paper as a starting point to include and analyze all the elements and managing methods that need considering when booting a new global project. These results could also prove useful to general global organizational management, not just projects. Results are looked more deeply into in the last chapter, conclusion.

This paper is constructed as follows. First chapter after introduction reviews existing complexity theories and how they are linked to organizational sciences. Complexity dimensions are introduced and the basis is made to the next chapter which observes each of the dimensions related to global IT projects. Each chapter is divided to subchapters, first explaining the basics of the current topic and then moving on to methods of management, and finally to the analysis phase. After every dimension has been gone through, conclusion will gather the main findings together.

2 Complexity theory and global IT projects

Global projects can be viewed as complex, multidimensional totalities (Binder, 2007). There exists theories of the idea and optimization of complexity and those theories will be the basis of this research. This is why complexity needs to be analyzed thoroughly.

This chapter will explain the basics behind complexity theories, how they work and how they are used. Starting point is how the theories have been viewed by different authors. From that, the literature will be analyzed. First only purely regarding the complexity theory and afterwards the analysis will be done about the complexity in global IT projects and how it could be managed.

2.1 Existing theories

2.1.1 Definitions

Thompson (1967), describes how a complex organization can be viewed as a set of interdependent parts and those combined form a whole that is interdependent with another larger environment. Simon (1996), views complex systems as a large amount of parts, which interact with each other. McElroy (2000, 196), defines the research of complexity as: "...the science of complexity is the study of emergent order in what are otherwise very disorderly systems." He further gives an example by stating flocks of birds as one of these kind of systems in which the behaviour is not centrally planned nor centrally being controlled. Brown and Eisenhardt (1997) state that complex systems include many independent actors and those actors interact with each other. Arthur's (1999, 107) definition is: "complex systems are systems in process that constantly evolve and unfold over time." From these definitions, it is safe to assume that a complex systems is always formed from multiple parts, which affect the others, creating a complexion that is hard to predict.

2.1.2 Complexity theory

Before diving deeply into the complexity theory, it is worthwhile to look at how Mitleton-Kelly (2003, 26), makes an important notion: “Complexity is not a methodology or a set of tools (although it does provide both). It certainly is not a ‘management fad’. The theories of complexity provide conceptual framework, a way of thinking, and way of seeing the world”. It is important to keep this statement in mind while analysing the offered literature and making assumptions.

Regarding the complexity theory, it is stated that there is no one single complexity theory but many under the general research of complexity research (Manson, 2001; Mitleton-Kelly, 2003). Main theories are presented here, but the emphasis is kept on concepts that are suitable regarding organizational sciences.

Arthur (1999) states that a commonality within complexity studies is that they observe systems with multiple elements adapting or reacting to the elements, which are created by these same elements and “Such systems arise naturally in the economy” (Arthur, 1999, 107). Manson (2001) suggests variations of: algorithmic complexity, deterministic complexity and aggregate complexity. The algorithmic complexity theory focuses on mathematical research and calculating different kinds of events. The mathematical details of these calculations are out of scope regarding this research paper. Deterministic complexity is worried about how a few key variables can create mostly stable systems. Aggregate complexity is concerned with how different parts work together adjusting and creating systems with complex behaviour. (Manson, 2001.)

The deterministic complexity theory is said to be evolved from chaos theory and catastrophe theory (Arthur, 1999; Grobman, 2005). It is also stated that: “Complexity theory suggests that organizational managers promote bringing their organization to the “edge of chaos”...” (Grobman, 2005, 356) On the other hand, the whole idea of complexity theory has evolved from systems theory, which is not reviewed in this paper (Anderson, 1999). The chaos theory focuses on observing chaos that seems random, but within lies an underlying order (Manson, 2001). The main difference of chaos theory and complexity theory is that in chaos theory, the formula which is calculated does not change over time, while complex systems are capable of evolving and changing the rules which are used (Mitleton-Kelly, 2003). Catastrophe theory has its eye on systems which experience large changes due of a small change in some other element. (Manson, 2001).

Like algorithmic complexity, deterministic complexity also uses mathematics to a certain extend to determine where a system is currently headed to. It is very influenced by the thinking way of previously mentioned chaos theory and catastrophe theory. Algorithmic and deterministic complexity both also rely on a number of assumptions about how complex systems function. (Manson, 2001.)

Aggregate complexity in other hand tries to grasp the whole picture and synergy of the interacting parts in complex systems. The main focuses of aggre-

gate complexity are the relationships between functioning components. (Manson, 2001.) For example, the components in an IT company would be: customers, employees and the products. The idea of aggregate complexity is close to this researches way of looking at organizations.

Mitleton-Kelly (2003) suggests that the complexity theory rises from different types of natural sciences. She states that all of these theories have certain things common. Figure 1 shows how this approach is viewed.

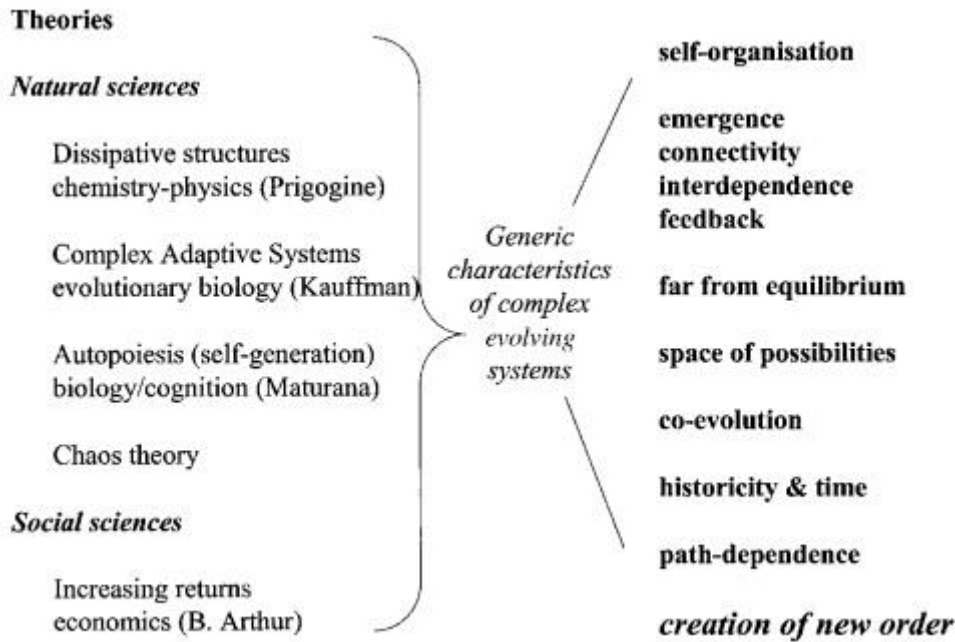


Figure 1 Complexity theories and characteristics of those theories (Mitleton-Kelly, 2003, 24)

The term equilibrium means a state of balance (Figure 1). Arthur (1999, 107) describes equilibrium as: "static patterns that call for no further behavioral adjustment". This term is often used by complexity theorists, as a large part of complexity research is determining the equilibrium of the observed systems. Prigogine and Stengers (1984) suggest that when the system is far from equilibrium, it becomes sensitive to triggers and the smallest of changes can create large effects. The term Complex Adaptive Systems (CAS) (Figure 1) is also viewed plenty in literature and will discussed next in greater detail.

Complex Adaptive Systems are entities which are examined to find regularity patterns that emerge from interaction of parts connected together within these complex systems, for example organization or human brain. (Anderson, 1999) Anderson (1999) describes four elements of CAS that have useful implications for organization theorists, with which it is tried to make easier to simplify the complex. The idea of these implications is highly used in the analysis part of this research. These implications are:

- *Agents with Schemata*

- *Self-Organizing Networks Sustained by Importing Energy*
- *Coevolution to the Edge of Chaos*
- *Recombination and System Evolution.*

To understand *Agents with Schemata* and the other three implications, it is required to look at a system and think how it is formed from agents. In an example of an organization, these agents could be: individuals, groups, or combinations of groups (Anderson, 1999). Now as the agents are observed, their behavior patterns are dictated by a schema. Creating and analyzing these cognitive schemas, it is possible to predict and control the patterns which the person is likely to complete. (Anderson, 1999; Holland, 1996) These schemas can vary among different agents and evolve during time (Anderson, 1999). Holland (1996) also states that these agents interact with constantly changing rules and these rules are called as 'schema'.

Self-Organizing Networks Sustained by Importing Energy are explained with the importance of feedback loops. Feedback loop means a continuous function of feedback towards an agent. This feedback can be either negative or positive. The theory of CAS suggests that these feedback loops affect the behavior or state of each agent (employee) within the organization and thus these loops are seen as energy. In CAS models the agents are connected to each other and affect each other. (Anderson, 1999.) In other words, the feedback loops within a CAS affect the way how agents are behaving and forming their decisions. To keep the CAS self-organized, it is required to import energy into the system (in this case, feedback) (Prigogine & Stengers, 1984).

Coevolution to the Edge of Chaos is about the evolution of agents. Agents are seen to coevolve together (Anderson, 1999). The earlier mentioned "edge of chaos" is seen as the perfect state for organizations. It is suggested that this state maximizes the complexity and adaptability of the system (e.g. organization) and thus the largest evolution is most likely to be achieved from the smallest of changes. (Grobman, 2005.) Kauffman (1996) states that the edge of chaos gives the CAS an advantage when compared to systems that are not in this state. This advantage is achieved from the large enough changes that occur at the edge of chaos and result in survival in the future (Kauffman, 1996). The edge of chaos can also be seen as effective, because too stable and too flexible organizations are seen as ineffective (Grubman, 2005). Each agent's involvement's payoff depends on other agent's decisions. The equilibrium that results from this coevolution can be viewed as dynamic, not static, because the state is constantly changing (quasi-equilibrium). (Anderson, 1999.) Coevolution to the edge of chaos cannot happen in isolation (Mitleton-Kelly, 2003). The reason why coevolution is important, is learning and the transfer of information (Mitleton-Kelly, 2003).

