INTER-ORGANIZATIONAL CHALLENGES OF UNDERGROUND CABLING IN THE RURAL AREAS

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ABSTRACT

Some decades ago, power companies in Finland owned, designed and built all of the electric lines in their market area. At present, distribution companies are increasingly utilizing external service providers. For example, cabling work is usually outsourced to specialized contractor companies and to their subcontractors. A similar development occurred earlier in the construction sector.

Research effort has been conducted to obtain an overall picture of the current problems and challenges related to medium-voltage underground cabling projects in the rural areas of Finland, where cabling is a growing trend. The research constituted several interviews and a workshop. The interviewees and workshop participants were representatives of energy distribution companies, cabling contractors and other stakeholders.

The focus in the interviews and the workshop were the major challenges and development possibilities of the current cable network construction processes, especially from an inter-organizational perspective.

The identified challenges could be classified under the following main themes: preliminary design, contract contents, documentation, quality assurance, joint construction and collaboration with authorities and other stakeholder groups. Deeper co-operation and fewer obstacles in the information flow could moderate many of these challenges.

INTRODUCTION

Traditionally, electricity has been distributed mainly with overhead lines in the rural areas of Finland. Currently, the cabling rate for medium-voltage networks is only 11 % in Finland (Ministry of Employment and the Economy, 2012). However, recent large-scale and long-term power outages have brought discussion about the reliability requirements of electic distribution in the rural areas, where failures in the electicity supply are often slow to be repaired. There appears to be political pressure to speed up the large-scale cabling in Finland, which has happened somewhat earlier in Sweden (see Larsson et al. 2009; Bengtsson et al. 2009).

The environmental conditions are the main causes for faults in the medium-voltage networks in Finland (Marttila et al. 2009). Wind, storm, ice and snow together are the most common reasons for faults in overhead lines (Lehtonen 2010). Also underground cables have some special types of incidents, such as flooding and digging, and their faults can be slow to repair. However, their fault frequency is typically lower, and the timing of their faults is not so

weather dependent as in overhead lines (Fenrick & Getachew 2012). The increase of cabling has been seen as a prospect to improve the reliability of electricity distribution networks. (Fenrick & Getachew 2012; Yu et al. 2009)

Political forces can affect the amount of cabling, for example, via the regulation model and provisions related to cabling work. Currently, there are, for example, plans to raise compensation charges for power outages with the background idea to motivate network owners to develop their networks more reliably. In addition, the provision related to cabling in the inner slope of roads is planned to be changed to make cabling the more preferable option. (Ministry of Employment and the Economy, 2012)

The aging of the old electric lines is one significant backround factor driving the large-scale cabling in the rural areas. A large volume of Finnish overhead lines were built in the 1960s and 1970s. The average serviceable lifetime of these overhead lines is estimated to be approximately 40-60 years, and thus, several thousand kilometers of electric lines will be rebuilt annually in the near future. (see, e.g., Haakana et al. 2009)

Technological development has been another essential background factor driving the continuos increase of cabling frequencies. Both cables and installation methods have developed in recent decades. In the case of medium-voltage cabling, the plowing method has recently become more generalized in Finland. New cable types have also enabled the utilization of the plowing method in many cases where it was previously not possible. This development has been important because the plowing method is a significantly less expensive way to install cables than open cut trenching. However, the investment cost for underground cabling is still usually more expensive than that for overhead lines in medium-voltage networks. (Immonen et al. 2009)

Economic factors and especially life cycle cost considerations can drive a preference for underground cabling in some cases. Even though the investment cost for underground cables is typically greater than that for overhead lines, underground cables can reduce costs in the operation phase. The Finnish regulation model has been created in such a way that it would encourage network companies to execute investments. The computational capital involved in a network has an effect on the allowed profit. The reliability of the power supply has a direct effect on network business profitability through this price regulation model. In addition, the cabling rate is one monitored variable. The energy regulation models differ internationally, and this kind of valuation of underground cabling investments seems not to have been general practice in many other countries (see Haney & Pollitt 2009).

