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# **Property Maintenance - Concepts and determinants**

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Henry Muyingo

# Overview

## *Introduction*

Strategic property management aims at balancing the question of how the needed space is to be secured, maintained, increased or disposed of in a cost effective manner under a mixture of decisions and actions. In recent years, the interest in building maintenance has increased as more and more of the housing stock built after the Second World War is in need of major renovation. For example, approximately 1 million dwellings were constructed in Sweden in the period 1960-1970. Currently there is growing concern about the expected huge cost of maintaining this aging housing stock especially in the portfolio under municipal ownership. Private housing companies have been shown to report lower maintenance costs than those in the public sector but which are the factors that can explain the apparent differences? During the last decade there has also been a growing trend of governments diversifying themselves of their properties and/or outsourcing the property management. A question of interest is whether it is advantageous to do so and if the maintenance management differs substantially between the government sector and the industrial sector which is seen as business oriented and with a production centred maintenance strategy. In a number of industries there has been a paradigm shift in maintenance whereby the focus is no longer only on availability but reliability and cost effectiveness. New maintenance strategies and policies such as reliability centred maintenance have seen the light of day though without winning ground within property management. Shouldn't building maintenance be handled in the same way?

This licentiate thesis focuses on the strategic management of housing properties under public and private ownership as well as the management of special purpose properties in the government and industrial sectors in relation to the ongoing discussion about neglected maintenance. The purpose is to contribute to the process of cost efficient and effective maintenance both in the housing sector and in the management of special purpose properties through underscoring the factors that lead to differences in the maintenance levels in the different categories.

## *Method*

The questions above are analysed through a theoretical part that discusses the concept of maintenance and strategies in building maintenance in relation to other industries. The thesis also contains an empirical part that is based on a survey in the form of a questionnaire on housing maintenance and an econometric analysis of the maintenance costs contained in the financial reports of the municipal and private housing companies as well as a questionnaire on among others how state and county governments as well as industrial companies have secured the availability and management of their special purpose properties.

The thesis consists of four papers the first two of which are co-authored with Hans Lind. It starts by demarcating the concept of maintenance in the context of standard investment theory followed in paper 2 by a discussion of the term "maintenance strategy" and some stylized facts concerning building maintenance in Sweden. Maintenance strategies and approaches used in some other industries are presented as a background to an analysis of why building maintenance is different. The various factors that affect the maintenance costs reported within the housing sector are surveyed and analysed in paper 3 before the results from a survey on management of special purpose properties in the state and county governments as well industry sector are presented in paper 4. A questionnaire was used to get a broader material about aspects that were difficult to observe directly, including views about underlying factors.

## ***Results***

From the perspective of investment theory everything that is usually classified as maintenance is also an investment. The concept of maintenance can in a number of situations be taken to be unnecessary. A review of strategies from other industries reveals a focus on systematic data collection and cost analysis before action is taken and a move away from time scheduled maintenance to acting on the condition of the object. However building maintenance contains a substantial degree of corrective maintenance with a high degree of opportunistic maintenance and detailed maintenance planning is not ideal due to constantly changing needs and demands. An important result is from the surveys and econometric analysis which indicate that the ownership category has a significant effect of approx. 35 per cent on the maintenance costs reported by the housing companies. Furthermore a major factor affecting the cost level in the housing companies is the influence of external factors such as pressure from the media and politicians. The degree of special property ownership in the surveyed companies is high and the probability of the leasing market increasing in the coming five years is very low. According to the respondents there is very little neglected maintenance in the industry in contrast to the government sector especially in the counties. Furthermore, the maintenance plans in the public sector were shorter than those in the private sector.

## ***Discussion***

The outstanding result from the surveys is that classification of activities as maintenance or investments in both housing and special purpose properties differs in that the public sector companies lean more towards maintenance than investment in their accounting and have a higher degree of adherence to laid maintenance plans. The distinct difference in the pay-back duration used by the government sector as compared to that in the industry sector in effect lowers the effectiveness of the government sector as the lower required rate of return allows the government sector to have more activities that appear to be profitable. Maybe the problem to worry about should not be that of neglected maintenance in this sector but that of unprofitable maintenance that should not be carried out. This might also just explain why more activities are classified and dealt with as investments by the industry and not by the county or state companies or the municipal housing companies.

## ***Conclusion***

There are strong arguments for saying that building maintenance rationally differs from the kind of maintenance and maintenance planning that could be observed in some of the other industries and the concept of maintenance is much more suitable in a world where there are smaller changes and where it is believed to be possible to know long in advance what is rational to do. The divergence in classification of activities even within the same category and company revealed by the two surveys is problematic as it complicates comparison of activities and services provided as well as benchmarking and it should be given appropriate attention by the managers. This goes to show the great need to use the same well defined concepts in order to benchmark and develop more efficient maintenance management strategies.

## ***Future research***

Though each building is unique the goal should be to develop a model that is rational given the specific uncertainties that characterise a building and the institutional system in which decisions are made. The limited size of the sample and the lack of transparency and uniformity in the financial reports constrain the research efforts in this study. However research is needed towards a clearer and more transparent classification of maintenance activities with the purpose of not only reducing the gap between the reported maintenance costs of the companies but also increasing the comparability in the branch. This will help to isolate and possibly limit the external influence in the management of the companies especially in the municipal housing sector.

# Paper 1: Investment theory and why we do not need the concept of maintenance

This paper<sup>1</sup> aims at discussing the concept of maintenance and why it is not needed for a rational actor that is expected to be forward looking. The analysis is anchored around the perspective of standard investment theory in which an investment is defined as spending resources today in order to get some kind of "advantage" in the future. By spending resources today the company either gets higher revenues in the future, or reduces future cost. From this perspective *every activity that typically is called maintenance is also investment*: resources are spent today in order to get lower costs in the future (or higher revenue) compared to if the maintenance is not made.

The argument that the maintenance concept is unnecessary and also misleading if the focus is on efficient decisions today is developed first through an analysis of how maintenance is defined and demarcated in the two standards AFF04 and EN 13306:2001 that are in use in Sweden. AFF 04 implicitly assumes that the technical functions are deteriorating and that maintenance is done to *restore* the original functions of the systems while EN 13306:2001 includes "actions intended *to retain* in a functional state" as part of the definition.

A short section about investment and maintenance from an accounting and taxation perspective is also utilised to illustrate the argument above before an alternative conceptual framework is sketched. From the perspective of both accounting and taxation it is important to define and measure a *yearly result*, something that is irrelevant from the perspective of investment theory. Traditionally, the accounting rules have focused on minimising the risk for overestimation of the yearly result. From a tax perspective the problem is the possibility that firms can report too low profits by treating all investments as a cost the year that it is made. The tax rules typically focus on forcing firms to activate certain expenses, and spreading the costs over a number of years. The common feature from both an accounting perspective and a tax perspective is then that what is investment from the perspective of basic investment theory is *subdivided into expenses that are activated and then written down over a number of years, and expenses that are treated as a cost the year that they are made*.

However from a longer time perspective it should always be an open question what to do in a specific situation. Any predetermined maintenance strategy needs to be evaluated and adjusted when the situation changes and new options become available. One problem with thinking in terms of maintenance is that it indicates some given long run strategy in relation to historical standards, neglecting that what is rational will constantly change when situations change and new information is available. Thus from the forward-looking perspective what is especially important is the meta-strategies in terms of how to keep informed and how to make decisions, and the insight that the future is uncertain and that therefore long-run and detailed plans are inefficient. In a longer perspective it is always an open question as to whether the standard of an object should be kept in, improved or discarded.

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<sup>1</sup> Co-authored

## Paper 2: Is there anything special with building maintenance?

In this paper<sup>2</sup> the concept of a maintenance strategy is analysed and components of policies such as corrective maintenance or predictive maintenance are described. The presentation of maintenance models from other industries contains examples from the aero and maritime industries as well as electric power production and distribution. A study from the military industry is also used. Some especially interesting features can be noted in the models described.

- The focus on collection of information that makes it possible to predict failure rates.
- Explicit modelling of the "revenue" side of maintenance, based on failure rates and failure costs. In this way an optimizing framework can be formulated and applied.
- A move away from time-based maintenance to condition based maintenance. The problem with time-based maintenance is that it tends to lead to over-maintenance, especially if it is based on recommendations from a manufacturer where reducing the risk of failure of their product is more important than reducing costs.

Some stylized facts can be summarized from the results from several studies about building maintenance in Sweden such as:

- A large share of maintenance activities are corrective maintenance carried out when faults suddenly are observed.
- Detailed maintenance planning covers a short period of time, maybe a year, and the specific maintenance actions are rescheduled all the time and that when more long run plans are made, maybe 3-5 years, it only takes a few months before they are outdated.
- Maintenance measures are affected by the budget situation such that the maintenance budget is utilised as a buffer whereby the maintenance volume increases or decreases dependent on the economic situation of the company.
- There is a considerable amount of opportunistic maintenance.

A consideration of the above facts leads to temptations to apply the reliability centred or production centred practises used elsewhere. However the rationality of the industrial section might be overestimated. Furthermore for many building components the consequences of waiting with certain maintenance measures a year or two are often not very dramatic.

A second comment is that this kind of rationality is possible and rational only given certain assumptions. The stylized facts above can be rational given the characteristics of the situation which embodies the uncertainty due to each building being unique and consisting of a number of integrated components that interact. The building's economic life is also affected by maintenance carried out earlier, the quality of which is usually not documented in a detailed way. This means reduces the predictability of how the systems work and the kind of databases discussed for serially produced objects will not be possible. Changes in maintenance planning are not only related to changes in the general economic situation, but they are also related to changes in priorities within a maintenance budget.

Our conclusion in this paper is that there are strong arguments for saying that building maintenance rationally differs from the kind of maintenance and maintenance planning that could be observed in some of the industries above.

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<sup>2</sup> co-authored



### **Paper 3: The effect of the ownership category on the maintenance costs of housing companies**

The third paper finds a number of factors that affect maintenance costs and analyses the effect of ownership category on housing maintenance and the magnitude of this effect. This is done partly through a questionnaire survey on maintenance strategies in the private and the municipal housing companies and also through an econometric analysis of the maintenance costs contained in financial reports of private as well as municipal companies.

The survey which focused on maintenance management covered 55 companies out of the 89 that received requests, and was directed towards persons in a managerial position. The seven-section survey consisted of 38 questions. The questionnaire started by establishing the company name, the respondent's position as well as length of employment in the company. The second part of the questionnaire aimed at clarifying how the companies categorise the concept of maintenance and how a number of given activities would be classified. Part three was aimed at soliciting answers on the company's own maintenance levels and the factors behind it and to find out the factors that were deemed to be significant causes of immediate maintenance whereby an answer was required on a number of given problems. The way the company organises its maintenance was surveyed in the fourth part of the questionnaire to find out the extent of decentralisation and utilisation of external help. The fifth part of the questionnaire focused on how the company plans its maintenance as well as the inspection frequency and the documentation of information. Parts six and seven addressed the issue of neglected maintenance and the possible causes of the lower maintenance costs reported by the private housing companies.

How the activities are classified as well as the demarcation between planned and immediate maintenance play an important role in the differences in maintenance costs. There is also a clear difference in the planning horizon as well as flexibility in changing the plans. The rent control is also given as a major factor together with the belief that political pressure raises the maintenance costs in the municipal companies.

The results of the survey were utilised in modelling the econometric equations in which the type of owner as well as rent level, size of housing area under management and the company's proportion of housing that was built during the period 1961-1975 were used as some of the independent variables.

The econometric results in this paper indicate that the ownership category has a significant effect of approx. 35 per cent on the maintenance costs reported. On the other hand, results from the survey suggest that the gap in maintenance costs is partly due to the difference in the maintenance planning and demarcation of the concepts in the two categories. They further suggest that private housing companies have a different tenant composition and an acceptance of a lower standard whereas pressure from the media and politicians influences the cost level in the municipal housing companies. The high dependence of reported costs on the ownership category points to a need for a more transparent and consistent classification of the activities carried out.

## **Paper 4: Managing special purpose properties: A case study of the current practises in the state, county and industrial companies in Sweden**

Traditionally large organisations have owned properties specially constructed for their particular business. Mergers and takeovers further increased the total space under management. On the other hand changing demographics and recessionary situations have led to a need for divestment or the possibility to co-share space with other types of organisations. The business of property management is a mixture of decisions and actions and for special purpose properties the focus is on the business and goals of the company which determines the amount of space needed for optimal production. Securing property availability can be seen as a decision making process in rights related to the space used. A wide range of contractual options from direct ownership at one extreme and all out leasing at the other provide just enough space without the underlying issues due to ownership or leasing.

The role of special properties is to support the business goals of the company or institution and therefore the choice to retain ownership of the properties will depend on the nature of the business. Among the reasons for retaining direct ownership is the need to have control over arduous and sensitive production processes as well as securing the premises against industrial espionage. Securing the availability of the premises for production also entails the separate question of whether the properties are to be managed internally or outsourced to an external service provider. Strategic property decisions are best solved internally while routine activities can be left to external providers. Outsourcing works best for functions that can readily be provided by established suppliers as they are usually routine and well delineated as well as being measured and managed at arm's length which makes maintenance activities good candidates for outsourcing.

The study intended to cover the 3 national government companies/agencies specialised on property management, all of the 18 county governments plus the regions of Skåne and Västra Götaland, as well as 15 manufacturing companies. The six-section questionnaire elicited structured answers on how the organisation chose to secure the availability of its required premises, how the division of responsibilities is structured between the organisation and the operative units involved (internal or external), some details on the property management of both the leased and owned space, how the maintenance concept is demarcated and, on a few questions concerning a prediction of the future space management.

A number of similarities and differences in the management of properties under the three categories are discernible from the survey.

- There are clear differences between the private and the government sectors in the demarcation of concepts and how activities are classified whereby the private sector capitalises more of the costs and accounts for the activities as investments.
- Responses from industry point at their having a lack of neglected maintenance which indicates that the definition of maintenance is economical in nature whereby the focus on investment returns allows the company the liberty to discard a planned activity in case it is not profitable.
- There is a distinct difference in the pay-back duration used by the government sector and the one in the industry sector. Maybe the problem to worry about should not be that of neglected maintenance in this sector but that of unprofitable maintenance that should not be carried out.

# Paper 1

# **Investment theory and why we do not need the concept of maintenance**

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# Investment theory and why we do not need the concept of maintenance

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## Abstract

The concept of maintenance is widely used in for example property maintenance but its definition tends to vary even within companies. The purpose of this paper is to discuss the need and interpretation of this concept from the perspective of standard investment theory.

This paper is based on a review of some current practises in demarcating maintenance, which is seen as aiming to restore or retain a given function, and the presumed consequences of each choice from the perspective of accounting and tax systems. A rational decision maker is expected to be forward looking and weighting the costs and benefits of a chosen action. This implies that comparisons with past standards or functions of an item are irrelevant.

From the perspective of investment theory everything that is usually classified as maintenance is also an investment and from a forward looking perspective focus should be on how to keep informed and how to make decisions. The concept of maintenance is much more suitable in a world where there are smaller changes and where it is believed to be possible to know long in advance what is rational to do.

