Aalto University
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Critical success factors in ICT standardization - Assessing internet and communication industries

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ABSTRACT

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CRITICAL SUCCESS FACTORS IN ICT STANDARDIZATION - ASSESSING INTERNET AND COMMUNICATION INDUSTRIES

OBJECTIVES OF THE STUDY

The purpose of this thesis is to assess the Critical Success Factors (CSF) in internet and communications field. There have been a variety of CSF studies on ICT area, but very little in standardization area. The earlier literature has focused on providing tools and definitions for the matter. Furthermore, no literature exists on how CSFs are perceived in the standardization area. This thesis is set to fill that research gap. The goal is to find out critical success factors occurring in the ICT standardization area, and to find out how the factors are perceived when no pre-determined context is given.

METHODOLOGY

The empirical part of this thesis is formed on expert interviews conducted to ten specialists from telecommunication, maritime, and banking industries. Their background in the standardization scene varies from observers to contributors and to managers in the field. All participants have worked in several standardization efforts over time. The viewpoints of the interviewees are spread between private and public organizations, as well as the standardization organizations in which they work have both formal and informal organizations represented. The nature of the study is qualitative. The empirical data was transcribed and analyzed against the earlier literature. Finally, a CSF model is derived that is applicable in the standardization context.

MAIN FINDINGS

Earlier literature has addressed the issue on many levels, but on rather excluding tone as well. The results of the study indicate CSFs on many dimensions. Few on a practical level, but the most important factors were found on a more abstract level. Study indicates that the world is not black and white in a sense how the Critical Success Factors are perceived. The perception of a critical factor is extremely broad. The success factors proposed by interviewees vary from a concept of a need and ecosystem, into the determination of how narrow scope should the effort have. Therefore the study indicates that the perception of a critical success factor is very subjective and depends on the experiences of people who are providing the answers.

KEY WORDS

Critical success factors, ICT standardization, multi-vendor environment, CSF perception

AALTO YLIOPISTON KAUPPAKORKEAKOULU TIIVISTELMÄ

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Information and Service Management

Pro Gradu -tutkielma

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KRIITTISET MENESTYSTEKIJÄT ICT-STANDARDOINNISSA - ARVIOINTIA INTERNET- JA KOMMUNIKAATIOALOJEN NÄKÖKULMASTA

TUTKIMUKSEN TAVOITTEET

Tämän tutkielman tavoitteena on arvioida kriittisiä menestystekjöitä (KMT) internet- ja kommunikaatioaloilla. Tutkimuksia aihepiiristä löytyy ICT-alalta runsaasti, mutta stardardoinnin menestystekijöiden näkökulmasta tutkimus on ollut vähäistä. Aikaisempi tutkimus on keskittynyt tuottamaan työkaluja ja määritelmiä aiheesta, eikä tarkempia tutkimuksia löytynyt kuinka onnistumisen tekijät todellisuudessa käsitetään. Tutkimuksen tavoitteena on täyttää aikaisemmassa tutkimuksessa ilmenevä aukko ja löytää menestystekijöitä ICT standardoinnin alueelta. Lisäksi tutkimuksessa pyrkimyksenä on löytää vastaus siihen, kuinka menestystekijät käsitetään ennalta määritellyn kontekstin puuttuessa.

METODOLOGIA

Tutkimuksen empiiristä aineistoa varten haastateltiin kymmentä telekommunikaatio-, merenkulku-, ja pankki-toimialoilla toimivaa asiantuntijaa. Heidän taustansa standardointialalla vaihtelee tarkkailijoista spesifikaation kirjoittajiin, ja myös johtajiin. Lisäksi haastatteluihin osallistuneilla on laaja-alaista kokemusta useista erilaisista standardointihankkeista sekä yksityiseltä ja julkiselta sektorilta, että virallisista ja epävirallisista organisaatioista. Tutkimus on luonteeltaan kvalitatiivinen. Empiirinen haastatteluaineisto litteroitiin ja analysoitiin aikaisempaa tutkimusta peilaten, mistä johdettiin tähän standardoinnin kontekstiin sopiva KMT-malli.

TULOKSET

Aikaisempi tutkimus on tarkastellut asiaa monitasoisesti, mutta myös hyvin eksklusiivisesti. Tämän tutkimuksen tuloksena on menestystekijöiden kuvaus ja arviointi monen eri ulottuvuuden kautta. Tulosten joukosta löytyi muutamia käytännön tekijöitä, mutta suurin osa tekijöistä löytyi abstrakteilta, käsitteellisiltä tasoilta. Tutkimus osoittaa, että standardointimaailma ei ole musta-valkoinen kriittisten menestystekijöiden käsittämisen suhteen, vaan yksilöt kokevat menestystekijät hyvinkin laajasti. Haastateltavat esittivät kriittisten menestystekijöitä vaihtelevasti tarpeen ja ekosysteemin näkökulmista sekä projektin laajuuden määrittelemisen tärkeydestä. Näin ollen tutkimus osoittaa, että kriittisen menestystekijän havainnointi on hyvin subjektiivista ja riippuu paljolti ihmisten kokemuksista.

AVAINSANAT

Kriittiset menestystekijät, ICT standardointi, moni-toimittaja-ympäristö, KMT havainnointi

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Chapter 1

Introduction

This chapter begins with background information about the study. A brief introduction to the topic is given as well as reasons why the study was conducted. Research objectives are introduced after the background. This chapter is concluded with the structure of the remaining study.

1.1 Background

The purpose of this thesis is to assess the critical success factors (CSF) in internet and communications areas. There have been a variety of CSF studies on Information and Communications Technology (ICT) area (Sumner, 1999; Vasconcellos en Sá, 1988; Onuegbu and Kumaraswany, 2007; Aldayel et al., 2011), but very little in standardization area. The earlier literature has focused on providing tools and definitions for the matter, and no literature exist on how CSFs are perceived in the standardization area. This thesis is set to fill that research gap. The goal is to find out critical success factors occurring in the ICT standardization area through expert interviews that work in the field, and to find out how the factors are perceived by them. Therefore, no pre-determined scope for CSFs is given to the interviewees. The interviewees are inspecting the CSF area through case examples they choose as well as their own personal working experience from other standardization projects.

The results can be beneficial if the perception is found to be hard to exclusively determine the scope in the standardization area. As the current literature focuses on exclusive factors taken from earlier literature, the results from this thesis can help determining how conclusive they really are in real world scenarios.

Standardization has become an important instrument in bringing compatibility and interoperability to Information and Communications Technology (ICT). The market has evolved from producing stand-alone systems into mass-market products. Standards represent not only technological questions, but also they ensure the interoperability and compatibility between ICT products and services (Belleflamme, 2002). It is well established that standards are essential in ICT sector for them to enable full rewards back to society, make innovative entrepreneurship possible, and act as a change-agent for companies. (Swann and Shurmer, 1994; Keil, 2002; Katz and Safranski, 2003)

Motivations for using standards are of many. For user-side benefits, Jakobs (2005) gives a few practical examples of aspects that can yield large savings. The avoidance of technological dead-ends is important especially to users of standards. Dead-ends can be avoided by postponing adoption to new technology. However, possible bandwagon effects can lead to the early adoption of technology, but if the bandwagon effect is strong enough on socio-level, the risk of heading towards a dead-end gets smaller, since strong user-base is beneficial for standard adoption and wider use. (Jakobs, 2005)

The dependency on external vendors through lock-in is also a factor that can enhance organization will to standardize, because it will lead to wider vendor-markets and the organization is not dependent only on one vendor. The last argument is the promotion of universality. The author posits that users would like to see seamless interoperability between hardware and software both internally and externally. (Jakobs, 2005)

Standards are part of a socio-economic system. Every invention is shaped by its surrounding environment where it was originated. The same applies to innovations and standard development. However, standardisation process holds broader influencing factors, since the working groups for standardisation usually hold people from very different backgrounds to support the demand for many. Standards emerge through collaboration and the joint effort of people from different backgrounds. (Jakobs, 2005)

1.2 Research objectives

The main goal of this thesis is to find factors that are considered the most important in the creation of standards. Additionally, the perception of success factors is investigated in general, how the term *success factor* is perceived. To achieve these goals, expert interviews are conducted to people who have the proper expertise in the field.

This thesis addresses the following research question:

- What are critical success factors in creating a successful internet or communication standards?

And in addition, the perception of what kinds of factors people tend to consider as critical is inspected as well.

- How CSF's are perceived when no pre-defined context is given?

1.3 Structure of the study

The thesis is divided into five chapters. This introductory Chapter 1 has outlined the overall picture of the studied field and gives a condensed view regarding the research findings. Chapter 2 includes the literature review. Chapter 3 describes the used methodology used in this thesis. Chapter 4 describes the actual research and findings over the subject. Finally, Chapter 5 ends in the main findings and what the implications are in both theoretical and practical viewpoints.

Chapter 2

Literature review

The purpose of the literature review is not to exhaustively go through all the aspects of standardization work, but to bring out a portion of it what is found important in earlier literature. This is due to the fact that there is no particular theory this thesis is trying to emphasize, but to try and find what is conceived to be critical from the eyes of experts in the field. This chapter gives insight about earlier literature. The focus is on standardization research, which is intended to present some of the important aspects in standardization research and use that as a baseline for the structure of the interviews. Similarly prior critical success factor research are reviewed, which will provide the categorization of how the matter is currently conceived.

2.1 Standardization

Standards play an important role in the ICT field. A standard specifies a set of measures, agreements, conditions, and specifications between parties (Lyytinen and King, 2006). Nickerson and Muehlen (2006) similarly characterize standardization as an agreed-upon specification for a way to perform actions, and as a way to communicate between separate parties. Standards are similarly important in single companies level as well. Wegberg (2004) argues that companies deem standards necessary because they enable them to integrate systems into each other also within the company. The work of combining the separate components of both hardware and software needs standards to make coherent working systems especially in innovating companies.

European Telecommunications Standards Institute (ETSI) considers interoperability perspective as one of the most important aspects of standard creation together with the harmonization of technological connections. ETSI focuses especially on complex multi-vendor, multi-network,

and multi-service environments with their standards, thus the standardization activities they are involved with are usually high-demand and high-stakes undertakings where the interoperability between parties is considered critical. The outcomes of the standardization activities can define the outcome of the activity, and determine whether it is successful or not. Although the standard is only a part of the actual outcome, but is still critical part. (ETSI, 2011)

The parties in standardization can be anything from users or manufacturer to governments. Companies that are creating de-facto standards can gain significant competitive advantage and increase their share of markets against their competitors. Similarly standards can be used to signal presumed winners in ICT markets in designing and implementing new ICT products. (Lyytinen and King, 2006; Nickerson and zur Muehlen, 2006)

Lyytinen and King (2006) argue that although standardization use and awareness are increasing in ICT markets Information Systems research has not been pursued with the same rigor. Especially what is lacking in IS research is the *hows* and *whys* of standardization processes and factors. The research has more focused on anticipatory contents of IT standards and the description of such endeavors. Similarly absent research fields are standardization concepts, processes, and their impact on industry coordination and strategies. This also means that increase in standard use in certain market forces non-participating companies to either come up with new competing standards or to join in using the prevailing one. Nickerson and Muehlen (2006) note that the use of a standard in a market can lead to a dominant company to lose control and ultimately market shares due to the merging of the market. At the same time barriers of entry are lowered since market entry is no longer tied to a proprietary means of communication or other similar barriers.

Sen (2006) on the other hand claims that literature from industry organizations tends to address the emergence of de-facto standards while information systems literature is focusing on diffusion and adoption of standards. Author also claims that especially little is understood regarding the activities that happen during the initial phase of standard development.

2.1.1 Formality against informality

Standards are categorized into two categories; de-jure, and de-facto standards. Former standards are created through a formal standardization process, and the latter through a more informal process, which essentially is the outcome from market processes (Belleflamme, 2002). Author also claims that the tradeoff between these two standardization options are of higher quality and speed, where formal standards usually tend to be of better quality, informal standards have faster time to market (Belleflamme, 2002; van Wegberg, 2004). Furthermore, with formal standard creation consensus is considered negatively affecting the quality of delivered standard (Rada, 1995). This is not shown to affect on informal standards at the same manner.

As the consensus is clearly the key element of formal standards Rada (1995) notes that the development speed of formal standards is not quick enough for stakeholder needs in the market, in which informal organizations perform better at. The discussion in the article is comparing matters between ISO and IETF, which represent both types of organizations. ISO is a formal organization, and IETF an informal organization (the organizational abbreviations are represented later in table 3.1). Furthermore, Rada (1995) claims that there is also a third dimension of quality. Both consensus and speed are considered lowering the quality, so the tradeoff is similar but in different ways here. However, the relatively slow movement of formal organization and the slow consensus they build still is not enough for fast moving markets. Furthermore, the fast introduction to the market can have downsides. Wegberg (2004) argues that as long as the market does not settle for only one standard, network externalities are lost within the industry. This is due to the fact that industry has to keep developing multiple standards for a single market. This might indicate that consensus, at least on some level, must be achieved in order to avoid this.

Companies in Europe are still involved in both informal and formal standardization organizations. Both options are liked, because decision depends on the aspect of standardization companies are involved with. It makes sense to invest resources in consortia standardization, since it is fast moving and close to company's R&D activities. Resources are put to formal organizations use as well, since the large consensus is built among the other technology

providers is considered beneficial. (Blind and Gauch, 2008)

Beside these two facts there can also be a regulatory side of the matter. A formal standard that is developed can have a European Union regulatory behind it and the implementation of it is de-facto obligatory. This would leave the company only little flexibility. Therefore, it is justified to work on both formal and informal organizations for the same technical field from and economic stand point Blind and Gauch (2008).

2.1.2 Does openness matter?

Saltzman et al. (2007) gives another approach to classification of standards. They apply *public policy analysis* into the standard creation process. Public policy analysis is based on the work of David Wermer and Aidan Vining they did in 1999. Saltzman et al. (2007) divide the aspects into a four-by-four matrix, which indicates the amount of rivalry on the horizontal scale and the amount of sharing between participants on the vertical scale (figure 2.1).

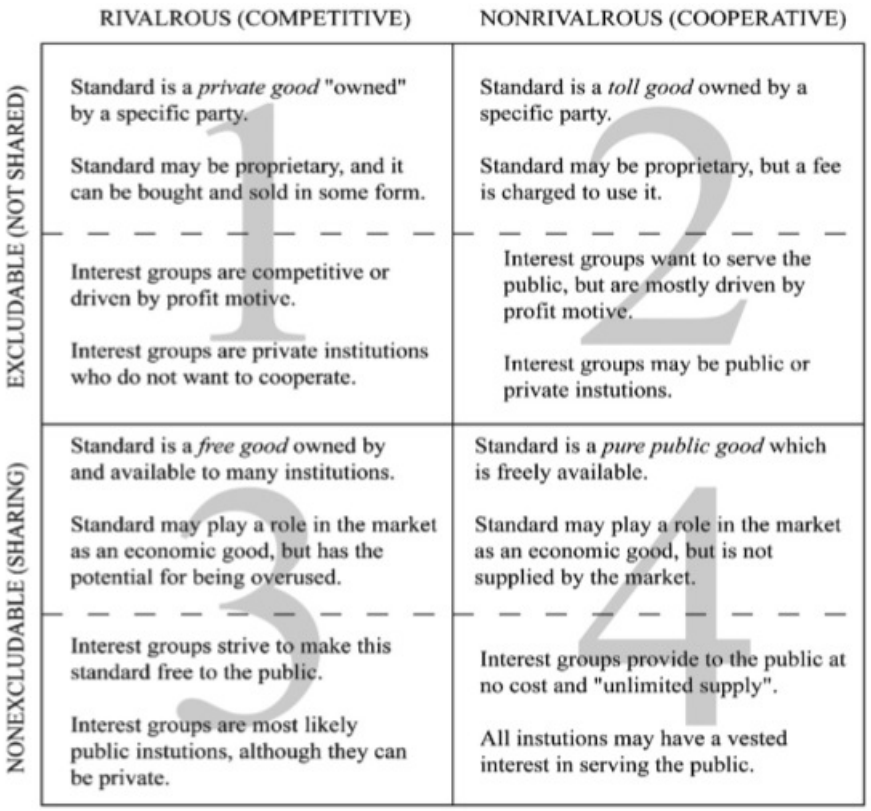

Figure 2.1: ICT standard classification matrix (Saltzman et al., 2007)

In the first quadrant lies privately owned standards that are not shared with other organizations. Authors (Saltzman et al., 2007) claim that standards in this quadrant could be considered as intellectual property. However, they also state the doubt that it can be problematic to call a standard an economic good if it is in this quadrant. The second quadrant is similar to quadrant one, with the difference that in this quadrant the standard is offered to the public in change for a fee (Saltzman et al., 2007). The profit generation is made through licensing, which is to let both private and public interest groups use your intellectual property against a fee. The third quadrant contains standards that are considered as "free goods", which means that open access to the good is available (Saltzman et al., 2007). The standard can be considered as an economic good, but since the categorization is a good to the public without cost, it is more seen as a good that public institutions could offer to others. However, Saltzman et al. (2007) claim that a private entity could have a motive to have their proprietary standard taken into public use. This type of activity could also be represented in the fourth quadrant.