Some decades ago, power companies largely administrated the supply chain in their local area. They owned, planned, routed and built all of the electric lines in their market area. Furthermore, the same companies generated and sold the energy. During the past several decades, the business environment has changed, and the power industry itself has undergone structural reform, which is still ongoing. (Immonen et al. 2009; Lassila et al. 2011) Many such tasks that were earlier performed internally by the power company are often outsourced to several discrete organizations now. Some of these changes have followed public policy, such as the decisions to open electricity markets, where power delivery and sales businesses have been separated from each other by law. Some changes have happened because network companies, who own the power lines, have focused on their core business and are utilizing more external service providers to improve their profitability. Currently, for example, cabling work, some planning and measurement services, and at least some maintenance work on electric lines are often outsourced to specialized companies. The supply chain is becoming longer when many contractors are also utilizing outsourced services.

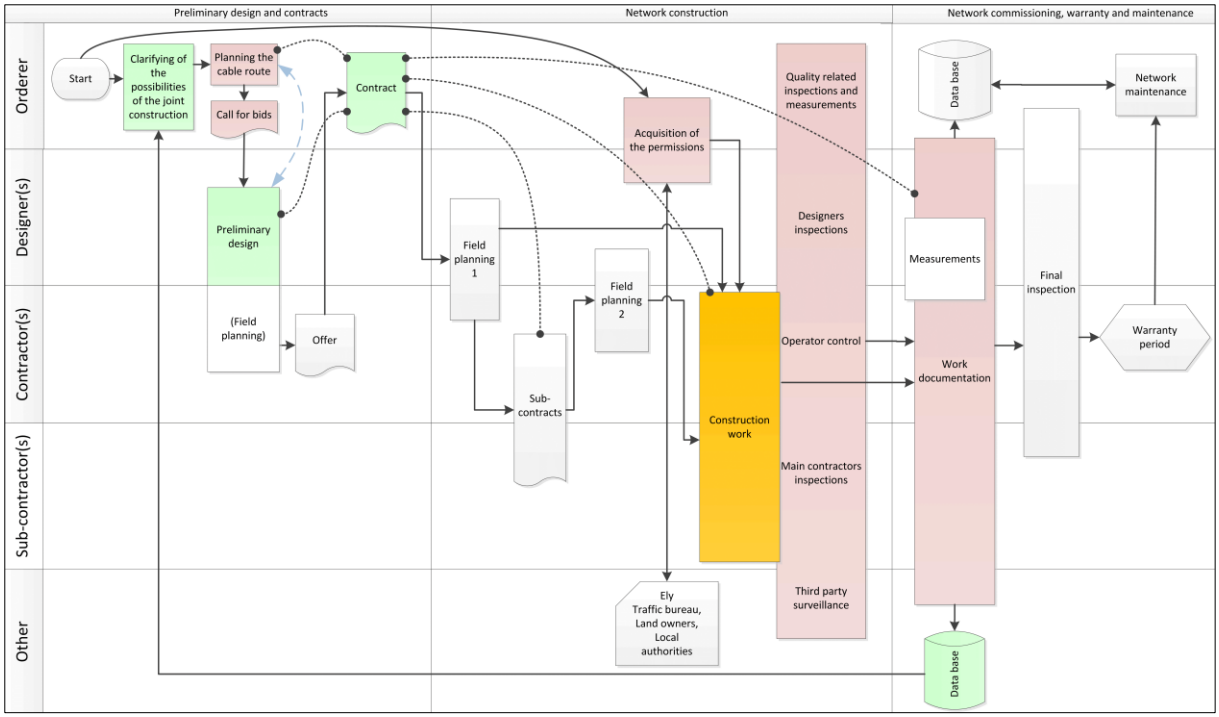

Figure 1. *Cabling process flow diagram*

Inter-organizational relationships have generally received a great deal of attention in organizational and managerial studies (see, e.g., Dyer & Singh 1998; Dekker 2004; Gadde & Dubois 2010). However, even though there are more organizations involved in the cabling process, challenges related to inter-organizational collaboration in cabling processes have received little attention, at least in academic circles. In this paper, some of the inter-organizational challenges relating to the construction process (see Figure 1) of medium-voltage cabling in the rural areas of Finland are discussed. The most central research question in this study has been what kind of inter-organizational challenges the organizations working with cabling currently see. The kinds of improvements that could be conducted to reply to some of these identified challenges are also discussed.