**Keywords:** Maintenance concept, investment theory, accounting for real estate

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# 1 Introduction

The concept of maintenance is widely used in for example property management but its definition tends to vary not only between authorities but also between companies (SWECO, 2006) and within the same organisation (Gustafson, 2005) and the classification of activities at times changes from year to year depending on how the company would like to account for it (Lind 2002). A natural reaction to such a situation is to try to clarify the concept of maintenance (Oresten 1997; Lind 2002) in relation to nearby concepts as operation and investment.

The strategy in this paper is to start from more basic investment theory, and it is interesting to note that in that context the concept of maintenance is seldom used (see for example Geltner, Miller et al, 2007). The explanation for this seems to be very simple: An investment is defined as spending resources today in order to get some kind of "advantage" in the future. By spending resources today the company either gets higher revenues in the future, or reduces future cost. From this perspective *every activity that typically is called maintenance is also investment*: resources are spent today in order to get lower costs in the future (or higher revenue) compared to if the maintenance is not made.

The aim of this paper is therefore to discuss the need and interpretation of the concept of maintenance from the perspective of standard investment theory.

The structure of the paper is as follows. In the next section the perspective of standard investment theory is presented briefly. Before maintenance concepts are discussed in section 4, there is a short section about investment and maintenance from an accounting and taxation perspective, primarily based on Nordlund (2008). In section 5 it is argued that the maintenance concept is unnecessary and also misleading if the focus is on efficient decisions today, and an alternative conceptual framework is sketched. Concluding comments can be found in section 6.

## 2 The basic perspective of investment theory

The basic idea in investment theory is that - for a number of reasons - a dollar received today is worth more than a dollar received tomorrow. This is transformed into the fundamental formula where the Net Present Value of a series of expenses and revenues are calculated by discounting the future consequences by a discounting factor reflecting the rate of return demanded, which is related to the risk of the project.

The starting point is usually some kind of "investment"  $I_0$  - a negative cash-flow in "year 0" – and using the formula below it is possible to evaluate whether the investment is profitable or not. This is done through subtracting the initial investment ( $I_0$ ) from the total sum of the present values of the future cash-flows ( $CF_t$ ) giving a net present value (NPV) of the investment, given a certain rate of return demanded ( $r$ ).

$$NPV = -I_0 + \sum_{t=1}^T \frac{CF_t}{1+r^t}$$

In property management the cash flows discounted and used to calculate the NPV are the annual net incomes that are received, calculated as the difference between the rental and other related incomes and the total operating, maintenance and other related costs, inclusive of the investment.

There is of course nothing in this theory that says that this "investment" -  $I_0$  - has to be large. Repainting a room, or replacing a machine part is formally a decision that has the same structure as a larger investment and is therefore suitable to be analysed within the same framework.

The basic NPV-formula is of course also relevant in recent discussions about *life-cycle aspects*. If the framework is applied correctly it will include a life-cycle perspective that takes into account e.g. the remaining value or remaining cost at the end of the period analysed. The analysis can be carried out over the whole life span of a building or a component or for a particular stage. There are some controversies about the usefulness of the NPV-framework if there are option aspects involved, e.g. that a standard investment changes the future possibilities to adjust a building to changing circumstances (see e.g. Gunnelin 2000), but this will not be discussed any further here.

The conclusion so far is that maintenance should be seen as a sub-category of investment, and the next step is to discuss what can explain why this sub-category exists.

### **3 Investment and maintenance from the perspective of accounting and tax systems**

There are two general "administrative" systems that affect the conceptual structure related to investment: *accounting and taxation*.

From the perspective of both accounting and taxation it is important to define and measure a *yearly result*, something that is irrelevant from the perspective of investment theory. In both accounting and taxation an important issue is which expenses should be activated and written off during a number of years and which should be counted as a cost directly. "Investment" from both an accounting and tax perspective is in that case defined as expenses that should be activated as an asset and written off over a number of years.

Traditionally, the accounting rules have focused on minimising the risk for overestimation of the yearly result. One kind of accounting fraud, found e.g. in the famous Enron and Worldcom scandals (see Nordlund 2008, p 36) is to call ordinary costs investment and thereby showing higher profits than the true level. From this perspective we can then define "maintenance" as "investments" that should be treated as a cost and not be activated. A common definition, as will be returned to below, is to call all expenses that are directed at *retaining* the standard of the object maintenance. Expenses that lead to higher standard than that, or to larger areas, are called investments.

From a tax perspective the problem is almost the opposite to that in accounting (see Lind 2002), as the tax authorities do not want firms to report too low profits by treating all investments as a cost the year that it is made. The tax rules typically focus on forcing firms to activate certain expenses, and spreading the costs over a number of years.



The common feature from both an accounting perspective and a tax perspective is then that what is investment from the perspective of basic investment theory is *subdivided into expenses that are activated and then written down over a number of years, and expenses that are treated as a cost the year that they are made*. The first type of investment is then called “investment” while the second type of investment is called “maintenance”. The rules are often described in terms of “investment should be activated” and “maintenance should be treated as a cost immediately”, but it would be more correct to say that if something should be activated then we call it investment, and if something should be treated as a cost directly we call it maintenance.

There are some interesting changes in the rules and applications in recent years (see Nordlund 2008 ch 3). If the IFRS rules about “fair-value accounting” are applied consistently then there is no longer any need to make a distinction between investment and maintenance. The “cost” a specific year is calculated as the total expenses related to the property minus changes in the value of the properties. If a measure taken leads to a higher value it is automatically “activated”, and of course everything that is a (successful) investment in the sense of investment theory - in that it increases future cash flow - will lead to a higher value and therefore we are back with a perspective where all investments according to investment theory are treated as investments! Tax rules however still treat realised and unrealised capital gains differently.

Another accounting principle that avoids the problem of dividing expenses into investment and maintenance is when an investment (in the theoretical sense) is divided into a number of components that are depreciated separately. The whole sum is then activated when a part is replaced or a room repainted, and thus this investment is written down component for component. When a certain component is replaced it is automatically activated and a new period of depreciation follows. In this approach there is no need to make a distinction between investment and maintenance: all expenses with an effect on future cash-flow are treated as an investment that is activated and then written down, some over a long time period and some over a short time period.

From these arguments we want to draw the following conclusion:

- Traditionally the division into “investment” and “maintenance” was central in both accounting theory and tax rules.
- Recently this has changed and today there are accounting systems where no such distinction is needed.

A general conclusion is however that whether the distinction between investment and maintenance is important or not from a planning and decision making perspective, must be determined independently of concepts introduced for administrative reasons.

## **4 The concept of maintenance**

### **4.1 The standard demarcation of maintenance**

In order to conceptualise maintenance the standard procedure is to demarcate it from its closely related terms, operation and investment. In this section these demarcations are presented and also some of the differences between the maintenance standards AFF 04 and EN 13306:2001 are commented upon. AFF 04 is the standard used by most property and facility management firms

and organisations in Sweden. EN 13306:2001 Maintenance Terminology is the one in use internationally.

The definitions of the concepts differ from author to author and company<sup>1</sup>. EN13306:2001 defines only maintenance whereas AFF04 contains the definitions given below of operation and maintenance.

AFF 04 defines operation as “*Actions with an expected interval of less than one year that aim at sustaining the function of a manageable object.*” It is subdivided as shown below:

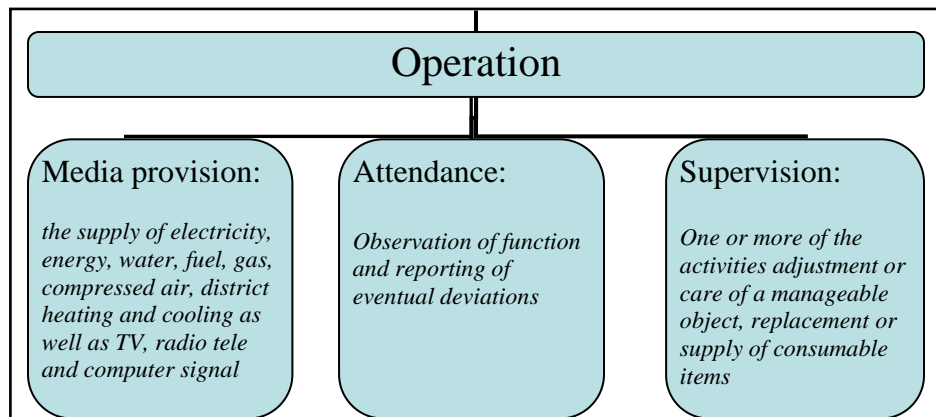


Figure 4-1 Operation types in AFF 04

The definition of maintenance in AFF 04 is limited to

*“Actions aimed at restoring the functions of a managed item, fixture or appliance.”*

The European standard on maintenance terminology (EN 13306:2001), defines maintenance as

*“Combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function”.*

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<sup>1</sup> See Gustafsson (2005), SWECO (2006)

Though AFF 04 does not define investment explicitly the following subdivision is provided:

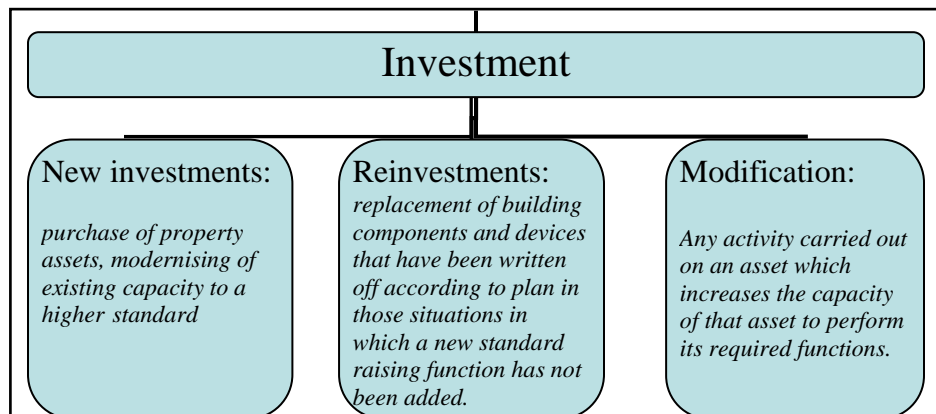


Figure 4-2 Investment types in AFF 04

We can summarize these, and the discussions in section 2 and 3 above, with the following figure that shows the two flexible - or unclear - borderlines from maintenance to operation, and from maintenance to investment.



Figure 4-3 Demarcating maintenance

## 4.2 General comments on the definitions

The two definitions of maintenance presented above differ somewhat in perspective. AFF 04 implicitly assumes that the technical functions are deteriorating and that maintenance is done to *restore* the original functions of the systems. According to EN 13306:2001 the phrase “actions intended to *retain* in a functional state” is also included, which is a somewhat broader concept. Sections of what is called operation in the Swedish terminology are included in the international definition of maintenance - this is roughly the two boxes to the right in Figure 4-1 above. Operation is then reduced to media provision, while all supervision, repair and care which aim at either restoring or retaining a function fall under maintenance

However, there are some common problems, and one is the use of the vague concept of "function". Things can work more or less well, and the fact that an object is in good working condition and to say that it "functions" is, in the end, a decision that is based on views on evaluation of consequences and resources available. This can be illustrated by a roof of a building that leaks a little once every second year or so during both strong winds and rain, but is otherwise not leaking: Does the roof function or not? The distinction between "retain" and "restore" also seems rather dubious in a situation where demands and views on necessary functions change over time.

These problems will, however, lose their importance if the arguments in the next section are accepted.

## 5 Why the concept of maintenance is not needed and an alternative framework

### 5.1 The central argument

A central idea in economic theory is that the rational decision maker should be forward looking, weighting the future costs and benefits of a specific decision. This implies that it is *irrelevant whether this decision leads to retaining, restoring or improving on the earlier or original standard* of the system. Comparing the standard after implementing a certain measure with the standard at some earlier date, says nothing about whether the decision is rational or not, as it is a backward looking description. This is especially true when the point of comparison is some earlier original standard as when maintenance is defined from the perspective of whether it leads to *restoring* a certain function or not.

From a forward looking perspective all decisions are unique in the sense that the future consequences are evaluated given the current situations, which are subject to change together with the expected consequences and the evaluation of these consequences. Another way to put this is that it should always be an open question about what the optimal standard for the object is: Should it be kept at the current standard, allowed to deteriorate or should it be improved?

An example is if a component breaks down in a technical system, it will depend on the current situation whether

- Any action should be taken at all, because maybe the building is soon to be demolished and it can function without the specific function for the remaining time. Perhaps an elevator breaks down, but as there is another, nothing is done to repair the broken one.
- If something should be done, should it be something that increases the standard or not. Maybe the technical development has been such that when a repair should be done, the marginal cost of adding some extra functions is lower than the marginal gain from this increase in the standard. For example when a tap breaks down, the extra cost of replacing it with one that reduces water flow might be very small.

From a decision making perspective a more interesting distinction seems to be between situations where measures should be taken without any special investigation and others where a special investigation should be done. As it takes resources to make a specific evaluation, it can be rational to do certain thing on a routine basis for a certain period of time, e.g. cleaning the corridors once a week, and replacing a light bulb that does not work with a new one of a specific type. But such routine measures need to be evaluated on a regular basis.

### 5.2 Basic framework

The starting point for the discussion is that there is an object under the control of a decision maker. We are of course primarily thinking in terms of a building or a set of buildings, but it can of course just as well be a machine or a set of machines. From the forward looking perspective of investment theory the history of the current situation is of less importance. As discussed above it cannot matter how the current situation relates to an earlier situation (concepts like retain, replace are then uninteresting).

What then matters is:

- the current situation
- the alternative options and predictions about their future costs and benefits
- the alternative "meta-options":
  1. how we should collect information about the current situation
  2. how actions should be chosen in a certain situation

### **5.2.1 How to keep informed**

Here we have a continuum of opportunities like:

- Automatic surveillance
- Inspections
- Waiting until something happens and the user reports this to the maintenance organisation.

The technological development and increasing wage level reduces the relative costs of reliable automatic surveillance and we can therefore expect to see that in more and more situations. On the revenue side, the rationale for investing in surveillance or many inspections is related to the importance of finding eventual problems early. This in turn could be understood in terms of how early information affects the future cost and/or the probability of fixing a problem. When installing new pipes for central heating sensors are for example put in place in order to reduce the costs of finding future leaks. We assume that one reason why there are so many surveillance screens in the cock-pit of an airplane is that it is very important to find problems early. However a well-known problem with automatic surveillance is that if the system signals that something is wrong, there is always a certain probability that it is the surveillance system that is faulty and not the system being monitored.

Waeyenbergh and Pintelon (2002) note that human senses can detect a wide variety of failure conditions which is utilised under what they classify as detection based maintenance. It has a much lower set up cost but it is vulnerable to the subjectivity and experience of persons as some will detect irregularities that will be missed by others.

In extreme cases where for example a part is replaced or servicing carried out according to a schedule intended to reduce the risk of problems to almost zero, there is almost no need to keep oneself informed about how the specific system is working. If there is some rare condition, it will automatically be found when the specific part is replaced or the servicing is done.

