OUTSOURCING MAINTENANCE PROCESSES IN ELECTRICITY UTILITIES

Philip Wester

NUON InfraCore, The Netherlands

Liberalisation of electricity markets has radically altered the business environment of power utilities, introducing significant pressures to perform more efficiently and reduce costs. As a consequence many companies are now considering outsourcing of more traditional in-house services, including primary plant maintenance, as a means of increasing shareholder value.

In this field it is essential to make the right decisions regarding the organisation of maintenance, keeping in mind that the first responsibility of the utility is to control the process in such a way that the demanded performance is realised against the lowest cost possible.

The paper partly reviews work as prepared by the CIGRE JWG23/39-14. Amongst other subjects this group covers the organisation field of maintenance and reliability in order to structure discussions concerning outsourcing by describing a framework to enable consistent decisions in this area.

The paper describes business re-engineering models that give insight in the outsourcing issue regarding the level of risk with which a company feels comfortable. The models provide a means of mapping a company’s strategic aims to enable a broad understanding of it’s most important capabilities, or distinctive competencies, to be achieved and hence the areas of outsourcing likely to be appropriate for that particular company’s business environment.

The Competency Model enables current activities to be classified to enable a clear understanding of the role of particular activities within an organisation and hence what and how to outsource. The Effectiveness and Risk Model tries to capture the efficiency of in-house service provision with the aim of avoiding problems that can cause difficulties in outsourcing relationships. High-level analysis of the nature of contractual relationships indicates that a collaborative approach to outsourcing provides the best risk management solution for utilities.

By practicing this approach, the NUON utility has proven that the approach as outlined in this paper not only provides a useful methodology by which utilities could develop their outsourcing strategies. It also shows that it brings proven possibilities to increase turnover from the market, at the same time avoiding personnel costs due to downsizing of internal processes, optimise knowledge about maintenance processes and create an attractive environment for young engineers.
1. ABSTRACT

Liberalisation of electricity markets has radically altered the business environment of power utilities, introducing significant pressures to perform more efficiently and reduce costs. As a consequence many companies are now outsourcing traditionally in-house services, including plant maintenance, in order to increase shareholders value. In this field it is essential to make the right decisions regarding the organisation of maintenance, keeping in mind that the first responsibility of the utility is to control the process in such a way that the demanded performance is obtained in the most cost-effective way.

The paper partly reviews work as prepared by the CIGRE JWG23/39-14 [Eyles et al (1)] describing business re-engineering models that give insight in the outsourcing processes. The models provide a means of mapping a company’s strategic aim to enable a broad understanding of it’s most important capabilities and the areas of outsourcing likely to be appropriate for that particular company’s business environment.

The management of maintenance skills, an important item in the outsourcing discussion, is described in the approach of InfraCore, a subsidiary of the NUON utility. This company applies condition based maintenance on distribution and transmission equipment for both third parties and the NUON network, thereby cooperating with the Delft University of Technology and some manufacturers. This cooperation is focused specifically on maintenance knowledge for high voltage and complex medium voltage equipment, and additionally, it resulted in a continuous flow of college trainees in the field of development of diagnostics for condition-based maintenance.

2. INTRODUCTION

Decisions regarding outsourcing can be highly subjective. As a minimum these should include consideration of what has been traditionally defined as core and non-core activities. However, this simplistic approach could lead to bad decisions and contradict to the organisational goals.

The amount of outsourcing of maintenance services is depending on the implications of plant failure and this is, as a consequence, often regarded to be less relevant for distribution than for transmission networks. When account is also taken of the significantly greater capital costs of transmission equipment, it is evident that the management of risks for transmission companies was always looked upon as a strategically important issue.

This situation however is changing radically. As a result of the liberalisation process, (smaller) industrial customers are facing their own responsibility for an optimised performance of industrial networks thus forcing the providing utility to support a reliable, penalty forced, energy supply. This paper therefore concentrates on the outsourcing discussion and possible consequences as such and covers the situation from both transmission and distribution network perspective.

Whilst outsourcing can increase risk it also potentially provides significant business advantage through reducing cost of labour, value added services and greater focus on core skills it should be recognised at this stage that there are certain activities that cannot be divested under any circumstances. These include responsibilities under Health and Safety legislation, conformance to Regulatory and National Code requirements and Public Acceptance.