RESEARCH PROCESS

To obtain an overall picture of the current problems and challenges related to medium-voltage underground cabling projects in the rural areas of Finland, six representatives from energy distribution companies (from four companies), six representatives from cabling contractors (from four companies) and six external experts were interviewed in 2011. The energy distribution companies interviewed covered two organizations that are among the largest players in the field of energy delivery in the rural areas of Finland and two medium-sized players.

The semi structured interviews consisted of four themes of partitions. These were (1) current practices relating to underground cable network construction, (2) major challenges of current practices, (3) identified development possibilities and (4) quality assurance of execution. In addition, some selected pictures from underground cabling projects were presented at the end of the interviews to provoke additional comments and discussion. The first part (1) of the

interview considered how things are perceived to be now, and, in the later parts (2-4), the focus was on how things could or should be.

It was found that many challenges and developmental needs described by interviewees were related to inter-organizational collaboration. It is easier to settle challenging inter-organizational issues when different parties are present. The workshop was seen as a suitable environment for further discussing inter-organizational challenges identified earlier during interviews. Therefore, many of the challenges found were taken under further contemplation in a workshop, to which many different stakeholders related to cabling were invited. The workshop had participants from three different network companies, two different cabling contractors, Finnish Centre for Economic Development, Transport and the Environment, cable location service provider, project management service provider and staff from Tampere University of Technology.

The quality assurance and the contract contents were raised as the main themes of the workshop. Eight different topics related to cabling processes were discussed in small groups. The topics included project execution (at the level of preliminary design and joint construction), contract issues (rules, call for tenders and contracts, spread of risks and bonuses) and quality assurance (intensification of the work monitoring, quality criteria and documentation). The idea was to collect development ideas for each topic and to determine the most important issues under each topic.

FINDINGS RELATED TO CHALLENGES

Several challenges were identified (see Table 1), which were classified under the following main themes: preliminary design, content of the contracts, documentation, quality assurance, joint construction and collaboration with authorities and other stakeholder groups.

Preliminary Design

Until recently, the most common division of duties between the ordering network company and the external service providers was that the network company did the network design, which includes preliminary design of field planning. The design task of the contractor was to make the final field planning for cabling work. A recent trend in Finland has been an increased outsourcing of part of the network design work by some remarkable network companies. In the deepest version, not only the cabling work but also part of the network design and the field planning is sometimes outsourced to the contractor, whose assignment is to conduct all necessary planning and cabling work either itself or by buying the required extra services from another company. Traditionally, the ordering network companies have themselves conducted more planning before calls for offer than they currently do.

It was highlighted in the interviews and in the workshop that costing can be challenging for contractors if it has to be done before accurate planning information is available. It was also recognized that current practice, where every contractor does some field planning (necessary for tender calculations), causes overlapping work that has to be priced in one way or another into the offerings by contractors. Thus, the current practice is not necessarily the most economic option from an inter-organizational perspective.

Table 1. *Inter-organizational perspective for different themes*

Category	Content (e.g.)	Central meaning of the theme from inter-organizational perspective	Effect of outsourcing in this theme	Examples of inter-organizational challenges
Preliminary Design	General planning, setting of targets that are used in the contracts.	Prerequisites are set for those organizations that are doing field planning and excavation work.	A different organization is doing preliminary design than the organization doing field planning or excavation.	Costing is challenging by contractor without adequate design and soil information, especially in the case of total price contracts.
Contract Contents	Written agreement about what will be done, and how.	Defined targets have an effect on the quality and documentation produced by contractor and sub-contractors.	Before, many things were done inside the network company; currently, targets have to be exactly defined in the contracts.	Confusion in the interpretation of contracts; Text changes in the call for offers are not always easily observable. Distribution basis for risks is not always fair; contracts do not always encourage good quality.
Documentation	Saved and collected information about things that can be needed in the future.	Serves different needs for different organizations: not only the network company but also other designers and excavating workers utilize location information, and the contractor can verify produced quality and quantities by documentation, etc.	When a different organization is executing cabling than the owner of the network, documentation is especially important.	All such information that could be useful to other organizations is not documented (for example, whether there is space in the tube for additional cables).
Quality Assurance	Confirmation that quality corresponds to the requirements set in contract.	Monitoring whether quality produced by contractor and subcontractors fulfilled set requirements.	Assurance is currently needed over organization boundaries.	The practices vary related to external operator control. It can be difficult and expensive to control quality produced by another organization. The period of guarantee the contractor receives from material supplier can be shorter than what he has to promise his own customer
Joint Construction	Different holders of underground infrastructure are executing construction projects together.	Can produce savings to many network companies and reduce negative impacts for local people. Joint contraction is in practice done by contractors, but joint contraction agreements are often done by network owners.	Contractors typically have experience about many kinds of underground infrastructure, not just about power cabling. Therefore, it may be easier to do it when works are outsourced.	Deficiencies in informing about future plans between organizations; different schedule needs for new infrastructure. Challenges related to documentation and information management in joint construction projects. Distribution of costs between different parties when the utility of joint construction is not the same for all parties. Challenges related to the timing of projects.
Collaboration with Stakeholders	Licenses are needed for cabling when works are done in the area owned by someone else.	Adequate informing and licenses applied in good time can reduce potential problems; that is an advantage for all parties.	Tasks have to be distributed between organizations, e.g., whose responsibility it is to apply for licenses and to inform about the project	Handling times of license applications sometimes considered to be long in the Finnish Centre for Economic Development, Transport and the Environment