Saltzman et al. (2007) state that as in quadrant three the standard is expected to be competed upon, thus making it limited regarding access. In quadrant four the standard is considered freely available with unlimited access. Authors argue that information has the similar characteristics to standards in quadrant four, where the added production cost of information is close to zero. Standards in this category are considered as "pure public goods", which also means they cannot be considered itself as economic goods, since nothing is bought or sold.

2.1.3 Intellectual property

The impact of patents and intellectual property rights (IPR) is considered large in standardization organizations. Between second and third generation mobile phones in Europe, the number of patents have been increased eightfold, and number of patent holders only threefold. This indicates that the patent holding is concentrated to few, and their use is more considered strategic than before. Furthermore, the patent creation of operators has declined same time as component manufacturers and technology licensing firms has increased (Bekkers and West, 2009).

Standardization between multiple parties has a tradeoff between consensus and differentiation. The consensus that is created in the standardization process is the tradeoff for a company to differentiate in the market. This makes it possible that the sources of competitive advantages could transfer into cost reductions instead. This means that patented technologies would not support competitive advantage through differentiation. However, for some industries standardization is important for the commercialization of products, consensus is still the most effective way of coping with cooperation. (Arai, 2010)

There is a certain tradeoff between the IPR's and compatibility. Although in conflict situations it is IPR's that claim victory over compatibility. According to Egyedi (2001) most standardization organizations tries to avoid the use of patented work in their standards. This is usually due to the fear on legal claims and litigations involved with them. This can paralyze the standard process. Although the reasons behind IPR's are the increase in innovation and the natural protection for its holder against competition, Egyedi (2001) argues that compatibility is the way to equally serve the public.

Blind et al. (2004) suggest that stronger the IPR protection for company's technological know-how is, more likely it is that company will join formal standardization processes in order to increase the value of their technological portfolio. The hypothesis behind this is that as the companies try to achieve a link between strong standard portfolio and their IPR's, this would lead to an even stronger market position. However, authors continue that there is another possibility. As companies that already hold a very strong market position they do not necessarily need the support of standards to increase their status in the markets, since as the intensity of R&D and patents in certain industry increases, it tends to lower the desire to join standardization processes.

2.1.4 Complexity

Schneberger et al. (2003) describes complexity in ICT by the number and variety of components, and their interactions between them. Depending on the system, complexity can be considered static within the system itself, or dynamic in case the interactions vary the actions

of the systems. Complexity increases as system changes become faster, thus making it harder for the system, users, analysts and programmers to adjust accordingly.

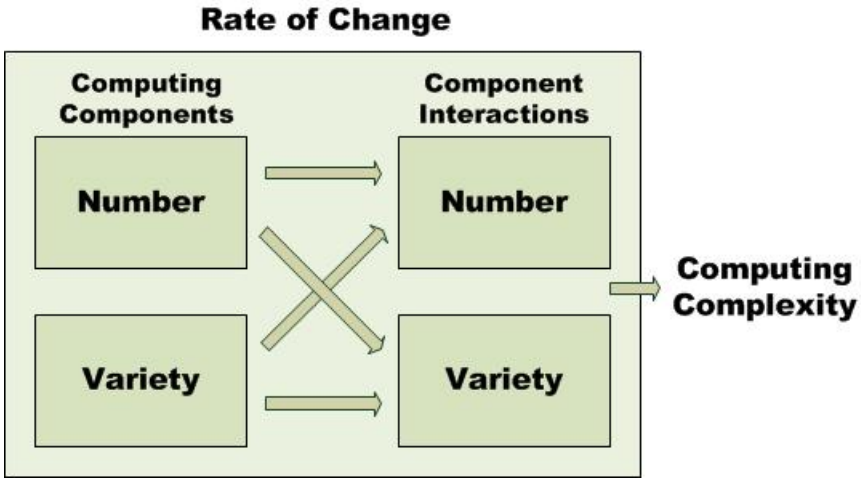

Figure 2.2: Computing environment complexity (Schneberger and McLean, 2003)

One interpretation of ICT complexity is depicted in the picture above (figure 2.2). The complexity is determined by the number and variety of components and their interactions together with the overall change rate Schneberger and McLean (2003).

Hanseth et al. (2006) analyze standard creation through Actor-Network theory (ANT), which tries to explain the surrounding world through a maze of actors working together in a network. They indicate complexity to be one of the most important factors in standard creation success. Standards can reduce or increase the surrounding complexity. The measurement of complexity of very hard, since the term itself is vague, and if anything is inspected closely enough it usually becomes very complex at some point. The case study authors made were conducted in Norwegian hospital in order to create new Electronic Patient Record standard. The study indicated that engineering approach in standard creation for multiple work practices is generally risk prone. Characterization of the problematics with this approach is following: "These approaches tend to overestimate the universality of work practices, thus seeking order by simplification and abstraction and putting strong emphasis on design criteria such as consistency, completeness, and non-redundancy" (Hanseth et al., 2006, 577). These factors are considered modern engineering principles, and explicitly so with the creation of ICT standards. The engineering approach is considered good if the problem field can be isolated into a closed

environment where variables are static or known about. The risks rise when these assumptions are not in place, making the simplifications and abstractions harder to estimate. (Hanseth et al., 2006)

Hanseth et al (2006) concludes that to create successful standards we need to accept our world as a complex entity, which is filled with diverse orders that are inconsistent. Secondly identify *subworlds* that are manageable, and they must interfere with each other as little as possible. That is, to make the *subworlds* "loosely coupled". Authors argue that maintaining the *loose coupling* between technical and social aspects might be the single most important strategic element within the creation process. For this to work, the people working with the issues must understand that local practices tend to flow into the technology, which should always be avoided.

Decreasing organizational complexity is another way to reduce the complexity of standard creation (Hanseth et al., 2006), as the assumption is that standard creation is a socio-technical undertaking. As organizations grow, the complexity of its product tends to increase since the reach and range of the undertaking increases as well. This means the intended scope for the project grows in par with the increase of participants.

One strategy addressing the issue of scope is to try to reduce the scope through splitting the standard into multiple smaller standards, which Hanseth (2001) calls as *gateways*. This means that instead of creating one large standard, the *loose coupling* can be achieved through multiple *gateways* between infrastructure and the standards. The gateway can be defined in general terms as "a link between elements", or within telecom and computer industries it is used to denote an object linking two networks together. Besides these two, a gateway can also be characterized as a converter or translator between different formats. Hanseth (2001) continues that gateways are equally important than standards. They are a central tool for building and maintaining complex networks, which also rely on standards. The argument here is mostly based on a collaboration between Nordic Universities in order to establish a computer network between the parties named Nordunet. The argument is that building such large networks is not possible to do from the beginning, but are established by interconnecting smaller heterogeneous networks through the gateways.

2.1.5 Who are involved

Jakobs et al. (2001) studied the composition of various standardization organizations and determined the portion of participants with different affiliations. The research showed that in the inspected organizations (ITU, IETF, ISO) 58% of participants were employed by the private parties of service providers and vendors, 3% were external consults, 16% were involved through academic research, 6% were common users, and 16% had a governmental background and affiliation. The differences of affiliations between organizations were however large. This however can depict the overall power construction within a standard creation process.

	Vendors	Consults	Academia and Research	Users (comm.)	Users (gov.)	Total
ITU	19 (76%)	1 (4%)	1 (4%)	0 (0%)	4 (16%)	25
ISO	6 (43%)	0 (0%)	6 (43%)	0 (0%)	2 (14%)	14
IETF	9 (56%)	1 (6%)	3 (19%)	0 (0%)	3 (19%)	16
Total	40 (58%)	2 (3%)	11 (16%)	4 (6%)	12 (17%)	55

Table 2.1: Affiliations of involved participants (Jakobs et al., 2001)

The table above (table 2.1) shows that public participants including academics tend to be less represented in standard organization than private participants. It can therefore be argued that economic interests have influence on the standardization matters in general. Moreover, Wegberg (2004) argues that companies usually try to tie their standardization strategies into their business strategies. This will eventually mean that the same applied strategies aim to drive the actual standard setting within the standard setting organization, thus making the issues more prone for competition within affiliated parties.

This can also partly explain the proportions of participating in organizations. If economic interests are high, the expected portion of private companies in the Standard Development Organizations (SDO) should be higher. With the expectation that the SDO organizes itself freely. Jakobs et al. (2001) comes to the conclusion that against the wide conception of equal decision making within a SDO, big part of the decision making is dominated by “seasoned veterans”, who have the knowledge of standard making processes. As it is argued that most of these veterans come from different vendors and service providers, real-world requirements

might not reach the actual process. This argument boils down to the point that decision making in various SDOs could be in the hands of private companies. Furthermore, Jakobs et al. (2001) continue that the motivations for decision making are not solely made on technical behalf. Their study indicates that outspoken supporters are more important for the proposal going forward than technical interests. Similarly company interests play a major role as well.

However, Nickerson et al. (2006) conclude in their study that institutions and SDOs are not acting merely on economic rationality, but also the institutional values and preferences count in the decision as well. It is not always self evident that a consensus between participants can be reached even in a longer period of time regardless of economic interests.

Sen (2006) argues that users usually gain the most from standards. Although this is not universal, since some users don't participate due to free-riding possibilities, or due to fear of having to pay more for the compatibility. Vendor participation depends on the fact whether or not they want to compete within the market.

2.1.6 How the work is done

The standard creation process usually goes through a set of draft versions before it is actually ratified by the members of standard setting organization. The typical process usually has multiple stages, which are draft proposal, adaptation through feedback, and adoption of standards (Nickerson and zur Muehlen, 2006). The standard setting organizations usually have industrial corporations, research laboratories and other users involved in the process and interact with each other in order to get the work eventually ratified, as depicted on following figure 2.3. (Choi et al., 2004)

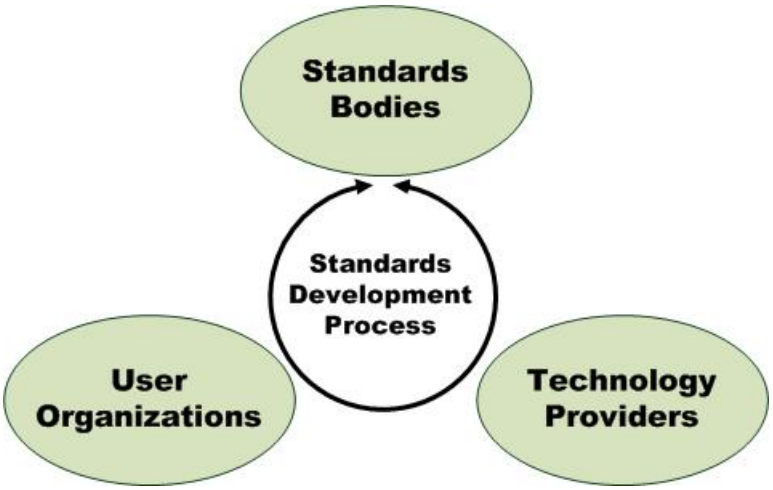

Figure 2.3: Stakeholder interactions in standard creation process (Choi et al., 2004)

Choi et al. (2004) also argues that when a group of participants seek to find a mutual agreement, they all tend to behave in goal-oriented manner. A single participant in a standardization group naturally prefers a standard over a non-standard, but they all also prefer their own standard over the other participants alternatives. This usually leads to conflicts within the group. To this extent, we will view the standardization process as a socio-economic collaboration between stakeholders.

Standard Development Organizations (SDO) are not however competing companies, but organizations that help companies and other institutions collaborate together. Nickerson and Muehlen (2006) argue that these organizations form through an ideology, since they are not facing market competition. This assists them in finding their identities and establishes legitimacy among the members of the SDO. These ideologies are in some sense the core of the organization, since they persist through the whole time the SDO exist. However, these ideologies do not interpret the possible actions of individuals, which can affect largely on organizations behavior. Especially if the industry standard organization is small (Nickerson and zur Muehlen, 2006). This means that the motivation of a single entity within the SDO can influence beyond the actual intended ideology.

Nickerson and Muehlen (2006) hypothesize that the weak institutionalization of internet standardization essentially means there is no imperative, normative power to drive complex standardization efforts. At the same time, authors hypothesize that individuals with technical

aesthetics usually suspect standards that are driven by business goals. Authors encapsulate their hypotheses by proposing that technological oriented individuals might prefer loosely institutionalized ecology, where high-level business-driven standards can receive more resistance since they tend to be aggressively promoted before technologists believe it is ready.

Although there relies a wide understanding how standards are created, there also is a wide consensus that no particular standard for creating standard exist (Saltzman et al., 2007; Choi et al., 2004), but the process involves innovation, creativity, and intuition. However, the standardization documentation itself is pretty well standardized.

2.2 Critical Success Factors

2.2.1 Defining the terminology

According to earlier research (Vasconcellos en Sá, 1988), critical success factors are factors that are considered very important for company performance. Success in this context is considered being outperforming competing companies in terms of profitability. Although this is strictly an economic interpretation of success, ICT research is not really far away from this. Research on ICT projects argues that success factors give considerable practical value for making investment decisions (Onuegbu and Kumaraswany, 2007). Similarly Bullen and Rockart (1981, 7) define a critical success factors as: "the limited number of areas in which satisfactory results will ensure successful competitive performance for the individual, department or organization. CSFs are the few key areas where 'things must go right' for the business to flourish and for the manager's goals to be attained.". This means that is resources are scarce and cannot be fully attained, these factors must succeed on the cost of other perhaps less important activities.

Leidecker and Bruno (1984, 24) characterize success factors to be the conditions, characteristics and other variables that: "when properly sustained, maintained, or managed can have a significant impact on the success of a firm competing in a particular industry". They similarly suggest that critical success factors are usually found around activities or conditions that have the biggest profit impact. This largely determines the importance of a factor. These factors are

usually found in major business areas, or areas that have large amount of money involved in the transactions. Furthermore, the phenomenon is claimed to be industry related (Leidecker and Bruno, 1984). A retail company might have very much different kinds of CSF's than a wholesaler has. Although they differ on industry level, it is not to say that they would not share some of the factors on an environmental level.

2.2.2 Depth of analysis

Plenty of research has been conducted on success factors in ICT area. The prior literature has research on ERP integration, software process improvement, organization IS development, and construction ICT implementations (Sumner, 1999; Aldayel et al., 2011; Dybå, 2005; Aggestam and Söderström, 2006; Ugwu and Kumaraswamy, 2007). The tendency in the success factor research field is to create toolsets and provide ways to address the issues in real world project environments.

Sumner (1999) for example approached the critical success factors from the ERP integration project standpoint of large international companies. The success factors affecting the end result were perceived as organizational dimensions, such as the importance of management involvement, training the staff, communication within the company and project, and sensitivity to user resistance. The approach that Sumner (1999) had to the critical success factors was to examine earlier literature what kind of factors have been in ICT integration history that has caused those projects to fail. This approach gives further characterization for CSF's. This approach sharpens the view that critical success factors are actually the tipping point whether or not the effort is considered as successful or a failure.

Aldayel et al. (2011) had the similar approach as Sumner had. The approach was centered on project issues, where top management commitment and support, change management, and project management were considered critical for the project to succeed. Similarly, the scope of the implementation as well as competition was considered as an unimportant factor, but the significance was a lot lower than other factors. Ogwu and Kumaraswamy (2007) had a similar project oriented viewpoint for success factors. In par with earlier research mentioned,

CSF's found important were factors like cost of development, top management support, the availability of appropriate hardware and software, the ease of use of IT systems, security matters, and user acceptance.

Dybå (2005) had a somewhat similar approach, but the scope was a broader than Sumner (1999) and Aldayel et al (2011). The research was about software process improvements and factors affecting its success. The factors that were assessed were not on the specific factors within the project, but more on the organizational issues. Factors that were analyzed were, in the order of higher to lower correlation, business orientation, involved leadership, employee participation, measurement, exploitation, and exploration. Although similar, the factors evaluated in Dybå's (2005) research were on a higher abstraction level than Sumner (1999) or Aldayel et al (2011) or Ogwu and Kumaraswamy (2007), but still keeping the project success on the scope of research.

Aggestam and Söderström (2006) however had a strictly organizational viewpoint in their study. Especially they investigated firms involved in standard-based Business-to-Business (B2B) information systems developments. They developed a framework for identifying such factors and found it beneficial especially on three separate phases. The phases they found to be critical are strategic planning, process analysis, and partner alignment. The scope of the study was on an organizational level, and factors considered critical on that level of analysis. Therefore, the scope is on a significantly higher level of abstraction compared with earlier ERP research. The focus is on how organizational factors are affecting the outcome instead of specific factors in the project.

Moving on to a higher level of viewing the critical success factors, Leidecker and Bruno (1984) divide the factors into three dimensions, environment, industry, and to a single firm (figure 2.4). The factors affect each other in one direction only. Environmental factors affect both industry and a firm. Similarly industry related factors affects both the whole industry and a single firm in it and factors that affect a firm stay within the context of the specific company.