Lastly, *Recombination and System Evolution*. CASs are constantly evolving and it is possible that new agents are formed from recombinations of previous agents. The connections of agents can also evolve and create new patterns or

even new CASs inside the observed one (Anderson, 1999). In the case of organizations, this could mean the formation of new teams for example.

It is stated that there exists four properties to every CAS (Holland, 1996). These are also important to keep in mind when analyzing complexity in organizations. The properties include: *aggregation, tagging, nonlinearity and flows*.

Aggregation means the co-operation of agents as a single unit, a brain as an easy example. *Tagging* means that the formed unit has recognizable characteristics and those give possibilities to determine the unit's possible working patterns. Companies' logos have tags that immediately make people make assumptions regarding those organizations. *Nonlinearity* describes the hard-to-predict nature of CAS as it is hard to understand the whole picture of CAS from observing a single agent. *Flows* mean the effect of agents doing the same decision as the other agents, making similar purchases for example. (Holland, 1996.)

Mitleton-Kelly (2003) suggests that to survive, CAS needs to try the possibilities and generate variety. Complexity also suggests that the process of trying to find the perfect optimal strategy is not suggested and it can also be impossible (Mitleton-Kelly, 2003).

2.1.3 Complexity theory and organizational management

If the thinking of complexity theory would be used with managing an organization, self-organization would be the way to create order. Co-evolution would be a key element which would be attempted to maximize. The management would let the order form itself. The main focus of management would be to create optimal conditions for evolution and enforce optimal feedback loops. (Mitleton-Kelly, 2003.)

Mitleton-Kelly (2003) also describes a former global bank related management case, in which, after sufficient amount of meetings, every country's local management was let to do as however they saw the best. They were able to re-organize without powerful ruling. The project was successful. She suggests that some key elements that allowed the smooth process were related to constantly required and open communication and encouraging atmosphere (feedback loops) which was not pressuring any unfamiliar processes, thus creating optimal conditions for evolution. "Too little structure makes it difficult to coordinate change. Too much structure makes it hard to move" (Brown & Eisenhardt, 1997).

However, Anderson (1999, 223) states: "... there is no accepted, standard way to model organizational or inter-organizational networks in the abstract, and the outcomes of many simulations are sensitive to small changes in the assumed structure of connections among actors".

Brown and Eisenhardt (1998) state that the most innovative organizations navigate at the edge of chaos. According to them, the optimal state is achieved when the organization uses few very strict rules but is very flexible at the same time. This could be compared to agile software development. (Agile develop-

ment stands for methods, which use self-organizing teams and the project details are very lightly planned ahead (Bourque & Fairley, 2014)).

2.1.4 Analysis

As the literature is examined, it is possible to see a few similarities rise up from the mass. One of these is the way complexity theory is viewed by different areas of studies. Even though the starting point is different, the way of thinking seems to follow a similar line (Figure 1).

The most interesting points regarding this study are related to organizational management. Even though plenty of studies have been conducted about complexity theory and organizational science, they seem to focus mostly on theory. There does exist some business cases (for example the bank case introduced before), but the amount of these cases is not large enough to be able to make generalizations of how effective the idea of complexity theory is in practice.

As stated before, the way how complexity works can be compared to agile development methods. Agile methods have been used in software development all around the world, and they continue to increase (Boehm, 2002). This idea logically leads us to agile organizations. Basically that is what an organization would be, while managed with complexity theory. There is some research about this matter (see Atkinson & Moffat, 2005), but these studies are limited to a few. In literature, agile organization as a term seems to mean more of an organization that uses agile methods in developing products with agile teams, not in higher level of management.

To summarize, there is not enough research about complexity theories in practice to say they always work. When looking at a global organization, one could easily assume that the complexity is too great to balance at the edge of chaos and the whole firm would be cast into chaos. The following subchapter will make more connections from complexity to global IT projects and will be the starting point of this paper's study about managing the complexity.

2.2 Connections to global IT projects

2.2.1 Introducing complexity dimensions

“Complex systems are multidimensional, and all the dimensions interact and influence each other” (Mitleton-Kelly, 2003). This is the starting point of this study's way of looking at global IT projects.

Binder (2007) presents a figure in which he describes the dimensions that are included in global projects (Figure 2).

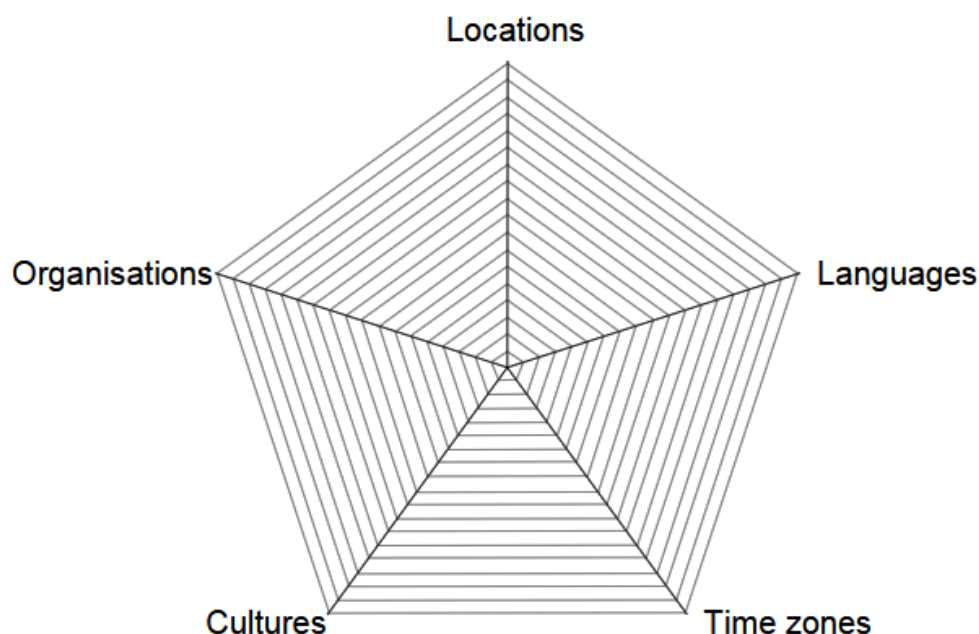


Figure 2 Global project dimensions (Binder, 2007, 3)

When looking at these dimensions, it is agreeable that they are present in all kinds of projects. However, IT projects can include other elements as well and should be introduced. The suggested extra dimensions are: *knowledge and data* (management) and *information security*. *Knowledge and data*, because those resources are seen as one of the main assets and concerns of an IT company, and they are present in every location where some part of an IT project is dealt with (Wiig, 1997). *Information security*, because it is also present in every location where information is handled. If information security disregarded in one location (e.g. another country), the whole project could fail (Tiller & O'Hanley, 2014). One could argue that these two dimensions are present in every single global project because of the vast increase of IT usage. If so, Binder's figure cannot be seen as complete.

If these dimensions are to be analysed regarding the management of global IT projects, a slight formal change is suggested here: the dimensions; *organizations*, *time zones* and *locations* can be seen as very close to each other and need to be altered to more sufficient means of this paper. Basically, an organization can have multiple units in multiple time zones, or multiple units in the same time zone. Also the amount of employees can differ from location to location and from time zone to time zone. Whatever the case is, the amount of complexity increases thus making it a valid point to separate them (as in Figure 2). However, it is a lot easier to observe the management methods of locations, time zones, and organizations as one, since they are linked together so closely; each location has a time zone, and each part of the organization is located somewhere, making it very hard to touch one of these three dimensions without

touching another. Basically this combination is created purely for the reason of making handling the subjects simpler. This unified dimension will be called as *Global Teams*. The differentiation of these three dimensions is still recognized.

Using the previous logic, dimensions *languages* and *cultures* could also be combined, since language can be seen as one of the dimensions of culture (Hofstede, Hofstede, & Minkov, 2010). It was chosen not to combine them, because previous literature has a great amount of research about both subjects separately, making it easier to handle them individually.

The suggested dimensions, as stated before, include:

- *Cultures*
- *Languages*
- *Global Teams*
- *Knowledge and Data*
- *Information Security*

More about these dimensions and their management is discussed later on this paper.

2.2.2 Connecting complexity theory and the management of dimensions

As stated before, complex systems form from multiple dimensions. This makes an argument: “managing complexity is the management of its dimensions”, valid.

Inserting the wanted positive feedback loops to each dimensions could, in theory, form a nearly balanced whole (Anderson, 1999; Manson, 2001). The so called “perfect state” for innovation or in other words “edge of chaos”, can be approached through analysing the ways to manage each dimension. After acquiring the needed knowhow on these subjects, the state of quasi-equilibria (“almost in balance”-state) that is sought by complexity, could be more easily achieved. The following chapter will look deeper into each dimension of global IT projects and the ways to manage them will be the main issue that is looked into through literature.