Contract Contents

Some challenges related to the contract contents were also found. The contracts were sometimes considered to be open to various interpretations. As an example, there were cases where invitations for tenders and construction guides had been in contradiction. It was also mentioned in some interviews that sometimes the agreements between the contractor and its subcontractors had been only verbal. This kind of behavior can cause extra risks for various interpretations.

Contractors who were working for several network companies found it difficult that the same terms may carry various contents depending on the ordering company involved. Even though uniform definitions have been created for the energy industry, not all companies utilize them, which causes extra work for contractors, for example, in tender accounting. It was also mentioned in the interviews that sometimes the changes to contractual terms earlier used had not been emphasized in the invitation for tender by the orderer, which can cause extra challenges and risks for contractors if they do not discern these changes. It would be better for them if the differences to typical or earlier contractual terms were always emphasized clearly.

When working inter-organizationally, potential economic risks have to be distributed somehow. In the underground cabling projects, for example, there appears to be nearly always some kind of soil risk because it is not definitely known in advance what kind of ground exists 0.5-1 m below ground. If the soil risks are realized, it can cause extra work and expenses. How the risks are divided between the orderer and the contractor(s) depends on contract type used. Cabling contractors are typically small or medium-sized firms, whereas network companies are typically considerably more massive when measured by their revenue, balance sheet, or number of employees. The bargaining power (see Porter 2008) of network companies seems to be stronger than that of contractor in the case of price but not in the case of demand for better quality. Abilities to bear economic risks are not very high in all contractor companies. These risk factors seem to be one reason why some of the companies would prefer such types of contracts, where risks outside their own influencing possibilities are rather limited.

It is a challenge in the organization networks for the whole supply chain to work and develop cost-effectively but in such a way that all parties can obtain fair rewards for their work (Chan et al. 2003; Malik et al. 2007). The contract documents also have a significant impact on the quality issues because the target for quality is defined there. It was expressed both in the interviews and in the workshop that there should not be method requirements that are too tightly set for cabling because tight requirements do not encourage contractors to develop more efficient ways to work and to develop their competitive edge.

Documentation

As a consequence of the outsourcings, not all information is readily available over organizational boundaries. In the outsourced structures, there are not only demands and cost information asymmetries in the supply chain (see Guo et al. 2010) but there can be also shortages in other information flows. The content and quality of documentation is especially important in outsourced collaboration. The benefits of good documentation can be more significant to other organizations than for the organization that is documenting.

The cable routes are documented after the cables have been installed. The ordering company is responsible for documentation, but the documentation of new cables usually seems to be the task of the contractor in practice. The contractor (and subcontractors) can be the only

one(s) who has really seen *what* was done and *how*. The other parties are relying mainly on documentation.

When someone intends to install a new cable, information about the old ones is needed. The Laws of Finland demand to find out whether there are currently cables before excavation work is allowed to start. The basic problem is that the information about the location of the old underground infrastructure is not always easily and quickly available. For example, defense forces, energy, telecommunication and water companies know themselves where their own cables lie. However, when someone needs information about the infrastructures of other organizations in some area, it can require a great amount of work and time to find out what cables are there and who the present owners are, as well as contacting all of them.

