INTRODUCTION

Electricity distribution business is shifting from traditional utilities to commercially driven companies operating in competitive service markets. Some business segments in the field of electricity distribution business are under corporatization. This change requires studies and development of new kinds of business models. To understand the possibilities these new companies have, it is important to study the cost structures of their operations more closely. The analysis of current cost structures of different processes and activities make it possible to understand the changes required for municipal organizations to enter the competitive service markets.

Figure 1. New business operation environment for electricity distribution business.

Figure 1 illustrates the development of distribution business. The shift from traditional and centralized business processes to core business units acting under competition is the predicted development in the electricity distribution business in future. This development has been studied in cooperation with Tampere University of Technology and Lappeenranta University of Technology. The aim of the project is to study the changes taking place in electricity distribution business and forecast the business scenarios for future.

The measurement process is one possible business to be outsourced. In this study, the basis of understanding and analyzing the business framework for measurement in competitive environment is created. Another shift that is going on in electricity business is the rise of Automated Meter Reading (AMR) technology. Investment decisions for automated meter reading are currently under consideration in many European countries. Enel in Italy has published plans to deploy AMR to all of its 27 million customers. [1] The possibilities that new technology in the form of automated meter reading offers can be studied more closely when cost structures of traditional meter reading are more accurately known.

The aim of this study is to analyze the cost structures of traditional and automated reading, and to compare the differences between these two technologies. The analysis is carried out in one electricity utility in Finland. The analysis supports decision-making when considering whether to outsource measurement or not, and selecting the measurement technology.

This study was carried out as a single case study. In future, it will be broadened to cover larger number of electricity utilities. Exact numbers of costs structures are confidential and they have been replaced by fictive numbers.

RESEARCH METHOD

The aim of activity-based costing (ABC) is to determine the actual product cost by studying activities performed by resources. The idea of ABC is presented in Figure 2. Companies’ processes can be described as activities at the selected level of details. In order to reach its goals, an ABC system should assign cost factors to cost-objects via resource and activity drivers. Both activity and resource drivers should be defined according to cost-objects’ activity and resource use before this assignment is possible. [2, 3]

Figure 2. Assignment of cost factors to cost-objects.

Conducting activity and resource analyses needed to follow the procedure of Figure 2 is very complicated because of the time and cost requirements of these analyses. Therefore, a fast interview-based research method was applied in this study.
The study was conducted as a single-case study. The case organization of the study is a Finnish municipal electricity utility. The measurement environment can be described by “Profile meter” which refers to the inhabitant and customer statistics of the utility’s service area. There are over 100,000 measures out of which over 20,000 have to be change read every year. This means that, on average, all inhabitants in the area move every fifth year. Furthermore, the measurement process was divided into seven activities: New measure assembly, Annual reading (traditional & automated reading), Change reading, Meter replacement (traditional & automated reading), and Data system integration. These activities were selected as cost-objects, and costs for each of these were measured via resource and activity analyses.

The data for analyzing the activities was gathered from the following sources: the accounting systems of the utility, a vendor for measurement systems and equipment, and the director of the measurement operation. The data of the accounting systems concerning the seven activities mentioned above was examined thoroughly. The representatives of a vendor for measurement systems and equipment were interviewed once. They were asked for, e.g., information about the costs of investment and maintenance of automated reading. The director of the measurement operation was interviewed twice on-site and via telephone a couple of times. The director replenished the information gathered from the accounting systems.

The information of the activities was put together and analyzed in a Microsoft Excel spreadsheet. The spreadsheet included the activities mentioned above and the costs of each activity divided into material, direct labor costs, indirect labor costs, fixed labor costs, and capital costs. An example of the spreadsheet is presented in Figure 3.

<table>
<thead>
<tr>
<th>Resources</th>
<th>Activity: New measure assembly</th>
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<tbody>
<tr>
<td>Costs</td>
<td>Resource driver</td>
</tr>
<tr>
<td>Direct labor</td>
<td>Portion of work time (Activ. drv)</td>
</tr>
<tr>
<td>30,000 e</td>
<td>5 persons</td>
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<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Indirect labor costs</td>
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Figure 3. An example of the spreadsheet used.

In Figure 3, indirect labor costs were divided e.g. into designing. In this example, the resource driver consisted of the number of designing workers. Percentage of design work time used for “New measure assembly” was put into “portion of work time” (Activity driver). Annual costs for designing (which are assigned for New measure assembly) were calculated by multiplying the average annual pay for a white-collar worker (Cost factor) with the number of designing workers (Resource driver) and with the portion of work time (Activity driver).

In the similar way, all cost factors were assigned to each of the seven cost-objects. All cost values presented in the results section represent real ratios between different cost-objects, but the absolute values represent a fictive indexed currency.