3 Complexity dimensions and their management

In this chapter, earlier mentioned global IT project dimensions and their management will be gone thoroughly. Each subchapter will start with introducing the dimension first and how it functions in daily corporate life. Second part of each subchapter will be about the possibilities of how to manage the dimension. After introducing the suggested management methods, analysis is done and the most optimal solutions for IT projects are decided, if possible. Even though every dimension is not directly related to only IT, the examples used are tried to be brought from IT project context.

3.1 Cultures

3.1.1 Cultures in the workplace

In Western Languages, the word culture usually means “civilization” or “refinement of the mind (Hofstede, Hofstede & Minkov, 2010). “Culture is often considered the driving force behind human behavior everywhere. The concept has become the context to explain politics, economics, progress, and failures” (Moran, Abramson & Moran, 2014, 11). Culture is basically patterns of human interaction and it can be learned and passed on to other people (Hofstede, Hofstede & Minkov, 2010).

It is important to make clear that cultures can mean either organizational cultures, or cultures outside of work. These two cannot still be fully separated, because the culture in which people have grown, affects the organizational culture common to the regional area. These differences cannot be easily made by comparing two countries, since border as the differencing factor might not tell anything. The information is just much easier to collect this way. (Hofstede, Hofstede & Minkov, 2010.)

Gender can, and should be, also included to the discussion of cultures in the workplace. “...within each society there is a men’s culture that differs from

a woman's culture, this recognition helps to explain why it is so difficult to change traditional gender roles" (Hofstede, Hofstede & Minkov, 2010, 45).

According to Gannon (1994), national culture explains from 25% to 50% of alternation in people's attitudes. This differences in attitudes can be used as a strength: Cox and Blake (1991) suggest that if people with different backgrounds, attitudes and ethnic groups work together, it will increase team creativity and innovation. Plenty of organizations see cultural diversity as a competitive advantage (Søderberg & Holden, 2002). To achieve that advantage, organizations need to first avoid cultural conflict, which occurs "...when some aspect of cultural distance causes conflict between an organization and its host culture" (Ojala, 2015, 832)

Regarding adapting cultures, it is seen that when an individual moves to a new culture, the person can adapt easily. If a group of one culture is moved together, the culture they represent will also move with them. The people in groups develop habits and ways of interaction that are very difficult to reform. (Hofstede, Hofstede & Minkov, 2010.) On the contrary, Butcher (2011) stated in general that moving from a culture to another usually leads to a feeling of not fitting in anymore.

3.1.2 Managing cultures across borders

Going global is often a very appealing proposition for organizations. The main reason is often the competition that it will face there; if let unchallenged, the company could achieve a great advantage for the business in the future (Deresky, 2000).

Hofstede, Hofstede and Minkov (2010) claim that there is no single way to develop successful managers since the success can be defined differently in different cultures. Their view of the matter is to train a manager to the needed objective. In any case, they state that there are two mandatory roles in management across borders that need to be fulfilled: *The country business unit manager*, whose job is to communicate between the target country and international head office, and *the corporate diplomat* who is used to living and working in multiple cultures. No other bicultural employees are required (Hofstede, Hofstede & Minkov, 2010). Figure 3 shows how culture is connected to other elements of management: strategy, structure and control (Hofstede, Hofstede & Minkov, 2010).

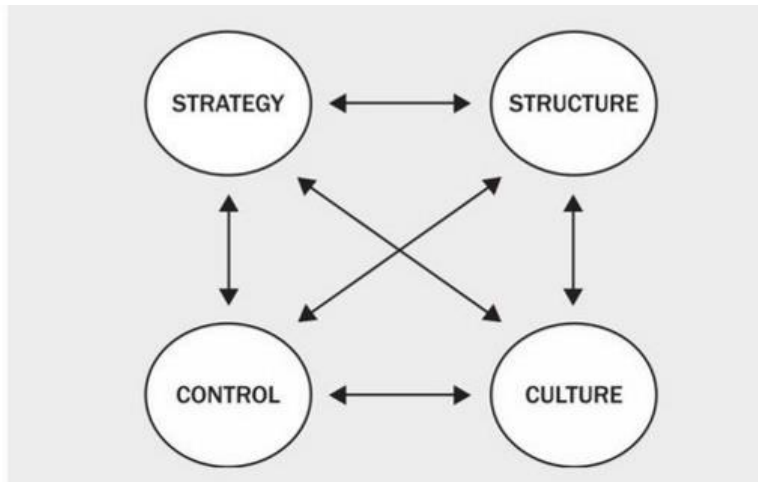


Figure 3 Cultural relationships regarding management (Hofstede, Hofstede & Minkov, 2010, 372)

"The simplest way of managing multicultural project teams is not to pay any particular attention to cross-cultural differences" (Chevrier, 2003, 145). She also states that this is often the case especially when the cross-cultural dimension is particularly overwhelming. This method leads to a situation where the team members must be very patient and tolerant regarding the encountered difficulties. These difficulties are rather ignored than spoken of in attempt to avoid conflict. (Chevrier, 2003.) "...almost all interviewees have stated that cross-cultural teams could not be effective without special personal qualities of their members, namely "openness", "patience", "self-control"" (Chevrier, 2003, 146).

The suggested starting point is to make the team members to get to know each other more closely, which would make them more proactive towards organizing meetings and other work related events. The missing component of this method is that it does not solve the conflicting issues regarding cross-cultural differences if they occur. The proposed strategy to overcome these obstacles is to have a person work inside the team as a mediator helping to solve problems and cross-cultural differences. The mediator would basically keep meetings with the team where the problems would be discussed as a group and later individually. (Chevrier, 2003.) Söderberg and Holden (2002) also agree, that this earlier mentioned "ignoring culture while managing"-method is outdated and needs revising.

According to Cox and Blake (1991), the prevalent starting point for managing diversity is training. This training would be divided into two different types: *awareness training* and *skill-building training*. *Awareness training* would include teaching self-awareness to the employees about cultural differences and sensitivity. It would also educate why valuing and managing diversity is important. *Skill-building training* would focus on educating employees about specific cultural differences and what to do when encountering them. They also suggest that top management's support is extremely important when managing cultures. (Cox & Blake, 1991.)

3.1.3 Analysis

Culture as a dimension is very complex as itself, since there is so many cultures and they all act at least a little differently. It seems that culture is one of the hardest concepts for managers to manage because of this vast diversity. Ignoring cultural differences is agreed among researchers to be the wrong approach and some guidelines and methods need to be used in order to maximize the benefits of the multi-cultural corporation. The most reasonable starting point seems to be distinguishing the cultures that are involved with the target organization. Hofstede, Hofstede and Minkov (2010) present six dimensions of culture:

- *Power Distance*
- *Individualism*
- *Masculinity*
- *Uncertainty Avoidance*
- *Long Term Orientation*
- *Indulgence*

Hofstede's extensive research rated tens of countries with this methodology and that globally available data could be an easy way for managers to get started with unfamiliar cultures. The main point being that by using these dimensions, countries can be rated and their characteristics more easily handled by the management. For example; a country with high rating in masculinity has a culture of aiming at achieving as much as possible and being successful at everything they do. A low score of masculinity means that the country's people are more concerned about their own well-being and enjoyment than objective success. The concepts of these dimensions in deeper meaning are out of bounds regarding this paper. If used, they should be viewed critically.

In the other hand, if the managers need to find completely new information about the culture they are going to manage, could they be the wrong persons to manage those cultures in the first place? An assumption can be made, that to avoid problems above the multi-cultural team, the project manager, or his/her supervisor at the latest, should be well informed regarding the cultural differences within the team. This single fact should make the managing easier by itself.

When talking about managing culture within a team, Chevier's (2003) view on having a mediator involved seems like a formidable choice. Team members would get feedback in a constant basis and the conflicts would be handled quickly since they would be noticed within a short time period. When comparing the so called "mediator approach" with training the employees, mediator seems to be the best choice. Even though the training can make the employees more aware about the cultural differences and also educate them of how to react in certain situations, they will still lack personal feedback and the given instructions can be easily forgotten throughout time. Including the medi-

ator could also be called training in a way. By training the employees about cultures, the teams could become more co-operative.

Regarding global IT projects, the team members can be divided across multiple borders, forming a so called “virtual team”, meaning they will only be in contact through internet and phone (more on virtual teams later). This aspect could diminish the amount and scale of cultural conflicts, but it could also increase them depending on the team. (Martins, Gilson & Maynard, 2004.) It is also worthwhile to consider that the effects of cultural differences can increase the negative impacts of long distances between units (within business context) (Ojala, 2015). These points lead to the conclusion that the dimension of *cultures* affects the dimension *global teams* greatly. Each organization should evaluate the situation they are in and make the adjustments accordingly.

As mentioned earlier, managing of culture can increase the amount of cooperation and thus self-organizing within a team/organization. What this means is that the organization is one step closer on achieving an agile environment and the “edge of chaos”. On the other hand, if left unhandled, culture can be the deciding fact which casts the project into chaos.

3.2 Languages

3.2.1 Languages in the workplace

According to (Dhir & Gòkè-Paríolá, 2002), it is difficult to find a comprehensive definition to language. They also state that the one common thing that researchers agree is that language is an essential human skill that makes the transmission of information and knowledge to other people and generations.

“Co-ordination makes global communication capability a pre-requisite for success” (Feely & Harzing, 2003, 4). Obviously there are different kinds of requirements for different positions in organizations. A local secretary might survive with less multilingual skills than a globally working software engineer. Globally working international project managers in the other hand need to possess a really high level of proficiency to succeed in negotiations and also to be able to grasp every detail exactly how it is to not cause any misunderstandings within the project. (Feely & Harzing, 2003.)