Another problem seems to be linked to the form of documentation: Information about the old cables may be in paper form or too broad by scale. Sometimes, the information on the cables of different organizations is in different charts and documented at a different scale. Even though some nationwide cable location database services exist (provided by at least the companies Johtotieto & Keypro), they do not include information on all underground infrastructures. In particular, information about the oldest cables is missing. However, this situation is becoming better. Currently, the location information of new cables is usually saved into nationwide digital databases, and a shared interface where all of the country's cable location information could be accessed has been set as a target for the near future (See Ministry of Transport and Communications 2010).

Currently, the documentation saved typically seems to contain information about the cable route, the location of the cable joints and the cable type, -length and -cross section. However, for example, the z-coordinate information or information about soil ingredients around the cable is typically not currently documented, even though that information might be useful in the future, at least for (other) parties planning underground infrastructure later in the same area. There was also a small discussion about documentation of the results of commissioning tests and other measurements in the workshop. Currently, it seemed to be difficult to link the measurement place and measurement results to each other afterwards because documentation about their link is inadequate.

Quality Assurance

When a network company evaluates the quality of their contractors, many things are considered, e.g., work quality, delivery date, customer satisfaction, environmental management and the number of accidents and close calls (Salomäki 2009). However, it is important that the different components of quality are properly weighted. The quality of the installation work must be weighted more in cable network construction in comparison with overhead line construction. The reason is that the actual quality of the installation work has a significant influence on the reliability of the constructed cable network. In addition, it is harder and more expensive to detect the possible quality errors during the final inspection once the work has been completed.

The human factor is significant when it comes to quality issues. For example, the motivation of workers and their education can have effects on cabling quality in addition to, for example, material quality issues. It is not usually possible to observe all quality risks in the underground cables afterwards, and even the measurements do not show all of the failure risks in the cables. Therefore, good quality should be produced in the first place.

Before starting the interview study, visits to 6 randomly selected cabling sites were conducted without informing them beforehand. In five of these six, there were at least some questionable

courses of action observed visually. Some potential risk factors for quality faults, such as sharp rocks left near the cables, are difficult to find after the dike is covered (see Figure 2, which was taken at one site). This kind of issue can cause failures to the cables in the future. The required technical measurements are performed before the commissioning of the cable, but not all questionable work appears in these measurements because of the limits of the measuring methods.

Figure 2. *Sharp rocks are left near the cables, contrary to installation guides.*

Because it is perceived that quality assurance over organization interface can be rather expensive, in the case of cabling in rural areas, quality control often seems to be primarily based on contractor's own control. Therefore, the quality is reliant on workers' expertise and motivation, even though some supervision is also conducted by the orderer. There was a strong opinion among network companies in the workshop that the quality monitoring should be primarily developed through the contractor's own operator control in the future as well, rather than through increasing supervision by either the network company or a third party.

There appeared to be some worry among network companies about whether there are enough service providers to respond to the increasing demand of large-scale cabling in the future. This problem was mentioned as one reason why the orderers are very cautious when setting requirements for the work and supervising them. It was argued that, to obtain more players in the market, the field must remain attractive for contractors and that therefore many requirements cannot be advanced.

Joint Construction

Excavation causes a significant part of the investment costs when building underground infrastructure. It has been seen as preferable to install not only power cables but also other infrastructure simultaneously, if possible. For instance, in the case of fiber cables, excavation costs are argued to cover even 80 % of all of the construction costs (Niemelä 2010). Therefore, the motivation to do joint construction could be assumed to be strong. However, according to the interviewees, joint construction is still rather rare in practice. It seems to work well in some parts of Finland, but in many other areas, the situation is different.

In the case of underground cabling, joint construction means that those organizations who have a need for underground infrastructure are working together. Potential collaboration partners in joint construction can include the owners and/or the builders of energy networks, roads, streetlights, telecommunication networks and pipes. Joint construction can include joint tendering, joint selection of the contractors, joint informing and joint applications for licenses.