Figure 2.4: Three levels of CSF analysis (Leidecker and Bruno, 1984)

The environmental aspect in CSF analysis includes many approaches. The different factors in environmental level affect both to the industry level's performance as well as firm levels performance. The factors can be political, economical, or even social forces. The breadth of factors on this level should be possible to connect to every industry in the applicable field. The industry aspect has more narrow view to the factors. The factors on this level are such that affect to the performance within the whole industry as well as on any company working on the industry. Thirdly, the narrowest scope is on the firm level, which consists of factors that affect to the performance of a single company working in the industry (Leidecker and Bruno, 1984).

2.2.3 Perception of the significance

Determining the significance of a success factor is important. As profit impact tends to be the most important factor in economic sense (Leidecker and Bruno, 1984; Vasconcellos en Sá, 1988; Bullen and Rockart, 1981), it is not necessarily directly applicable to standardization activities and to the estimation of successful outcomes from it. The matter might be more complex.

In project oriented success factor studies the factors are more mechanical, focusing on the actual execution of the project instead of the monetary gain received from the successful execution of it. Factors such as top management commitment, project management, training the staff, resources support, and the scope of the implementation are seen as possible success factors instead of a profit oriented view (Aldayel et al., 2011; Sumner, 1999). Similarly Aggestam and

Söderström (2006) study the matter on an organizational level, and finding critical elements from different business processes that determines the success of an IS implementation in B2B environments. Furthermore, Leidecker and Bruno (1984) examined the matter on even higher level. They inspected success factors from the environmental level into the level of a single company.

The prior literature indicates that even though there are clear definitions of what a critical success factor means, there are still a multitude of options from which point of view the matter can be inspected. This leaves a lot of room for the perception of the matter. The analysis can be conducted on multiple levels regardless of the context. The scope in earlier literature varies from single factors affecting to delivery success, into analysis on environmental factors affecting ICT matters.

In this thesis, a critical success factor is considered such factor that makes the standard successful and adopted by the customers. However, the scope of definition is not pre-determined in a sense earlier literature has done. The perception of the depth is left open regarding what success factors are considered critical among the people interviewed. Instead only loose boundaries for the definition are given, since part of this study is to determine on what level the critical success factors are perceived within the experts the study is conducted to.

Chapter 3

Methodology

This chapter focuses on the methodology of the study. First the philosophy for conducting the study is given, and practical matters introduced. At the end of this chapter possible caveats are inspected and the overall reliability of method is assessed.

3.1 The philosophy behind

A qualitative study is usually the preferred method in studies that tries to find out "how" or "why" something occurs, when the investigator has of little influence on the occurring events, and when the phenomenon is considered contemporary in a real-life context (Yin, 2003). Contemporary in this context means events and phenomenon happening in present time.

The epistemology of research is essentially different philosophical views of how to find objective knowledge about the surrounding world. Four different viewpoints are presented for the discussion; positivism, realism, interpretivism, and poststructuralism. Positivism generally assumes it is possible to view and describe the world objectively, which in qualitative studies usually leads to the tendency of making studies fit on top of quantitative models or models used by natural scientists. As other theories expect that it is possible to obtain valid knowledge about the surrounding world through these methods, poststructuralism is the other end of this spectrum. The standpoint is that nothing in the world is possible to objectively obtain valid knowledge of the world or acquire correct knowledge regarding the social reality. In addition, theory suggests that it is problematic to interpret the world though texts. (Travers, 2001)

Although this study does not deny the problematics regarding making generalization about the world and the poststructuralism is its theoretical standpoint accepted, a position in between realism and interpretivism is taken in this study. This study takes its philosophical generalizations from both realism and interpretivism schools of thought with a tendency to descriptiveness where actions are explained through actors own understanding about the matter.

As realism tries to explain human behavior by looking behind appearances to machine different laws and generalizations, interpretivism inspects people through emphasizing the understanding of their own actions. Interpretivism has the tendency to assess and learn from given face values from people, realism sees these matters incomplete or at least deficient for making proper generalizations (Travers, 2001). Therefore, as this study assumes disciplines from both realism and interpretivism this means that as data collected through interviews with specialists and managers can to some extent be considered with their face-value, but making statements and generalizations regarding population as a whole is unachievable. However, some generalizations in the scope of this study are suggested and to some extent advocated.

Travers (2001) suggests five separate methods for qualitative study; observation, interviewing, ethnographic fieldwork, discourse analysis, and textual analysis. In this thesis, the interview method is solely used for implementing the empirical research. The evidence that case methods especially for chosen interview aspects provides, according to Yin (2003) are in its targeting capabilities, and insight it can offer. Targeting capability, in this context means the possibility to focus on the essential parts of the case, thus making it possible to achieve more accurate results to the research problem. Yin (2003) considers the interviews to be one of the most effective method for inspecting cases.

3.2 Performing the study

This thesis will concentrate on interviewing various specialists from internet and communication technology industries. As Koskinen et al. (2005) explain there are four types of interviews typically used in economic science research; structured interviews, semi-structured interviews, open interview, and group interview. The interviews are conducted using a semi-structured

interview method, which is according to Koskinen et al. (2005) the most often used qualitative method in social and economics research. This method gives the interviewee possibility to express themselves quite freely, and at the same time the person conducting the interview has the possibility to control the movement of the discussion.

Koskinen et al (2005) also note that the question setting should not follow the theory closely, since the interviewee might be able to find a pattern how the theory links into questions, and thus exposing the questions for distortion. However, in this case this is not overly significant. The purpose of the questions are to pave the way for discussion and act as themes that have been found in earlier literature, for which the interviewee might have common experience with them or not. The discussion is also guided by real life case examples that interviewees have experienced, which have been either successful or unsuccessful.

The purpose of this thesis is not to search for a single phenomenon or emphasize some portion of a theory, but to seek common denominators in standardization area. The purpose is not, however, to be naive about the research. Universal phenomenon or truths only rarely exist. However, when assessing the critical success factors of something that has huge amount of people working with it on multiple industries, some level of universality must be expected.

Furthermore, as Dey (1993) describes, the core of qualitative analysis is in the related processes of describing a certain phenomenon, and after that classifying it and seeing how the concepts interconnect to each other. Similarly as Hirsijärvi et al. (2005) point out that qualitative research is about characterizing real life. This includes the sentiment that life is diverse. Therefore, as research happens in real life conditions, matters cannot be shattered arbitrarily into pieces either. Instead the world must be inspected as a holistic entity.

As part of the problem definition three professors from Aalto University (A.1) were interviewed in order to narrow down the scope of my thesis, and to get views and insights regarding the ICT standardization area. For the actual empirical part of this thesis ten specialists from telecommunication, maritime, and banking industry were interviewed. All experts had ICT standardization as the common denominator. Their background in the standardization scene

varies from observers to contributors and to managers in the field. All of the participants have had multiple tasks in various standardization organizations. To name a few standard organizations interviewees have worked in or are working currently are gathered in an alphabetically ordered list:

Abbreviation	Organization name
3GPP	The 3rd Generation Partnership Project
ETSI	The European Telecommunications Standards Institute
GSMA	GSM Association
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IMO	International Maritime Organization
ISO	International Organization for Standardization
ITU-T	International Telecommunication Union-Telecommunication
	Linux Foundation
OMA	Open Mobile Alliance

Table 3.1: Standardization organizations that interviewees have worked in

The point here is not to go through them all here, but to point out the variety of experience interviewees have. Viewpoints are also spread between private and public organizations, as well as the standardization organizations in which they work have both formal and informal organizations represented. Many of the interviewees are working on telecommunications industry and nearly everyone is involved in internet or communication technologies. The combined working experience of all interviewees is 115 years in the ICT standardization area. A list of the experts who were interviewed is found in the appendix A.1. The questions used in the interviews are found in the appendix A.2.

All interviews were conducted during March and April 2012. A total number of ten hours of interview material was gathered during the interviews, and a total of 179 pages of transcripts were written based on the ten hours, from which the empirical material in this thesis was gathered.

3.3 Reliability and possible caveats

The overall concern of reliability of a qualitative study is hard to determine in it's strict meaning. To put it into context, Travers (2001) points out that historically the poststructuralist discipline often expresses the "truth" as a non existing dimension, and rather suggesting to celebrate the alternating viewpoints of and interpretations of social occurrences. However, this assumption of the implicit reliability regarding the study cannot be taken for granted. To address the possible caveats affecting the results Yin (2003) underlines several factors that can affect the end results.

The bias occurring due to question setting is something the investigator can, with careful planning get around, but the bias due to the respondents personal reasons can only be spotted through the focus of the person who is conducting the investigation. Yin (2003) emphasizes this with the *listening* dimension that investigator needs to have. The investigator must have good listening skills to spot possible response bias. However, the other side of this coin is depending on the investigator not having his or hers own personal views bias either.

Inaccuracies due to poor recalling what interviewees have answered is another caveat for this type of method (Yin, 2003). However, this can be avoided by using a recording device for the interviews and making notes during the discussion. This makes possible for the interviewer to focus more on the actual content instead of transcribing everything the interviewee says. This method also allows the interviewer to be more aware of mentioned caveats during the interview process.

The reflexivity of the interviewer is the last caveat that Yin (2003) lists out. This could be due to the fact that investigator is taking the easy way out, but also in some sense it could be considered as interviewer bias, where the investigator hears things that fit better into the conducted research and its outcomes. Either way, this conduct can lead to a misinterpreted conclusion of the study. The reliability of the data can always be questioned due to the possible caveats for the reasons mentioned in this section. However, this matter is entirely on the hands of the author and judgement of possible falsehoods are left to the reader. The author takes full responsibility on the interpretation of carried out interviews.

Chapter 4

Empirical study

This chapter is divided into themes found during the expert interviews. After the empirical portion, an analysis is conducted on the basis of the data gathered and the possible consequences are assessed. The findings are categorized based on themes indicated during the interviews. They are addressed in similar fashion throughout the empirical portion of this thesis. The analysis is deducted from the interviews and possible links to earlier literature is tied together there. At the end of the chapter, an illustration is provided to give a better picture of what are the results of the study. That will end the empirical portion of this thesis.

4.1 Themes from the interviews

This section includes the conducted interviews in thematic order. The order is from what interviewees had to say about the actual working, to organizational and human factors, and ends to environmental matters. This section starts the empirical portion of the study. The indented, *italic* paragraphs are direct quotations from the interviewees. Most of the interviews were held in Finnish and translated by the author. Furthermore, to improve readability expletive words are removed from quotations.

4.1.1 What gets standardized

4.1.1.1 Do we really need this?

The demand for a standard came up in several occasions between multiple parties. Most of the interviewees kept it as an important or most important factor for a standard to succeed. This is applicable to all market driven standard efforts. However, there are still situations where a

certain push is needed. This applies especially to matters that are required before future vision is possible to achieve.

One interviewee considered the need to be the most important factor for doing something, and that it has to be real customer pull. Regulation is the most effective way to achieve pushing of standards. The lack of pull can be a major hindrance to the effort, and it is considered a big reason why efforts can fail.

> *The overall need is very important. So there is a real need to the thing we are standardizing. And with that there is a real use for it as well, pull so to say. In other words if we are only pushing something, then regulation is the most effective for doing it. And if there is a clear need or shortage perhaps, then it will have the need and pull to get it done. So this is, I believe, the most important motivation, that it is used to something real. And not to just some theoretic need, because that won't be enough. At the end of the day, those theoretic needs won't go into use, and probably everyone has wasted their time. [...] This is also a big reason for efforts to fail, if the real need base does not exist. So a sign that it either has not been done for a real purpose, or it has not been done as the real need would have required. And through this, at the end of the day, comes the significance, can it be applied to the purpose.*

There is a good example of this. In IPv6, the actual need is a powerful factor in accomplishing the standard. End user needs overcome the technological needs in real life scenarios. So in this sense necessity is a powerful driver, and a way to determine whether or not this is needed. The actual merits of the technology used tend to be secondary.

> *Many times technologies are implemented on the basis of the actual need. IPv6 is a good example of this. We have had IPv4 address space and it has worked well with NAT, so there hasn't been a forcing need to implement IPv6. So these technological qualifications become secondary. It derives from the end-user need. So when it starts to hurt, and today it is becoming painful due to the IPv4 address space we are running short of, the discussions start should we implement this anyway. The order of bits in some protocol field is not significant.*

Another characterization about how much the lack of some technology is hurting end-users can affect to the interest to demand something new from the markets. The need can be very basic at the end from the eyes of the end-user. A comical reference of three necessities in end-user needs are depicted to be porn, paying bills, and surfing internet. Although not intended to be a serious statement, it condenses the point of user needs very well.

> *As an end-user, you couldn't care less of what IP version are you using as long as you can reach Google, you have access to your bank account, and are able to surf porn whenever you like. And if one of these stop working you get interested what is going on. Do I need a new device or can I do something to this one in order to get the bills paid.*

Similarly one interviewee kept the lack of the real need as a major hindrance to a standard effort. When discussed the worst pitfalls in standard making that can lead to problems, the real need for the standard was raised as number one. HIP is a real life example of this where it didn't matter how good the technology was, since it was lacking the customer pull.

> *The worst is certainly if the effort lacks the real need for it, that tends to be a problem. This happened to IPv6 before we ran out of address space. That you lack the pull from the customer who wants to buy from you. This has been a big problem in many projects. There are other good examples as well, from which HIP is also a good example, that it didn't succeed because in some sense it didn't have the need, regardless of how well the bits were organized in the protocol. It is the customer pull, if that is lacking there will be problems.*

Even though the need might exists. Sometimes the slowness is just too much and world keeps moving past it. The changing world can be a hindering factor as well. This case example comes from Mobile-IP standardization effort, where underlying reasons made the effort not to succeed. This is a good example of how closely tied standardization efforts really are. As IPv6 was delayed due to the lack of mutual need between participants, the Mobile-IP got delayed as well, but with further consequences. This is not to say that it is the only reason, but a valid reason still.

It was mainly a timing issue. Some assumptions regarding IPv6 were made, and it got delayed. And at the same time we had cellular-technology that got better. Radio's got more capacity. [...] So in this type of heterogeneous environment there was a demand for it, but the pieces just didn't fit together. And probably there was also the economic development on the background as well. Meaning where to allocate investments. The cellular-network still existed and it was developed. If you don't have enough capital, you tend not to develop the infrastructure, but fix the existing one. So these new take offs tend to be challenging.

There are situations where demand is not necessarily driving the efforts. The decision of doing something new can lack the guidance of business needs. This can lead to doing something without actual justification for it. The characterization here is when smart people smack their heads against each other the results can be ambitious, but this can also distort what the actual need was.

The decision making can get distorted in some situations. When you let engineers and researchers loose, and companies loose, they invent lots of things that can be interesting for them, but that doesn't mean they would always actually be needed.

The interviewee ended up noting that standardization although is important, is secondary in the face of a real world demand. If the need is actual, the standard will come sooner or later regardless what behavior people surrounding the matter have.

Looking at the success factors. I think it is probably the customer demand. That is someone is eager to buy something or really needs it, then it will probably happen one way or another. The standard comes along or it doesn't.

The next interviewee continues with the same viewpoints. Although the standard might look good in every aspect, there still must be an incentive or a need for all participants to use it. In other words, there must be a real-world need established in order for people to gain the expected incentives from it.

I think that standards are standards are still made with multiple viewpoints, many different kinds. There are many nice looking standards that I have seen, but have never really

succeeded. And then again there a lot of de-facto standards that everyone uses. This is the essential difference, that you have the incentive or certain need for it.

However, one interviewee notes that the market pull is applicable to market driven processes, where there is a clear indication that it is needed. There is also a need for a certain push in some applications instead of market pull. This applies to things that require vision for other, future matters to succeed. This is not always clear and require determination. The case examined here, Quantum Key Distribution (QKD) is a mechanism for distributing encryption keys in the quantum computer world.

If you look at the smartphone side, then it is definitely demand driven. If you look at a QKD it is the opposite. It is a necessity in case the quantum computer really comes, and most of the people don't realize that yet. If they are not deeply enough involved. Because we have been more or less secure so far with always developing newer and more complicated algorithms, and it worked more or less so far except for couple of exceptions, where things were hacked, but it worked good enough so far , so that is another thing. So, on one hand you have this complete innovation from the scratch and when it is really hard to tell people or to convince people which will, by the way, become market demand. Imagine the first quantum computers being out and Quantum Key Distribution not being fully applicable. So, then the whole thing would immediately turn around to a smartphone situation, where everybody wants to have one, and only handful on companies are able to produce such devices. So, it can turn to the opposite within the second, but you never predict why or what triggers it. Such things just come up.

4.1.1.2 Real world problems only

As the need for something is clear, the problem that the solution is solving must be real as well. Simplicity of the solution should be emphasized, but only at the level it accomplishes the mission. Added complexity should still be avoided, but a key point is that whether or not the solution is good or bad, if it is not solving what it is supposed to solve, it can cause problems later on.