There are many negative effects of language barrier; “It breeds uncertainty and suspicion, accentuates group divides, undermines trust, and leads to polarization of perspectives, perceptions and cognitions” (Feely & Harzing, 2003, 9). Harzing and Feely (2008) also suggest that failures of communication can lead to anxiety and self-esteem of the team can decrease. The consequences of language barriers cannot be calculated through objects like money or days lost on translating; the cost needs to be seen through the damages to relationships within the project team and the whole organization (Feely & Harzing, 2003).

If an employee does not have confident fluency in a language he/she is required to use, the common response is to ignore that language or disregard it. These kinds of employees also often, instead of dealing with the matter themselves, try to find a more proficient language user and make that so called “language node” translates everything. (Marschan, Welch & Welch, 1997.)

3.2.2 Language management

It is largely agreed upon, that to successfully manage language, a language policy must be conducted (Dirk, 2006; Dhir, 2005; Dhir & Gökè-Paríolá, 2002; Marschan, Welch, Welch, 1997). Companies are often underestimating the importance of language management (Feely & Harzing, 2003). The language barrier creates problems within the basic communication and management. Feely and Harzing (2008) describe this impact with a cycle that is shown in Figure 4.

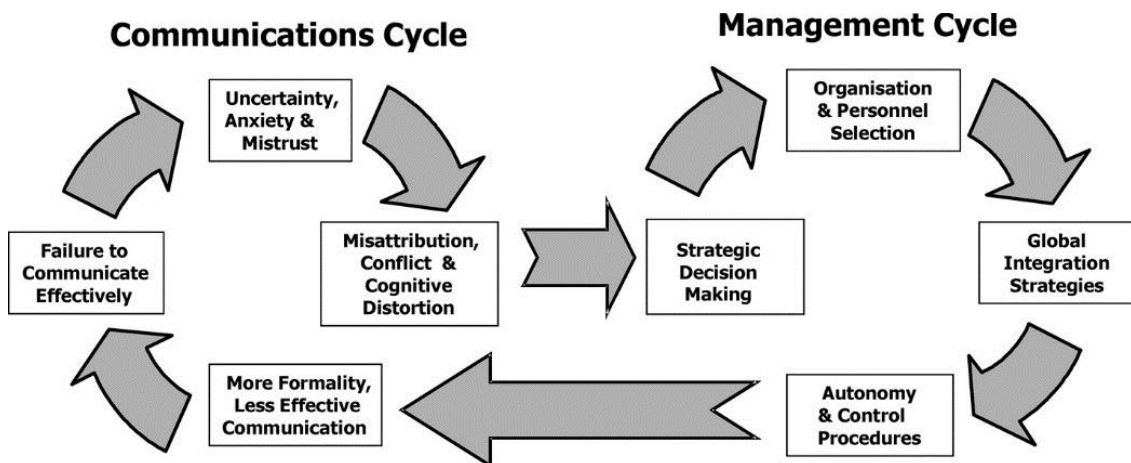


Figure 4 Impact of the language barrier (Feely & Harzing, 2008, 58)

The most common choice to manage languages for organizations is to adopt a single corporate language. This language is most often English, due to its global value. (Dirk, 2006.) Adoption of English as the only used language has undeniable advantages; it deals with the issue instantly and easily opens the markets for globalization (Dirk, 2006). Single corporate language still comes with plenty of possible problems (Feely & Harzing, 2003). Feely and Harzing (2003) list a number of positive and negative aspects related to single corporate language;

Positive:

- Reporting becomes more uniform throughout the organization
- Eases the access and maintenance of documents
- Communication becomes more uniform within operating units and teams working across borders
- Creates a sense of belonging and strengthens corporate culture

Negative:

- It is a long term strategy that is hard to maintain everywhere throughout the organization
- It is sometimes impossible to use a single language for every circumstance
- Resistance will often occur, if the language level (of selected language) of certain groups is low

“...although a corporate language may well enhance intra-company communication it does nothing to ease the language barrier with external bodies such as customers, suppliers, international agencies and governments.” (Feely & Harzing, 16) They also suggest a few other options that are introduced next.

Language nodes (mentioned earlier) are an easy and cheap solution, since not much organizational change is needed to make them work; the existing personnel with high language skills will automatically adjust to deal with the problems of communication and reporting. In the other hand this method has many weaknesses (Feely & Harzing, 2003):

- Nodes are forced to spend great amounts of time with translating and cannot use their full capabilities anymore in their regular work.
- The risk of miscommunication increases, because the node might not be an expert regarding the translated topic.
- Nodes could obtain too much power because they are the single group with possibilities to distort and filter the information as they wish to.
- The power of managers is lowered because they need to rely too much on the language nodes.

Language nodes could also be used in the other countries where the organization is active and make them report to the headquarters. Feely & Harzing (2003) list a few weaknesses that this method has: it is relatively expensive to hire the expatriate managers, especially if the company works in a great amount of countries, it does not get rid of the language barrier, and it limits the local managers to supporting roles.

One option that seems like an easy way to deal with language management is hiring personnel whom already possess the skills required. This could lead to situation where the old employees might not be useful anymore and get fired. Finding the optimal personnel could also prove difficult. According to Feely and Harzing (2003), this method is only advantageous in three situations: to fill certain areas of language, to create a language node, or to develop managers that are expatriate.

The last suggested solution by Feely and Harzing (2003, 19) is “...to in-patriate personnel from subsidiaries into the head office operation.” The benefits are as follows: the headquarters becomes more culturally diverse, it is very easy

to communicate to all the countries through the in-patriate personnel, and the method is also relatively cost-efficient. The in-patriates need to be fluent in the language(s) used within the headquarters for this method to be effective. (Feely & Harzing, 2003.) Another drawback is that the in-patriates require extensive support and education to get used to working in this new environment (Harvey & Miceli, 1999).

Dhir and Gòkè-Paríolá (2002) suggest that global companies could adopt multiple languages to their use and decide then which language to use is which context to create strategic advantage. This method would require the teams to be formed within the subsidiary countries, or the personnel would need to be fluent in multiple languages.

The most time and money -consuming strategy is to train the personnel to learn a new language. It does create the optimal conditions for business but—as stated before—is extremely resource consuming. According to Feely and Harzing (2003), a successful training program takes multiple cycles of 6-9 months and requires plenty of effort by employees outside work; a fully trained employee would then be “ready” after minimum of three years.

Overall the management of language can be very taxing to a global company due of the management required to make sure everything is running smoothly; the personnel might need to visit overseas units frequently and optimize the language management methods for years to find the correct way for that particular company. (Feely & Harzing, 2008.)

3.2.3 Analysis

As the options are looked into through literature, the easiest and most common choice of a single corporate language is not the most optimal when looking at the best possible outcomes. On the other hand, it does offer an immediate solution to the problem about communicating across borders. Regarding global IT projects, English is widely used throughout the community because the terms and programming languages are often standardized in English. Even though the IT personnel would possess the needed English skills, some other areas could prove difficult to manage. Again, the problem is highly dependent on the organizations current situation. To create the “perfect” long-term language policy, the company has to obviously look into the long term strategies with maximum benefits, which are training, and hiring personnel with required language skills.

Hiring new personnel is troublesome in a way that the old employees might prove sort of useless after the integration of the new personnel. The old personnel still possess the knowledge and experience from working in the company for many years, creating a difficult situation for the human resource (HR) managers. Increasing the amount of people also increases organizations complexity. A new company with hiring the first group of people could hire the most suitable personnel in the first place, thus countering the problem. The problem in this case obviously is, that new companies rarely are instantly going

global and they could also have trouble finding such perfect employees for a completely new firm. A compromise could be to hire people to certain areas of the organization or create new areas or teams, in which they would only communicate with other equally skilled personnel. This obviously does not remove the fact that the old personnel still do not understand the new ones. Suggesting that the old ones might not need to understand in this case; if the communications are clearly divided and organized, everyone should not need to understand everything regarding the projects. Regardless, it is important to keep in mind that hiring new personnel is not the cheapest method to go with.

Training as the other option, is extremely time consuming as stated before. If an IT company has a long term plan in which countries it will be working in for the next years, training could prove to be the most effective choice. The plans need to be concrete, since the time and money consumed this way is a big strategic investment. As for the effectiveness long term, training is clearly the best choice. It still has to be monitored strictly and test the language levels after every phase of training. The optimal result would be a whole company filled with proficient skills in both their work area and language. This option is clearly not suitable for single IT projects.

Breaking the language barrier is crucial in creating friendships and teams that can co-operate properly. Language is also tied to the culture; to understand the culture of some employees, it might prove useful to try to understand the language as well (Hofstede, Hofstede & Minkov, 2010).

3.3 Global teams

3.3.1 Behavior of global teams

The term global team basically means a team which is divided across borders of a single country. In IT projects, these teams usually are in contact through World Wide Web, and thus are called *Virtual teams* (VT). VTs are also the focus-group of this subchapter, because of the nature of IT projects. Martins, Gilson and Maynard (2004) describe virtual teams as teams that use technology to keep contact across borders and other limits. The most common limits are geography, time, and organization (Martins, Gilson & Maynard, 2004). Hertel, Geister and Konradt (2005, 71) state that virtual teams consist of:

...(a) two or more persons who (b) collaborate interactively to achieve common goals, while (c) at least one of the team members works at a different location, organization, or at a different time so that (d) communication and coordination is predominantly based on electronic communication media.

According to Maznevski and Chudopa (2000), members of VTs are often from multiple organizations; the reason being joint ventures.