### **5.2.2 How to make decisions**

We can divide the decisions in a number of categories depending on the amount of resources spent before making the decision.

#### *Extreme case 1*

One extreme is when decisions are made without any special investigation related to the individual case. There are several sub-categories:

- Certain measures are taken independent of any specific information about the system like when a filter is always replaced after a certain time period. This is rational in a situation where it is costly to inspect but the predictability of the system is rather high making it possible to know roughly the optimal time in which to take action.

- Certain measures are always taken when specific information generated by the ordinary information systems on a particular condition of the object is reported. An example is when an air-filter is replaced if the system monitoring the quality of the air reports that it is below a certain threshold.

These two cases are what is usually classified as "time-based" and "condition-based" "maintenance", but it should be noted that in the cases above it might, as discussed below, be rational to replace an old part either by a part that has a higher or lower quality.

### *Extreme case 2*

The other extreme is when a special large scale investigation is done before a decision is taken. Typically when there are a number of unexpected events it is not obvious what the rational thing to do is. The rational decision might also depend on a number of characteristics of the situation, and instead of specifying all these in advance, it can be more economical just to wait and see what happens before deciding on the action to take. This will depend on the specific situation. If the roof is leaking in a new building it might be rather straightforward what to do, but if it leaks in an old building it might be necessary to make a deeper investigation of the future of the building before deciding on the action to take in the case of the roof.

The difference between Case 1 and Case 2 above can be compared to the difference between a complete contract, where everything is regulated in advance and a relational contract where only a problem solving mechanism is specified (see for example Milgrom & Roberts, 1992). Another way to describe the difference between these extreme cases is to focus on who is making the decision about what to do. The more mechanical the decision the more it can be decentralised. If a lot of resources are spent on preparing a decision, then the final decision is usually taken on a higher level in the organisation.<sup>2</sup>

## **5.3 The options and the actions**

From a forward looking perspective the historical standard of the object is irrelevant. The policy options in a certain situation should only be distinguished by how the current standard should be changed.

From this perspective there are a number of possible actions. The following examples might illustrate the options: Suppose there is a problem with the brakes in one of the company cars. One option is to scrap or sell the car and do nothing else: It might be rational to reduce the number of company cars. Or if there is a problem with the radiators in one classroom in a school, it might be rational to close-down the classroom, because there are vacant rooms where the heating is working. Another alternative is of course to repair the brakes and repair the radiators in a way that makes them work roughly as before the failure. But the company may also choose to buy a new car, or replace the heating system with a new one with many new qualities, e.g. automatic adjustments to predict weather conditions.

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<sup>2</sup> There is also a meta-meta level concerning decision-making: How should we make rational decision about how to make rational decisions? Rubinstein (1998) discusses the infinite regress problem in relation to rational decision making: The rational person makes rational decision about how to make decision, but must then also make rational decisions about how to make rational decisions and how to make decisions, etc.

From a longer time perspective it should always be an open question as in what to do in a specific situation. Any predetermined strategy needs to be evaluated and adjusted when the situation changes and new options become available. One problem with thinking in terms of maintenance is that it indicates some given long run strategy in relation to historical standards, neglecting that what is rational will constantly change when situations change and new information is available. This is often neglected in optimisation models that help to determine the interval between different measures that maximises reliability, availability and profits.

Some examples of changes that might affect the decision making on what is rational to do are:

- new technologies and new products come on to the market
- changes in the need of the services that the object produces or changes in the value of the services produced by the object
- changes in the relative cost of various actions.

## **6 Concluding comments**

The general ideas in this paper can be summarized in the following way:

- From the perspective of investment theory everything that is usually classified as maintenance is also an investment, in the sense that resources are spent today that produce reduced costs or higher benefits in the future compared to if the resources are not spent.
- Maintenance is generally separated from "true" investments by saying that maintenance is a matter of restoring an old function or keeping up an old function. This means that maintenance is defined in relation to historical standards. Rational decision making is however forward looking and the old standard cannot matter.
- From the forward-looking perspective what is especially important is the meta-strategies in terms of how to keep informed and how to make decisions, and the insight that the future is uncertain and that therefore long-run and detailed plans are inefficient. In a longer perspective it is always an open question as to whether the standard of an object should be kept in, improved or discarded.

Most attempts to revolutionize a conceptual structure fail, as the perceived advantage of changing the conceptual structure into something that perhaps is more logical does not match the obvious costs of trying to introduce a new way of looking at things. But discussing the fundamental conceptual structure is, as we see it, important in any case, as it makes us see things clearer and also makes us aware of the fact that all conceptual structures change over time. When technology and society changes, the concepts that we need to describe and understand that structure change, and also the way that we structure the problems that we handle. The concept of maintenance is much more suitable in a world where there are smaller changes and where it is believed to be possible to know long in advance what is rational to do. The conceptual structure presented here seems to us more suitable to a society with more rapid changes, and when it almost all the time is an open question what to do with for example a specific building.

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# Paper 2

# **Is there anything special with building maintenance?**

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**Stockholm 2009**

**Building and Real Estate Economics  
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# Is there anything special with building maintenance?

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April 2009

## Abstract

There has been a paradigm shift in maintenance from that of a necessary evil to becoming an integral part of the business process. The focus is no longer only on availability but reliability and cost effectiveness. But the level of integration of these methods in the planning and execution of building maintenance is low and this paper aims to show that this might be so because building maintenance rationally differs from other industries. The paper describes maintenance strategies used in other industries before discussing why building maintenance is different.

Though the reliability centred practises applied elsewhere are tempting, for many building components the consequences of waiting with certain maintenance measures a year or two are often not very dramatic, e.g. repainting the walls, changing the roof or the windows. In such a situation, the economic situation of the actor can be expected to be important for the volume of maintenance whereby the maintenance budget serves as a “buffer” in bad times. The focus should be on developing a model that takes into account the specific uncertainties that characterise a building and the institutional system in which decisions are made.

**Keywords:** Building maintenance, property management, maintenance strategies

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# 1 Introduction

Managers in the manufacturing industries have seen a paradigm shift in maintenance from that of a necessary evil to becoming an integral part of the business process. The focus is no longer only on availability but reliability and cost effectiveness (Moubray, 1999). Bejrums (1999), Boverket (2002), Shen (1997), Horner et al (1997) and Hellström and Lind (2006) have analysed aspects of building maintenance strategies. However, though the successes of various maintenance methods and strategies in the industrial sector have been well documented, (Pintelon et al, 2006; Pun et al, 2002; Bertling, 2002; Bevilacqua and Braglia, 2000; Chuenusa et al, 2004, Jonsson, 1997) there is a lack of integration of these methods in the planning and execution of building maintenance.

This paper aims to contribute to this process through a description of strategies used in other industries and by presenting some theories about why maintenance of buildings seems to be so different. It starts with a discussion of the term “maintenance strategy” (section 2) and then presents some stylized facts concerning building maintenance in Sweden. Section 4 describes a number of studies of maintenance strategies and approaches used in some other industries, found by a literature search and through other channels. In section 5 an analysis of the difference between the different sectors is presented and the paper ends with some conclusions in section 6.

## 2 Defining “maintenance strategy”

### 2.1 General definition

The concept of maintenance is widely used in property management though not always in the same context even within the same organisation (Gustafson, 2005; Lind 2002). The concept can be questioned but here it is used in the standard meaning of “to restore or to retain a state in which an item can perform an initially specified function and all actions aimed towards this are maintenance activities” (see Lind & Muyingo 2009).

The concept of a maintenance strategy can be defined through the analysis of its component terms. A strategy is here defined as “a long term plan of action designed to achieve a particular goal”. A closely related term in this context is “policy”, which according to the Webster dictionary is “a definite course or method of action selected from among alternatives and in light of given conditions to guide and determine present and future decisions.” Waeyenbergh and Pintelon (2004) define a maintenance policy as “a rule that specifies, depending on stated variables, what to do exactly in a particular situation”.

Bevilacqua and Braglia (2000), take each maintenance policy they list to be a strategy of its own. The above vagueness is further evident in delimiting a strategy from a concept. Pintelon et al (1999) define a maintenance concept as “the set of various maintenance interventions (corrective, preventive, condition-based, etc) and the general structure in which these interventions are brought together”. Horner et al (1997) and Al Najjar (1996) also refer to the above activities as concepts but list them under maintenance strategies.

Dunn (2003) defines a maintenance strategy as “a long-term plan, covering all aspects of maintenance management which sets the direction for maintenance management, and contains firm action plans for achieving a desired future state for the maintenance function.” The European standard on maintenance (EN 13306) simply defines a maintenance strategy as “a management

method used to achieve the maintenance objectives”. No distinction between a maintenance strategy and a maintenance type is made.

According to Moubray (1997), in order to choose or develop an appropriate maintenance strategy the firm needs to “determine the maintenance requirements of each asset in its operating context and then decide what resources are needed to fulfil those requirements.”

## 2.2 Classification of maintenance policies

Maintenance policies have been classified in a number of different ways. In AFF04, which is used in Sweden, and the European EN 13306 maintenance strategies are subdivided in the way described in Figure 2-1 and Figure 2-2.

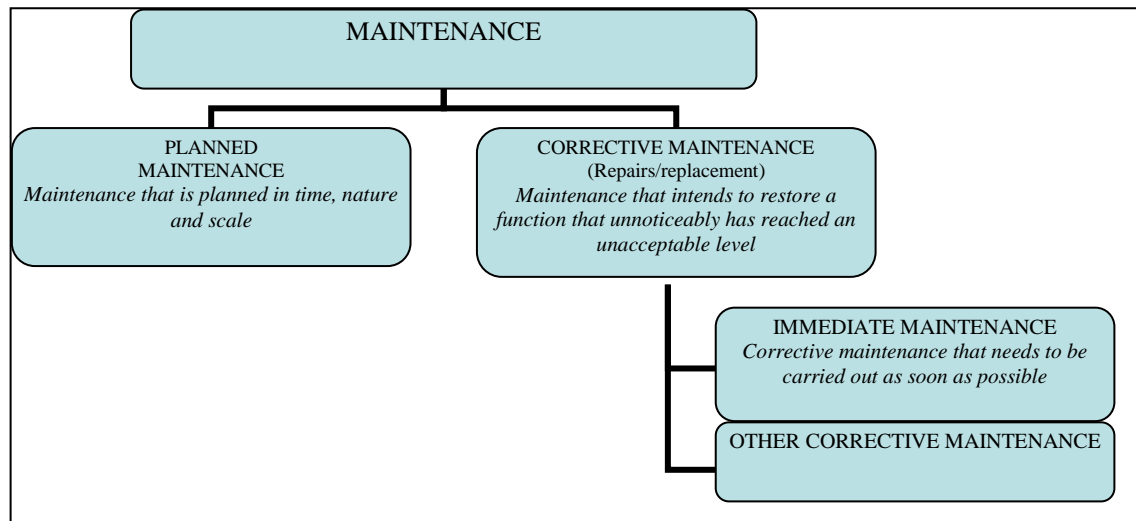


Figure 2-1: Overview of maintenance in AFF 04

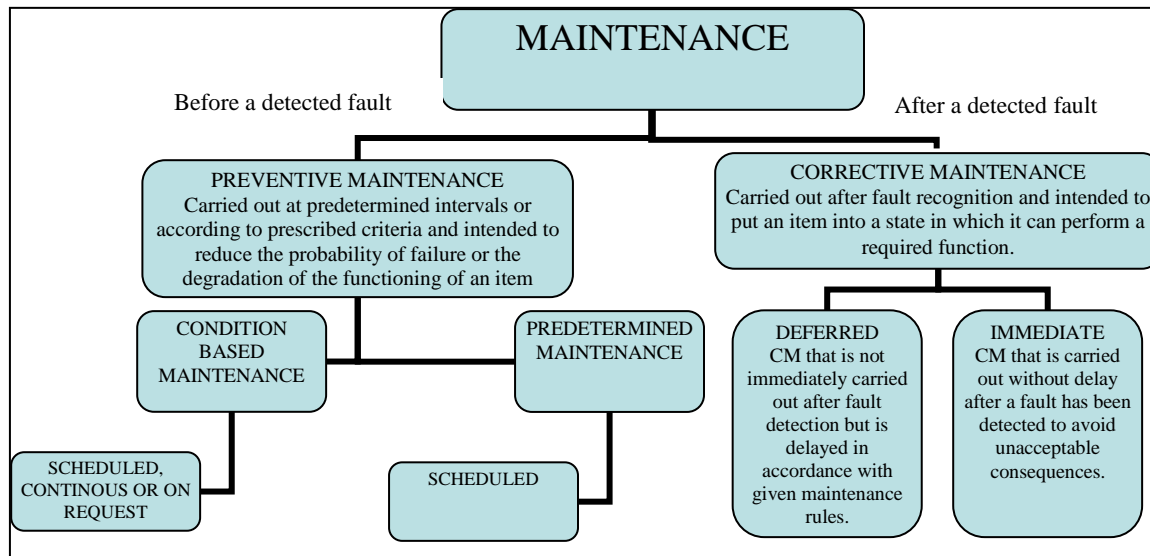


Figure 2-2: Overview of maintenance in EN 13306

*Corrective maintenance*, also known as breakdown, failure based, run to failure or unplanned maintenance is the simplest type of classical maintenance policies where an item is used until it breaks/faults with the only activity centring on repair and servicing of the parts.

Corrective maintenance can then be subdivided according to whether it is done immediately or deferred to a later date, and perhaps included in a longer run maintenance plan.

*Preventive (or planned) maintenance*: In this case certain measures are taken, or certain parts are replaced without there being any specific fault. As the name indicates, the plan is to prevent faults. In many preventive maintenance models, the system is assumed to be as good as new after each PM whereas a more realistic situation is one in which the failure pattern of a preventively maintained system changes to somewhere between as good as new and as bad as old (Ben-Daya and Duffuaa 1995). The preventive maintenance effects can be subdivided into a perfect, a non-effect and an imperfect effect where the perfect effect restores the system to good-as-new, a non-effect to bad-as-old, and an imperfect effect to partly good.

Preventive maintenance is usually subdivided further into *condition based maintenance* which is preventive maintenance where the object is inspected on a regular basis and the object serviced or replaced when a certain condition is observed. *Time based maintenance* is preventive maintenance in which tasks are performed at a frequency dictated by the passage of time regardless of the actual condition of an item.

Figure 2-3 below introduces some further concepts that can be found in the literature.