A good example is also IP versus X.25. The X.25 was ITU-T's packet based protocol. And the question here was that the other protocol was simple, IP was simple and it did what

it was supposed to. The other one was complex and it tried to solve multiple problems, which turned out to be unreal. Simply put, the implementation for it became too expensive and complicated. Network solution became too expensive and slow. So in this situation simpler solution won, and not necessarily due to the standard organization, but the issues was that it was loaded with expectations and that caused it to be filled with all kinds of features. And the other one was simple and also cheaper at the end of the day. [...] So the point is to solve a problem, and solve the correct problem instead of the wrong one. Both cases solved the problem, but the other one solved many other problems as well, which turned out to be unreal. And that made it more complex and expensive as well.

Another interviewee has the same opinion to the problem solving. Solving the correct problem is important. The key point besides the factual solution is to have the possibility to implement in incrementally. You can always create beautiful, expensive solutions, but if you are unable to implement it into production environments without largely disturbing other production, there might be problems ahead.

We had a real need for it, a real problem. And then we had a group of other people that saw the same problem. Even though we originally implemented it into a certain environment, we have seen it afterwards to be used in other environments and architectures. So it was a general solution at the end cross multiple standardization organizations not only in IETF, but in 3GPP and others as well. [...] So the key point here is that you have a real problem and a proper solution for it. And then that it can be deployed into the network incrementally, it doesn't require fundaments, so bringing it to the network is painless. And also cost effective, this is often forgotten that when new great solutions are built, but then require ridiculous investments from network or terminal manufacturers. They just tend to fail.

4.1.1.3 On complexity

More complex the effort gets, more expertise you will need in the organization, and in some situations the correct experts can be hard to get hold of. The lack of correct people to grasp the problems has led to troubles in some standardization organizations. There is no actual theoretical background to support this, but this is based on the experience of the interviewee.

I would say that some of these standardization organizations are not really.. They have problems handling fairly complex standards, because you need more complex standard there is the more expertise you need, and that maybe be difficult to get hold on, in some cases. Depends a bit, I haven't investigated it, but I will guess that this type of complex standard is much more difficult.

To address complexity one basic need is to have very talented people working with it. The problem is that at some stage the system complexity adds up to a point, when PhD is required for people to get into it as new players. The discussion was about the complexity of a telecom network system.

It requires a bunch of very talented people, and they can be found in the world, but it really requires very talented people. And this is also some degree of a problem that it has become so elegant that to get inside it you need a PhD for the narrow field you are working on.

There is a tradeoff in what kind of functionality is needed in the standard, and how much complexity it should have. As the functionalities increases within the standard, it tends to increase the complexity at the same time. Balancing between the two factors in the work group is part of the problematics in standard creation.

It is always a tradeoff, because you have this, on the other hand you want a lot of functionality into standard, but that increases implementation costs, so that was one of the main factors. Trying to find the best balance between complexity and implementation cost.

In IP technologies addressing the complexity has, according to one interviewee been successful. IPv4 is both simple and has a wide support of technologies under it, and above it. However, the differences are visible with newer IPv6 protocol. According to the interviewee it is clearly visible that IPv4 was designed by people, when IPv6 was and is designed by a committee.

I think addressing the complexity has been fairly successful. That what was built was, like the old internet, IPv4 protocol is fairly simple. You don't have a lot of functionality. So it is the idea behind that it functions as a kind of a bottleneck, or the narrow waist of a hourglass, which supports a large quantity of link technology underneath it, and on the

other hand a large quantity of applications above it. And it is clearly visible that IPv4 was designed by people. IPv6 has been designed by a committee. The difference is visible, but we are still on the same scale.

When question was asked about could the control over complexity be achieved through smaller sub parts of it, the interviewee replied that there is no systematic control for it. Rather it comes through the limited capability of humans to understand large complex entities. So in this sense there is a natural limitation to address complexity.

We don't have any systematic control for managing complexity, it is more through a process, it comes naturally with the limited capability of humans to understand matters. Meaning we can't make anything overly complex. That we can't do more than one thing at a time, or few things at a time, but still rather small matters. Like we started that, hey let's build IPv6, it has a header in the protocol that looks like this, and later on we build additional things to it and move forward. Naturally the complexity increases when we add new stuff to it, but still it has a sort of modularity in it. The best constraint is that humans cannot or be able to do overly complex things. And besides we have quality control so we cannot just suggest anything that comes in mind. It still needs to be a perfect, working solutions, so it tends to weed out the stupidest ideas.

However, if standardization effort has gone to the wrong rails and has not succeeded as it was intended the consequences can be widely spread. The added complexity will cause severe problems at the implementation stage. This has happened for example in SIP project. The problems can be somehow managed, but the end result is not as it was originally intended.

It has become very complex at the end. The interoperability between implementation is probably better these days, but baseline is that it has been very poor. The specifications are so complex that regular developers who implement them clearly cannot understand them anymore. [...] So they make shortcuts and don't include everything, so the specifications are in this sense too complex. And only after massive amount of interoperability testing they can get things in order, so everything works as expected. And then the most complex stuff won't get implemented by anyone, they are too complex. It is definitely a problem.

Other example of a complex world, which have succeeded better in terms of complexity is the web browser world. The number of web browser-type standards is similarly very large, but quick implementations have kept things from not going into large depths without actually implementing them first. However, the risk increases when incomplete standards are implemented on top of other incomplete standards. That can cause problems in the long run, since no one really knows will the implementations follow after it is finished.

> *They have been implemented, in a way, especially in past years things have moved to that point that Google and Mozilla and Microsoft, even Apple actually implement the standards into browsers at the same time they are specifying them. So in a sense the standardization cannot run off into utopistic measures easily. So the implementations follow pretty quickly, and if it is realized that no one implements them, they die off pretty quickly as well. So this SIP has more been like this kind of traditional committee standard effort, where things have gotten out of hand at some stage, things have been specified, which nobody actually have implemented. And then new features are specified on top of them, and on top of them, and so forth. And still the base line is still lacking the specification at the same time. The standard people themselves have realized that there is a great risk that if we specify something on top of this that no one has implemented, which is based on an earlier specification that similarly has the same situation. So the real question is are we living in some sort of virtual world, or will the implementations actually follow?*

Another approach to the complexity is through modularity. The complexity is usually more manageable after splitting it up. Even though mobile networks are very complex and IP protocol is complex, the community has split up the complexity through modular knowledge of people. Few people know the whole field, but many people know small parts of it very well. This makes the complexity approaches modular, through the people.

> *Who was it that said "things need to be as complex that it solves the problem, but never more complex than that". So a large complexity can be managed. For example current mobile networks are very complex. IP protocol is, even though the protocol is simple, as a system IP and internet are very complex. And people have been able to, let's say, internet is a very good example that have very few people who know its whole structure, but plenty*

of people who know well a part of it. So in this sense the community has separated the complexity into several smaller parts.

The interviewee continues that engineers live well in complex circumstances, but there is a limit. After a certain limit the complexity increases the system vulnerability to face competition. However, complex matters deem complex solutions. It is the over-complexity should be avoided.

We can say that engineers are good living with the complexity, and complexity can be addressed feasibly. The problem comes that if you have added complexity that does not actually address the problem it was solving, it makes the technology stiff and expensive. This might not be a problem, while there are no competing solutions to compete with it. But then if you have a competing technology that is cheaper and easier to maintain, then it can follow that in the long run it will be chosen over the old one. But as said, technical complexity is necessarily not a problem. Matters are as complex as they are. So, to implement complex things you need complex mechanisms. But you need to keep it within reasonable limits.

The added business interests can also bring unnecessary complexity into standards that are not perhaps optimal for the whole global implementation. The more popular it gets, there can be too much focus on small matters that really doesn't matter in the big picture. The scale of matters should be taken into account, especially on matters that have global scope.

Now that the business interests are getting more important. IETF was earlier held as a kind of uninteresting organization, people thought that address spaces and all would last forever. But that it has gained the interest from business participants. That different players, vendors, operators and so forth get their matters accomplished, I am getting worried that in last year or so there have been a lot of very needless decisions. Only for the sake that someone has argued that we have this incomprehensible combination of circumstances that when they occur, we can save 7% in signaling costs if we do this and this optimization. But on global scope these things have no significance at all.

Another interviewee similarly says that increased interest to a standard can increase its complexity. The key is to control the scope of the effort at all times. The case of SIP was discussed and what the reasons might be that led to the situation where the standard is currently.

It probably derives from the fact that at first they built a light protocol, and then traditional operators got interested and wanted to implement it. There is a lot, for example in IETF they also go through many of 3GPP wishes. And because 3GPP decided to use SIP, then some small part of it gets standardized that 3GPP needs in it implementation. Perhaps it is not the wisest way to approach, but since it is like that, it tends to pull more features into them. When you have invented some interesting technology that seems to work, that tends to raise people's interests and increase the need for different features. And then it will easily grow into incomprehensible dimensions.

The remedy for this is to maintain control over the implementation, and not to get the features get the upper hand. The question was about if there is a great demand, is it easy to loose control over it. If the tool that is provided is good, people will probably use it.

Yes, if you don't keep tight control, and maintain the original purpose of it, it is a matter of how it is scoped, who can change it and so forth. But if you start from the situation that you have this tool that people can use, then people will use it if it is good.

A good example of increased interests is 3G system compared with the GSM system. The added complexity between them was large due to organization size and overall added interest. This has slowed the implementation of it, but not destroyed it. It was also considered very visible that as GSM was designed and implemented by a small amount of people, and WDCMA was designed and implemented by a bigger group of people.

A good example is 3G-system, WDCMA which is currently used is much more complex and complicated than GSM-system was. And partly it was due to the fact that the problem was more complex to solve, and the chosen technology was more complex. Part reason is that standardization has also changed during the years. GSM was specified inside Europe with only a few people involved. And WCDMA was specified with a big group of people. So everyone had their interests to bring their technology into it. Everyone had their interest to possibly get their IPR inside it. The system just became much more complex to implement than GSM was. It didn't destroy the system, it just slowed the process of making into the market.

On already complex systems when something is up and running, and have customers using it, the migration into a new network is really hard. WIMAX tried it, but it wasn't enough to get customers change from working one. This means that complexity, once at high level, is not necessarily addressable just by making a new one. This also supports the evolution aspect of standardization. Once it is built and have customers using it you will need a lot of work to get them moved into another.

> *It tends to be so that when you have something working, people usually don't want to change it. The fact that if you have something that works, even if we build a new one next to it that would be simple, it is not enough. You have your customers on the one that already works. To get the same momentum and turnover to the new one, it just doesn't work like that. WIMAX tried it and it didn't work out.*

4.1.2 Organization and human dimension

4.1.2.1 Motivated voluntary workers

The standardization is a voluntary process. Taking part in one is not required by anyone. The motivations of participants differ and this can affect the contribution to the effort. The motivations can be easier to find if you have been fully appointed to join the project, but this can vary as well.

> *This is a voluntary process, so nobody gets paid. This is one of the fundamental problems to this day, that there is always a kind of different motivations for people participating. I work in a research organization so I get something for the research project to participate. This makes it easier to work for me, than others that are nominated from companies are less available to do the work.*

As the work is voluntary based, the risk always is that if you are not fully working for the project, the normal work load can get in the way of standardization effort. This is addressed with an early calling of participants, which gives more time to participants organize their line work duties before the standardization efforts start. This can also be a part of the reason why the standardization efforts can take so long.

Well the baseline is that you won't get paid for the contributions, it is voluntary based work. Every one gets paid from their day jobs. So in this sense it is an investment from the organization sending experts to the work groups. So there is always a risk that daily line work gets in the way, but that is tried to address in the process, that nothing comes as a surprise. But when evaluations are needed, it is known well before the actual work. There is a separate early call who will participate.

The tradition of "voluntary work" in European telecom standardization organizations is also seen as a benefit to European standardization work. This is important aspect as business logics are assessed. Standardization work in other countries is perhaps not similar in this sense than it is in Europe.

But in a way it has been a tradition that for example Cisco and Microsoft type of American talk much about standardization, but they are not necessarily always serious about it. They are strongly seeking their own advantage. Meaning you go ahead and do this, but afterwards they still make a better version of it. And on the other hand here in traditional GSM-world we have seen standardization as a work party, where all work together and it is considered as a mutual advantage. No one is trying to achieve world domination. World domination is achieved elsewhere. That is one reason why we have achieved the momentum to standardization.

Motivation within the work group is also important. If there is no motivation, chances are it won't get done quickly or at all. And similarly is there is a great motivation to accomplish something, it tends to move more quickly. Having existing customers for example can enable people to participate more and work faster as well.

This naturally applies to everything, but on some level all that are involved in the effort, regardless is it the chairman or a member in steering group or an author or even a contributor, if we lack the motivation to do it, chances are it won't get done quickly. So with everyone participating, has to have a reason for it to succeed.

The important standards, when assessing the whole economy instead of a single star, are about interoperability. And this bring some scale benefits to all who participate in the process. Similarly, the multiple feedback received from other participants can save in the costs of a single

participant as well. The development cost is divided between all participants since the work happens together.

> *The good and necessary standards are about interoperability. The benefit is manyfold, because you don't need full development. You always have the feedback of other companies, of other problems of other issues. [...] So, you have multiple feedback. And by working jointly toward a common solution you have a much wider pole of people working on it. So it means that the development go much faster. So you can be much faster than you you would be without standardization. And you don't need to bear all the development cost 100% from scratch all the way through, because you can share it with others. And you share it already with the right people, so you don't need to search for people. They are already there. Those are the people you want to talk to.*

The interviewee continues to describe about the motivation of operators to join in standardization efforts. They want to lower their risk by demanding a multi-vendor network, and at the same time they can affect the possible vendor lock-in that might occur on less competed markets. This is a big reason why vendors are for example joining the standardization efforts. They don't want to be dictated what they must buy, when and on what price.

> *And on top of it, many would never to be able to make in wide market, because especially if you go to telecom operators, to the big ones like Vodafones and T-mobiles and Telefonicas of this world, they will never make themselves dependent on one single vendor. They always want to make sure at least to have three four five vendors present in their networks, because if one vendor goes bust they are not so much impacted because they have others to cope with the problem. If one vendor is the only supplier to them, then of course this one vendor can tell them that you need to upgrade this and that, and it will cost you such and such. They could dictate the price. But if there are others, if they are competing then the customer the operator as a customer is safe against such price politics from a single vendor. And the standardization is required, because somehow it must be made sure that equipment from various vendors play together. And this is where the operators are really heavily in the standardization game, because they dictate I want to buys stuff that does this and that. That way they can for example guarantee to have backwards compatibility networks, or environments. Otherwise the vendor, or a group of vendors could come and*

say no we upgrade to next generation of networks and you have to throw away your old networks because they don't work anymore. But the operator comes to the standards meeting and says by the way one of my requirements is backwards compatibility for the stuff I bought from you ten years ago. So it is an important mechanism for the market as such.

4.1.2.2 Mutual benefits

Healthy business logics and mutual understanding regarding earning logic is mentioned on several occasions during the interview. This is considered also an important factor. And likewise it is considered a hindering factor if the benefits received from the efforts are obviously disproportionate or otherwise discriminating. Here mutual benefit is seen as an important factor between the participating companies. An obvious advantage can cause serious problems in the process. Every participant joining is expecting some sort of benefit out of the effort. If these benefits are not in balance, problems might arise.

I mean the main motivation, I mean you have an interesting issue, of course standards like this it should be giving some manufacturers some kind of benefits from this kind of competition issue here. It has to be mutual, or at least that is important that nobody gets an obvious advantage over, of this particular standard. That is a major show stopper. That is one issue, kind of constraint to the process that is not very competitive, so to speak.

The next comment comes from telecom industry, where the business logic has been very clear. It makes agreeing upon something easier when there are multiple parties involved. On the other hand, in software industry this might not be so clear as it is in telecom industry. This might be an indication that earning benefits in telecom multi-vendor environment are so clear that this sort of work peace is possible.

And then there has always been the assumption how to make money out of this. Operators invoice the end users, and operator buys these boxes, and then we need phones and we sell them. So it has been very clear how the money is made. And all these Jabbers and such have been unclear in this sense, meaning ok why we are investing resources to do this, how do we get money out of this. So these cases have been more unclear.

If the efforts are seen as a thread to the participants business interests, it usually is a show stopper. This case example comes from ENUM standard, where it would have been possible to route telephone calls outside operator networks. It started out well and had lots of support, until operators realized it might not be in favor of their business after all. The benefits were uneven.

> *It went like it would be a nice feature to have, and for that reason participants were originally interested about it. But then they started to think, the operators, that is this actually a good thing for us. [...] Why would operators offer a service that decreases their turnover?*

There are also situations where even though the need is there, but if it clearly contradicts the business interests of one or several participants, it will be troublesome as it was with this case. The case comes from a Finnish operator change process regarding how customers can change their internet operator. The lack of the process was causing problems for end customers, but due to the refusal of a single party the effort did not make it. The other parties did not want to give a competitive advantage to the refusing participant.