3. BUSINESS MODELS

Transmission and distribution utilities are, related to their environment, considered to cover the four business functions as described in figure 1. A business re-engineering discussion directed at outsourcing possibilities will lead to organisations that cover one up to all of the separate functions: (independent) system management, network management, asset management and service provider.

Figure 1: business functions
3.1 Business environment

The asset owners, the regulator, the trader and the consumer are looked upon as ‘business environment’ with different interests. The (future) asset owner forces the organisation to maximise the shareholders value (maximise gap between accepted and real costs), the regulator to a maximum acceptable cost level, the trader to the contracted amount of energy capacity and the consumer (industry) to a reliable connection to the regulated grid.

3.2 Basic models & core businesses

Network management is regarded to be the basic function of a utility. The level of independency of system management sets the rules for a business orientation where this latter function is possibly linked to network management. The basic network management function in this model is divided into a day-to-day management of the grid operations, including safety and health management, and an asset management function. Providers act in the field of maintenance and/or engineering and construction. Hence the basic core-business of a utility consists of at least the network management function. The degree of independency of the system management function and the result of outsourcing discussions resulting from the models described in chapters 4 and 5 the asset management and/or (service) providing functions might be part of the utility organisation. The organisation scenario’s vary from very slim, ownership acting and managing processes and resources, to very complete, covering all the necessary work to be executed.

4. DECISION MODELS

To what extent of outsourcing a utility decides, will be governed by the level of exposure it considers appropriate for its’ business environment. In order to make the right decisions against the background, two decision schemes have been developed [Cordon et al (2)]. The model described in figure 2 enables a clear understanding of the current situation to be developed. The model described in figure 3 helps decisions on what and when to outsource.

4.1 Competence Classification Model

The model is based on a classification of activities that aid understanding of their role in a business. The five classifications are:

- Distinctive competencies
  The most important capability of an organisation. In the field of maintenance this could be the competence to effectively set a maintenance policy.
- Essential competencies
  Needed for an organisation to operate. In the case of a utility this could be the competency of fault restoration and safety control/energy restore.
- Spill over competencies
  Allow a company to obtain profits in a related activity through its distinctive competencies. In a utility this could include marketing of maintenance expertise.
- Protective competencies
  Close to the distinctive competencies but related to activities that cause considerable risks for the success of the whole organisation if they are not managed properly. An example in the case of utilities could be protection system control.
- Parasitic competencies
  Activities that are done in house that waste organisational resources. Tower painting is an example.

Figure 2: competence classification scheme

The model helps to discern activities, which differentiate the company, but it should be looked upon as dynamic. Changing market conditions can cause activities to shift from one category to another over time. As an example, air blast circuit breaker maintenance may be considered to be a distinctive competency since appropriate skills may only reside within the utility whereas in the case of SF6 circuit breakers, skills may be available through manufacturers, enabling maintenance to be considered even as a parasitic competency. Pressures to minimise maintenance costs may force changes of opinion in this area.

The model supports decisions on what and how to outsource. Obviously parasitic competencies must be outsourced to the best provider available. Essential competencies can be outsourced if an appropriate relationship can be created to ensure continuous availability of the service and the minimisation of risks. Finally, spill over competencies can be outsourced providing the utility is going to keep the profits that could be made.

4.2 Effectiveness and Risk Model

Where the competence classification model helps in describing and understanding the effects of different activities in differentiating a company from its competitors, the next model tries to capture the
efficiency of the in-house activity. The model supports the decision process regarding outsourcing with the aim of avoiding problems that can cause a difficult outsourcing relationship.

The matrix-drivers are the:
- Risks associated with the maintenance activity, including risks of losing know-how.
- Effectiveness of the maintenance activity when performed in-house compared to an outside provider.

![Figure 3: Effectiveness and Risk model](image)

For each quadrant a logical action follows:

A) If the effectiveness of the regarded maintenance competence is high it is logical to keep the activity in-house, assuming that the company can maintain effectiveness into the future. Risks can be managed by the distinctive competency. In high risk areas in-house provision enables an operation to be better controlled.