There appears to be many inter-organizational challenges related to joint construction. The division of costs has turned out to be quite challenging at times because the benefit of joint collaboration varies according to organizations. Joint construction can implicate compromises in the routing, timing of the cable installations and the costs. Even though joint construction can provide remarkable saving possibilities in the construction phase, it can be laborious to bargain. Successful joint construction projects seem to require early design work and also early collaboration (see also Niemelä 2010). According to our interviews, one key reason for the rarity of joint construction seems to be the limited and not easily available information about the plans for the future of external organizations.

Co-operation with Stakeholders

Currently, it is usually preferred to build cables near the road, if possible, where the faults are easier to repair, instead of installing them in forests. It was argued several times in the interviews that installing the cables near public roads is still made too difficult by the rules of the national authority "Finnish Centre for Economic Development, Transport and the Environment" (known in Finland as "ELY"), even though some facilitation development has happened during the past few years. In addition, the required time to obtain the licensing from this authority was seen to be at least sometimes too long by both the owners of the networks and the contractors. According to ELY's representatives, a basic problem for them is that several applications are sent to them at the same time in the spring, which congests the handling process. If the organizations would anticipate this problem and send more of their applications earlier in the winter time, the handling would be more efficient in the spring because, in the winter time (when less cabling is conducted), handling resources are more readily available. Thus, inter-organizational collaboration could be useful here as well.

Society has changed greatly from the 1960s and 1970s, when a large number of overhead lines were built. According to a few interviewees, landowners and holders are not as eager to give permission to install power lines on their land as before, at least without good compensation. Some interviewees supposed that some of the landowners do not see cabling just as a public good anymore, but as a business and therefore are not so eager to co-operate. Landowners are sometimes also difficult to contact because, currently, many landowners live outside of where their lands are located. It seems to be partly a consequence of urbanization and legacies. It was said that it is especially difficult to connect with those landowners who live in foreign countries.

The workshop participants were asked to discuss the question of who should acquire the required licenses. The unanimous opinion was that, in the first place, the one who does the field planning should acquire the licensing. In such cases where it is known beforehand that requisite licenses are especially difficult (e.g., time consuming) to obtain, these rights are usually acquired by the network company. However, one contractor said in the interview that, when orderers were not present, in practice, there are problematic situations where the ordering company has known beforehand about "difficult land owners" but the contractor has not been informed about it. This situation is a good example of how asymmetric information sharing can lead to problems in the timing of the projects. Adequate and fair informing is always a significant aspect of inter-organizational collaboration.

DEVELOPMENT POSSIBILITIES

In this research, some of the current problems and challenges of medium-voltage underground cabling construction projects were studied. The challenges identified were classified under the main themes described previously and shown in Figure 3. Some improvement possibilities related to these themes are discussed more deeply in subsequent sections.

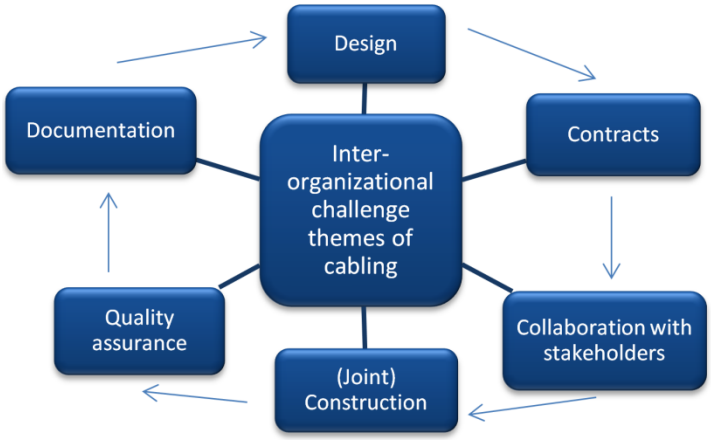

Figure 3. *Inter-organizational challenge themes covered in this study*.

Contracts are among the most important background factors guiding the supply chain in the desired direction. The problems can be handled in co-operation with the network companies and the contractors as the business matures. Many problems in the collaboration with stakeholders can be affected by negotiations. However, it can be very difficult for single companies to change some common practices in the field by themselves. Some of these problems may also require both national and inter-organizational company level advancements. Some more concrete examples are discussed in Table 2.

For example, a need for joint construction has been recognized for decades, but there are still many barriers for overcoming this in many parts of Finland. One of the barriers is linked to the insufficient sharing of information. More easily available information about existent cables, which is sufficiently reliable and detailed, could be useful for designers who are evaluating new cable route possibilities.