> *And the need is not always enough. We made this swap order-specification, meaning how the end user can change their internet service provider without long delays. So we defined not a technical standard, but a process for how it should work. [...] Here we had a clear need, we implemented it, and problems lessened. It is still in use and everything looks good. We did an extension to the process, which would have made it better, but one of the significant actor in the market refused, with it's own good reasons, to implement it. And so other actors decided that they don't want to give an obvious advantage to a single entity and also refused to implement it.*

As previously mentioned, healthy business motives are needed to succeed. Clear business logic and understanding in the organization is essential. The example comes from Mobile-IP standardization case. The original design was to enable anyone to act as a "home agent" and function outside of operator's jurisdiction. This would have caused for the operator to have less control of the data flow, thus the revenues as well.

> *In standardization, the most significant factors were mostly on security issues, but also in the investment aspects as well. The role of home agents, and the fact that they would not*

have been vertically bound into the operator production process was a significant factor for the implementation.

4.1.2.3 People still do the work

Everyone needs to be heard and consensus achieved in some level. This is important for things to keep evolving instead of forking into separate tracks. This especially applies to telecom industry, where the customer base is practically extended throughout the world. The temporary position of chairmen also contributes to the healthy structure within an organization.

The speciality of the telecom world is the 6 billion people customer mass. So you can not just ignore someone, like who cares what India thinks, or what Latin America thinks. It doesn't work like that, because that causes it to deteriorate and pretty quickly it will for into another track. And because of this listening to people is very important. And this is part of the reason why chairmen are chosen with votes. They are not just some officials. So in a way the people choose their chairman amongst them to a temporary position. And these are pretty strong game rules, which will lead to that the structure remains healthy, or at least relatively healthy, it is always relative.

Personal matters in organization work applies in standardization work as it does in every organization. The human side can be seen in both. Matter can become principled very easily, which can be amusing looking from outside, but people are very serious really. Human emotions are therefore not excluded from the equation since people are doing the actual work.

One thing that in some sense affects to standardization, or can be connected to standardization are human factors that relates to either their expertise or to their egos. Things easily become a matter of principal for many, and looking them from outside they seem usually amusing. And still the concerned people are very serious. Many time emotions are included as well. Humans as actors, it is what it is.

Multiplicity in cross-industry terminology can be if not hindering, at least a slowing down factor when multiple industries try to integrate separate service layers into one consistent entity. People must have a shared language upon the matters they are working with. This usually requires a lot of work and can cause delays in the process.

And other challenging factor with the electronic invoicing specification was that the national or industry specific or such had numerous different ways of representing data. And it was challenging. It really delayed the start a bit. We intentionally wanted to wait that other standardization organization was finished with their wider semantic definition finished. So they worked also with the invoicing matters and we could say that the basic work was finished and ready for implementation, so we could ensure that we get as compatible and fitting specification for ISO20022 as possible.

The tendency of differing terminology and the abstract nature of matters can also cause confusion between participation. This example came from ISO20022 process, where different industries that operate in financial industry aim to achieve a common integration of financial messages.

Actually, the matter is about the conceptuality of matters, meaning they are very abstract. And the truth is that we have a great deal of terminology and concepts, which are intrinsically general, but still have different meaning in different places, in different industries and so forth. And it brings the challenges. That I would say we all speak somehow understandable English, but still understand each other differently. And that is where the topmost comes from. You must have the chance to reserve enough time to be able to making matters clear, so we could have mutual understanding about the actual contents. [...] So you nod regardless of do you understand or not. Or at least didn't understand it in the same way than the other one. And this can cause problems.

Business interests should drive people also in work groups as well. It is not always certain. People's own motives can overcome business motives. This can lead to a situation that it is just floating in the air without actually moving anywhere, since the driver is missing. This is not due to the company interests, but the people's own interests going ahead of business interests. People who should have goals set by their companies are instead working on their own behalf.

The people that work in companies and act in work groups. So the companies interest in all of this. Meaning that we do things that have business interest as well. We often see people, in every forum, that are researchers who might come from a company, but are clearly driving their own things, and not so much that there is business behind them

driving the things. That is not a success criteria for anything. [...] And I don't mean that to have company support that it necessarily means that it is determined by the company they work for. The point is that you often see people working for someone, and should have a motive to do something, but they don't. And that causes the people not be connected into the activity. And in these situations it tends to be unclear what they are actually doing.

One typical matter is also how things are looked through before doing. We can always create new and massive algorithms, but they must be moved into production environment as well. The focus on the algorithm is excessive comparing it with the general focus how it can be implemented in production.

One typical problem is, I have been involved in information security matters, and it is typical that something new is built and all is secure. It has nice massive algorithms, but nobody has really thought it through how to really get it running.

The interviewee continues that even bigger problem within the organization is unrealistic, almost fanatic views about something. In the scale of internet standardization, the quality needs to be considered as a major factor as well. These are not just matters that will affect only a few, but all people using the internet can be affected if central parts are developed.

But perhaps even bigger problem is people with unrealistic views, fanatic views of some aspect. Meaning that security must be done like this or that. And if that does not reflect into reality, it can cause big problems. Of course everything should not be approved, because everyone can publish websites and write a proprietary standard. But if we are making things in the scale of internet you will have to consider quality as well.

When question about how a work group is formed, the same interviewee states that some participant groups might be underrepresented than others. While this might not be the optimal situation, it is hard to address. It would still be beneficial if the user end participated more in the process.

Well there currently are vendors and researchers for example, and from time to time we also see, you could say as private individuals, independent experts. Some consultants as well, who do not directly work for a vendor. And also operators, but overall end user and

operator viewpoints are underrepresented in IETF but also many other standardization organizations. That I think of it as vendors push more their own products and other technology and standardization matters. And, it is a kind of a problem, but it is hard to do anything about it. End users lack the competence, but at the same time they don't have time to participate in these forums. But it can be wished for that for example network operators, they participate in some level, but maybe not in wide scale that they should.

When assessing a case example of a standardization effort that wasn't successful, one success factor that drove it to the end was competence in the people doing it, and solid technical base for the standard. So even though the actual effort was not successful, the competence of the group still saw it through.

I think that the basic technical base was good, and that people involved were technically capable developing this. When some standards that are created on top of market hype can in this sense be less good that you don't have capable people involved.

Similarly, the lack of operative experience in matters that is under standardization and implementation can affect the complexity without them realizing it. The smallest move in the process can affect greatly at the end, and understanding this requires operative experience in such matters. There are arguably many people doing only a specific thing, which makes it hard to understand the bigger picture in matters.

As I previously said that operative experience of people tends to lead simpler solutions. Meaning that if you have never done such things there is a risk that you don't see the full effects of your implementation. The thing you created can be simple, but the parallel and environmental affects can be wide. So even the smallest wrong move can change the direction of the large train in some situations. To understand this requires operative experience and understanding of the wider scope that is involved in the area. So in the standardization organizations there are too many people doing only one specific thing.

A case example of a part of LTE delivery, a subset of DNS functionality in a cellular network that lacked the real life experience of maintaining such large network. This led to the situation where the maintenance of the system is very complicated in production environment. Real life experience of the things that are on the design table can be critical.

It works, it is not broken, but it turned out to be something we didn't originally design. The operator viewpoint at that time that it needs to be administrable. The system is terrible to admin. Later on I see matters from another aspect, and I think we made a couple of bigger mistakes during the standard creation. Maybe the biggest mistake was that anyone involved in the project never really had administrated a really big DNS-system. As the requirements kept coming in during the project, that wasn't really part of it, and nobody really stopped it. So if everyone would have had solid experience about the operative issues, this would never have happened. [...] You need to have experience in running and administrating the solution that you have built. That teaches a lot.

The relation between scientific research and standardization can be problematic. Although more research is according to interviewee needed, the stage when actual specification should start can be rushed, which can lead to problems. Patience is a virtue in this sense in standardization work. The matter at hand must be understood from many aspects before it should be standardized. And this usually takes time from people. Rushed decisions in standardization area should be avoided.

Even though research is a good thing and should be done more, too many matters are brought into the standardization process which still are clearly in the research stage. I don't have anything against it, we aim to implement every possible thing we have time for. But if you have some EU-project or such that develops something, do you really need to standardize the protocol right away. Because the risk is that some other group grabs to it. And it has not been around long enough for people to have proper ideas and have good conceptions about it.

There is an actual real life example of this case that actually got into the market. The mobile network on IP level was brought to the market before it was, according to interviewee, ready for it on system level. The problems tend to be strange when implementing is made something that is not yet finished on system level.

One example comes from 3GPP architecture, where the network promise was mobile net. When you move in the network, the network follows you when you move into another cell. There are two protocols that does it on IP level. Two choices, for vendor two implementation. The other protocol has been there since 1997, it is ugly and bad, but it works to this

day. Then another one was brought to the market, which was sketchy at the time. The few vendors that had to support it had all sorts of weird problems with it, because it was not ready for standardization at system level. And if also on this occasion the protocol would have been done first, people use it for small things, play with it and do research with it, and only after that would have brought it to be part of a larger system. But this case was implemented into a large system right after the first things were put to the paper. And now we have to live with it.

Another aspect is the lack of education about standardization. It can hinder the results due to the unawareness when reaction would be beneficial to the standard process. This derives from the fact that timing the standardization effort is not always clear. If the work is too long gone, participants can find it difficult to reach an agreement, thus making the standardization almost impossible. The education helps to recognize when to do what in the standardization field.

So I think the what is really missing is education about standardization. For example at university level for the technical people. Im a standardization advisor to the university of Waterloo in Canada, but as far I am aware this is the only university in the world that has such a role. So, there are universities in Europe dealing with standards mostly it is the business schools, but the actual people who have to do the standards who are the engineers. Maybe every once in a while they have read something about standardization because it is important for their technical solution, but they have never learned about standardization as such why, how, and what is it good for. And this is what is missing, the basic educational problem.

In the end, standardization is a systematic way to work. You must know what you are talking about to be successful in it. Cutting pieces of information doesn't necessarily mean that a good judgement is made. Understanding the big picture and realizing that everything is tied to each other is important.

And this I think is important when you work with these things. You need to know what is spoken about. This means if you just cut away a portion of the information, you still know something is happening, but necessarily know what it is really about. And then it is hard to make a good conclusion of anything. Standardization is systematic work in its every

direction. Everything is dependable of everything. And if you cannot perceive and accept it, you are going to have difficult time.

4.1.3 Standardization environment

4.1.3.1 Ecosystem where it all happens

When assessing the case examples of both worlds of rivaling standards, from which another one won and other won lost, the ecosystem is seen as the tipping factor. In this case, the successfulness was determined through implementation, other one was implemented and taken into use, other one has only a marginal market established. This is a real-life example from the competition of 3G and WIMAX technologies.

And the question was that there was the larger ecosystem behind other standard. There was existing business logic, existing manufacturers, operators, terminal manufacturers, network device manufacturers. And with the other one everything was new. And it was easier for an operator to choose from, which they knew had multiple manufacturers, they were relatively well established financially. There were many terminal manufacturers, which meant that there was competition between them. And that was significant, not so much the standardization itself. Or what I mean was that the actual specification was not the point, but how many companies were involved. The amount of supporters for the standard was actually more significant at the end than technical specifications.

The definition of the ecosystem is manyfold issue. It contains besides the users involved, the need categorization as well. When asked to define the ecosystem, one interviewee defined it as a potentiality amongst the participants. The potential clients and vendors who have the will to be a part of it is central in the ecosystem existence.

We have a set of potential users that are involved in the standardization. And we have a potential client base as well. Although they might not use the technology currently, but we have a client base with the interest to use it. And have a real interest of using it. In the same way, it drives the standardization that we have a potential customer base, meaning we have a timetable when we want to be finished with it and not in a way we have a lot of time doing it. This way it will never be finished, or it will be very complicated at the

end. So usually if a standardization effort is delayed, the delay does not make the actual specification any better.

This translates also into the timing constraint of standardization. This factor of timing in standardization efforts, and how it can affect the end result is assessed later.

A key finding of standardization in general is that it is not a separate activity. It is a pre-determined agreement with participants regarding the business logics and how the technology works. The interviewee defines standard work as the upfront documentation of technology and business models.

Standardization is not any separate activity. Standardization is upfront documentation about how the technology works, and how the business models are created. That it is not separated activity from anywhere, but it is pre-competitive. So then specifically try to find solutions, where we could hear the different viewpoints from everyone, get good requirements, get to hear ideas in order to get the best technology on the table. And also in a way that it is time restricted. Many people ask why we need to constantly develop standards. It is largely due to the fact that people demand changes, but also due to that technological capabilities keep getting better.

To add to this representation of what standard is, another interviewee reminded that standards are not created just for the sake of them. Instead the whole ecosystem must be assessed. It is a multi-dimensional matter where no single matter does not determine success. The whole ecosystem with all its parts is supporting the standardization efforts. The standardization should not be assessed as a single entity, but as a part of the equation.

The standard is not created just the sake of it, but for example we do research work, and try to think of the whole palette at the same time. We want to establish this thing X, but it doesn't come just by making the standard. We have the standard, and some Open Source implementation, for example a client software and a server we sell as a product. In other words, we have business for it. Then we consultants, some buddy in his company who is creating applications on top of this. The ecosystem is more than just the standard. These all factors together support the standard. If we are merely creating a standard, we

usually aren't doing anything good. [...] It would be nice if it would work, would be nice if someone would use it, and it would be nice if there would be a business reason for doing it.

According to one interviewee standardization efforts especially in telecom can be characterized to as "pre-competitive", which means that the competition is done before the business competition begins. This conceptualization fits well in the telecom industry since it is a multi-vendor environment, where this sort of open way of working is essential.

Pre-competitive means that we do it kind of before, before the actual business is running, because then you can, if we take 3GPP-work as an example. There you have waterfall-structure of work, where the work is phased to separate steps. You have stage 1, 2, and 3, where stage 1 is where you make requirements. Stage two you create the architecture. And on stage 3 you will do the actual detail work. And so besides it is an open process, it is also kind of invitation for people how to come and contribute.

The same interviewee continues to emphasize the factor of openness for standardization. As the new and breaking innovations are getting harder to invent, the tendency is focusing on improving the existing. And this calls for an open environment, where participants can work together and the best people are invited to attend.

And I really think that when we look at these matters, the technologies aren't really different at the end of the day. And these days information travels so fast that significantly different concepts are really hard to invent. Most of the innovations is that we improve, improve, improve. Innovations are significant in a sense that we keep getting better things. That it is both backwards and forwards compatible. So therefore this type of open process where we seek what we need, how is it conceptually made, and how the details are achieved, so the open process makes open involvement possible, which at least in principle invites the best people to attend.

The same interviewee points out a PhD thesis work he was recently acquainted with. The unpredictability of the market was decreased when a standard is taken into use, which on investors point of view as well as the end users point of view is considered beneficial.

One important aspect in standardization is its predictability. The term "market uncertainty" is used, which means that the market uncertainty is taken into account. But when you decide to implement a standard solution, the uncertainty in the market decreases significantly, which is good both for the investor and the end user, so they know that they make the decision on safe grounds. But on the other hand it is also for the external investor decision beneficial since they know this exists and it is created.

The structure of standard creation must be based on an unchanged structure. This supports the predictability of the standard. The base must be on solid grounds, preferably standing on good solid theory that cannot be altered quickly or without good reasons to it. But if the structure can be changed without any proper suitable means, it will lead to a disaster. The trust will vanish from the standardization.

Instead that there would be war, which means standard needs to be in that sense special, and how you create a predictable standard is that it is relying on physical laws, and it is relying on some heuristic laws, like Moore's law. We know that other similar scientific, or at least somewhat scientific facts can be build upon, because you cannot change them. When you create a structure that does not change, or at least relies on invariable facts, you will get an unchanged structure. This is fairly often discussed about, but if you take different elements that you can change just with a stroke of a pen, pricing for example, that will lead to a disaster. [...] It will eventually lead to the situation where you start scrapping everything already done and start over. And if this point is reached the predictability will disappear and therefore the value of the standard is diluted into nothing.

Standards can also have n legal insurance type of aspect in them. They give assurance to users. This can affect the adaptation of the standardized product. This argument is somewhat in par with earlier comment regarding the predictability of standard. Customers have something unchangeable that they can trust it has been built with proper means.

Another thing is trust of customers, because if there is a publicly available paper that says what has to be in to be standards conform then it is kind of an insurance. It not a certification, but it does have a legal impact. Because, if vendor sells something and claims that this product is created according to standard xyz the customer can trust that

he buys something that is according to standard xyz. If it proves not to be according to be made against that standard, then if a procurement specification with customer that I want to buy a product that complies with such and such standard you claim your product was complying to but it does not, Im gonna sue you. So it has a legal impact, a reassurance for the customer.

4.1.3.2 Building on top of consensus

Overall consensus on the standardization organization is considered a factor by more than one interviewee. This seems to apply most of the organizations the interviewees have been acquainted with. This means that the traditional democracy where voting is used as a way of deciding upon something, these organizations try to achieve common understanding and make the standardization on top of the understanding. This applies more to the de-facto organizations, such as IETF and 3GPP. In formal standardization organizations there is voting, but the consensus is still important to indicate interest there as well.