As the name indicates, VTs communicate mostly virtually. The methods vary between teams and organizations, but the most common methods include: "...telephones, web sites, instant messaging, file- and application-sharing, electronic bulletin boards, group decision support systems, and real-time calendar/scheduling systems." (Martins, Gilson & Maynard, 2004, 808).

According to some studies, conflicts occur more frequently in VTs, than "normal" face-to-face teams (Mortensen & Hinds, 2001). In the other hand, Mortensen and Hinds (2001) also suggest that the effects of conflicts are decreased if the VT feels that it has a common group identity. Setting goals for VTs is researched to have positive results regarding cohesion, commitment, coordination, and quality of decisions (Huang, Wei, Watson & Tan, 2002).

VTs often have a schedule of working around the clock. The idea is to transfer the job to another team working on the same project; the other team is working on different time zones. This makes it theoretically possible to work 24 hours a day on a project. (Taweel & Brereton, 2006.)

3.3.2 Managing global teams

The management of global teams differs in how the teams/organization(s) are distributed across the globe. Management of global teams can also be thought as managing a single team, or managing a set of teams as an architecture. One of the good traits of VTs is that the teams can be formed based on the persons' expertise instead of "whoever we can get from this particular country" - restriction. Also the amount of traveling and space required in a single working unit are reduced. (Hertel, Geister & Konradt, 2005.)

The idea of the earlier mentioned method of transferring the job onwards is presented in Figure 5. The figure shows how the workload is cleverly distributed to maximize working hours spent on the project.

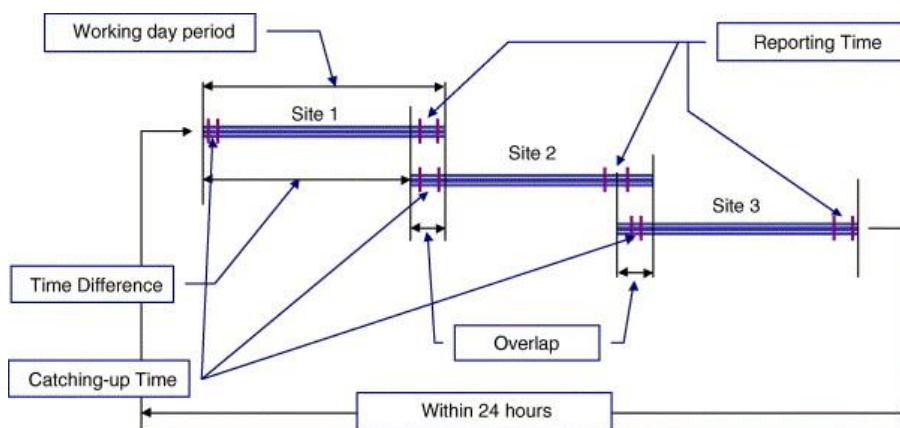


Figure 5 Work distribution of a virtual team on three sites (Taweel & Brereton, 2006, 2)

Taweel and Brereton (2006) describe two ways of distributing software engineering tasks across multiple time zones: *Sequential task distribution*, in which a piece of work is split between multiple persons, located across time zones (Fig-

ure 5), and *Dependent task distribution*, where the idea is to work on different tasks across time zones. These tasks would depend on each other. For example programming would be done on one time zone and testing on another.

Taweel and Brereton (2006) also suggest that a crucial point in making these methods work is to have good communications facilities to make sure the software and other information are transferred safely and effectively. The suggested ways to do this communication are listed on chapter 3.3.1. Meeting of team members face-to-face is highly recommended before beginning of a project with a new team (Hertel, Geister & Konradt, 2005).

Hertel, Geister and Konradt (2005) present a heuristic lifecycle model for VTs to organize their behavior and management. The lifecycle model contains five phases: *Preparations*, *Launch*, *Performance management*, *Team development*, and *Disbanding*. The detail regarding each of these phases can be seen on Figure 6.

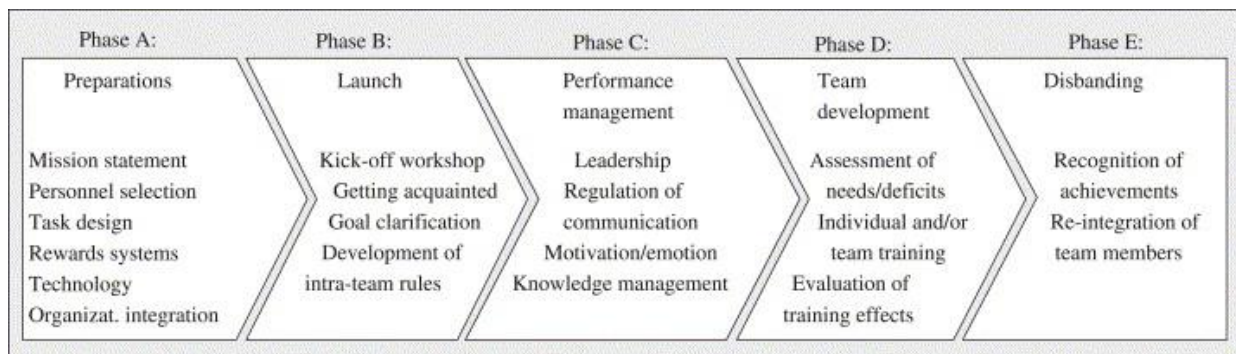


Figure 6 Lifecycle model for managing virtual teams (Hertel, Geister, Konradt, 2005, 73)

According to Hertel, Geister and Konradt (2005), leadership is one of the main challenges when managing virtual teams. They suggest to divide some management procedures to team members. Although, this can be counterproductive, if the members are unmotivated (Hertel, Geister & Konradt, 2005).

Regarding of managing multiple global teams as a structure, Binder (2007) presents multiple models for managing and organizing a set of teams based on the structure of the project and the organization; these structures are: *centralized structure*, *distributed structure*, *distributed functional structure*, and *project network structure*. The formations of these structures are shown in Figure 7.

Centralized structure (1. in Figure 7) is the simplest one. There is one project manager who manages everyone included in the project. The team members are divided across the globe. This method can be useful if the project's scale and the amount of personnel is small enough to be managed by one person (Binder, 2007).

Binder (2007) states that the *distributed structure* (2. in Figure 7) is recommended for most global projects. The basic idea is that there is one project manager and then the local coordinators of other countries involved will report everything to the main project manager. This method requires the teams to be divided by continents so that every divided section (=continent) can create a concrete part to the total project, which makes it simple to use global VTs with this

structure. Organizations with this type of structure can easily utilize the *Sequential task distribution* if wanted (Figure 5). Binder (2007) states that if this round-the-clock -method is to be used, multiple project managers should be used instead of simple project coordinators. This is to make the general management stronger. (Binder, 2007.)

Distributed functional structure (3. in Figure 7) is a little problematic for global VTs, since the main idea is that the functional coordinators of each section control the communication of a team, which is divided across multiple continents. Basically a single person of a team might be working on the other side of the world, while the others are close to each other regarding time zones. These coordinators communicate their team progress to the main project manager, similar to distributed structure. This method is used, when some particular personnel are required to work near a stakeholder or a customer. (Binder, 2007.)

Lastly, *project network structure* (4. in Figure 7). In this structure, multiple organizations are a part of the project. Each organization is located in a certain area and completes a set of tasks and communicates to the project manager via local coordinators. For example, one section could be doing consulting and another outsourcing. According to Binder (2007) this structure is very common and is one of the main reasons of the project failures, because of the difficulties of managing between multiple organizations across borders. (Binder, 2007.)

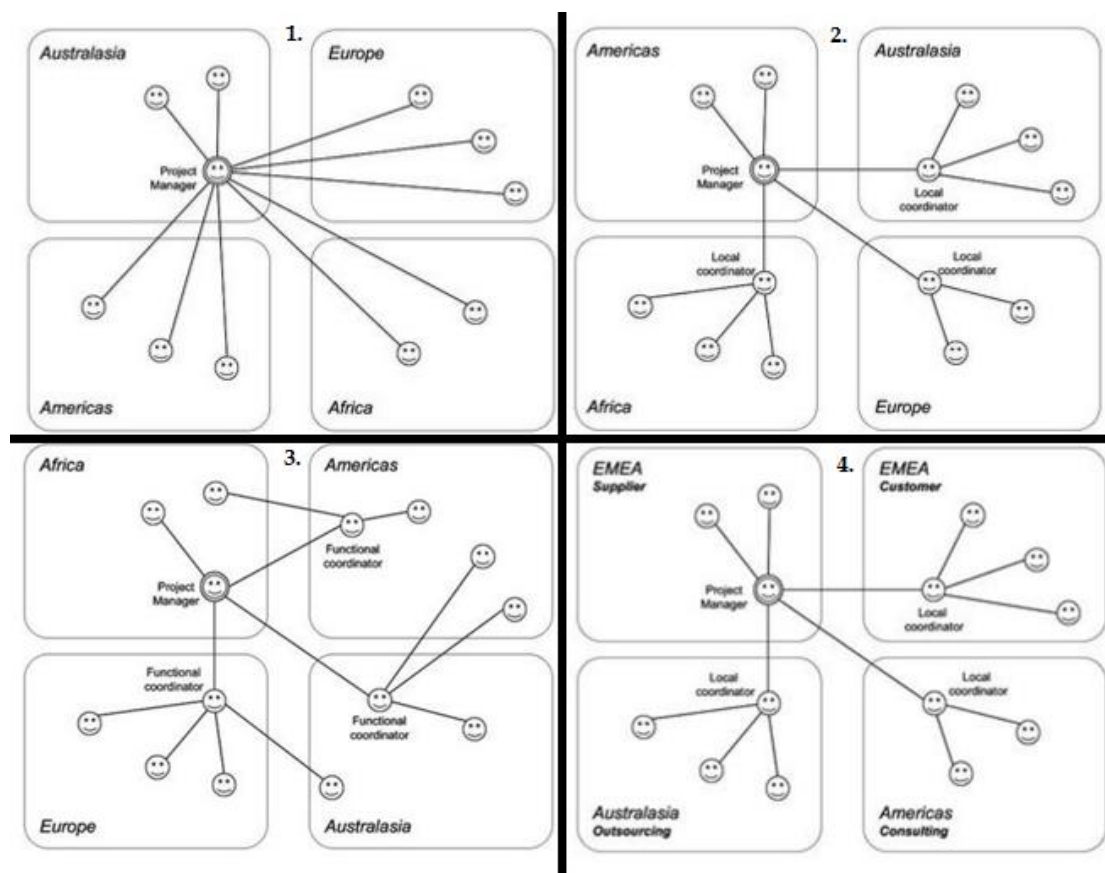


Figure 7 Global team management structures (Binder, 2007, 132-137). Also mentioned in PMBOK (2004)

Binder (2007) emphasizes that in order to make these global structures work, it is very important to have right people for right jobs (managers and other personnel); global experience, cultural awareness, and sufficient communication skills are seen to possess great value.