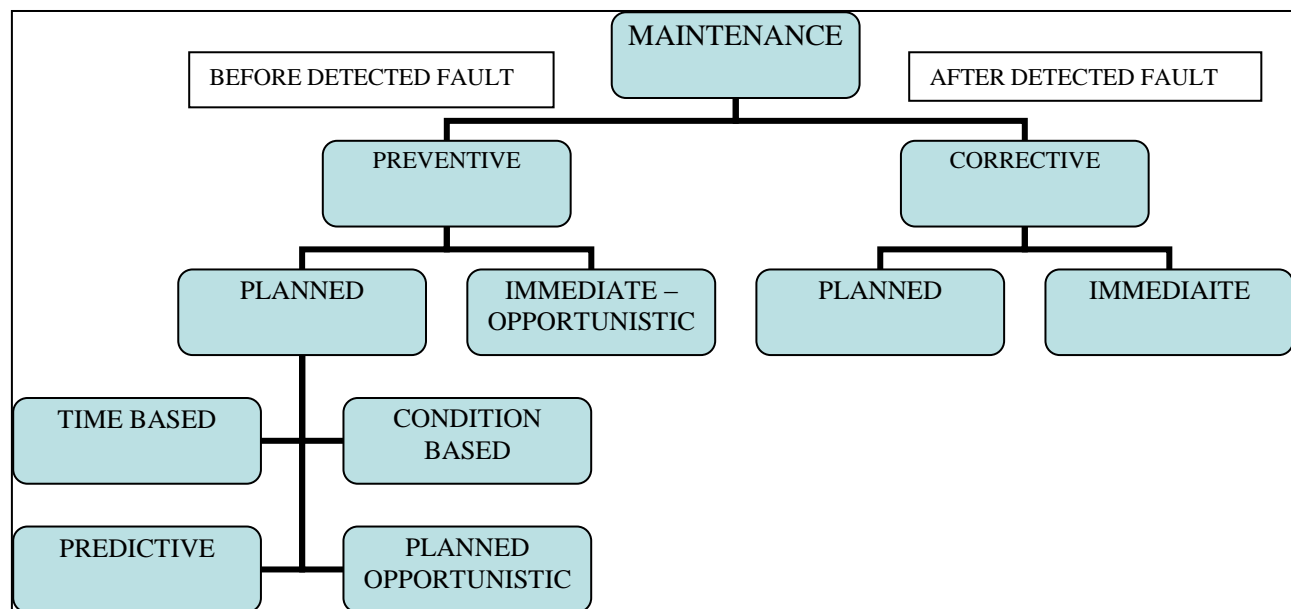


Figure 2-3: An alternative model

*Opportunistic maintenance*: This concept covers the case where certain things are done because there arises an "opportunity" to carry out a certain activity in a cost-effective way. Typically something breaks down or is scheduled for maintenance and when fixing this problem the opportunity to do some other things, that may have been planned to be carried out a later year, is utilised. A situation might arise where it is cost effective to carry out corrective maintenance on

another previously undetected failing item or to reschedule another maintenance activity so as to take advantage of scales of economy in the ongoing activity as is common in the aero industry. Studies show that cheap parts are always replaced which might lead to uncalled for expenses whereas more effort is put into deciding on the replacement of the expensive parts. Saranga (2004) suggests the use of genetic algorithms to decide on whether a particular item needs opportunistic maintenance and how cost effective the OM would be in comparison to a later grounding.

*Predictive maintenance:* Advances in technology have made it possible to develop time based and condition based maintenance schedules. Under the predictive maintenance policy, data is analysed for a trend that would make it possible to forecast the performance degradation. Maintenance activities are then scheduled based on the time of future failure and other relevant aspects. Fault prognostic techniques in predictive maintenance can be utilized in an intelligent maintenance system with the purpose of achieving near-zero-downtime performance of equipment. Mckone and Weiss (2002) evaluate the simultaneous use of continuously predictive tools and traditional periodic maintenance tools.

## 2.3 Structural elements in maintenance

There are also authors who take a broader perspective on maintenance. Pintelon and Pinjala (2006) define maintenance strategy as “a series of unified and integrated pattern of decisions made in four structural and six infrastructure decision elements” based on Hayes and Wheelwright's decision elements of manufacturing strategy. The decision elements with respect to maintenance strategy are the following:

<b>Structural decision elements</b>	
Maintenance capacity:	Capacity in terms of work force, supervisory and management staff.
Maintenance facilities:	Tools, equipment, spares, workforce specialization (mechanics, electricians, etc.), location of workforce
Maintenance technology:	Predictive maintenance, or condition monitoring technology, expert systems, maintenance technology (intelligent maintenance)
Vertical integration:	In-house maintenance versus outsourcing and relationship with suppliers
<b>Infrastructure decision elements</b>	
Maintenance organization:	Organization structure (centralized, decentralized, or mixed), responsibilities
Maintenance policy and concepts:	Policies like corrective, preventive and predictive maintenance. Concepts like total productive maintenance (TPM), reliability centred maintenance (RCM)
Maintenance planning and control systems:	Maintenance activity planning, scheduling. Control of spares, costs, etc. Computerized maintenance management systems (CMMS)
Human resources:	Recruitment policies, training and development of workforce and staff. Culture and management style
Maintenance modifications:	Maintenance modifications, equipment design improvements, new equipment installations and new machine design support
Maintenance performance measurement and reward systems:	Performance recognition, reporting and reward systems, Overall equipment effectiveness (OEE) and balanced score card (BSC)

Table 2-1 Summary of maintenance strategy decision elements (Pintelon and Pinjala; 2006)



## 2.4 Concluding comment

However, though a well defined maintenance strategy will have a major impact on the manufacturing and business strategies of a company, a study of the status of maintenance management in Swedish manufacturing firms by Jonsson (1997) found that only 48% of the companies had a documented strategy while 23% of the companies did not have any maintenance strategy at all. Jonsson (1997) further notes that “the proportion of firms having fully developed written maintenance strategies is probably actually lower than the 48 per cent reported, since some of the respondents considered ISO 9000 to be the written strategy”. In ISO 9000 a strategy is defined as “an elaborate and systematic plan of action”.

## 3 Maintenance strategy outside the construction sector

### 3.1 Introduction

Moubray (1999) traces maintenance through three generations depicted by a “fix it when it broke” mentality before World War II, the development of preventive maintenance between 1950 to the late 1970s and a more condition-based maintenance approach from the early 1980s to the present. This section presents, without any classifications into particular approaches or strategies, a cross section of maintenance procedures used in a number of industries. In the next section this will be analysed in relation to results from studies of building maintenance in Sweden. The sectors described were chosen as information was available for these.

### 3.2 The food industry

The bakery industry is constrained by the requirement for non-stop production as a failure leads to scrapping due to quality problems like that caused by the dough rising. Tsarouhas (2007) presents results of a case study on how changes in maintenance procedure led to increased productivity and quality of the products as well as reduced costs. The aim of the maintenance strategy is to reduce or eliminate losses due to breakdown, set up and adjustment, idling and minor stoppage, reduced speed, quality defects and start-up. The first two are time losses, the next two are speed losses and the last two are quality losses. These are factors that impact on the availability, performance efficiency or quality rate which are used to determine overall equipment efficiency OEE.

$$\text{OEE} = \text{Availability} \times \text{Productivity efficiency} \times \text{Quality rate} = A * PE * QR$$

where

- Availability = (Loading time – Downtime)/Loading time
- Performance efficiency = (Processed amount x Actual cycle time)/Operating time
- Quality rate = (Processed amount - Defect amount)/Processed amount

The indicators reveal the weaknesses of the system and they will indicate the points where improvements and changes should occur.

The production line operates non-stop in three eight-hour shifts and is shut down over the weekend. During the shutdown preventive maintenance, which involves performing a well-defined set of tasks at specified points along the line, and predictive maintenance which involves

estimating when a piece of equipment is near failure and should be repaired during the regular preventive maintenance operations of the immediately following weekend, is carried out. These tasks are done by the equipment operators. In case of a failure the technicians who are responsible for the proper operation of the line during production perform the necessary corrective maintenance operations to repair the failure.

The above procedure is a characteristic of the Total Productive Maintenance (TPM) concept which aims at improving product quality, operational efficiency, capacity, assurance and safety through the focus on the relationship between production and maintenance.

### **3.3 The aircraft industry**

In the aircraft industry maintenance is carried out based on the industry accepted MSG-3 (Maintenance Steering group-3) procedure which is a ““top down” procedure that analyses the probable effects of a functional failure and the capability to detect the failure taking into consideration the costs of failure and of maintenance actions. Based on this analysis, the scheduling of inspections and other maintenance tasks is recommended to be performed at specified intervals. In general the aircraft maintenance process can be divided into two: the first is the preparation stage and the second is the analysis and action stages. The preparation process covers the detailed planning for all aspects that ensure the supportability of the equipment while the analysis and action process follows the MSG-3 procedure. This procedure utilises a condition based maintenance policy in scheduling the maintenance program for each component and it is suitable for mechanical components whose failure can lead to human injuries or large economical losses.

#### **Preparation**

The preparatory stage is based on ILS (Integrated Logistics Support) which is the US Army’s internationally acknowledged process view that ensures that all aspects of an equipment’s life, from conception to disposal are considered during its design and development and aim at achieving, restoring and maintaining the operational capability for the whole life of the equipment at the least life cost. ILS aims at influencing the design of the equipment, its support during operation and procurement of the support package that takes into consideration the requirements for spares, special tools and documentation as well as ensuring that the necessary quantities required under a specified period are at the right place at the right time. ILS consists of the following 10 elements that all have to be considered and planned for: maintenance planning; supply support; support and test equipment; manpower and personnel; training and training devices; technical data; computer resources support; facilities; packaging, handling, storage, and transportation as well as design interface.

Among the maintenance planning activities is:

- ◆ Defining the actions and support necessary to ensure that the system attains the specified system readiness objectives within minimum Life Cycle Cost.
- ◆ Setting up specific criteria for repair, testability, reliability, and maintainability, support equipment requirements, manpower skills and facility requirements.
- ◆ Stating specific maintenance tasks, to be performed on the system and that the maintenance concept ensures prudent use of manpower and resources whereby analysis

of the proposed work environment on the health and safety of maintenance personnel must be considered together with minimising the use of hazardous materials and the generation of waste.

- ◆ Conducting a Level of Repair Analysis (LORA) to optimize the support system, in terms of LCC, readiness objectives, design for discard, maintenance task distribution, support equipment and manpower as well as personnel requirements.

LORA is a method that is used to determine whether the level at which maintenance should be done at the system, component level or lower. This analysis also helps in determining a replacement policy for items that are below the level of repair.

## Analysis

Bengtsson *et al*, (2003) describe the maintenance work done on JAS 39 Gripen (a military airplane) performed at Saab Aerospace. The procedure starts with the identification of the Maintenance Significant Items (MSI) through the use of a detailed family tree that relates functions in a system based on system specifications and function descriptions. Thereafter components in a function are identified and analysed to determine whether they could affect safety, their failure might be undetectable any time during operations; their failure can lead to significant economic or operational consequences i.e. maintainability. The same judgement is then carried out again to determine whether a function is a possible MSI. The system safety/reliability department then carries out a system Failure Mode and Effect Analysis (FMEA) which identifies each MSI in relation to its normal function, the way it can fail, the technical and operational consequences of failure as well as the cause of failure. MSG-3 is a process that identifies the most suitable maintenance policy for a system or component. All actions in the process are documented starting with a functional description of the MSI including diagrams of the wiring scheme. Thereafter a “failure effect category” form is filled in which also specifies whether the failure is detectable or not. Each failure cause and mode is then analysed to find if there is a cost effective preventive maintenance action. If so, this action is suggested with specifications for the motivated interval between actions. If no preventive maintenance action is judged to be suitable this must be noted and justified. A task summary form specifies the total preventive maintenance for the MSI that is analysed. This form contains the action’s AECMA<sup>1</sup> number, a description of the action, the suitable interval between actions, the failure cause category and reference to the failure cause corrected by this action. Through this rigorous process the MSG-3 procedure serves to prevent or rectify failures at the same time as data is collected for possible design improvements.

## Data collection

The scheduled maintenance of complex systems like aircrafts relies on the collection of a lot of data for reliability predictions. Bengtsson *et al* (2003) further describe the Swedish armed forces’ operation data system (DIDAS) for airplanes and helicopters which is used for the follow-up of equipment and accessories. All maintenance actions and modifications are registered in the system. The data is collected from three sources:

- Report on equipment failure – Pilots and ground technicians report all incidents and actions taken on the aircraft or component into the system,

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<sup>1</sup> European Association of Aerospace Industries

- Report on operation disruption – All incidents or failures in the equipment or with the staff to the extent that flight safety is affected or the flight discontinued are recorded. This data is reported into DIDAS by the pilot for incidents during a flight or by the ground personnel for incidents discovered during ground maintenance. This report must include a description of how the incident manifested itself, time of occurrence, operation or maintenance point when it occurred and any actions taken in relation to the occurrence of the incident,
- Report on actions taken – This is a follow up report on any action taken after the registration of an equipment failure incident report. This report must include an identification of the maintenance item and workshop, type of action, description of action taken, record of replaced items and failure mode or tendency to degradation and reference to test results.

DIDAS is programmed so as to provide an automatic or manual periodic maintenance scheduling based on flight hours, number of days or cycles. The maintenance can be carried out on a long term basis or running basis. In order to collect enough data on rarely flown aircraft types like Saab's JAS 39 Gripen, some of them are given a priority status and flown more often up to a specified amount of hours before maintenance. The data collected can then be applied to other aircrafts.

## Maintenance

The maintenance of aircraft engines is extremely expensive mainly due to the cost of the spare parts and, for passenger traffic planes, the downtime cost in form of substitute aircrafts. Thus the aim of maintenance is to minimize the maintenance frequency as well as the number of parts replaced. In their pioneering research, Nowlan and Heap (1978) noted that about 95% of aircraft components have a random failure probability and should not be maintained according to a scheduled program. They coined the concept of Reliability Centred Maintenance (RCM) which is a procedure that aims to develop cost effective maintenance through identifying what is wanted out of the equipment, what the equipment can do, the ways it can fail to meet the requirements on it and what can be done to ensure that the equipment meets expectations in a safe and cost effective way. It integrates the logic decision making in MSG-3 with a Failure Mode and Effect Analysis (FMEA).

Volvo Aero Corporation (VAC) has been the maintenance facility for the Swedish Armed Forces and is responsible for the maintenance of the RM 12 engine in the JAS 39 Gripen. The extent of the work on the engine is based on the remaining period to the statutory limit, the status of various condition monitors as well as modification needs. This also provides an opportunity to carry out a more careful inspection of other normally inaccessible components that require maintenance or replacement. This opportunistic maintenance involves the replacement of some non-failed components that are not expected to last until the next opportunity occurs and therefore the maintenance decision also involves optimising the combination of maintained (correctively or preventively ) and replaced parts so as to lengthen the life of the engine in the most cost effective way. Optimisation also aims at solving the problem whereby cheap parts are always replaced whereas the inclusion of a minimum time between replacements for cheap parts leads to large savings. A model for the optimisation of the opportunistic maintenance in the aircraft industry is presented in Almgren et al (2007)

## Summary

Aircraft maintenance is principally based on the detailed planning for all aspects that ensure the supportability of all the equipment based on Integrated Logistics Support (ILS) before the commissioning of the aircraft. During operation the maintenance schedule and process will depend on an analysis based on the Maintenance Steering group-3 (MSG-3) procedure, a “top down” procedure that analyses the probable effects of a functional failure, the ability to detect the failure and the costs of failure and of maintenance actions. A failure cause and effect analysis that is carried out during the maintenance process helps to provide important information that can be used in equipment design improvements.