In these organizations, they will typically, there will be a suggestion from one of the national members of IEC. And that has to be approved by standards organization either by voting or general consensus or stuff like that. So there is a kind of consensus process before the standardization work is started, so you show a number of votes to start the work.

Similarly one interviewee that works as a manager in IETF work group also states that consensus is a significant driver for standard work. The community decides upon what gets done and chairmen just interpret the will of the participating community.

And community consensus is significant. In a way, we are just clerks, or interpreters. Meaning that sometimes I need to count the matters suggested in the list. Like I seek through 500 e-mails of what people have said and try to find if any critical problems exist. But we don't, we interpret the end result, but don't dictate anything if the community has different opinion.

However, even though most in the de-facto standardization forums the consensus is the important factor, it doesn't necessarily mean that voting is actually totally out of the picture. In IETF

For example chairman can check the consensus through trying to sense the overall tendency. This is not official voting, since there is no official member base.

> *In a matter a fact in IETF consensus has always been very important, but on the other hand it is important in 3GPP as well. Talking about ETSI, 3GPP history derives from, 3GPP procedures mainly comes from ETSI procedures. And there has been for a long time, like it has been in Europe for a long time, consensus as an important factor. Trying to avoid voting, trying to avoid confrontation, but instead try to reach goals in collaboration. And in 3GPP and ETSI, they have the opportunity at the end of the day to vote. In IETF consensus building has been taken into higher level, they don't have any official voting. You cannot vote since you don't have any formal organization. But unofficially they still vote. [...] This is done by chairman asking people to raise hands to indicate support, which looks a lot like a vote. And the other option, which is called humming, so first people supporting the work makes humming noise. And after them, the people not supporting the work makes the noise. And then chairman tries to figure out which one was louder.*

This does not apply to formal organizations, where voting is a normal procedure. This type of organizations have more formal membership base as well. ITU-T for example has formal voting between the participants, including governments.

> *In ITU-T, you have formal voting, to which governments take part as well. And there you have, it doesn't necessarily get built upon consensus, but according to political policy, which is somewhat different.*

There are still matters that cannot be built only on consensus. These matters are those that require governmental or otherwise political intervention. A good example of such matters are emergency phone calls, which can be a poor business case for a company, but is still very useful for end users. As the standardization organizations consist mostly of companies, the market driver is not enough to get such cases into the market.

> *Companies care a lot that matters are made on market-based needs. It doesn't mean that we should forget about politics, but there are some political matters. One example of political matters is what we call "lawful intercept", which means legal eavesdropping, it is a political and lawful requirement. Another one is emergency phone calls, a political*

requirement. If you are planning to set up a network or aim to bring network terminal into markets, it better support emergency calls. And at the end of the day it is a pretty useful feature for the end used.

However, political guidance can be problematic to companies. If political guidance is overwhelming the market factors, this can eventually lead to a bad standard technically. Therefore, a balance between political and market factors must exist in order to expect good results.

But then again, if the political side is playing lion's share of the standardization. So for example in a situation where matters start to go into geopolitical aspects, or the decisions are based on them, this is really hard for companies and other participants, because in situations like these you won't get a good technical standard, but a politically pulled standard. And in these scenarios you don't necessarily receive the end user benefit. The end result can be expensive and ineffective. This is one scenario, so it does matter to companies to have certain market-pull, and important to all standardization is that it is done on technology in mind.

Although it is widely agreed that standard is very much about consensus building regardless of internal struggles to achieve it, but it also has a time restriction. The timing of standard effort is affecting as well, as it can affect will the standard get created at all if participants have developed their own solutions for too long.

Standardization is a lot about consensus building, and the later in the process it comes, the more difficult it is to build a standard. Everybody is investing man-power and money into certain development, and further the development has gone the less likely it is that he will be willing to give up on it for the sake of another solution. And it may happen that if standard comes too late, you'll end up with different solutions and none of them really wins. Famous example the electric plugs across europe and US where you have to carry around adapters. It is typical example of lack of consensus in standardization at the right time.

The basic need to reach a consensus is straight forward, you need more support on the other participant. There still is time dimension of forming the consensus. Long negotiations and discussions tend to take place in standardization organizations to reach the consensus.

You have the requirement that some kind of support is formed to one of them. The situation that you don't have support for either is easy, you don't need to implement either of them. And if the support is formed clearly to the other one it is easy to choose, since it has support. And usually in some way the support is formed to one or the other, it just might take some time. And usually this means that you have long negotiations and in discussions it means that both parties are seeking friends both in standardization organization and the particular work group.

4.1.3.3 Formality against informality

The role of de-jure standard organizations has lost their meaning throughout the years. However, in which type of standard exists for a technology is not very significant no longer. There are some aspects still that are regulated by formal organizations, but for market driven matters de-facto organizations tend to be more popular.

Whether or not standard is considered official or not is not really significant. Actually these official standardization organizations, such as ITU-T have lost their meaning throughout the past decades. And the significance it has today is very small in comparison with what it used to be. And standardization organizations, such as 3GPP, IETF and W3C for example, are organizations that the standards create these days. So the question whether or not an organization has this official status or not doesn't really apply these days. [...] This has actually happened a long time a go. These official standards aren't shown in technology markets. ITU-T recommendations, that are mostly used on optical networks physical layers, meaning some phone networks, but they are implemented a long time ago. [...] I would say that currently de-facto standards that get specified, in a sense they are actually specified by an organization, but do the organization have an official status is insignificant.

The reasons for this are manyfold. The official organizations have very stiff and slow procedures in comparison to unofficial organizations. Today the standards are mostly created by private organizations and universities instead of national participants, where they were created before.

Part of the reason for this is that in ITU-T standardization the formality and slowness are seen as a problem for todays fast moving standardization cycle, or at least relatively

fast moving. And the fact that the work methods are not necessarily fitting in todays work methods. The model was more applicable at the time national network operators did the standardization, when governments had a bigger role in the equation. Currently private organizations and universities are doing the most part of standard efforts. And even though nations are participating and sending people to different standardization work groups, they usually follow the development instead of actually contributing to the technology.

More informal standards benefit also from their tendency to reach the customer base through markets instead of writing them down to paper first. This point is made a number of time with multiple interviewees. The perspective here is that de-facto standards are driven by the need and implementation, whereas formal standards are designed on paper first.

ISO standards they have problems kind of surviving, because I could guess that the problem was that internet has a different internet standards, they are developed more, you get a group of people develop it independently and test it works. ISO standards are written down on paper first, and that makes it demanding to develop.

To have an actual implementation of something tends to help the standardization efforts. This especially applies even more to complex efforts. However, if a standard already achieved the de-facto status, the de-jure status becomes significantly lower.

I think if you want to handle a complex standard I think you have to start with something that more or less works. That has kind of de-facto-status in the industry. Then standardize that through people who know it. But then again, if it has de-facto status, the value of international standard is significantly lower. So you could guess, that a lot of the standards you see on the market are not very important, or they are very simple. But then again, there are differences. I think that handling the complexity really requires the people to know the contents of the standard, which means you cannot develop the standard from the scratch. It is really difficult to create standard from the scratch. With IEC and ISO, they need to have good starting points.

This point is repeated by other interviewee as well. In some organizations, the implementation weights more than in other organizations. In IETF, this is seen as a positive thing, but for example 3GPP does not work this way.

In IETF circles one that has played a big role is the existing codes. The motto is actually "We reject kings and voting, we believe in rough consensus and running code", so the existing implementations, that people can show up with something that actually work, or even better an Open Source implementation, it usually makes a strong statement. This is one factor. It might be little different than in other standardization organizations. 3GPP for example does not work this way.

For the claim that standardization tends to move slower it can also be seen as a function of interest. More of the interest standardization effort has, the faster it tends to move on. This indicates that business interests play some kind of role on how fast the standardization effort is achieved.

People tend to complain about why didn't this come any faster, but things usually run as fast as people have interest to put resources into it. There are a few areas that have tremendous interest in the world. In IPv6, for example we have 4 or 5 separate work groups, which all are big groups. And we do things that have hundreds of people contributing. And on the other hand there are matters that people have only slight interest to, where you have like 3 people working on it. They tend to move slower.

However, it is much slower than software development for example. The comparison here is an imagined Skype feature against a SIP feature, which requires standardization before it can be implemented. The differences are drastic, comparing the 2 months of proprietary development into 5 years of work in order to get the standard out.

If I had a direct link with an implementation team that develops a client for example, we could probably get a new feature implemented in a week. It only depends on the company hierarchy. If it was Skype, it could be in customer use within two months. But now if I am in the position to standardize my new idea in SIP, it can take two to three years before it is accepted in the standard, and then we wait. And if it were a very good idea, it would probably take four to five years before it was on the market. So compare two months with five years. The difference is quite large. [...] It is all not this bad though. If we think that I would have an idea of an extension that it could be done to browsers, you could probably build it in two months. And after that some web sites could start using it. So it doesn't

necessarily take 5 years to get it standardized in the browser world, but it would still take a couple of years. So there is still slowness. Of course if you compare the browser world with Skype they are pretty different things.

The same peculiarity of software business as a standard creation is shared with other interviewee. This peculiarity that software side can function like is this is explained with minimal production costs. The cost of copying another copy of a software product approaches zero, and that makes it easy for companies to try to take off with their products before it is more or less formally tried to standardize.

This has already happened a long time ago, at least 15 years ago. The change started when internet and IP started to develop more. In a way, it repeats in internet specifications that participants create first their own protocols, which is brought to IETF only when it is mature enough. [...] It all comes from the peculiarity of software business that the production costs for the software are minimal, so you can try to achieve a monopoly position from the markets, and only after that game is over, you can bring it to standardization organization and make it an open standard. You just cannot pull this off in other industries. Or at least there aren't any examples from this that you could make it work elsewhere, when you cannot create the network effect that you can in software business.

Bureaucracy is seen as a negative factor for de-jure organizations. The relation between de-jure and de-facto organizations is in this sense also meaningful. Some groups don't join in standardization organizations at all, because of their bureaucracy.

In certain matters, things are gone into the situation, where some groups don't come to any standardization organizations. They are too bureaucratic and slow. They just can't modify their process to fit into them. Meaning if at some point they notice that things aren't going as supposed you just cannot make another branch to the source tree and start over. These organizations just won't fit into it. Many developers that do not have the need to invent a new zero level protocol never come to these standardization organizations. And this is a sign that in some matters standards start to loose it's meaning, especially in service industry. [...] And this can be boldly used for companies benefit. Just look at what Google is doing today. They just build software, roll it out to the market, and then at some

point people find themselves using it a lot. And after this other software developers just have to follow it.

The slowness has the effect that de-facto standards (in the non-organizational sense) win over standards. The standardization cycle takes so long that the world can change before the product is implemented for customers. This affects especially software markets, where creating a proprietary solution takes very little time.

It has the effect that de-facto passes others. Meaning someone just writes software, people start to use it, and that is it. Or the world changes before you get to standardize a frame work or such. So during the five years you push the standard through, the world has changed so much that the original assumptions of the outcome will be outdated.

One interviewee points out that the slowness of more formal organizations has been a part reason why informal organizations are forming all the time. You need a big demand to have companies start something from the scratch. For this reason industry forums are forming all the time in the market. This can be more effective, but is not without problems.

You need a very big need to start something from scratch. And these industry forums keep on forming all the time, that just cuts and pastes already finished stuff together. Try to agree among major players that how to do it. [...] So they just might take some de-facto, or some solution among other standards, which is equally bad for everyone, a compromise. So these industry forums appear all the time. And whether or not is it really standardization is not clear, but these forums can function a lot faster. And not even consider developing something from the scratch. [...] But every once in a while someone commits the original sin, and starts to fix and tune it, and then it will get delayed and everyone is unsatisfied. This happens to Voice-over-LTE for example.

In addition to earlier comments, one interviewer points out that Open Source is a new form of doing, where you don't possibly have any organization at all. This is a good characterization of how the times have changed since earlier days of standardization, when formal organizations were the primary place to standardize. The times have changed since the early days of standard making.

Open Source is a kind of new way of doing, where you might not find organization at all. And possibly no meetings or specifications either. People contribute code, like Linux has showed. And such model has been used by other Open Source projects as well, and have shown that this is also very efficient and a good way to build standards. Standards are different than those created in a more traditional standardization world. [...] So times have changed and keep on changing. And standards keep changing as well, how they are created, and what sorts of organizations you have. You have physical forums, like the traditional IETF, 3GPP, ITU and so forth. Or then you have these virtual forums like Linux Community, where people might not meet each other, but handle the communication by other means. And I think this change will increase during time.

Although times have changed and informal standards have more significance today, official organizations still have some areas that are governed by law, but whether it really is significant for any one or not is another question. The term de-facto-shopping is used to depict the current situation, where organizations "shop" for suitable standard organization for optimal fitness.

De-facto standardization has significantly increased its role in many aspects. The traditional, official standard organizations have lost their role, but not in all aspects. You could say that there are some legal structures that require official organizations. This is the reason why ITU-T for example decides upon numbering, and thats it. But when you want to spin off something new, I think that currently there is a lot of "forum shopping" going on. Meaning that people visit multiple forums and try to find out where they can get their ideas through with most success. So in principle you are doing things in many forums.

So at the end, it really isn't significant, according to the interviewee, where the standard is created. And similarly interviewee claims that perhaps the companies involving are not interested either. And to some extent formal organizations are "rubber stamping" standards that are created in an informal organization.

So, I think that it really doesn't matter is the specification published by ITU-T or IETF. I don't care. And I think is the operator interested either, so in this sense it is insignificant to speak about "official" standard organizations and on the other hand these de-facto organizations. I think of them both as standardization organizations, and that is it. Especially

these official organizations sometimes act only as rubber stamps for a specification. So they take a specification made somewhere else and approve it without further work. What is the added value here?

Another interviewee similarly shares thoughts regarding the aspects of de-jure and de-facto standards. The black-and-white perception is troublesome since they do not purely exist as such. There is a lot of gray area between the two organization types, thus making it hard to determine exclusively which one applies better to a standard.

They are both needed. The perception of these organizations is troublesome, because either of them really don't exist purely. Because authorities always consider technical meritocracy, they don't create them in a vacuum. So in this sense that something is just molded into its place does not exist. And on the other hand these de-jure standards that industry participate in, or even lead them, they are still based on laws. They can't just go around the laws. [...] And then again if you have an informal organization that throws their technology to the world and claim it is a standard, a de-facto standard, it still is troublesome since who can really determine is it so widely used for it to be considered as a de-facto standard. And here is where the gray area starts. I would claim that either of them, de-facto of de-jure, does not exist as pure organizations as such, but only as a shade of gray.

So interviewee's point is that the real world decision on which standardization organization is used tends to be a combination of both worlds, which is similar characterization as earlier interviewer had. The question is interesting and perhaps it is impossible to determine exclusively which organization type applies for a single standard.

Usually, the end result is a combination of both. So if you look at the American system, and why not little at the European as well, they have the tendency think that de-facto is the way to go. But still at the end of the day they will take it to ANSI, which rubber stamps the standard, making them official so they are publicly approved. So, is the standard de-jure or de-facto since it has a judicial basis? Many people would respond it is de-facto. But how the hell is it de-facto if it has judicial approval? This is an interesting question, and defining it is somewhere from hard to impossible.

The actual meaning of which type of organization is used to standardize is not significant, but the environmental openness is important. More different models are allowed, the better the results can be.

> *But I don't see a big difference between the two. I would say that the more you have the degrees of freedom, the more alternative models are allowed, it will be better the end of the day.*

4.1.3.4 Patent pending

FRAND is a general practice in standardization area. FRAND stands for Fair, Reasonable, and Non-Discriminatory terms. This comes up in multiple occasions. Nearly all interviewees agree upon this that process is clear in this sense, and no one really disagrees directly.

> *In ISO20022 have applied it so that the standards are free. In IPR sense the party that suggests a standardization and makes the specification commits to its free distribution and its free use and also to the maintenance of it.*

Similarly ETSI applies the same FRAND rules to its standards. There is a clear process how organizations work in these situations. If a patent is found during the process, the owner is given a chance to provide the part in FRAND terms. If it suits the owner, the work goes on.

> *The standards are downloadable for free from the internet for free. There is no cost involved, we don't sell standards, we offer them for free. The IPR is FRAND rules. FRAND is Fair, Reasonable, and Non-Discriminatory. So that means if somebody or group decides on a technical solution, but somebody says Oops I got IPR on this, whatever, then he will be asked are you willing to grant your license for FRAND conditions and if they say yes it is all done, if no the group will have to develop a work-a-round. FRAND means, it can be for free. If the owner of the patent is willing to give it for free, but under FRAND rules same conditions must apply to everybody.*

However, it doesn't necessarily mean it is free. FRAND only means the terms that the owner must provide the use of the patent to other participants. The interviewee also states that on ETSI perspective this tends to be a positive factor. Or at least it is not considered to be a hindering factor.

That means it has to be given free for everybody, or he can a certain amount of money. It has to be FRAND. Same to everybody. It is not necessarily royalty-free, but I think this is what makes it as a success, because we see a lot of standards outside ETSI getting stuck where people are trying to do something without in royalty-free actually. There are huge companies who have their business model based on royalties, so this does not seem to be practical for it to be royalty free.