B) If the effectiveness is low and risks associated are low the logical action should be to outsource the activity. Examples could be tower painting or building maintenance.

C) If effectiveness is high and risks low, the activity would only be outsourced if the effectiveness as delivered by an external organisation is higher.

D) The main challenge arises when the effectiveness is low and risks high. In this situation the task of management is to redesign the activity so that either it becomes more effective or the risks become lower. In the case of a maintenance activity low effectiveness could be increased by the design of consistent maintenance practices and high risks could be decreased through the application of rigid quality control.

As a common rule outsourcing should only be considered after the activity is managed out of the risky quadrant, and the effectiveness, as delivered by third parties, is higher.

4.3 Illustration for predictive cable maintenance

To illustrate the impact of the above considerations a practical example of outsourcing cable maintenance is given. In recent years new compact diagnostic techniques were introduced to assess discharging defect sites in HV and MV cable systems [Gulski et al(4)], which enabled the possibility to characterize possible fault locations. Consider our practical case, where we carried out 160 diagnostic measurements on suspected cables in one year. Of the latter cables only a fraction (F) contained defect sites were hits, i.e. the elimination of this kind of defects prevents the cable system to fail.

Cost calculations were made for distribution and transmission cables for carrying out condition based maintenance in-house and outsourced, as is shown in fig x. The cost of preventing a cable fault in-house was derived from the cost of including all “unsuccessful” measuring actions plus the depreciation of diagnostic investments. In addition to that the cost of void man hours of the utilities repair capacity was taken into account, in this case as low as 50%, i.e. capacity is twice as large as the repair work demanded. The latter effect is ineffective in case of outsourcing and that result is shown as the lower curve.

Decisions on the need for outsourcing maintenance are possible by comparison with the cost of non-delivery, which was taken as NLG 20 for industrial clients and NLG 2.5 for households, see the horizontal lines. As can be seen from the figure x the introduction of CBM is already feasible from a fault rate of 1 hit in 100 in case of outsourcing for 6 MW industrial clients, while this feasible scenario exists from say 1 hit in 10 for the distribution networks for households.

Interestingly, in case the utility management succeeds to reverse the void man hours capacity by additional work on site (the idea of Total Quality Management) or by attracting external projects, the internal and external lines will cross and become competitive. This example shows shortly how easily decisions are influenced by the maintenance management policy and the efficiency of the maintenance organisation.

![Figure 4: cost-base choice outsource/insource at 50% void man hours capacity](image)
5. **BEST VALUE**

A key consideration in any analysis of outsourcing options is best value, which is about obtaining services, not just in a cost effective way, as could be demonstrated by competitive tendering, but through seeking additional advantage in terms of quality, performance and ongoing service improvement.

5.1 **Supplier Relationships**

Traditional outsourcing contracts are competitively given as short-term, price based, discrete transactions. The analysis in Figure 3 demonstrates that such adversarial contract arrangements are not suitable for managing the very significant risks associated with outsourcing protective or distinctive competencies. Also, whilst adversarial relationships might deliver the lowest price for a service, they may not deliver best value nor indeed the lowest overall costs, when transactional and other possible costs are accounted for. Very close collaboration is necessary if the relationships are to generate the scale of benefits needed to justify a decision to outsource. This requires a foundation of long term contracts. A collaborative approach to outsourcing of essential or protective competencies is the only realistic option for utilities.

5.2 **Collaborative Relationships**

A collaborative relationship or partnership can be defined as a high performing, genuinely mutual relationship, and producing significant added benefit to both parties. Partnerships can include customer supplier relationships; joint ventures with equity share and the establishment of a separate legal entity; extensive strategic alliances as well as mergers and acquisitions. The term partnership, therefore describes the quality and not the form of the relationship. They are highly demanding, involving considerable investments in time, management attention, know-how and resources, particularly financial and technical. It is therefore important that companies are selective in the relationships they try to build.

5.3 **Other issues**

Differences in in-house and outsourced services are knowledgeable in the field of health and safety (often covered by ISO certification), flexibility related to outage planning possibilities, transactional costs and specific barriers to entry like:
- Understanding of operation of the network.
- Specific supplier skills and knowledge.
- Emergency response capability.