### 3.4 The Electric Power Distribution industry

An electricity distribution company aims to ensure the safe and, as far as possible, constant delivery of electricity to the customers. The distribution network consists of power lines (overhead or underground), electrical substations and pole-mounted transformers that all require careful maintenance in order to ensure the reliable transmission and delivery of power. Bertling (2002) finds that “the industry is faced with a changing situation with increasingly complicated systems that are driven by economic rather than technical factors, and with the overall objective of achieving cost effective expenditures rather than maximum reliability”. The focus is “on maintaining the correct components at the correct time and with the correct maintenance activity through the preservation of system function, identification of failure modes, prioritizing of function needs and selection of applicable and effective maintenance tasks”. The above formulation describes the essentials of the Reliability Centered Maintenance (RCM) concept which was initially developed for the aircraft industry in the 1960s.

A case study presented by Bertling (2002) on causes of failures in an underground cable component illustrates the maintenance procedure in this industry. The survey aimed at finding out the location of the failures that cause the system to fail and how the preventive maintenance was to be planned so as to prevent these failures more effectively. The initial step was to collect all the available statistics on the failures coupled with detailed discussions with maintenance personnel. A total of 3980 failure reports from 1982 to 1990 were analysed. These were sorted according three voltage groups. They were further sorted by failed component type and cause of failure for the whole system as well as the voltage groups. A particular voltage group was identified as a major contributor to interruptions of supply. This systematic analysis also highlighted the lack of reporting detail about causes of failures. The survey was then concentrated at one substation and disturbance reports studied. There were a total of about 60 interruptions in a 20 year period. Further analysis revealed that materials or methods were the most significant causes of failure (59%) but none due to weather. A study of cable-specific data provided information on the types that were most exposed to failure. The survey on maintenance personnel experience revealed that “more useful information is known about the cable system failures than is actually being reported, which could help in identifying and preventing failures” (Bertling, 2002, page 133). The analysis resulted in several recommendations for the documentation system. These included reporting information for components treated individually, using a checklist and visual inspection during failure events, incorporating several information systems, improving feedback and communication within different reporting procedures and providing support for the organisation in the long term

work on with documentation led by their own expertise. The results from the survey were then applied in the RCM framework shown below.

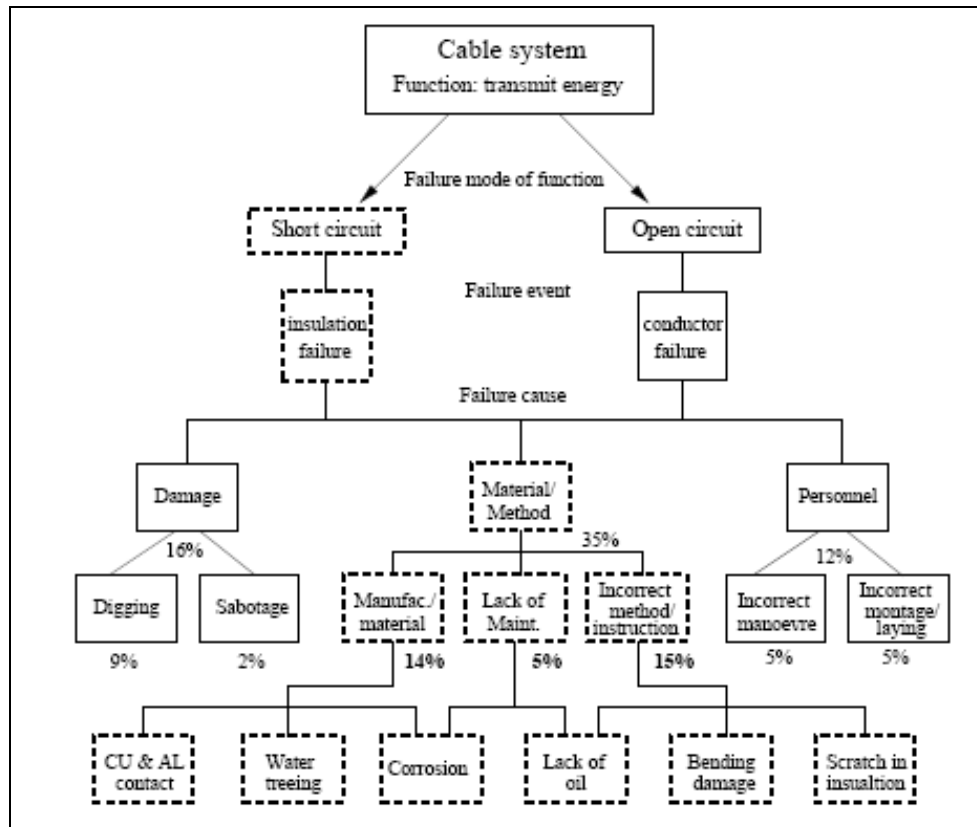


Figure 3-1 Results from the survey as input data for an RCM analysis. (Bertling, 2002 page 137)

After compiling results on the variation of the failure rate function over time the maintenance strategy that aims to find suitable and effective preventive maintenance activities that will reduce those failure causes so as to achieve optimal system reliability is defined. This is based on the type of preventive maintenance (no action, prevention by rehabilitation, or prevention by replacement) to apply as well as the frequency at which it is to be applied together with the points in time that ensure availability and cost efficiency. The activities are also planned so as to have a spread in the maintenance of the different components. The optimal strategy is further arrived at after a cost and benefit analysis that takes into account the cost of failure, the cost of preventive maintenance and the cost of interruption.

### 3.5 Other studies of Power Generation

*Gas power:* – Periodic scheduled preventive maintenance is based on manufacturer's recommendations otherwise the policy is that of corrective maintenance. Security requirements stipulate basic minimum inspection interval for items that can lead to environmental dangers or those that are most significant for production (Svenska Kraftnät, 2004).

*Hydro power:* Backlund and Akersten (2003) present a study of the process of introducing the RCM approach at Vattenfall, a hydropower production and distribution company. "Plant maintenance currently consists mainly of overhauls and inspections, executed according to time schedules established by usage and custom". The case study highlighted obstacles that have to be

overcome before the successful introduction of a new cost efficient maintenance method. Essential in the preparations is that of a common computerized maintenance management system, a computer system that can handle all of the failure mode and consequences analyses, a companywide register of all of the plants/items that are to be maintained, a clarification of routines, roles and responsibilities as well as a clear understanding of how to measure the benefits generated.

*Nuclear power:* Though nuclear power stations are complex systems often with a long start up time after shutdown due to safety requirements they are nonetheless assembled from parts that are in common use even in other industries. Landqvist (2004) finds that there are major differences between the maintenance models used within the Nordic nuclear power plants but that they all basically adhere to an RCM type of approach. However the complexity of the shutdown and start up procedure will lead to the utilisation of all opportunities available to carry out maintenance that would otherwise have been scheduled to be done or that would not have been possible. Allen et al (1997) present a report on the opportunistic maintenance of a nuclear linear accelerator.

### **3.6 Submarine (Swedish Naval Force)**

Submarines, like aircrafts are complex systems that can benefit from planned preventive maintenance due to the high level of downtime costs. The downsizing and reorganisation of the Swedish armed forces as well as focus on more international duties means that there are fewer submarines and that these will be serving in areas far from their traditional maintenance ports.

With a focus on availability, this has raised the need for cost effective and efficient maintenance onboard. Gunnarsson and Andersson (2006) have analysed the current maintenance procedure of the Swedish marine forces and find that it is either condition based or scheduled according to the manufacturer's specifications which at times can be up to 15 years outdated. They propose the introduction of a new maintenance concept Preventive Maintenance Optimisation (PMO) to take care of the current lack of a clear maintenance methodology and possibilities of updating the maintenance plan in a dynamic way. The proposed process is very similar to that of the RCM concept with its logical decision making with the main difference that the focus in PMO is not of setting up a new procedure but creating efficiency in the existing maintenance planning and organization. This is considered to be advantageous as it is less costly and faster to implement than RCM. In order to utilize the proposed concept it is crucial to have an accessible information support system.

Another major proposal is the modification of the maintenance organization so that is a specific group of people receives and analyses all of the maintenance information that will be coming in from the maintenance staff on the submarines so as to have an overall view of general maintenance planning much as it is in the US Navy.

In their study on the possible implementation of reliability-centered maintenance in maritime operations, Mokashi et al (2002) note that the shipping industry to a great extent follows the equipment manufacturers and suppliers' recommendations and carry out costly time based maintenance. Due to principal agency problems related with the costs of guaranteeing the equipment, the suppliers tend to suggest programs that lead to over-maintenance. However, though RCM can lead to reduced costs and efficiency, it is considered to be too resources demanding as conditions onboard ships are not the same as for shore-based industries.

As a conclusion it can be said that the maritime industry is still lagging in the implementation of cost effective maintenance concepts and strategies due to specific conditions as well as the lack of unified information of failure data that can be used by many operators. Downsizing and a widened sphere of operations is leading to the need for new maintenance procedures onboard the Swedish marine's submarines. The proposed methodology is similar to RCM but with the maintenance task as the point of focus and not the failure mode itself. However performing the RCM analyses for the first time is labour intensive and time consuming and is justifiable in high tech/high risk industries where reliability rather than maintainability is the main objective as it is too expensive in industries where maintenance is an economic rather than a reliability problem.

### 3.7 Other studies

*Mining equipment:* Leppäjärvi and Vilen (2008) report on the maintenance of a mining excavator at the Boliden mines. The company has a policy of daily inspection of the excavator leading to handwritten reports. These combined with automated reports as to the production levels are used in the corrective maintenance that is applied. Preventive maintenance is in the form of simple activities like oiling and inspection. A major problem is the apparent loss of information due to a lack of a central register of the maintenance activities.

*Train wagons:* Punctuality is a crucial criterion in the performance measures of passenger service rail transport. Availability as well as reliability are therefore of great importance when considering the maintenance schedule of the trains. Maintenance of trains is slowly evolving away from the traditional periodically scheduled activities to more of a condition based approach. This is due to the increasing use of automated condition monitors on the trains<sup>2</sup>. Though this has increased the time between activities in some cases from a 7 day cycle to a horizon of 90 days, safety requirements stipulate that certain items have to be inspected at least once every 7 days. The implementation of condition based maintenance has not been a landslide because of fear of changes and high investment costs (Bengtsson, 2007), as well as lack of clarity as to who owns the information gleaned from the monitors (and thus should pay for the installation costs) in situations where the operator and the maintenance organisation are separate companies.

*Military battle tanks:* A study by Bengtsson (2007, pg 56) focused on the possibility to utilise condition based maintenance on the final drive of the Swedish battle tank 112. The main criterion when deciding on maintenance was availability, which is a function of the mean time between failures, mean time to repair and the mean time waiting. Bengtsson (2007) found that corrective maintenance was the most frequently used method and the study revealed that since each military unit carried an exchange unit the waiting time and repair times were quite low. The benefits of installing a condition monitor only to lower the mean time between failures were minimal in relation to the costs involved and therefore condition monitoring of this part was ruled out.

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<sup>2</sup> <http://www.railway-technical.com/train-maint.shtmlm>



### 3.8 Analysis

There are some especially interesting features in the maintenance models described above.

1. The focus on collection of information that makes it possible to predict failure rates. The assignment of responsibility to a smaller group of people is also a way to increase the available information about how a system works. It is clear that in order to have cost effective maintenance an accessible and dynamic information bank of all maintenance activities at all levels is essential.
2. Explicit modelling of the "revenue" side of maintenance, based on failure rates and failure costs. In this way an optimizing framework can be formulated and applied.
3. A move away from time-based maintenance to condition based maintenance. The problem with time-based maintenance is that it tends to lead to over-maintenance, especially if it is based on recommendations from a manufacturer where reducing the risk of failure of their product is more important than reducing costs.

The results from the case studies are also in line with the general theoretical results above when different maintenance strategies should be used:

*Corrective maintenance* is justifiable when the impact of failure is rather small. As corrective maintenance can lead to inconvenience caused by the unplanned failure and corresponding downtime in dependant systems, the situation must be such that the cost of this is rather small. Alternatively there must be an organization (personnel, spare parts) for carrying out corrective maintenance quickly as well as the need to keep a large stock of spare parts. The problem with corrective maintenance is that faults may occur in unexpected ways and at the "wrong time" leading to higher costs than expected.

*Preventive maintenance* is rational if the consequences of a fault are high in relation to the cost of doing something that in advance reduces the risk for a fault. It also provides the advantage of being able to perform activities when it is convenient to the user, avoiding the cost of consequential damage due to break downs, a reduction of downtime and the possibility of identifying the equipment with excessive maintenance costs which could be maintained under a corrective policy. The decision to carry out preventive maintenance can be based either on the age, period between activities or on the monitored conditions of the item, depending on the specific situation. This approach provides a reduced probability of equipment failures and extends equipment life. However, under this approach a large number of unnecessary tasks will be carried out on items that could have remained in a safe and acceptable operating condition for a much longer time, especially if it is difficult to predict when something has to be done in order to reduce the risk for faults. For example, should preventive maintenance of a roof of a certain type be done every 40 or every 50 years? As noted by Tsang (2002) the replacement schedule is often drawn up on the supplier's recommendation, who has limited or no local knowledge of actual use conditions or past experience which seldom makes it is optimal, and also an incentive to overestimate the need for replacement. Nowlan and Heap (1978) identified six patterns of failure and showed that close to 90% of all items experienced failures whereby reliability would not be improved by a time based schedule. Zhao (2003) suggests a PM policy based on a critical reliability level and not time. Barlow and Hunter (1960) present optimum PM policies based on a consideration of minimum repair between actions. The stochastic nature of deteriorations has been modelled in a

number of operational research optimisation models. Tsai *et al* (2001) uses genetic algorithms to obtain an optimal solution that maximises unit-cost life based on the extended life after a PM action. Badia *et al* (2002) suggests an optimal period for the inspection as well as PM of units with revealed and hidden failures.

One way to reduce the cost of preventive maintenance strategies is to use a *condition-based maintenance* strategy, as it is then more likely to make repairs only when necessary. This strategy is however also based on some assumptions, e.g. that the current condition is a good predictor of the probability of faults. It also assumes that it is possible with continuous survey and that this provides useful information. Electrical faults are an example of hard faults that are difficult to localise but easy to rectify when found. Mechanical faults are an example of soft faults that are easily identified but require a lot of time to restore. Optimisation dictates that not all observed deterioration can be remedied immediately. Bahrami G-K *et al* (1998), Saranga and Knezevic (2000), Marsequerria *et al* (2002), Barbera *et al* (1999) all discuss and provide models for the optimal condition based maintenance of continuously deteriorating systems. As some items might be inaccessible it is impossible to monitor every item in a system in a cost effective way which limits the extent to which condition based maintenance can be efficient. In such cases an alternative policy is that of opportunistic maintenance as described above.