3.3.3 Analysis

A company should probably first look into the “bigger picture” of how it wants to divide team(s) to an IT project and then move towards adjusting the team members and other details (Binder, 2007). If a company wants to use global virtual teams there are two choices to consider from presented literature; from Binder’s (2007) architecture models (Figure 7), could choices 1 and 2 (*centralized structure* and *distributed structure*) be used.

Centralized structure, being the simplest, is a formidable choice, if the amount of team members can be set to a low number. Communication in this format is easy and all the members working on software engineering tasks and supporting tasks would know each other, which strengthens the bonds between members. This choice would force the project team to function as a VT, since the team members are divided across borders. The problem with this is that the manager cannot be working 24 hours a day and this structure does not provide localized coordinators. In the other hand Taweel’s and Brereton’s (2006) VT work distribution model (Figure 5) could be used in theory. *Centralized structure* does have the advantage of being flexible, since the tasks can easily be divided within one team, so everybody would know the current situation of other members and adjustments could be made accordingly to tasks and objectives. Too many members could easily create uncontrollable chaos, since many details could easily be missed due of the lack of controlled management.

In the case of *distributed structure*, the management issue is beaten by local coordinators. Bigger scale global IT projects could probably find this method useful, since the responsibilities of communication are divided to few key members. Since the communication is divided, the management is simpler, but it does make a single employee “weaker”; the coordinator is the person who communicates between his/her section and project manager, meaning that the voice of other personnel located to that section might be somewhat suffocated. This is also linked to the relationships between team members. If the personnel of one section are having personal issues with each other, problems might go unnoticed and create problems inside the project. This structure does provide great support to the earlier presented VT work distribution model (Figure 5). As Binder (2007) suggested, if the use of around-the-clock method is deemed as good, the local coordinators should be replaced with another project managers. This would also get rid of the problem of dissension between team members. Some kind of hierarchical structure between these project managers might prove useful to avoid misunderstandings and “clashes of power”.

Option 3 in Figure 7 (*distributed functional structure*) could be used in a similar fashion as *distributed structure*, the difference being those few persons work-

ing far away from the local coordinator. Tasks of these “offshore” -members should be adjusted in fashion that they do not damage the processes of other team members, because of the distance and time difference.

Last choice, option 4 in Figure 7 (*project network structure*), has certain upsides and downsides. Upsides are that when the project is divided to multiple parties, every party can be professional when it comes to its tasks. For example, the best consultation service and the best testing group can be chosen without the personnel needing to worry about other tasks they are not as good at. Basically everyone can focus on their main area. The problem with this is the management of the whole (Binder, 2007). Problems can rise from the differences of organizational cultures and the demands made by the supplier and customer might not be clear to everyone. A big part of IT projects fail because of poor communication between different parties (Al Neimat, 2005). Regardless, this choice might be the only possible one, if the scale of project is enormous and specialized expertise from multiple areas is required.

When observing these four structures (Figure 7) and their relation to complexity theory, it is noticeable that some of the options are more complex than others. The option 1 clearly includes the least amount of complexation because of the simple connections between team members, and the option 4 includes the greatest amount, because it basically brings together the complexity of multiple organizations. This means that from the point of total amount of complexity, option 1 would be optimal. On the other hand, option 1 might make the complexity inside a team too great to handle and cast it to chaos. That scenario might not happen in the other options because the complexation is divided, even though the general amount of complexity is greater.

The two earlier mentioned methods of distributing tasks for software engineering presented by Taweel and Brereton (2006) (*Sequential task distribution*, and *Dependent task distribution*) both seem usable. *Sequential task distribution* basically gives the possibility of producing code at a substantial speed, because it is been worked on all the time. This requires the written code to be documented precisely with agreed methodologies to assure that other programmers understand everything they have been working on. If a single programmer has hit a problem, it will not often be devastating, since the other programmer(s) can then work on without causing too much delay. This method obviously also requires time to “catch up” with the previous code as shown on Figure 5; an employee cannot start writing anything new, before going through everything that has been made while he/she was not on duty.

In *Dependent task distribution*, working around on one task is not as time efficient as on *Sequential task distribution*, but in return it is fast overall and gives much more clear boundaries for work. In an example of programmers and testers, time to “catch up” is not as long, since the programmers simply need to tell the functions and reasons of the new code so that the testers can test it. This method does require the programmers to finish something testable before the end of day; if nothing valid has been created, no testing can be done either, which damages the whole work cycle. If happening often, it might hurt the rela-

tionships between team members and also damage the company's processes and long term schedule.

Regarding the management of global teams (virtual teams in particular) and complexity theory, Hertel, Geister and Konradt (2005) did an interesting mention: "Virtual teams can even be envisioned as completely self-organizing systems that develop and dissolve by themselves without any external structure." This supports the idea of complexity's way of adapting to new, and organizing itself without being controlled by a structure.

3.4 Knowledge and data

3.4.1 What is knowledge and what is data? How are they used?

Data consists of pieces of observations that by themselves do not mean anything. Information comes to exist when the pieces of data are combined to create an understandable totality. Information can be judged and it creates opinions; it can be accepted or rejected. (Prough, Ibieta & Ohwada, 2002.)

For someone to possess knowledge, understanding the connections of information and data is required. One should be able to use information and expect predicted results from it. All knowledge is not based in concrete reality because matters like culture, history, experience and multiple other similar concepts might not be observable. (Prough, Ibieta & Ohwada, 2002.) "Knowledge has many features, attributes, and dimensions" (Rus & Lindvall, 2002, 11). Knowledge can also be either documented or undocumented (Rus & Lindvall, 2002). According to Benton and Magnier-Watanabe (2009), knowledge is personal and complex and it is formed from experience throughout the person's whole life; it is very difficult to share exactly as it is received by an individual. Especially hard cases are organizations.

Knowledge can be divided into two shapes: *explicit knowledge* and *tacit knowledge* (Benton & Magnier-Watanabe, 2009; Richardson, O'Riordan, Casey, Meehan, & Mistrik, 2009). *Tacit knowledge* is formed from experience and is located deep in persons mind. Because of the deep nature of tacit knowledge, it is extremely difficult to express and transfer to another through visual demonstration. Examples of *tacit knowledge* could be professional scope management for an IT project or cooking food for a five star restaurant. Explicit knowledge could be described as "not as deep" knowledge; it can be acquired from multiple sources such as books, education, and internet. This form of knowledge can be expressed through visual demonstration, like figures in this paper. (Benton, Magnier-Watanabe, 2009.)

Each company possesses some form and amount of both explicit and tacit knowledge in the form of experience, memories, folders, databases etc.; this knowledge is known as corporate knowledge (Richardson et al., 2009). When

knowledge is shared, it is seen to improve people's coordination and effectiveness when working together (Dingsøyr & Smite, 2014).

3.4.2 Global knowledge management

Wiig (1997) states that the objectives of knowledge management (KM) are about making the organization as intelligent as possible, and to realize the value of company's knowledge assets and use them correctly. He also declares: "The overall purpose of KM is to maximize the enterprise's knowledge-related effectiveness and returns from its knowledge assets and to renew them constantly" (Wiig, 1997, 1). Richardson et al. (2009) list a few aspects that KM consists of:

- managing knowledge as an asset
- promoting knowledge transfer and communication
- making learning and innovation normal activities in the organization; collaboration should be encouraged instead of competition
- maximizing the use of possessed knowledge
- storing as much knowledge as possible from every employee to still have access to it if the employee leaves the company
- using the knowledge so that work is not repeated and old mistakes are not made again

KM is seen as a source that has potential to give an organization a competitive edge (Benton & Magnier-Watanabe, 2009; Mudambi, 2002).

Rus and Lindvall (2002, 2) describe the goals and biggest challenge of KM as:

KM seeks to turn data into information, and information into knowledge. The most eminent problem is, however, that just a fraction of all knowledge related to software is captured and made explicit. The majority of knowledge is tacit, residing in the brains of the employees. This fact makes knowledge sharing and retaining of knowledge a challenge.