When question regarding the overall benefits for participants in IPR and licensing point of view, the interviewee remarks that the matters do not evolve around licenses and patents, but it is the whole ecosystem that matters. The benefits gained cannot be, therefore directly addressed.

The world doesn't evolve around licenses and patents, it is the big picture that matters. If we inspect internet for example, we have different kinds of parts there. We have routers, servers, access-devices, terminals, applications, and all such things. And all of them have different positions. One can be better equipped to move forward with IPv6, when other companies know better some other things.

Similarly, the interviewee continues that same multi-vendor environment reflects directly on standardization work as well. Some companies that want to have a certain feature as a competitive advantage tends to be more enthusiastic about some standard than those that only see it as a cost factor. Therefore the company strategies can also guide the work within the standard organization.

It is very clearly visible how the companies act in standardization work groups. I a way, others want to brake the development, but after you investigate further you'll find that they aren't ready with their products. They don't want to invest 100.000 euro to develop their products. And on the other hand other companies keep on marching onwards, since it is their competitive advantage.

IPR's can still be a hindrance to deployment. Organizations rather use something without IPR's if there is a possibility for it. In cryptography fields for example Elliptic Curves algorithms have been a major target for ownership, and that has had effects on how the standard is usable in general. There is also an aspect of time usage. Especially smaller companies don't necessarily have the resources to investigate all judicial facts, so they rather use a free version instead.

It is definitely more like challenge than it is helping. It is a barrier to deployment. Problems have occurred mostly in situations where different parties that own IPR to some portion, have practically prevented the use of other technology. There are examples in the cryptography field. For example Elliptic Curves has been a major target for IPR ownership from different parties. It has definitely affected it for example how easy it is to use. [...] So you rather use something else. You rather use RSA-algorithm and not ECC, because you don't want to think what it would mean for your company. You have better things to do than discuss it with lawyers. Or to think about what possible risks would there be if we decide on using this.

One interviewee similarly notes that overall tendency is that IPR's slow down the process as well. This is natural since legal matters require a certain punctual tone. However, the amount of discussion about IPRs also varies a lot depending on the organization. In 3GPP for example there is not much discussion regarding the IPRs.

Mostly they are slowing things down, meaning if IPRs are revealed, they usually slow things down. Naturally it depends on the organization politics. In 3GPP decision work group for example don't discuss much about IPR's. But on some other organization they have more importance.

And the existence of IPR for a certain technology can lead to a situation where the best technology not get chosen. But still if this is the situation, it is for the people who choose to make the decision regarding the overall strength if IPRs are involved. This means that even though the technology that gets chosen might not be the best, but it can be the strongest in an overall sense.

First of all you have to get the picture. First of all you have to evaluate in kind of what we call pre-standardization effort see what is out there, how far the technology develops. What are the different solutions or attempts towards solutions different approaches, and see if they are really useful or not. And then try to agree, and it is more or less an agreement among research and industry on what is the solution to pick. I don't necessarily claim that the solution that gets picked is the best solution, but to claim what is the strongest solution. I do say not always, because what if the best solution is so heavily

loaded with IPR and people are not willing to give out IPRs, so what do you do? You take the second best.

Although open does not necessarily mean free, it can still be a show stopper for some organizations. This is visible especially in Open Source communities or such endeavors which require re-distributions with similar terms.

So if for example Mozilla foundation is building a browser, they refuse to pay any license fees for patent holders. And similarly many Open Source licenses require that if you use this, then you are obligated to give it out to others as well with the same terms.

If the original use of IPR's is inspected, they are intended to give protection for the inventor. And similarly give a temporary monopoly for the markets since they have put investments to make it happen. However, things might have gotten a little bit out of hand.

Patents play an important role in telecom industry, and every major player must have strong patent strategy to protect itself, so you can make and sell products with a reasonable price without major risks to themselves and their clients. But as said, it might be that situation now has gotten a little out of hand. The situation where we currently are that everyone is suing everyone. And also that there are players within the industry that have no own products, and have no intention to build products, so they have no risk either. And this makes it possible to pull up royalty prices. So it is important that royalty fees are reasonable within the industry, which makes efficient markets possible.

Although patents and IPR's are important to protect a single actor, it can increase the complexity. This is a complex matter to dissolve, and has many dependencies in the need hierarchies of companies. Not necessarily all function in the same opportunistic manner. However, this is still a viable scenario that can occur in competitive scenarios.

The patent system actually inspires to add complexity. New features or functions that you can protect with patents. And this can easily drive into situation that more complexity is brought in to get your own technology in. Either on purpose or by accident. And this in the long run can decrease the flexibility of the technology and make it vulnerable for bypassing technologies, which are simpler at the end. So there is a relation between

complexity and patents. Maybe not a one to one relation, but at some level, which needs to be taken as a factor.

Software business has different layout than for example telecom industry, where FRAND is widely used. Monopolistic tendencies are tolerated more in software industry. There is no duplication problem in software markets, which makes the cost structure very beneficial.

Possibly in IETF, the name of the game is fair and reasonable, but there are different industries where monopolistic tendencies are tolerated more. Codecs and content matters are a good example of this. Someone plays high stakes to be able to rule the world. [...] But in this type of basic infrastructure business participants agree together how the IPRs are handled. It is in the intrests of the whole industry to gain the network effect. In basic infrastructure network effects differ in that sense that the investments are so big. Even though you could achieve total market dominance, you can never sell for them all, install for them all, produce devices for them all. But in software industry you don't have duplication problems. You can distribute Flash players and such pretty fast and gain the monopoly to yourself. But on basic infra technology, at least to this date, this hasn't been a problem.

Codecs are also a good example where IPRs can cause battles in the organization. This is another peculiarity of software industry, where gaining momentum is rewarded manyfold due to the low production cost structure.

We have something very good, but we cannot implement it because of the IPR's it has. Codecs are a good example of patented good in standardization. In 3GPP for example there are major battles of what codec they will use for certain implementation. [...] So in principle if there is a single codec that does two things even decently, they can prefer that over two separate codecs, just for cost reasons.

Eventhough IPRs and their quantity especially in telecom markets can be troublesome, the cumulative amount of patents should be taken into account. Telecom industry has been regulated for a long time, thus the patent game is well known and the rules are clear for everybody.

If we talk about telecom-systems, it is probably the largest thing human kind has created, with any kind of indicator. In that sense that every end-point is compatible with other end-point, then you get roughly 6 billion. So the investment level that has cumulatively gone into telecom throughout the years is extremely large. And that does not just come from building equipment, but you need to develop things as well, and the investment cycle is long. And in this sense the ownership matters should be inspected through the whole cumulative space.

The interviewee continues that understanding the big picture is essential for the whole society. This does not mean that we should be naive about it, but in the end if the benefits are reachable, they can in some sense be shared as well.

Now and them we are laughed at for the saying we have "for the best of the mankind". It is not badly put in essence. You don't have to be naive about it, it is a kind of gardening. You do it that you get a good yield of fruits for anyone. You sell them, naturally, but it is not over exploitation.

4.2 Analysis

4.2.1 Need is key

4.2.1.1 The demand and correct problems

The actual need for the standard to be successful was considered a very important factor by half of the interviewees. This was clearly the biggest single critical factor interviewees raised up. Few others brought it up as well, but did not raise it as a critical factor. Case examples were represented where standardization efforts were not succeeded due to the lack of the real need, and statements based on professional experience were represented as well.

As a case example, IPv6 has been developed, but not taken into wide use, for almost 15 years at least partially due to the lack of real need. Partially due to the delays in IPv6, the Mobile-IP was affected as well. Although the IPv6 protocol is complex in a sense that you need a lot of different industries to work together and agree on matters, the lack of the need is one explaining

factor in this particular case. The IPv4 protocol has been working satisfactorily during these years, so markets haven't really had the need to have it deployed any faster. Similarly HIP project was argued to have need based problems. Although the actual protocol was considered technically good, the pull from customers was missing, which led to problems.

There are still situations where the market pull is not the only matter to consider. There are also cases that require visionary push. The example of QKD (Quantum Key Distribution) was presented to be one such case. The argument here is that the demand dimension applies very well to the market driven processes, where the products are reachable by customers, but poorly on products that are in some sense working as the platform for them. However, this argument does not contradict the need dimension, but the push should be considered something that enables the pull to emerge at some point.

Therefore, with products that require some kind of a platform, the pull concept that is deemed as critical by most of the interviewees can in some situations require push for some parts of the outcome, before the demand dimension can emerge. This requires the vision of the people implementing this and might not always be successful. The QKD is a good example where this is yet to be seen how the vision will come true.

Real world problem solving was also considered an important factor. This matter was examined through IP and X.25 protocol battle that IP won due both it's simpler implementation, as well as it in fact solved the correct problem. The X.25, which was also a capable protocol, tried to solve many other problems as well. In this case, the latter became more complex and thus more expensive to implement. Besides the real world case example, the point was made that the solution should not just be "fun to solve", but it should also solve a real business problem as well. The real world problems can be considered as an extension to the demand dimension. Therefore, it is not enough that there is a need, but the need must be addressed with correct means.

This finding is significant in a sense it has not been addressed largely in earlier literature. The lack of earlier literature regarding the issue is an interesting finding since this was considered the most critical factor by half of the interviewees, with real case examples to reinforce the finding. The existence of a real need to accomplish something successfully could be considered more or less self-evident, but since this finding kept coming up during the interviews it might be that even though it can be seen as a self-evident factor, it still seems to be a problem in some standardization efforts. This can also be an indication that the research in the field has been focusing on matters with too narrow scope in order to find matters at such abstract level. This finding partly supports the earlier presumption that CSF literature has been providing mostly toolboxes and methods for specific agendas.

Similarly, the categorization to the CSF criteria is hard as well. Earlier literature offers the environmental aspect (Leidecker and Bruno, 1984), which is the closest match from the options available. The need and problem solving categories have both economic and social forces to drive them, but it is unclear if the findings are even too high-flown to match criteria accurately. However, the environmental aspect from Leidecker and Bruno (1984) is the closest match, but still a borderline assessment. Therefore, no definite conclusion of characterization can be achieved for this factor. It is still interesting that the most important finding according to the empirical evidence cannot be exclusively linked into the earlier literature.

4.2.1.2 Complexity addressing through simple minds

Complexity was not considered a critical success factor. This is in a direct contradiction with earlier research. Hanseth et al. (2006) suggested that complexity is one of the important factors in standard creation success. The findings do not support this claim. However, there was support for Hanseth's (2001) gateway research, where he indicated that to address complexity, the issues should be addressed by splitting the single standard into multiple smaller ones. This was partially supported by findings, where the same modular concept was considered a way to handle complexity. The modularity however comes through people's competence being naturally divided into smaller focused specialities.

One opinion regarding the complexity addressing is that there is no systematic way to address the complexity. One interviewee suggested that the complexity is addressed merely through the limited capability of humans to understand matters. Nothing overly complicated cannot be handled, therefore the matters tend to be modular in their composition as well.

The study of Schneberber and McLean (2003) received partial support from the empirical evidence. The support comes in a sense that increased functionality leads to more complex solutions in real life cases. This is however, only a partially supported, since the definitive nature of what the functionalities really were that were presented in the empirical evidence were human-based instead of pure technical additions. Therefore, the causation between the findings and earlier literature is in this sense unclear, but the phenomenon itself is present.

However, increased business interests tend to also increase the complexity through the fact that as the interest groups grow in numbers, so does the wanted features in the standard increase. This means that if the features are not controlled what gets in the standard, this tends to lead into more complex standards.

4.2.2 How it gets done

4.2.2.1 The actual work

Technical solution and the possibility to incrementally implement it into the production environment was seen as an important factor. This applies especially to large production environments, such as telecom networks, where maintenance breaks are both expensive and usually complex to handle. This means that for the standard to succeed you have to consider the implementation factors as well as the proper technical solution. If the implementation into existing networks is not assessed, it can lead into problems. There was a successful case example of this, which was related to IPv6, and its mobile tethering-features. A cross-organizational work between 3GPP and IETF, where this particular standard has found uses in other industries as well.

This factor has support from earlier CSF literature. Sumner (1999) had this level of analysis in her paper. The level of analysis was on project case level, thus this finding reinforces earlier literature on project level analysis. This might also indicate that CSF research previously made have had too narrow scope for general findings, or on the other hand this can be an indication of standardization having a multitude of different levels of critical factors that affects it comparing with other ICT areas that have more narrow field of affecting factors.

The matter of how the standard is scoped can be either success factor or a hindering factor. Correctly defined scope and use cases can be a key to success. The suggestion here is that you can standardize for a long time with too wide scope just for the sake of it, but it won't get done. If definitions and scope are clear however, it tends to keep the train going. There was no specific case example, but according to the interviewee there are and have been cases that have failed because of too loose scope.

Scope is also supported by the earlier CSF literature, but only on a limited level. Aldayel et al. (2011) found that scope has some degree of correlation, but it was not considered very significant in comparison with other findings they had. In ERP implementation projects other factors were considered significantly higher. The environments of this particular success factor are very different from each other. It is still interesting to find that a success factor that is not considered significantly critical in a project context, can still be considered critical in a standardization effort, which can be to some extent considered being just a more complex project environment. Therefore, the finding is in par with earlier literature, but the importance of the factor is in contradiction between the studies.

People always matter. They matter in the interest groups in a sense that they find each other to accomplish the matters they are implementing. They matter in contribution sense that technically competent people are the main source for the specifications of standards. This was also raised as an important factor in a telecom case example SIP, where the actual implementation of the standard was not considered successful, but technically competent people was one reason it still was possible to start the production use. Similarly people also matter on the chairs of different boards as well, where they have the role of keeping the standardization train going.

Similarly as the scope is considered critical for success, people are in the same line according to earlier research (Aldayel et al., 2011). This was a finding from multiple interviewees and is considered a critical success factor in this thesis. This again highlights the multitude of different kinds of critical success factors that are found in different abstraction levels throughout the research field.

There is also a societal dimension in standardization. The education regarding standardization matters is seen as inadequate. This is derived from the difficulty assessing the timing of standardization. This can be a problem especially with situations where technology is too far developed and people cannot find an agreement, since standardization effort was started too late. There are fundamental things in standardization that education can help to make better, successful standards. The competence of people is another finding in a sense that it helps to assess the correct timing when the standardization efforts should be made, and to avoid the situations where it would be too late. This is considered as an extension to earlier finding regarding the people dimension.

The actual work is the most easily conceivable aspect in the empirical evidence. There are easily understandable, and perhaps even measurable factors on this level such as the scope of the effort, competence in the work group, and technical solutions. Therefore, this level has the most similarities with earlier literature. As the factors have the support from earlier literature, they have a higher degree of confidence.

4.2.3 The ecosystem must exist

4.2.3.1 The ecosystem

The second most important factor according to empirical evidence was the existence of an ecosystem to support the business environment and standardization. The standards are not, or should not, be created just for their sake. There is a wider set of things that must happen in order the standard to be successful. There are developers who make clients and servers, people who act as consultants, customers who buy the several products, and so forth. The big picture is formed upon the ecosystem of separate participants that will, at the end of the day, create

the standard if it is deemed necessary. This applies especially to telecom industry since it is the clearest example of a multi-vendor environment with several different types of vendors and other participants taking part in it.

This finding can be considered as the environment, where the actual need, problem solving, and the work gets formed into a commodity. The real multi-vendor environment requires a proper business promise to all participants in order it can get formed. And on that the ecosystem is formed on. The place where the need and problems are are formed to respond to the actual needs of participants operating in the ecosystem. Earlier literature did not address the existence of the ecosystem to be a factor at all. Like the need dimension, the concept of the ecosystem is rather abstract and hard to quantify, but in the context of earlier success factor research, Leidecker and Bruno (1984) had the environmental dimension in their study. This finding can be considered being in par with the earlier literature.

Openness of the standard work procedure was also considered very important. This applies especially to standards that are created for the whole world, namely telecom standards. The case example of this was GSM versus CDMA, which GSM won because it was considered an open, multi-vendor environment where competition was able to form freely. Compared with CDMA, which was a more closed environment with fewer participants. The open environment in GSM was able to attract more people to contribute, and especially it was able to attract more vendors to attract competition into it. The industry was more open for people to join and contribute together. The openness dimension is internally linked to the ecosystem. It a mindset of what the work on the ecosystem is based on, and therefore the link to a CSF characterization is hard to determine. This phenomenon is considered as a subset, or a requirement for the ecosystem to function properly. Earlier standardization literature assessed the openness, but as a conceptualization of the actual standard in a sense how it is created and who owns it. As a function of the ecosystem, this phenomenon had no support from earlier literature.

In similar tense than the openness, one of the key factors in a successful standard effort was the predictability of the work, and how it affects the markets. When the whole community is aware of what is done and where the work is leading, less surprises there will be. Standardization is not, at the end of the day, a game of surprises, but more a game of transparency and openness.