A partial improvement could possibly be some kind of an obligation that one should inform the others about future underground plans and also check whether other organizations have plans in the same area before starting a project. This kind of practice already exists when operating in urban areas, but it could be extended to rural areas to assist preconditions for joint construction. In some parts of Finland, joint construction works well, but, in many other cases, informing other about future plans across organizational boundaries is rather limited. It could be a significant thing for the increasing frequency and level of joint construction if the future cabling plans of organization for a few years ahead could also be found easily over the interfaces of organizations.

There is not much practical experience in rural area cabling in Finland, and only a small number of installations have been made. By far, only a small number of problems have been encountered. However, it should be remembered that, certain types of defects, commonly

encountered in other countries, require years to develop. The work performed by excavation workers has a major impact on quality issues. Thus, it is very important that the excavators are well trained and that they do their job with care. Some of the excavation workers doing cabling might not have adequate knowledge about the special requirements related to the cabling work. Every worker handling power cables should have at least some kind of basic training.

Usually, the work of excavators is not documented, and it is supervised only by the excavator itself, which means that, once the cables are covered, the only way to inspect whether the work is conducted properly is to re-open the trench. The amount of money that excavators make basically depends on how fast they do their job. Hasty work usually affects the work quality, at least to some extent. Worksite photographing might help with this problem. However, without some smart way to file the photographs, the full potential of worksite photographing cannot be used. Another problem is how to encourage the workers to take the photographs.

Generally, the documentation should include information that might have later value either for the organization itself or for others. For example, information about the cabling method could be useful in the future, at least for studies where the connection between the original measurement results and failure rates in the later phases of the cables' life cycle are sought (compare, e.g., Eriksson et al. 2003; Piekarski & Brad 2011). A common impression among many interviewees was that cables installed with the plowing method can have more reliability problems later on. A need for further research is necessary to assess whether the installation methods in fact affect the reliability and lifetime of the cables in Finnish conditions.

Each party has different needs for the work documentation. The issue in documentation is not only *what* is documented but also *how* the important information is done and exchanged between different parties. When these requirements are considered, it is quite obvious that all of the documentation should be made in electronic form.

Better and more easily available documentation could be worthwhile for other operators as well, such as contractors. A significant number of interruptions in cable networks are caused by external reasons, such as excavation work: up to 28 % of the interruptions and 42 % of the interruption time in 2010 (Finnish Energy Industries 2011). Improvements in documentation could reduce the underground cabling costs and accidental break downs and thus also have some positive impacts on the reliability of energy distribution.