Benton and Magnier-Watanabe (2009) agree that both tacit- and explicit knowledge must be considered by management to get the best results; they require some kind of exchange mechanisms because the time and motivation needed by employees to make knowledge transfer feasible. "Motivation to share the knowledge" is an important aspect to work on as an organization, since not everyone is willing to share it; knowledge is seen as a powerful asset and it is not easily give away. According to Khalid, Shehryar and Arshad (2015), in cases which managers only focused on explicit knowledge, KM does not succeed in the way that it is wanted to. Employees can have large differences in nature and these differences affect the knowledge management methods. (Benton & Magnier-Watanabe, 2009.)

Because every IT project is unique in terms of goals and contexts, there is no single right answer for KM practices. Organizations should have some kind

of KM deployment plan, since according to studies 50-60% KM deployments fail because of lack of KM methodology or process. (Rus & Lindvall, 2002.) They also state that implementing KM practices to organizations those do software engineering is generally easier. This consists of two reasons: firstly, KM system needs to be supported by technology and software engineers are accustomed to adapting to new technologies. Secondly, the sold products and everything around them are already in electronic form, which means they can be easily shared. Sharing knowledge is also widely happening automatically between software engineers. (Rus & Lindvall, 2002.)

Rus and Lindvall (2002) presents two different tracks for KM systems to divide and make objectives clearer: *IT-track*, which has its eye on managing information and data through IT systems, and *people-track*, which focuses on managing people. They further suggest that there are multiple questions regarding KM that need to be thought of separately by managers. These questions revolve around storing information and data, and managing people; for example:

- How can the organization make personnel share their personal knowledge repositories (such as experiences)?
- How the organizational knowledge repositories (such as databases) should be organized?
- How can the personnel be persuaded to use organization's repositories?

In the contrary, tasks that the software engineers should be thinking of regarding KM are: improving team's ability to work, and improving organization's ability to create wanted outcomes. (Rus & Lindvall, 2002.)

One of the ways to manage knowledge with information systems is to implement a knowledge base where employees can ask questions and browse answers (Rus & Lindvall, 2002). The base would then fill up relatively quickly depending on the demand of knowledge. Another KM system could be a peer-to-peer system where users are considered as experts and it would be easy to ask questions even if working across borders (Rus & Lindvall, 2002). They also support the idea of using version control systems (VCS). They are systems that save each version of the saved files and information about each version, used especially in software engineering. VCS can also ease the KM processes by giving information about the current and earlier products, and can be seen as mandatory in modern software engineering. (Rus & Lindvall, 2002.)

Another method that Rus and Lindvall (2002) suggest to increase knowledge sharing is reward systems. The basic idea is to reward employees when they share information. Two suggested variations include "hall of fame" and "points system". "Hall of fame" would highlight employees with contributions to knowledge sharing and improving the organization and get rewards accordingly. "Points system" on the other hand uses the idea of earlier mentioned knowledge base. People would get points from answering questions and those "experts" would then get recognition and rewards from time to time.

Regarding the starting points of KM, Figure 8 shows the basic functions of KM, separating it to areas, also showing some knowledge related practices. The figure divides the areas to managers' and employees' perspectives and states how knowledge should be managed and distributed.

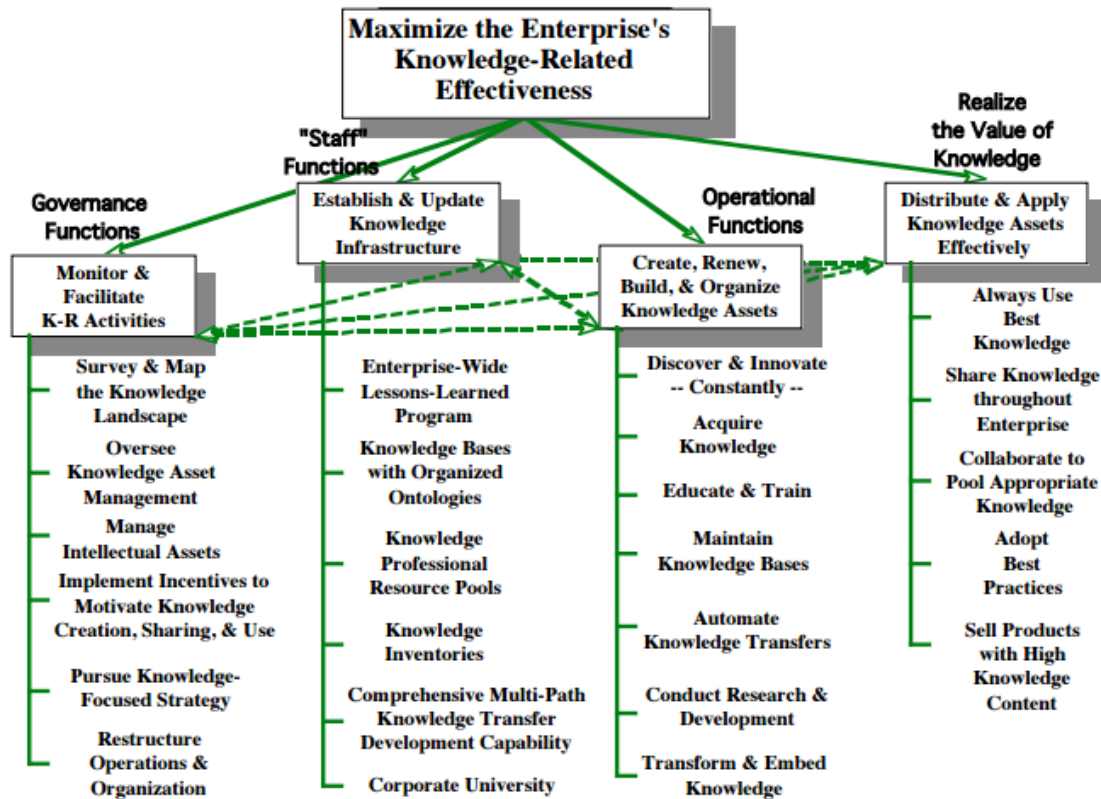


Figure 8 KM functions (Wiig, 1997, 2)

When looking KM more from global IT project perspective, Khalid, Shehryar and Arshad (2015, 1) state: "Knowledge management (KM) is essential ingredient of successful coordination in globally distributed software engineering." They suggest to give special attention to distribution of knowledge between organizations (if the project's tasks are divided to multiple organizations). Paik and Choi (2005, 84) suggest that: "Creating a successful global KM practice, like other kinds of globalization activities, requires a balancing act between global integration and local responsiveness."

Richardson et al. (2009), and Desouza and Evaristo (2003), mention that the usual problems with KM are connected to distance, culture, language, organizational standards and experience, which means that focusing on these areas can make KM easier.

According to Richardson et al. (2009) the most critical part about KM in global environment is to make employees aware of the fact that daily activities are a big part of knowledge management. This "humane" kind of view is also shared by multiple authors (e.g. Benton & Magnier-Watanabe, 2009; Desouza & Evaristo, 2003; Prough, Ibieta & Ohwada, 2002). To add to this, Dingsøyr and

Smite (2014) give some guidelines to go through when implementing KM to global IT projects:

1. Identify global challenges in the project
2. Decide the kind of information that should be shared locally and which globally
3. Discuss different KM methods from the beginning of the project
4. When starting a global KM strategy, begin with simple, less resources demanding solutions such as building on existing networks
5. Avoid KM pitfalls, such as not learning from previous projects

3.4.3 Analysis

Generally the amount of empirical studies about global KM is small (Dingsøyr & Smite, 2014; Richardson et al., 2009). “The choice of which KM strategy to pursue is typically based on other strategic thrusts and the value discipline that the enterprise pursues, challenges it faces, and opportunities it wishes to act upon” (Wiig, 1997, 5).

Seems like the main point in which there is some level of consensus is that knowledge management should be approached through peoples’ interaction. Encouraging knowledge sharing within employees is seen as a really important aspect. One of the more critical problems is that knowledgeable personnel often leave and take their knowledge with them. One way to counter this that was not introduced in literature would be to record interviews of employees regarding topics that match their expertise. This way other employees could access that knowledge even if that person leaves the company. The problem with this would be making sure those interviewed employees would actually share everything they know and have experienced. Again, encouraging the knowledge sharing atmosphere would play a crucial role.

Other side of the coin, using IT to manage knowledge, is also recognized by widely by researchers as discussed earlier. The recommended way seems to be to have some sort of knowledge databases and repositories. Using these, employees can easily access needed data, information, and knowledge. This comes especially handy in global IT projects, because of the employees working across the borders, and the information handled daily is already in digital form.

Managing data is obviously done mainly through digital methods. Version control systems and databases seem to be the most used ways to handle data especially in global projects and organizations. With all this data, information and knowledge stored in online servers, raises the question of information security. Knowledge leaks could prove harmful to the organization and need to be dealt with. The next subchapter will open these issues with more detail.

Regarding complexity theories, Rus and Lindvall (2002) mention how a knowledge sharing organization can create the wanted positive feedback loops without the need of enforcing this behavior; employees realize the benefits

themselves. Rus and Lindvall (2002) give an example of an honest dialogue between employees in an organization. This sort of behavior matches the earlier discussed “agile organization’s” ideal patterns.

The dimensions culture and language can also highly affect knowledge and data sharing. How to share information to personnel who don’t understand the language? How to explain something exactly as it is (knowledge sharing) to someone who comes from a different background and views the world differently? This means that these topics need to be discussed with KM to decrease the amount of complexity.