The decision between corrective and preventive maintenance are implicitly or explicitly analysed as a balancing of what could be called errors of type 1 and errors of type 2, using some concepts from statistics. In this context the following interpretations could be given:

- *Error of type 1*: An action is taken though it is afterwards seen that it was not necessary. Using the traditional terminology this is the basic risk of "preventive maintenance", things are done that in the end would not have been necessary, e.g. because it is shown that the component has a longer life than expected, or because some external events necessitates more drastic measure.

- *Error of type 2*: Nothing is done, or only some simple measures are taken in a specific situation. However after a short period it is seen that this "neglect" has created large negative consequences, making it necessary to spend considerably larger sums than would have been necessary if the - with hindsight - correct measures had been taken.

## **4 Stylized facts about building maintenance and how they can be explained**

### **4.1 The stylized facts**

The results from several studies about building maintenance in Sweden (e.g Hellström and Lind, 2006; Muyingo 2009a, b,) can be summarized in the following stylized facts.

- A large share of maintenance activities are corrective maintenance carried when faults suddenly are observed.

- Detailed maintenance planning covers a short period of time, maybe a year, and the specific maintenance actions are rescheduled all the time. In Muyingo (2009a,b) a question was asked as to the size of this year's maintenance that was included in last year's plan and the majority answer

was that approximately only 75 per cent of the work carried out. When more long run plans are made, maybe 3-5 years, it only takes a few months before they are outdated.

- Maintenance measures are affected by the budget situation. When a property owner, especially a public authority, has money left in its "investment budget", or when the economic situation is good, then more maintenance is carried out. When the economic situation becomes tougher, then maintenance expenditure is reduced.

- There is a considerable amount of opportunistic maintenance. When e.g. a building should be changed in a specific way because the tenants' needs are changed, or some corrective maintenance must be carried out, other maintenance measures are taken at the same time.

## **4.2 Is building maintenance underdeveloped or rationally different?**

The standard reaction to the stylized facts above is that building maintenance is underdeveloped and the goal should be to build up a system that resembles the systems from various industrial sectors, where there are more detailed plans that are followed rather closely.

A first comment to this is that the rationality of the industrial sector might be overestimated. As can be seen above there is a discussion in several sectors that maintenance planning is underdeveloped and needs to be improved,

A second comment is that this kind of rationality is possible and rational only given certain assumptions, and that the stylized facts of building maintenance can be rational given the characteristics of the situation.

- Each building is unique and consists of a number of integrated components that interact. The building has a long life and the uniqueness and interaction creates a relative large span for the economic life of a specific component. This economic life is also affected by maintenance carried out earlier, the quality of which usually is not documented in a detailed way (Muyingo 2009b pg 16). The quality of the original construction work might also be difficult to know. This means that the predictability of how the systems work will be rather limited, and the kind of databases discussed above for serially produced objects will not be possible.

- For many building components the consequences of waiting with certain maintenance measures a year or two are often not very dramatic, e.g. repainting the walls, changing the roof or the windows. In such a situation, the economic situation of the actor can be expected to be important for the volume of maintenance. In the "good times" more maintenance is carried out, while in the "bad times" maintenance will be postponed (Muyingo 2009a). The same kind of behaviour can be seen in the household sector, and it is possible to see expenses for building maintenance as a good "buffer" when there are economic fluctuations.

- Changes in maintenance planning are not only related to changes in the general economic situation, but they are also related to changes in priorities within a maintenance budget. A sudden occurrence might mean that the corrective maintenance increases, or that the need for a specific preventive action is increased, or that it suddenly becomes rational with more opportunistic maintenance. This will also mean that some measures will be postponed, sometimes in a very late stage, e.g. just before the work should be procured.

Our conclusion from this is that there are strong arguments for saying that building maintenance rationally differs from the kind of maintenance and maintenance planning that could be observed in some of the sectors above.

## **5 Concluding comments**

The analysis above does not mean that everything is well with building maintenance, but it suggests that the goal should not be to copy other sectors, but to develop a model that is rational given the specific uncertainties that characterise a building and the institutional system in which decisions are made. A crucial fact is the large number of uncertainties that affect the situation.

Trying to identify best practice in building maintenance could in this situation lead to the kind of planning that was observed in some of the municipalities in Lind & Hellström (2006).

- Dividing the buildings into core and non-core buildings with different maintenance strategies, with more planned and preventive maintenance on the core buildings.

- Dividing the components of the building into more or less crucial for the long run value of the buildings. This both concerns components that are crucial for the building value as such, e.g. that the roof does not leak, and components that are crucial for the specific activities that are carried out in the building, e.g. the heating system in an old-age home.

- Working with a set of plans with different time spans and levels of details. Maybe a rough one-page 20 year plan identifying standard intervals for repairing or replacing central components in the building. A somewhat more detailed 3-year plan focusing on the core buildings and the central components in them, and a detailed 1-year plan. As was noted above, even this plan will be modified a number of times during the year.

This also means that it must be accepted that a considerable part of building maintenance has to be corrective and opportunistic maintenance.

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# Paper 3



# **The effect of the ownership category on the maintenance costs of housing companies**

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**Building and Real Estate Economics  
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# **The effect of the ownership category on the maintenance costs of housing companies**

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## **Abstract**

The post World War II housing property stock is getting older and there are concerns about the consequences of the low level of maintenance activity in the sector.

This paper presents two empirical studies on the factors behind the housing maintenance costs reported by the private and the municipal housing companies in Sweden. The aim is to analyse the effect that the ownership category has on the strategic planning and execution of housing maintenance and the magnitude of this effect on maintenance costs that are reported by the companies. The studies are in form of a questionnaire survey on housing maintenance and an econometric analysis of the maintenance costs contained in the financial reports of the companies.

The results indicate that the ownership category has a significant effect of approx. 35 per cent on the maintenance costs reported. On the other hand, results from the survey suggest that the gap in maintenance costs is partly due to the difference in the maintenance planning and demarcation of the concepts in the two categories. They further suggest that private housing companies have a different tenant composition and an acceptance of a lower standard whereas pressure from the media and politicians influences the cost level in the municipal housing companies. The high dependence of reported costs on the ownership category points to a need for a more transparent and consistent classification of the activities carried out.

**Keywords:** Housing maintenance, property management, real estate, municipal housing companies

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# 1 Background and aim

A survey by The Swedish Board of Housing, Building and Planning (Boverket) in 2004, found that less than 10% of all the housing in Sweden was built after 1980 in comparison to the average of 20% in the European Union (Boverket 2005). As the housing property stock in the country is getting older there are concerns about the consequences of the low level of maintenance activity in the sector as indicated by a report commissioned by the Swedish government (Boverket 2002). Though various factors that may affect the level of maintenance and its cost have been noted in a number of papers (see e.g. El Haram & Horner 2002; Bejrums 1999; Shen 1997; Olubodun & Mole 1999) the profit requirements of the housing companies have at times been given as the main reason for the low level of maintenance especially in the properties constructed during the period 1961-1975 (Hyresgästföreningen 2007). A complaint (Swedish Property Federation, 2005), at the EU by the European Property Federation on behalf of the Swedish property owners association accused the municipal housing companies of receiving illegal public subsidies which tended to give these companies, which in principle are non-profit entities, an unfair corporate advantage (Lind 2006).

According to Bejrums (1999) and Borg and Lind (2006) the ownership category will affect the choice between activities aimed at maximizing profit or cost reductions. However there is a lack of empirical analysis on ownership category and maintenance and studies such as Wilhelmsson (2008) and Chau et al (2003) are mainly focused on the hedonic price determination of single family housing or finding the optimal maintenance level (Dildine & Massey 1974; Vorst 1987).

This paper analyses the effect of ownership category on housing maintenance and the magnitude of this effect. This is done partly through a questionnaire survey on maintenance strategies in the private and the municipal housing companies and also through an econometric analysis of the maintenance costs contained in financial reports of private as well as municipal companies. A difficulty in this type of analysis is the lack of like-with-like comparison of the properties. There is also a general lack of uniform disclosure on the way the concepts have been applied (Nordlund, 2008). The regulations governing financial reporting in Sweden stipulate what can be included in maintenance costs (Boverket, 2002 page 40), and this is used as the basis to make generalised comparisons on the levels of maintenance in different companies.

The results from the survey indicate that the political and media pressure on the municipal housing companies is a major factor behind the difference in maintenance levels between the ownership categories. Furthermore, the municipal housing companies in contrast to the private housing companies are found to have longer maintenance plans of more than 5 years which they also adhere too to a great extent. The results of the econometric analysis show that the ownership category plays the most significant role in the maintenance costs reported in comparison to other factors.

The remaining part of this paper is organised as follows: Section 2 contains the method and delimitations while section 3 presents the literature review on factors that may affect maintenance levels as well as on econometric data analysis and empirical studies on housing maintenance. The results of the survey are presented in section 4. Results from the econometric analysis are in section 5. The paper ends with concluding remarks in section 6.

## 2 Method and delimitations

The paper is based on a questionnaire survey that was carried out in the autumn of 2008 as well as an econometric analysis of company financial reports that were collected in the spring of 2008.

### The survey

The survey which focused on maintenance management covered 55 companies out of the 89 that received requests, and was directed towards persons in a managerial position. The companies were identified through a list of real estate companies on the website of a branch journal<sup>1</sup>. In order to ensure response, answers were sought from 2 respondents from each company. As the answers from the same company at times diverged, each individual answer is taken to be representative of the category and none of the respondents in the same company is given preference. The results are given as percentages of persons in each category that actually answered a particular question.

The seven-section survey consisted of 38 questions based on factors that were identified through the literature as well as in discussions with professionals. Close ended questions as well as Likert scaled response format questions were used in the electronic internet based questionnaire to elicit structured answers on maintenance planning, strategies and maintenance levels in general. Most of the questions were in form of statements that could be answered either as fully agree, partly agree or disagree.

The questionnaire started by establishing the company name, the respondent's position as well as length of employment in the company. The second part of the questionnaire aimed at clarifying how the companies categorise the concept of maintenance and how a number of given activities would be classified. Part three was aimed at soliciting answers on the company's own maintenance levels and the factors behind it and to find out the factors that were deemed to be significant causes of immediate maintenance whereby an answer was required on a number of given problems. The way the company organises its maintenance is surveyed in the fourth part of the questionnaire to find out the extent of decentralisation and utilisation of external help. The fifth part of the questionnaire focused on how the company plans its maintenance as well as the inspection frequency and the documentation of information. Parts six and seven addressed the issue of neglected maintenance and the possible causes of the lower maintenance costs reported by the private housing companies.

The statistical analysis programme SPSS was used in the tabulation and analysis of the answers. Questions that required detailed facts on each company were not included in the survey but the respondents had the option at the end to make extra comments.

The use of an electronic survey was deemed to be the most cost effective and efficient way of collecting the information needed as administration through the internet was easy. As noted by Coomber (1997) there is a bias in using the internet for survey research with a relative lack of representation of those who are not active or frequent users of the internet thus a reminder was sent out two weeks after the initial request which brought the total response to over 50% of the companies surveyed. The questionnaire was written and administered in Swedish. A translated version is provided in appendix 1.

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<sup>1</sup> [www.fastighetsvarlden.se](http://www.fastighetsvarlden.se)

## The econometric analysis

Econometric analysis using pooled time series cross section data is also known as panel data analysis. It provides the advantage of circumventing the problem due to small samples and many explanatory variables as the number of observations is greatly increased. Panel data also provides the advantage of being able to detect causal relationships both across time and section simultaneously. However panel data often violates the standard OLS error assumptions such as being serially correlated or contemporaneously correlated and heteroskedastic. The Durbin-Watson (D-W) test is used for testing for serial correlation<sup>2</sup>. A number of variables might be statistically insignificant by themselves based on the t-statistic. However using the F-test a set of variables may be shown to be jointly significant which in most cases warrants keeping them in the equation. Furthermore, model misspecification might lead to data which is homoskedastic and not auto-correlated but still produces a regression infested with heteroskedastic and auto-correlated errors. Podesta (2000) as well as Worrall and Pratt, (2004) present several methods used to correct for these complications such as the use of a fixed effects model in correcting for heterogeneity and the Prais-Winsten estimation for dealing with serial autocorrelation. The Breusch-Pagan test is one of the methods used to test for heteroskedasticity which can then be dealt with through robust estimation (Wooldridge 2006, p 280). Panel data analysis presumes that the data are stationary which can be tested using the augmented Dickey-Fuller (ADF) test. This is done through “regressing the first-differenced dependent variable on the one-period lag of the dependent variable and on one or more lagged first-differenced dependent variables” (Worrall & Pratt, 2004). The above procedure with lagged changes cleans up any serial correlation in the first differenced dependent variable. However due to a short time period (four years) and the low number of companies (16) it was not possible to analyse the data using the procedures of panel data analysis such as the augmented Dickey-Fuller test as the observations decreased even further. The data was therefore treated as a cross sectional time series using only some of the tests above.

Financial reports of the companies in the survey above were collected and the data on the reported maintenance costs for the period 2004 to 2007 was tabulated as a time series. In order to make the data from the different reports as comparable as possible only companies with a minimum rental space of 200,000m<sup>2</sup> and at least 30 per cent housing under their management were included in the analysis. Another criterion was that the company's annual reports for the period 2004 to 2007 were easily accessible on the internet and that the maintenance costs were clearly demarcated from repairs and central administration.

The analysis was carried out using a statistical program STATA 9. After specifying that the data was a time series a Prais-Winsten robust estimation was done<sup>3</sup>. Thereafter the F-test was applied to test for joint significance of those variables that exhibited insignificant t-values. The variables that were considered to be jointly significant based on a low p-value were dropped.

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<sup>2</sup> Wooldridge (2006, pg 419) provides a more detailed description of the DW statistic which generally for large samples, should be above 1.5

<sup>3</sup> The time series operators in STATA 9 were utilised in this analysis

The generic model has the following form:

$$y_{it} = \beta_0 + \beta_1 X_{it1} + \dots + \beta_k X_{itk} + e_{it}; i = 1, \dots, n; t = 1, \dots, m \quad (1)$$

Where  $X_K$  is a  $K$  vector of exogenous explanatory variables and  $y$  is the dependent variable. The observations are indexed by both unit of observation ( $i$ ) and time period ( $t$ ) (Dougherty, 2006, ch14).

## Limitations

The concept of maintenance is not always defined uniformly even within the same organisation (Gustafsson, 2005). In the survey part of this paper maintenance is analysed from a wider, all inclusive, perspective and only the addition of new space or new functions is considered as investment. Thus corrective actions such as repairs are taken to be maintenance activities. On the contrary, the econometric analysis is based on the definition of maintenance as stipulated by the Swedish law on financial reports of non-registered companies in which “only costs pertaining to planned maintenance and contained in a long term plan can be categorised as maintenance”, Boverket (2002, page 40). Under these regulations, expenditures due to repairs are reported under operational costs and are not included in the data on maintenance. Nordlund (2008, p.32) provides a detailed description of the issues related to the borderline between maintenance expenses and investments with respect to international accounting standards. Furthermore, a Swedish municipal housing company is delineated as one in which the municipal council has provided the whole of the initial capital and is run on a non-profit policy (Boverket 2006). In this study, any housing company that does not fulfil the above criteria is categorised as a private housing company. Housing cooperatives are not included in the study.