RESULTS

The cost structure analysis of physical work (New measure assembly & Meter replacement, material cost involved) shows that New measure assembly and Meter replacement are lower cost activities when using traditional reading technology than when using automated reading. However, the explanation for this is mainly the high material cost of automated reading. When assembling pilot measures, the number of purchased remote measures was low. Therefore, the economies of scale could not be fully achieved. In this study, the capital cost of automated reading was fully assigned to this activity. Furthermore, as illustrated in Figure 4, the activity costs (everything but material) of assembling and replacing automated reading are much less than in traditional reading. A significant reason for low activity costs in automated meter assembly is that the assembly work has been started from block flat customer segment. In block flats, the assembly work time per customer is low because of the ability to assembly many measures at the same site.

![Figure 4. Cost structure of physical work (New measure assembly & Meter replacement).](image)

The cost structure analysis of continuously running activities (Annual & Change reading, no material cost involved) reveals that traditional reading is slightly lower cost operation than automated reading in Annual reading but far more expensive in Change reading. Figure 5 illustrates the situation. The explanation for this is that in traditional reading Annual reading can be well-planned and efficiently carried out, but change reading takes place whenever an inhabitant moves his/her residence. Hence, the measure readers have only few residences per day to read and the measures cover all the area of a city. In automated reading, Change reading is actually the same data system process as Annual reading.
The calculated costs for Data system integration (2.6% of total utility costs) could not be assigned to any of the six other activities.

**ANALYSIS**

The Profile meter of the studied utility is in use for 15 years and during that time three different persons live in the residence. According to this kind of profile, the cost structure of a measure is illustrated in Figure 6. Traditional and automated reading cause almost the same cost but with totally different cost structure. The activity costs of traditional reading are significantly higher. With this current profile, automated reading causes 3% less cost than traditional reading.

A very simplified sensitivity analysis of changes in the inhabitants’ moving behavior reveals that automated reading is recommendable way of measuring in urban areas. In Figure 7, the time of using measures is increased to 18 years and the number of consecutive persons living in the residence is increased to four. This means that the average living time in same residence is decreased from current statistical five years to four and a half years. With this new profile, automated reading causes 11% less cost than traditional reading.

Results show that in urban areas where people move intensively automated meter reading can be more cost efficient. This is caused by the extensive traditional measuring cost in Change reading activity. In AMR, Change reading and typical Annual reading act identically when considering the meter reading costs.

New technology improves business most if the business models are tuned to make real all the possible benefits. Automated reading has its impact also on other activities than just measuring the amount of energy spent in certain time frame. In AMR both-way telecommunications is the technological basis of developing new services and business models. New technology makes it easy to cut off the power if a customer fails to pay electricity bills. More advanced load management possibilities exist as well. During peak power hours technology allows to cut off certain loads e.g. heating or air-condition. Also customer service can be improved by allowing customers to see their electricity consumption e.g. in Internet or offering energy saving tips. In wider area of new possibilities, the home automation and security systems can also be attached to AMR.

As suggested in earlier empirical analysis, the unit cost behaviour in outsourcing situations is not very well managed in public sector [4]. Compared to current in-house cost, two
time limits for the realized cost after outsourcing have been introduced (See Figure 8).

First, “zero point” is a moment when the total unit costs (all partner’s and principal’s costs included) of an outsourced activity are equal to the initial in-house costs. At zero point, the temporary increase of unit costs after outsourcing has turned into decreasing trend and no extra costs compared with the initial situation exist. Second, “break-even point” refers to a moment when the realized and reduced unit costs have produced cost savings equal to the losses caused by the increased unit costs in the beginning of the outsourcing (dashed areas represent equal amount of money). At break-even point, the principal’s total cost over time is the same as it would have been without outsourcing. Break-even point refers to profitability terms because it illustrates a moment after which a principal can benefit from the outsourcing decision also in the sense of increased unit profitability.

In addition to time limits, two cost limits for the realized cost after outsourcing are introduced. First, “maximum accepted unit cost” refers to the level of unit cost that is accepted to realize after outsourcing. If the unit costs are in any time after outsourcing higher than the accepted maximum, the outsourcing project can be classified as a failure. Second, “targeted unit cost” refers to the unit cost level that is set as a target for the outsourcing project early in the beginning. Without such a target the project may appear as too explorative.

The meaning of the limits is to design the outsourcing project beforehand and to control it in all phases so that the unit costs are not just “taken as they occur” but systematically managed [4]. If outsourcing of measurement process is considered, the in-house cost structure should be compared with the potential measurement service provider’s price and manage the outsourcing with the help of the proposed framework.

To broaden the understanding the cost framework of measurement process further studies must be done. The effect of economies of scale on measurement business should be studied more closely. This requires similar kind of analysis to be carried out for a distribution company that has a large scale implementation of automated meter reading. Benchmark data from several companies should be collected in order to publish average costs and further statistical analysis.

REFERENCES