3.5 Information security

3.5.1 Information security in organizations

IT organizations handle loads of data every single day. This data is accessed through company’s computers at the office but also often from home using a Virtual Private Network (VPN), connecting the home computer to company’s intranet. Some limits can be assessed to exclude unwanted people’s access to company’s data. Restricting the information to be accessible only by the selected people is what companies generally want to achieve.

There are other concerns as well as the information ending up to wrong hands; technology can break down or the information could be erased by accident. These situations can occur from technical errors or human made mistakes, but also from natural disasters (Tiller & O’Hanley, 2014; Vacca, 2014). Human made mistakes and natural disasters are often the most damaging to companies (Vacca, 2014).

Even though companies usually store their data to digital form, Information security is not just about technology; information security is present in every day human interaction and it is affected by such things as (organizational) culture, management strategies, and experience (Tiller & O’Hanley, 2014).

3.5.2 Information security management

According to multiple researchers, an *information security policy* (ISP) is the ideal starting point of managing corporate information security (e.g. Von Solms & Von Solms, 2004; Höne & Eloff, 2002; Tiller & O’Hanley, 2014). Von Solms and Von Solms (2004, 374) state: “...a proper corporate information security policy is the heart and basis of any successful information security management plan.” Höne and Eloff (2002) list the contents a comprehensive ISP should include:

- Scope of information security

- Objectives of information security
- Definition of information security
- Management's commitment to information security
- Approval of the ISP (signature of authorities)
- Purpose/objective of ISP
- Principles of information security
- Roles and responsibilities
- ISP violations and disciplinary action
- Monitoring and review
- User declaration and acknowledgement
- Cross references
- General elements, which include:
 - The authors
 - Date of the policy
 - Review date of the policy

ISP works as guidelines of information security management and should be made short and easy to read. When the document is made clear, the employees are more likely to read it. When everyone agrees to these policies, it eases management's efforts as the employees have guidelines to follow. (Höne & Eloff, 2002.)

According to Tiller and O'Hanley (2014), Information security management is generally poorly understood and it means different things to different people. They state that information security management is: "...the establishment and maintenance of the control environment to manage the risks relating to the confidentiality, integrity, and availability of information and its supporting processes and systems" (Tiller & O'Hanley, 2014, 103). They further present a strategic framework to clarify the interactions and processes included in information security; the framework can be seen in Figure 9. The figure also shows the connection to culture and human factors. "A strong organizational culture can control organizational behavior" (Tiller & O'Hanley, 2014, 106).

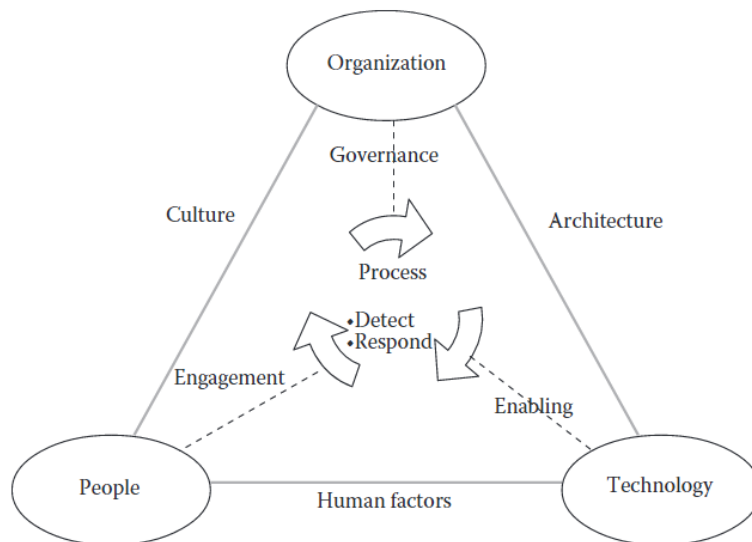


Figure 9 Information security interactions (Tiller & O'Hanley, 2014, 104)

Vacca (2014) states that everyone in the organization should solve security problems however they can from the positions they are working in; technical infrastructure does not guarantee a secure organization. If this goal is sought to achieve, the dimensions, *languages, cultures, and knowledge and data* need to be considered also, since information needs to be able to reach everyone with similar precision.

According to Vacca (2014), management of information security should begin with risk management. He lists the most common ones as:

- Physical damage
- Human interaction
- Equipment malfunctions
- Internal or external attacks (hacking, cracking)
- Misuse of data
- Loss of data
- Application error

“The idea of risk management is that threats of any kind must be identified, classified and evaluated to calculate their damage potential” (Vacca, 2014, 11).

Vacca (2014) states that training the employees those are responsible of information security is critical, meaning basically every single employee. He suggests that the first goal is awareness, after that comes training, and lastly education about acceptable security. Training should be targeted accordingly to correct groups, for example marketing personnel might not understand or need technical information about firewalls or networks. (Vacca, 2014.) The employee aspect is seen as the most critical component in managing information security (Bulgurcu, Cavusoglu, & Benbasat, 2010; Vacca, 2014).

Management methods can also be drawn from standards. Multiple information security standards exist that organizations often use to derive certain aspects to the ISP. Currently the most widely used standard for information security management is called ISO/IEC 17799:2005. (Vacca, 2014.) These standards seem to mostly offer guidelines instead of frameworks, such as: “A management framework should be established to initiate and control the implementation of information security within the organization” (ISO/IEC 17799:2005, 9)

Generally global information security management includes all the same things as local, but it also includes paying more attention the dimensions such as culture and geographical locations, making the basic concept of information security more complex (Tiller & O’Hanley, 2014).

3.5.3 Analysis

There seems to be little research about global information security management, even though global dimensions have been noticed (Tiller & O’Hanley, 2014). Literature focuses heavily on rules and policies but nowadays more and more to the people aspect as well.

According to literature, the most important aspect of managing information security is to prepare for everything; risk analysis, policies, and training are meant to assure the safety of information and data.

When comparing to the other earlier discussed dimensions, the least amount of governing options are given to information security. The reason for this is probably the strict nature of “security”. Authors seem so agree on that everyone in the organization is responsible for the security and they should be prepared for that mindset. When the literature of other dimensions offered different methodologies of approach, innovational –option giving- frameworks for information security management have not been presented. The complexity of earlier dimensions often seems to come from the amount of possibilities that can be used to manage them, but in the case of information security, the complexity rises from the vast amount of detail that needs to be considered. Organization being global adds to this complexion making it more difficult to address everything and make security optimized.

4 Conclusion

The research question was stated as: "*How to manage complexity and complexity's dimensions in global IT projects?*" In the beginning, complexity theory was introduced as one of the starting points of this research. It was found that global IT projects are complex wholes that can be divided into a set of dimensions (Binder, 2007; Mitleton-Kelly, 2003). Thus the assumption could be made that to manage complexity, one needs to manage its dimensions. The basis to the observed dimensions were derived from a figure presented by Binder (2007) (Figure 2). It was decided that the original dimensions: locations, time zones, and organizations will be combined to create a new dimension: global teams. Two new dimensions highly related to IT projects were added: knowledge and data, and information security. In total the dimensions that were deeper looked into, were:

- *Cultures*
- *Languages*
- *Global teams*
- *Knowledge and data*
- *Information security*

Complexity theory suggests that in the optimal state, every element (e.g. employee) in a complex system (e.g. organization) is able to work and adjust on its own while being influenced by other elements (Anderson, 1999). This is why it is important to try to make it possible by creating an enabling environment. This was approached by looking at each dimension on its own. It was found that the methodology of complexity theory highly resembles the methodology of agile teams, the difference being that complexity theory suggests agile methodologies to be used on the organizational scale.

Multiple management methodologies were reviewed for each dimension, and when looking at a single dimension from the perspective of complexity theory, the wisest choice would be to always choose a management method with the least amount of complexions to make the overall complexions less com-

plicated. From the organizations perspective this is obviously not always possible. On the other hand, choosing a seemingly more complex method could make another dimension's management less complex. This leads to the conclusion that each dimension is highly influenced by other dimensions, meaning that if one dimension is left unmanaged, it is likely that problems will somehow show through other dimensions (Anderson, 1999; Binder, 2007; Mitleton-Kelly, 2003; Ojala, 2015). For example, disregarding language barrier will likely show in the communication of global teams and knowledge management, thus affecting the results of the project. Because of this, management methods that combine aspects from multiple dimensions should be -in theory- very effective.

From the reviewed dimensions, global information security management seems to need the largest amount of future research. Dimensions such as culture and global teams had some researches written while looking at the impact to other dimensions. In the case of information security, the impacts of, for example culture, were barely mentioned and then dismissed. Future research regarding the effects of one dimension to another should be very interesting.

Another possibility for future research would be regarding using complexity theory with management, or simply call it as: "management of an agile organization." Agile teams are widely used in software development with great success, but would that flexible methodology work with higher level of management as well? The limiting factor of those researches is that such methods are basically not being used and it would require the companies to make some adjustments to their regular methods of management.

The results should make global project managers and other high level managers aware of the importance of each of the dimensions in global IT projects. Managers could use this paper as a starting point to include and analyze all the elements and managing methods that need considering when booting a new global project. These results could also prove useful to general global organizational management, not just projects. The reason for these is that this paper gathers together the starting points affecting global IT projects and gives basic understanding on how to manage that complexion. It is important to realize that this study was conducted as a literature review and the assumptions made in this paper need to be verified through a more extensive research.

This thesis covered a wide array of subjects and thus it would be easy and logical to choose some topic from it and continue with it to Master's thesis. That research could for example consist of measuring the effects of two dimensions in a global IT organization and make assumptions on what made the management system good/bad, and what could have been done better.

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