The results of the survey above show that many companies do not demarcate between planned and immediate maintenance (repairs). This explains the low number of companies that could be analysed in the econometric part of this study. Furthermore as the financial report for 2004 was missing in one of the companies the econometric analysis is based on unbalanced data. The criterion on separation between maintenance and repairs drastically reduced the number of possible companies from 89 to 16. In a future study this criterion can be relaxed so as to make comparisons based on the total costs which would help to increase the number of observations.

### 3 Literature review

Housing maintenance can either be required (long term planned), demanded (deferred or neglected) or wished for (by the tenant) and a number of papers have been presented including factors that may affect maintenance levels and costs. Profit has been mentioned as one of these factors and linked to the ownership category by Bejrums (1999); Speeding, Holmes & Shen (1995); as well as El Haram & Horner (2002a). Other factors found in the literature include the building's characteristics and age (Bejrums 1999; Olubudun & Mole 1999; El-Haram & Horner 2002b); the company's solvency (SABO 2003; Thomsen & Meijer 2007); the safety of persons (Shen 1997); municipal council policies (Speeding, Holmes & Shen 1995; Borg & Lind 2006; Boverket 2006); rent control (Klingenberg & Brown 2006); tenant demands (Van Mossel & Straub, 2007) and tenant ambitions (Bana e Costa & Oliveira, 2002); as well as the arbitrary classification of concepts (Boverket 2002; Lind 2002). The various factors mentioned can roughly be categorised according to whether they are building related, company related, statutory related or tenant related. Appendix 3 presents an overview of the factors affecting maintenance that are mentioned in the literature.

Not many empirical studies have been done involving housing maintenance costs as compared to the use of theoretical models on optimisation of maintenance. Vorst (1997) relates the maintenance expenditures to the quality of the building ( $q$ ), the rent on a building of quality  $q$ , the discount rate as well as price of the building of quality  $q$  at the time  $T$  in finding the optimal maintenance under uncertainty for a landlord who either can sell the building or rent it out. One of the earliest theoretical models on maintenance was by Dildine and Massey (1974) who derive the optimal maintenance strategy of a homeowner as well as the impact of public policy on private incentives to housing maintenance. Maintenance costs have also featured in hedonic price estimation models. Wilhelmsson (2004) finds that price depreciation rates are significantly different depending on the level of maintenance carried out. Knight et al (2000) hypothesize that the selling price includes costs to bringing the home to a condition equivalent to that of "normally maintained". Harding, Miceli and Sirmans (2000) use American Housing Survey data to test the willingness of borrowers to invest in proper maintenance so as to reduce the risk to their non-housing wealth due to the impact of mortgage laws in favour of lenders. Chau et al (2003) uses panel data in constructing a hedonic model to estimate the impact of refurbishment on the market value of properties in a large housing estate and find that it is close to 10 per cent. Nevertheless there is a lack of econometric studies that relate the ownership category to the maintenance of mainly high rise apartment housing in the possession of municipal companies and private companies that are not owner-cooperatives.



## 4 Results of the survey

### 4.1 The sample size

The survey was conducted during the month of September and October 2008 and was sent to 89 property companies in the private and municipal rental housing sectors. Of the 79 persons that took part in the survey, approximately 30 per cent of them were managing directors and 43 per cent real estate managers. The sample size and response rate is depicted below:

	Companies(M)	Companies(P)	Respondents(M)	Respondents(P)
Total Sent	59	30	108	55
Completed	33	22	46	33
Not completed	6	2	5	4
Not answered	20	6	58	18
% completed	56%	73%	43%	60%
% of respondents			58,2%	41,8%

Table 4-1: The respondents (M=Municipal, P= Private company)

The majority of the respondents had been employed in the same company for more than 5 years as shown in figure 4-1.

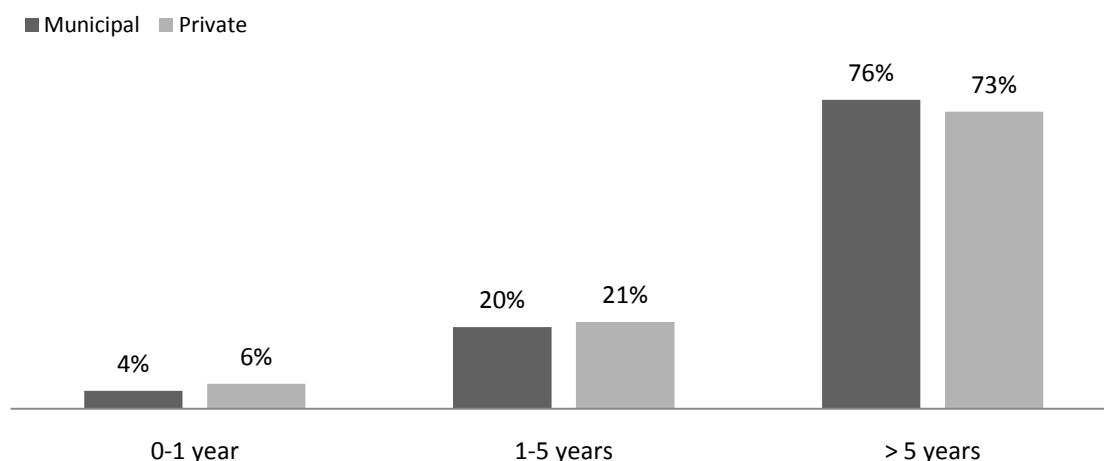


Figure 4-1: The respondent's employment length in the company

### 4.2 Categorising of maintenance activities

Responses in the second part of the questionnaire reveal that there is a slight difference between the private and the municipal housing companies in how they categorise activities and whether their accounting is based on the size and/or economic situation for the company with a higher consistency in classification of activities being displayed by the private sector. Figures below show the respondents' agreement with the statements in the questionnaire.

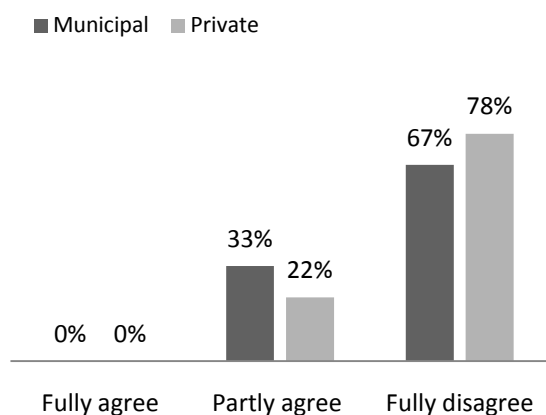


Figure 4-2: Economic situation determines classification between investment and maintenance

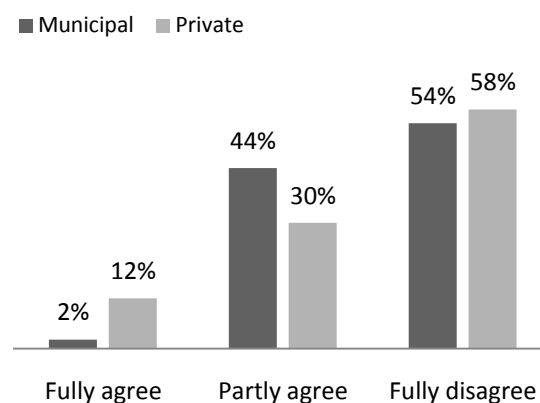


Figure 4-3: Size of activity determines classification between investment and maintenance

The private sector has a higher level of demarcation between planned and immediate maintenance than the municipal sector as portrayed in figure 4-4. However figure 4-5 reveals that the size of the cost is not a main determinant of the classification between operation and maintenance.

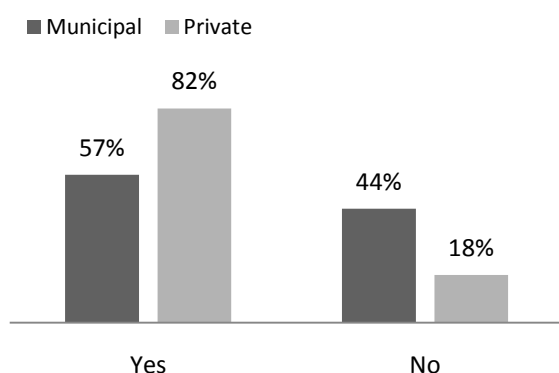


Figure 4-4: Demarcation between planned and immediate maintenance

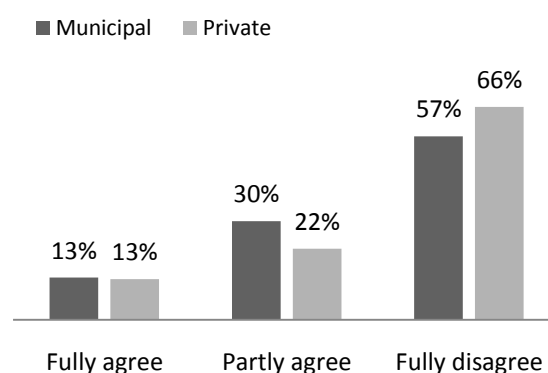


Figure 4-5: The total cost determines classification between operation and maintenance

Regarding how the respondents would classify given activities figures 4-6 to 4-9 show that façade and roof renovation are to the majority indisputably maintenance. However there is a clear difference between the categories when it comes to the pipe system and ventilation system whereby the private companies report a higher incidence of capitalising of costs instead of expensing them immediately i.e. to a higher extent they classify these activities as investments

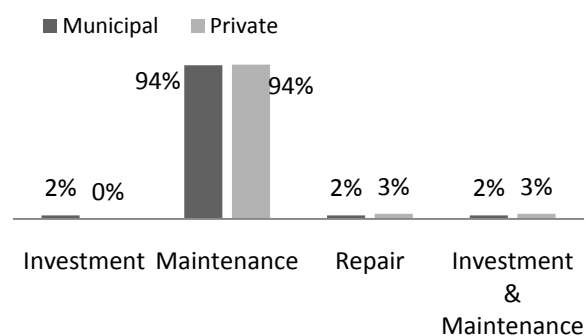


Figure 4-6: Classification of façade renovation

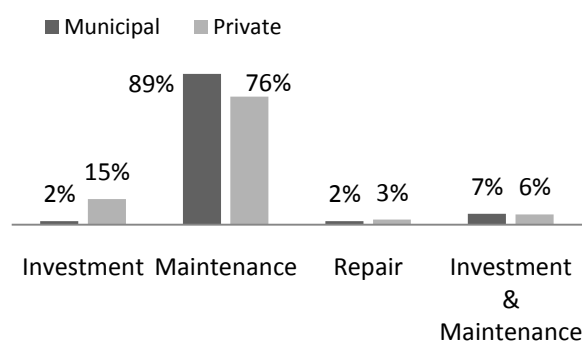


Figure 4-7: Classification of changing the roof

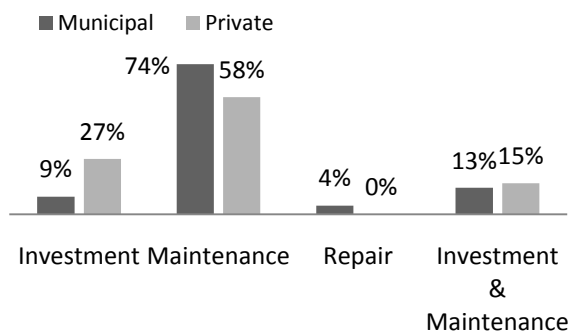


Figure 4-8: Classification of changing the pipe system

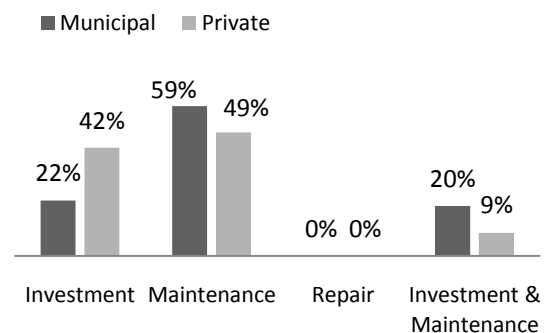


Figure 4-9: Classification of changing the ventilation system

Categorisation varies most in those activities in which some degree of modernisation can lead to all the costs being activated and paid over a number of years. Through categorising an activity as an investment a company can lower its reported costs and in so doing raise its profit levels. Comments provided by the respondents indicated that classification in a number of companies was predetermined such as “30% maintenance and 70% investment” or “70% maintenance and 30% investment”. A very simple interpretation of the results above could lead to the conclusion that the quality of pipes and ventilation is being raised more in the private sector than the municipal sector. Another interpretation is that municipal companies under a non-profit regime do not have any incentive to activate costs whereas the opposite is true for a profit maximising strategy.

### 4.3 Maintenance efforts and levels

Efforts to maintain are not always accounted for especially in the municipal housing companies as disclosed in figure 4-10 from the third part of the questionnaire. Figure 4-11 shows that a majority of the respondents in the municipal companies also consider the efforts within their company to be higher than those in comparable companies. However, in the private companies, these efforts are at about the same level as in similar companies.

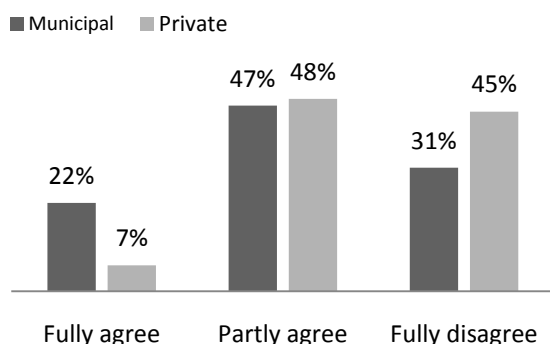


Figure 4-10: Efforts to maintain are higher than accounted for

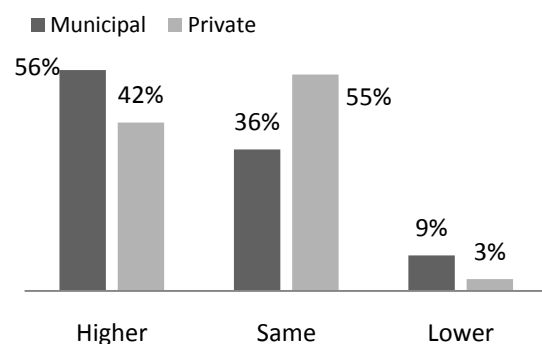


Figure 4-11: Efforts to maintain are in the level of comparable companies

The respondents in both categories are not wholly convinced that there are long term profits to be gained from increasing planned maintenance so as to decrease the immediate maintenance even though the response is more positive from the municipal participants than those in the private sector as shown in figure 4-12 below. However, results show that the tenants are less inclined to want to pay more even if the maintenance level is raised as depicted in figure 4-13.