And through them the risks can seem smaller to the participants. The analysis of openness applies to this matter as well. It is a mindset that participants in the ecosystem make happen, thus creating the predictability themselves. It is not an easily definable matter, since even though it is the appearance of how the ecosystem presents itself through openness, it is not easily quantifiable. Inspecting it through earlier literature, Leidecker and Bruno (1984) would characterize it as an environmental factor in a sense it has a social dimension, as well as an industry related factor due to the fact the inspection scope is limited to the industry where it occurs. Therefore the predictability is also considered as a linked phenomenon within the ecosystem, and it functions as a sub-dimension like the openness does. Furthermore, openness and predictability are a pair in a sense that they reinforce each other. Openness affects the better predictability, as well as predictability reinforces the openness to exist in the future.

The work in the standardization field is considered highly consensus oriented. The concept of voting in these organizations that emphasized consensus is considered secondary or non-existent. However, even though there is no formal voting, people still have their opinions and they express them within the organization. Therefore, the lack of voting does not mean that the consensus gets built on its own. Quite the contrary. It requires long negotiations and trying to find friends to support their opinions. The consensus was not considered a critical factor by the interviewees, but it can be due to the fact that this might be considered as a self-evident occurrence in standardization organization. However, since this factor was not raised to be critical, even though the lack of consensus probably won't get anything accomplished, it is included in the ecosystem conceptualization, but not brought up as a separate factor in the framework.

Similarly mutual interests between participants are considered a key element as well. This means that no single participant should get obvious advantages over other participants. As the work is consensus-based to a large extent, everyone needs to get something in return, otherwise it will most likely won't get done. There have been cases where this has not been clear, for example ENUM, Mobile-IP and SIP, and none of them were characterized as successful standard efforts, but were raised as the examples of what kind of problems can arise. So to some extent although not raised as the most important factor by the majority, this has had implications for multiple standardization efforts. This element affects the actual work as well

the environment. It is hard to exclusively determine whether this would only occur within the ecosystem or on the level where the interaction of working is happening. However, as the ecosystem is not a concrete definition compared with other elements on work level, such as scope or technical solution, the interest dimension is somewhere between them. Therefore in this interpretation it is kept on both levels.

Like the companies interests must be mutual between them, people doing the actual work should also have the support from their company. This means that people should not work on their own without their company support in the background. This is somewhat in par with the mutual interests as well as the need dimension, since if people work on their own, neither of them necessarily exists. Furthermore, the lack of mutual vision or different goals with participants can easily lead into problems as well. This is in par with the need for the interests being mutual, but with a twist, since the mutual benefits matters tend to be financial related, the vision related matters have more to do with how the things should be executed and achieved, it has an organizational dimension.

The interest of the participants is a sub-dimension in the ecosystem. An expression of consensus in its economic sense. Earlier literature gave some insight for this finding. Choi et al. (2004) for example argued that participants associated with the standard creating process tend to behave in goal-oriented manner, which will lead to conflicts within the group. The empirical finding supports this argument. Furhermore, this finding also makes it possible to sharpen the earlier findings of Choi et al. (2004) in standardization context. The reinforced statement is: "the conflicts are prone to occur when participants are acting in goal-orienting manner and when the goal orientation of one or more participants is guiding the effort to a point where the interests of creating the standard are no longer mutual". However, even though this finding is in par with earlier standardization literature, the characterization of success factor dimension based on literature is still hard. As this matter can be considered as a sub-dimension in the ecosystem it should be considered being in the same domain. The categorization is uncertain in this case as well.

4.2.3.2 Where it gets done does not matter

Whether the standardization work happens in a formal organization or an informal consortium was not considered critical. The overall tendency was that the market driven work has in fact moved from the formal organizations into informal consortiums a long time ago. The findings supporting this is backed up by earlier literature as well. The work is usually a combination of work in both kinds of organizations. One interviewee characterized this behavior as "forum shopping", where organizations visit multiple organizations with their ideas and try to find the one with the most support for their proposed standard. Blind and Gauch (2008) had similar suggestion, but they had an economic perspective to the issue that it arguably supports both R&D and long term strategies in the company.

Similarly formal organizations are, to some extent, used to rubber stamp the standards of informal consortia. This happens both in Europe and in the U.S. as well. Therefore it can be a combination from both informal and formal worlds, it has a regulatory aspect as well. Some issues demand the approval of a formal organization due to the legislation and regulation, which makes this sort of working understandable.

Software business has a distinctive difference in it that separates it from more manufacturing industries. The cost of creating another copy of the product is very low and keeps lowering after each additional copy. This raises the bar for standardizing anything in either informal or formal organizations. It is easier to capture the markets first with proprietary solutions, and only after that think about standardizing the product. The same logic does not apply on telecom industry, or industries that have the additional cost to creating a copy of a product.

Even though the organizational question had multiple aspects in it and it certainly is a factor on some level, it was not considered to be a critical factor among the interviewees nor the earlier literature. Therefore this factor is not included in the framework as a critical factor.

4.2.3.3 Patents merely slow down

Patents and intellectual property rights were not considered an important factor in standardization either. The overall tendency among the interviewees was that intellectual property rights slow down the process and it tends to have negative implications for the technical solutions. The implications can be technical in a sense the outcome does not have the best solutions in it, or just annoyances through infringement cases that must usually be handled in court.

However, as one interviewee suggested, especially on telecom industry where everything is patented and protected with IPRs, the matter should be put to correct perspective. Telecom industry has 7 billion potential customers. The industry is huge and has had huge number of people working in it for many decades. The number of IPR's and patents are naturally in par with this. So the ownership matters should be inspected through the whole cumulative time space. This is a reasonable suggestion. However, Bekkers and West (2009) suggested the amount of patents has increased at the same time the actual patent holders are decreasing in numbers. The literature indicates some level of condensing in patent holders as well as increasing speed in the patent numbers. This was neither supported nor disputed in the interviews, thus receiving no further indications of it in this context.

4.2.4 The resulting framework

The analysis ends with a framework (figure 4.1) based on the findings. As the basis of this thesis is not expecting to find universal truths about the subject, the same assumptions must be applied to the findings. The point of this picture is not to provide a direct tool or give guidelines how the standardization work should be executed in order to achieve good results, but to give an interpretation of the matter, and to point out how broad concept Critical Success Factor can be.

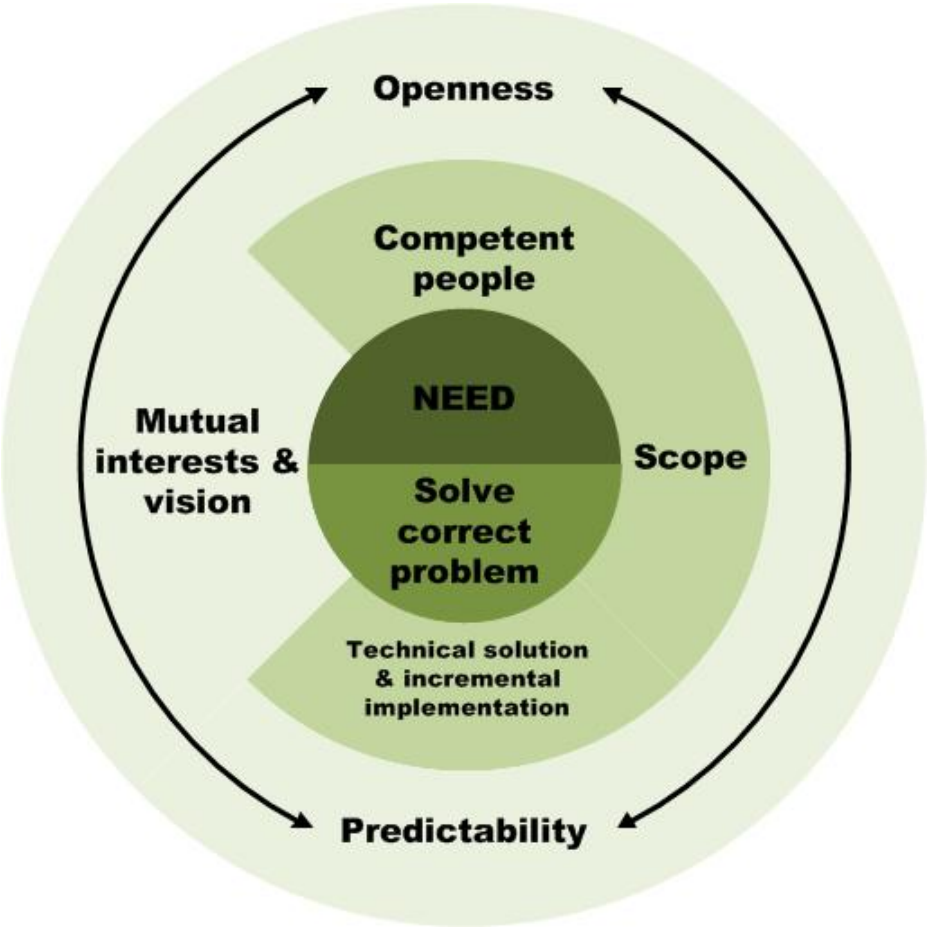

Figure 4.1: The resulting framework

This is not to say that the factors don't apply in the real world, quite the contrary. Many of the findings in this thesis are derived from real life experiences in actual standardization efforts. The people have been involved in the efforts themselves, which makes the data very valuable. The model derived from the findings should be assessed as a depiction of real world scenarios, but since the findings are on so many levels of different abstractions this does not serve very well to practical scenarios.

As the factors are found on many levels, they are tried to put in a context that gives a better view of the different layers of abstraction. The existence of a certain need, and that the need is responded with the correct problem solving is in the center of all. This was the most critical factor found in the interviews. One interpretation is that the need penetrates all layers in the illustration, because the lack of it can occur on every level of findings. However, on the illustration it is kept in the center, as it depicts the core of what is needed in order a single standard to be successful.

The same logic applies to outer layers as well. They are not in order of importance, but in order of abstraction. The middle layer is the organizational dimension with more practical concepts inside it, and the outermost layer represents the ecosystem where matters such as openness and predictability must occur. One way to look at the illustration is to imagine the second line being the mechanical tools for the projects that are easy to conceive. They are the factual matters that must be handled in the work group for the standard to be successful. Around the easily conceivable middle layer there are more abstract matters around it that require different mindset depending on which one is under the inspection. As the need dimension has a very narrow view to the problematics of a single case, the ecosystem requires very broad understanding how all participating members act and participate together.

The conclusion is that there are only few factors that can be easily turned into an exclusive list of factors that must succeed in order the whole effort is expected to be successful. The factors that were considered the most important are very abstract by their nature, thus being very hard to express in any excluding manner. However, the illustration of empirical evidence manages to express the whole field where the work happens in reasonably simple means. The empirical evidence represents the whole field from its origins the need, into where it all happens in the ecosystem.

Chapter 5

Conclusions

5.1 Main findings

The main objective of this study was to find critical success factors within the standardization field in internet and communication industries. The other objective was to find how the critical success factors are actually perceived by experts who have long experience in the field. The results were quite surprising at the same time they were partly expected. The most important factor that half of the experts raised up was the actual need for the standard. This can sound self-evident, but there were real life cases presented where this has been a problem. Like the need factor, solving the correct problem instead of broad variety of problems was considered a critical factor as well.

There were a variety of factors that can be considered as tools for project management. Factors such as the scope of the effort, the competence of the participating people, technical solutions and possibility to implement solution incrementally, and the mutual interests within the work effort. These are concrete factors that are easily comprehendable as tools, if this had have been a thesis that was set to provide such tools. These findings, although not directly addressed as significant in earlier literature, are still the kind that earlier literature have addressed widely.

The other end of the variety of critical factors that was raised up was the concept of the ecosystem. The ecosystem holds all participating groups with business interest that have mutual vision to accomplish the standards. At the core of the ecosystem are factors such as openness and predictability that feed each other in order to keep the ecosystem working. These are, like the need factor, considered as surprising factors as well. Together with the need dimension, the ecosystem factor is hard to comprehend in practical terms compared with the tool-like factors, which makes them harder to approach in a sense that they are hard to quantify.

The perception of a critical factor is extremely broad. There are earlier studies on higher levels of CSF matters, but this type of inspection of perception has not been widely addressed. As the success factors proposed by interviewees vary from the concept of the need and the ecosystem, into the determination of how narrow scope should the effort have, it is clear that the perception of a critical success factor is extremely subjective and depends on the experiences of people who are providing the answers. Therefore, the definition of a Critical Success Factor remains highly subjective as well. It is a context related factor that rarely has a universal meaning outside the context it is stated in.

5.2 Theoretical implications

The world is not black and white in a sense how to characterize Critical Success Factors. Earlier literature has addressed the issue on many levels, but on rather excluding tone as well. Excluding in a sense that literature has provided tool-like results, with the implication that success factors in ICT area can be perceived as exclusively suitable for them in all scenarios. This research demonstrate two possible scenarios. That CSFs are a complex matter that cannot be estimated with a tight scope of pre-determined matters, but the matter needs to be inspected with a broader view, or that ICT standardization differs greatly compared with other fields in the ICT area.

Either of these two scenarios is possible, or a combination of them both. What we can take for granted is that CSFs are very subjective, context-related, complex matters. Standardization area, especially in internet and telecom industries, is a complex multi-vendor environment, which actually can make matters even more complex due to the variety and number of involved participants. Regardless of what the conclusion might be, Critical Success Factors are multi-dimensional, and not uni-directional in their behavior. This means that the factors happen on many levels of abstraction and they interact with each other. The exclusive determination of such factors can be misleading.

5.3 Practical implications

For practical matters, this thesis does not provide a clear toolset to work with in the future. This thesis rather provides a change in the mindset especially for people who have previously considered that solving a single problem enables them to use it universally throughout the field. Quite the contrary this thesis provides the view that even Critical Success Factors are highly context-related, and it is almost impossible to remove the factors from its context. In this sense, this thesis will not bring solutions that help to solve standardization matters more efficiently or better in the future.

However, the positive side is that this thesis raises awareness of making better estimates regarding how the Critical Success Factors should be assessed. As the factors are found on so many levels, the knowledge of this can be valuable. There are high significances and high correlations in factors found all around the ICT area. That does not mean that the high correlations express the whole context of studied subject. In fact, making judgements with too narrow scope can eventually lead to wrong decisions. Therefore the awareness that the standardization CSFs are multi-dimensional and very much context related can prevent managers from making rushed decisions on matters that might be more complex that it may actually seem. And this is the practical implication this thesis provides, the awareness of the whole context instead of single, exclusive factors.

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Appendix A

Appendix

A.1 List of interviewees

All interviewees are in alphabetical order.

Name	Title	Company
Raimo Kantola	Professor	Aalto University School of Science and Technology
Jukka Manner	Professor	Aalto University School of Science and Technology
Esko Penttinen	Assistant Professor	Aalto University School of Economics

Table A.1: Professors interviewed for methodology

Name	Title	Company
Timo Ali-Vehmas	Vice President	Nokia
Jari Arkko	Expert	Ericsson Research
Hannu Flinck	Manager	Nokia Siemens Networks
Markus Isomäki	Senior Manager	Nokia
Jouni Korhonen	Senior Specialist	Nokia Siemens Networks
Gaby Lenhart	Senior Research Officer	ETSI
Klaus Nieminen	Senior Advisor	Finnish Communications Regulatory Authority (Ficora)
Ørnulf Rødseth	Research Director	Marintek
Jonne Soininen	Head of Standardization Strategy	Renesans Mobile Corporation
Tapani Turunen	Product Area Director	Tieto Finland

Table A.2: Experts interviewed for empiria

A.2 Interview questions

Interview questions: What makes a successful standard?

Interview with xxx on nnn

1. Few questions regarding background.
   (a) How long have you been involved with standardization efforts?
   (b) Do you specialize in standardization efforts of a certain industry?
   (c) Is the organization you represent considered as a public or a private organization?
   (d) What standardization organizations have you worked with?
   (e) In what roles have you been involved in them?
   (f) Did the standard undertakings have national, EU, or global scope?
2. Elaborate on the attributes of a specific standard creation process you were recently involved with.
   (a) What standard was created in the process?
   E.g. The name of standard, what was the purpose, intended user base, etc.
   (b) Did the organization have a common agenda in the beginning of the process?
   If not, how was the situation resolved?
   (c) What participant groups took part in decision making?
   (d) Did all participant groups take part with similar efforts?
   (e) Was Senior Management involved to support the process? On what level?
   (f) Was the standard open or closed in the sense of intellectual property? E.g. Open, free product? Licensing fees?
   (g) Were all participants clear and satisfied with earning logic created in the process?
   (h) What kind of benefits the created standard brought to stakeholders? E.g. Cost-effectivity, better interoperability, something else?
   (i) What level and kind of complexity the undertaking had? How it was addressed?

3. Elaborate on other attributes of the standard creation process.

    (a) What other attributes contributed to the creation process?

    (b) What factors that affected positively to the process should be considered as prevailing?

    (c) What kind of problems arise during the process? E.g. Any show stoppers or other constraining factors?

4. Other thoughts?

    (a) Some other thoughts that you would like to bring up?