In the particular case of partnerships key barriers are the number of potential partners and the skills/resources and time required to establish them. However, models based on Joint Ventures or In-house Service Companies offer the possibility of circumventing these problems.

6. **PRACTICES REGARDING OUTSOURCING MAINTENANCE**

Based on the described models and approaches the NUON utility organised their maintenance specialists’ organisation as an in-house service also acting as a provider on the market. In this way many of the thresholds as mentioned in chapter 5 are avoided. At the same time the maintenance company is positioned on the competitive market bringing advantages as:
- Commercial drivers force to minimise costs and maximise turnover.
- Avoiding internal personnel cost resulting from downsizing of the maintenance intensity by ‘shifting’ these personnel to the workload generated by the market.
- ‘Culture change to commerce shock’ for personnel going from public- into private sector.
- Concentrating specific knowledge in the field of maintenance of medium- and high voltage equipment giving maximum possibilities for development and application of condition based maintenance and thus for optimum life time usage of equipment
- Consequently an interesting, attractive and challenging environment for young engineers, as is shown by the continuous flow of students coming from universities to the regarded company.
- Possibilities to cooperate with other knowledge carriers like universities, research laboratories and manufacturers.

As a result of this approach the maintenance company, NUON InfraCore, was able to develop condition based maintenance and the necessary tool, systems and expert rules on its own risk, covering its own costs and generating its own revenue. NUON InfraCore is specialised on the field of condition based maintenance and initiated some interesting developments in this field as mentioned hereafter.

6.1 **Internet supported data base**

The company has a record of app. 8 years (of which the first part as department of the utility) in the field of condition-based maintenance.

![Image](image-url)
The expertise generated in that period, consisting of measuring principles and expert rules, is translated into an expert system which includes graphical data and allowance criteria.

Based on collaborations described in the next chapter it was possible to optimise the expert rules and use this knowledge to inform or advice asset managers about the condition level of their equipment including the support of decisions to be made in the field of re-investments and maintenance priority. The basic principle of this approach is shown in the figure 5. The next step will be to offer these services resp. information via the internet, trying to combine type specific information about condition measurements if possible on a world wide scale, giving incentives to all participants in the field of optimised decision making.

6.2 Knowledge platform

In order to use the knowledge as contained in their data bank optimally, NUON InfraCore also started a knowledge platform with the Delft University and some, from origin, Dutch equipment manufacturers. This cooperation, which principle is shown in figure 6, intends to support the customers decisions and actions regarding maintenance actions and/or re-investment policies optimally by combining:

- the in depth knowledge and expert data of the cooperating manufacturers about their products, product lines and applied techniques,
- the scientific knowledge of materials behaviour and capabilities for developing diagnostics of a university and
- the broad expertise of a utilities service company.

It also intends to cooperate in the execution of maintenance for medium- and high voltage equipment joining facilities and labour forces in case this has potential advantages due to specific knowledge or lack of executing personnel (both in mechanic as in engineering field).

7. CONCLUSION

Liberalisation of electricity markets has introduced significant pressure on utilities to reduce costs and many are now considering outsourcing of traditional in-house services, including primary plant maintenance. The extent to which outsourcing is employed by a particular company will be dependant on the acceptable level of risk, which is in turn governed by its business environment. Companies should look upon outsourcing decisions as complex business initiatives that cannot be lightly assessed. It is important that outsourcing decisions are considered against a framework that enables a consistent and focussed approach. The Business Models, based on the choice of functions should be part of the utility framework jointly with competency and risk/effectiveness models.

High-level analysis of the nature of contractual relationships indicates that a collaborative approach to outsourcing provides the best risk management solution for utilities.

By practicing this approach, the NUON utility has proven that the approach outlined in this paper not only provides a useful outline methodology by which utilities could develop their outsourcing strategies. It also shows that it brings proven possibilities to increase turn over from the market, at the same time avoiding personnel costs due to downsizing of internal processes, optimise knowledge about maintenance processes and create an interesting environment for young engineers.

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References

*) Philip Wester, email: Philip.Wester@nuon.com
managing director NUON InfraCore