Table 2. *Examples of some development areas*

Challenge	To whom it is a challenge	How things could be improved	Who could affect
Imperfect cable information complicates the design and the building of new infrastructure	Designers, excavation workers	By making more precise project documentation, which is offered in easily available format to other organizations + digitizing the old cable information, which are currently available only in paper format	Network owners
Handling of license applications is slow during the summer time	Contractors, ELY, Network companies	One key reason behind the slow handling time is that the license applications are filed mostly in the spring time, which causes a bottleneck in the handling process, and thus, obtaining the rights takes longer during this time. During the winter time, the ELY would have much more resources to be used in license handling because much fewer license applications are filed in the winter time. If the orderers would obligate the designers to send the license applications early enough to the ELY, the bottleneck situation in ELY would be smaller, which would benefit both parties. In ELY extra recruitments would not be necessary and the contractors would have faster license handling during the spring time.	Everyone with co-operation: contractors, ELY, network companies
The medium-voltage cables are not allowed to be installed to the inner slope of a road without expensive protections	Contractor, network company, (ELY)	At the moment, the obstacle for installing cables to the inner slope of road is the requirement of expensive concrete protection. Political decision to allow installation to the inner slope (using cost efficient methods) and to improve the documentation in this context can make installation to the inner slope a more popular and inexpensive alternative. To avoid potential problems related to this issue, common rules between the different organizations should also be created at the same time.	Government (Actions to realize this have already started)
Joint construction is not working partly because of bad information communication about future projects	Network companies, teleoperators, other infra constructors, cities and municipalities	The prerequisites for joint construction could be substantially improved with better informing about future projects. Mutual communication channels are required, where different stakeholders could inform each other about their future projects. New "joint construction portal" have been opened in the spring 2011 www.yhteiskaivu.fi. There is not much experience about its functionality yet, but the user interface and features of this kind of system could be further developed to serve the needs of different organizations better.	Network companies, teleoperators, other infra constructors, municipalities
Some of the excavation workers have limited knowledge about working with cables	Contractor, indirectly network companies	There could be more training available than there is today, especially for excavation workers, who do not necessarily know much about how to work with cables. A creation of some kind of common educational package for them could help to solve this problem. By using it, contractors and subcontractors could educate their own workers. In addition, more self-direction is required from the excavation workers. For example, maybe in the future, more often excavation workers will have to find out themselves (without external demonstration) the location of earlier installed underground structures so that they are not harmed during the excavation work.	Contractor, network companies, Training centers
Worksite photograph documentation is rarely used	Network companies, contractors, excavation workers	Photographing is seen as a good tool to document how the work is actually done and also to avoid problems between contractors and landowners about landscape changes (when both the original and final situations are documented). However, it takes much effort from a single contractor to document and store the photographs in a way that they can be easily used if needed. Most of the pictures are never used, so this does not motivate workers to take the photographs. It is easy to take the photographs, but, without a proper database, the usability of these photographs is very limited. Here might be a new possible business possibility in Finland. A service that offers the documentation of construction photographs based on time and location. In addition, automatic photography could be included. In the USA, this kind of service is already available.	Contractors, sub-contractors and the photo documentation service provider
Current commissioning tests cannot detect all possible defects	Network companies, contractors	Measurement methods that can detect more defects could be used. These kinds of measurements are, e.g., partial discharge measurements and tan δ measurements. Partial discharge measurements in particular require special expertise, and there are only a few companies in Finland offering these measurements. On the other hand, the most effective method for partial discharge field measurements is not yet defined.	Contractors, measurement service providers, network companies
The documentation of common practices is lacking	Each parties	The industry could define common rules for documentation. This is one factor that would help the information transfer between different parties. It is important to justify the documentation of each documented piece of information according to whether this information is really necessary.	Network companies, contractors, information system providers

CONCLUSION AND DISCUSSION

Several problems and challenges of cabling construction processes were found in this study, and some potential places for improvement were identified for future development. These issues were contemplated by the people representing different parties involved in cabling processes. Many of the challenges that came up in the interviews and the workshop seemed to be linked to collaboration with other organizations. Areas where development is especially needed are co-operation, quality control, and documentation.

The outsourcing trend seems to continue in this field because of the advantages in cost efficiency it can provide. Therefore, the prerequisites for organizational boundary crossing collaboration may have an even more notable role in the future. Co-operation and transparency could be increased at all levels. Special attention could be put on management of the business relationships. The quality control could be improved by nationwide quality criteria, intensifying the operator control, increasing training and utilizing advanced measurement methods. More common practices are needed in documentation. If there were fewer obstacles in the information flow of both documentation and future plans of different organizations, there could be cost saving possibilities in the cabling construction process if the industry is analyzed as a whole.

In a recently published study by Makkonen et al. (2012), it was argued, among other things, that there is a need for common terminologies and open communication in the energy industry. This kind of need was also identified in this study. The focus in their study was in the corporation relationships at the management level, whereas this study focused more on the aspect related to the cabling construction processes and lower level work in the organizations. Many of the companies interviewed during our research were also participating in that research.

The management of regulatory risk when outsourcing network-related services in the electricity distribution sector was researched by Tahvanainen (2010). The risks related to the outsourcing of rural area cabling were presented as a case example. The risk themes mentioned by Tahvanainen were managing the outsourcing process, loss of core competence, critical information flows break, service market functioning, fault situation management and unrealized cost savings. Many of the challenges identified in this study are related to the risks of outsourcing identified by Tahvanainen (2010).

The target to accelerate cabling in Finland means significant investments in cabling in the near future in the rural areas of Finland. There might be a need for further discussions inside the industry about how it will be ensured that the quality and content of these investments can be raised to the desired level, which is especially challenging because a significant increase in cabling will also mean a significant quantity of new, under-experienced contractors, subcontractors and workers in this field. The problems associated with this rapid growth needs to be addressed both in the industry and in future research.

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