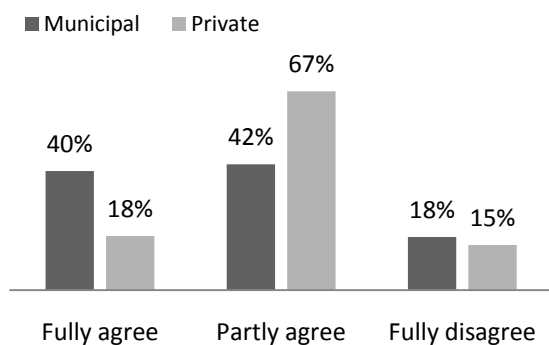


Figure 4-12: Increasing maintenance efforts will lead to long term profits

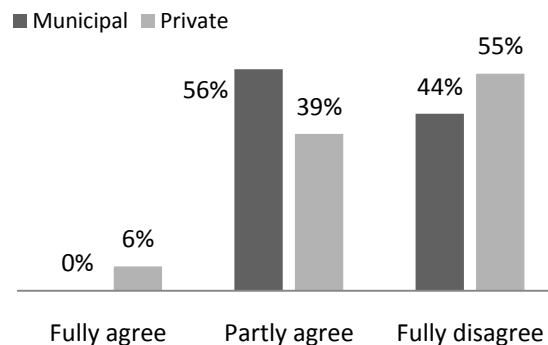


Figure 4-13: The tenants are prepared to pay more if the maintenance level is raised

The questionnaire contained spaces where the respondents could add comments. These show that the private sector sees energy saving activities as the most likely ones in which preventive actions would lead to an increase in the profits whereas the focus in the municipal sector is on activities associated with the pipe system as well as façade and kitchens. One of the respondents who agreed in part to the statement on whether increasing maintenance efforts would lead to long term profits wrote: “Depends on which direction the rent politics heads”. Regarding what the tenants would be willing to pay for, the respondents within the municipal sector mostly remark that the tenants are prepared to pay more if the maintenance level was increased especially if the standard of the apartments is raised.

The survey investigated what the respondents thought was the possible cause of immediate maintenance and a majority of them in both groups rejected tenant demands among the causes. However, unexpected technical problems as well as vandalism were major factors, especially for the private companies as shown in figures 4-14 to 4-17.

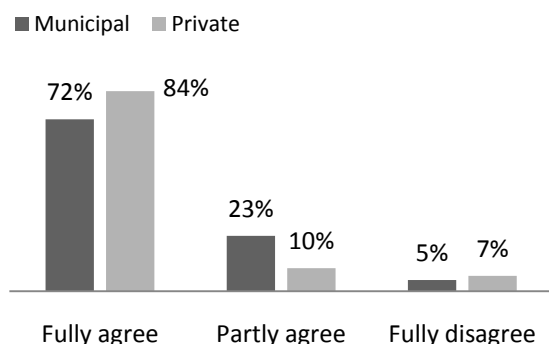


Figure 4-14: Immediate maintenance is connected to unexpected technical problems

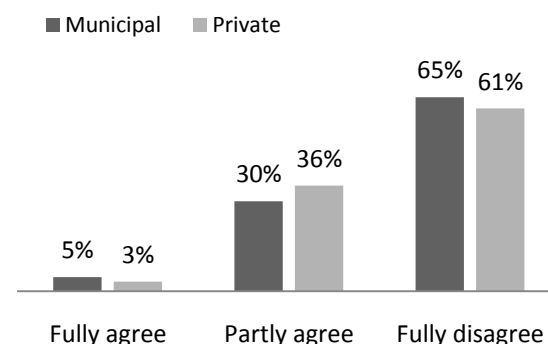


Figure 4-15: Immediate maintenance is connected to tenant demands

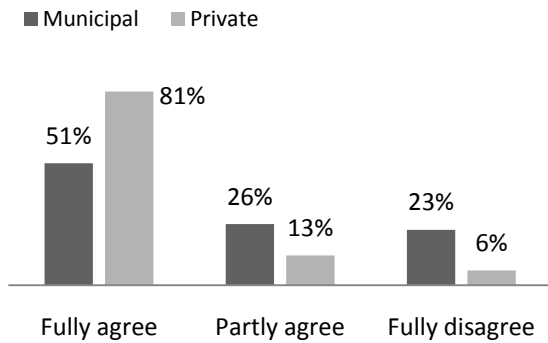


Figure 4-16: Immediate maintenance is connected to vandalism

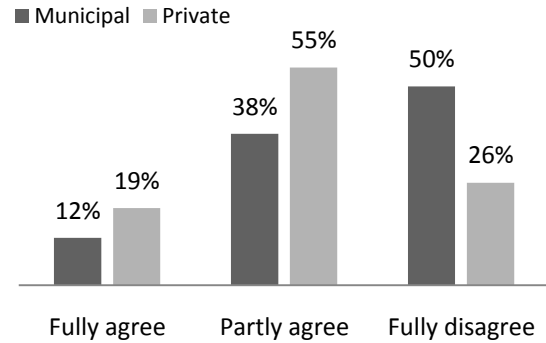


Figure 4-17: Immediate maintenance is connected to normal failure that is predictable

The results in figure 4-18 below indicate that the companies appear to have immediate maintenance under control as it is often not higher than accounted for. A majority of the respondents in the municipal sector fully agree that it would be profitable to use more preventive maintenance in order to reduce immediate maintenance as shown in figure 4-19.

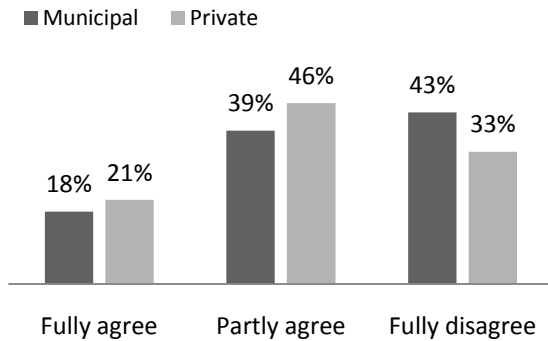


Figure 4-18: Immediate maintenance is often higher than budgeted for

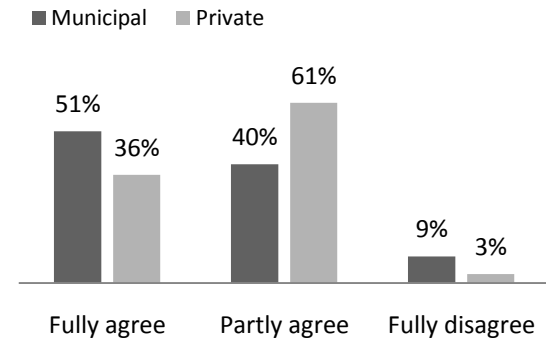


Figure 4-19: About more preventive maintenance being profitable

In case of tougher times the municipal companies are more likely to use the maintenance budget as a buffer and reduce the maintenance efforts more than the private companies as response to the statement in the figure below show.

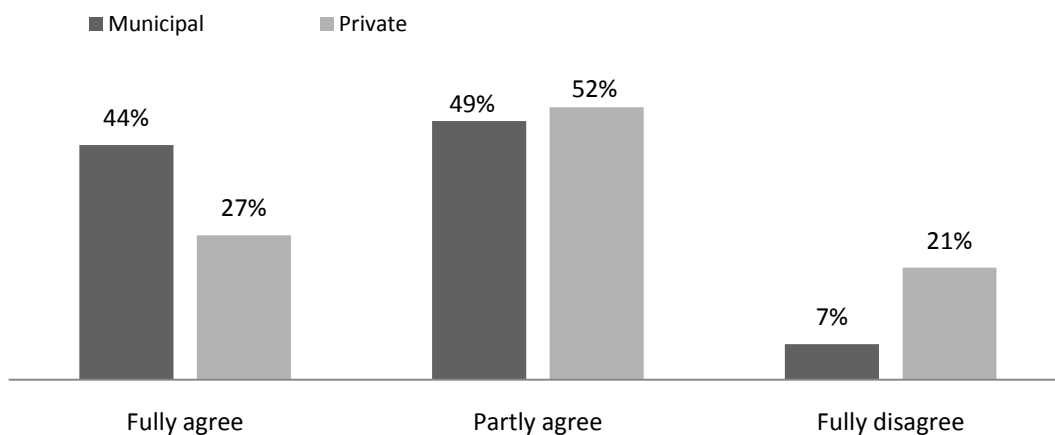


Figure 4-20: In case of tougher times with lower profits maintenance efforts will probably be reduced

A majority of the respondents fully or partly agree with the statement that efforts to maintain are higher than accounted for. This implies that the cost gap between the categories is even wider than what is shown in appendix 2, especially since the municipal companies appear to have a higher degree of unaccounted efforts at the same time as they consider that their efforts to maintain are higher than in comparable companies. The results on the causes of immediate maintenance suggest that the private companies have more immediate maintenance even though they are aware that it is due to predictable failure that is normal. An interpretation is that it could be rational to uphold a strategy to fix only what is broken and that way keep the costs down and the profits up.

## 4.4 Maintenance organization

Part four of the questionnaire (figures 4-21 to 4-26), reveals that there are no major differences in the way companies organise their maintenance management and execution in the different sectors other than the fact that the municipal housing companies have a significant level of centralised decision making. However a clear majority in the municipal companies than the private companies either fully or partly agree that subcontracting is used in the execution of repairs and small scale activities.

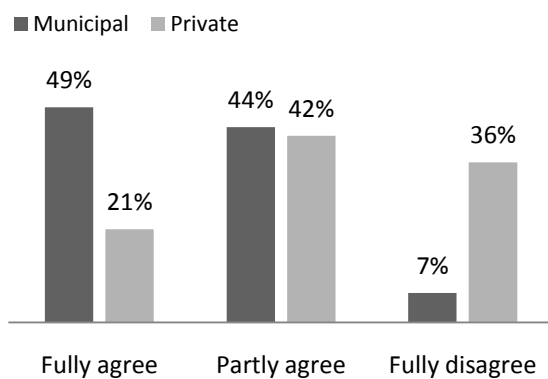


Figure 4-21: Maintenance planning and decisions are taken at a central level

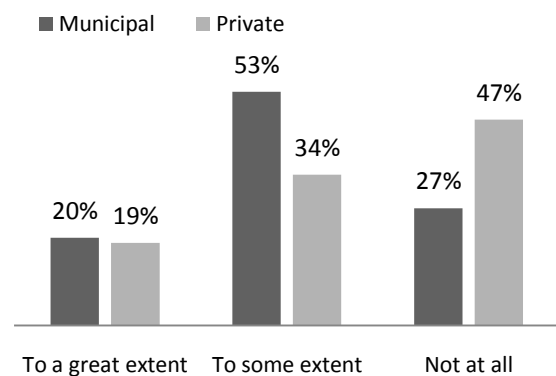


Figure 4-22: External service providers are used for execution of repairs and small scale activities

The execution of large activities that is subcontracted to external service providers is about the same in both categories as well as in inspection of the properties as shown below.

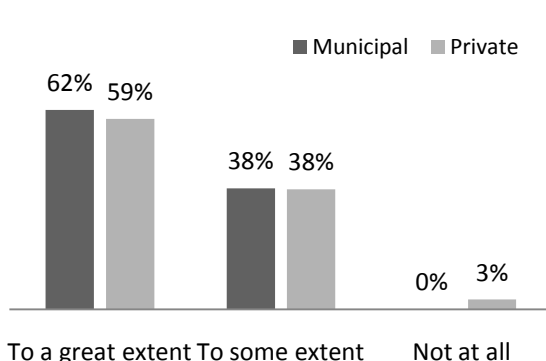


Figure 4-23: External service providers are used for the execution of large scale activities

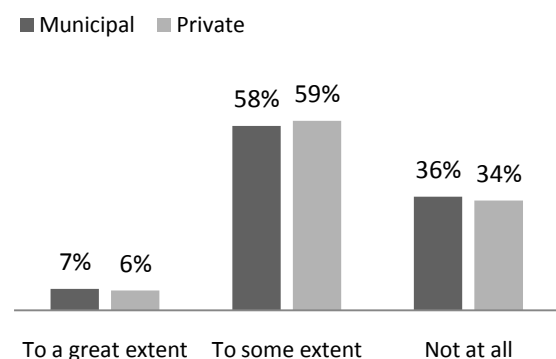


Figure 4-24: External providers are used for inspection of the properties

A great deal of the maintenance planning and majority of purchasing is carried out in-house in both categories.

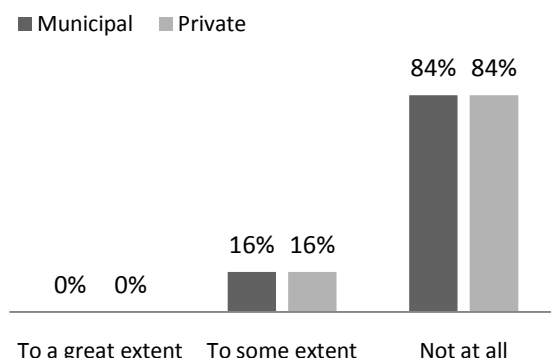


Figure 4-25: External service providers are used for maintenance planning

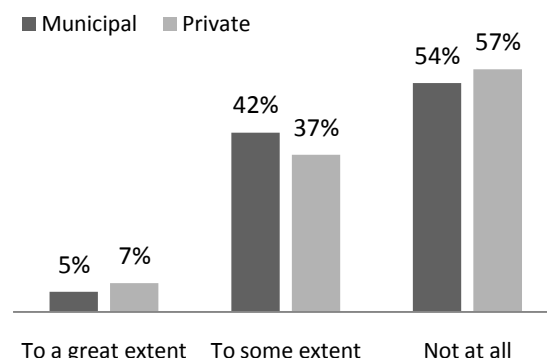


Figure 4-26: External service providers are used for purchasing

As noted in Borg and Lind (2006) the real estate crash in the early 1990s left many municipal housing companies with economical problems which led to the divesting of the non-core departments. This can explain the large degree of dependence on external competence for the large scale activities. The subcontracting of some activities is considered to be rational in a situation where the specialisation and economies of scale of the external service provider lead to lower costs and higher quality (Lundström, 2000) and a majority of the small scale activities are found to be either fully or partly subcontracted. That purchasing and maintenance planning are to a great extent kept in-house can provide the flexibility for the company management to prioritise between activities. However, this might also lead to economical considerations taking precedence over the strategic maintenance planning as evidenced by the response in 3:11 whereby the maintenance budget in the municipal companies is squeezed or stretched accordingly.

## 4.5 Maintenance planning and strategies

Responses in this section of the survey disclose that municipal companies have a higher percentage of long term planning that is more than 5 years and that they are also better at adhering to their set plans as shown in figure 4-27 and 4-28.

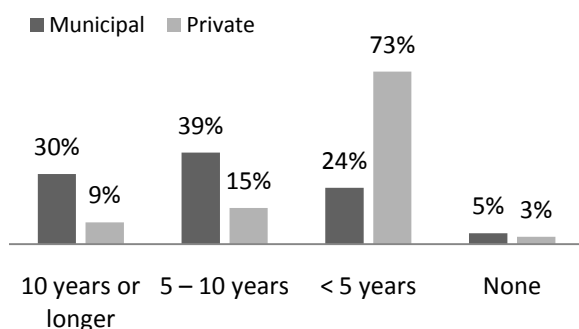


Figure 4-27: The company has a general plan

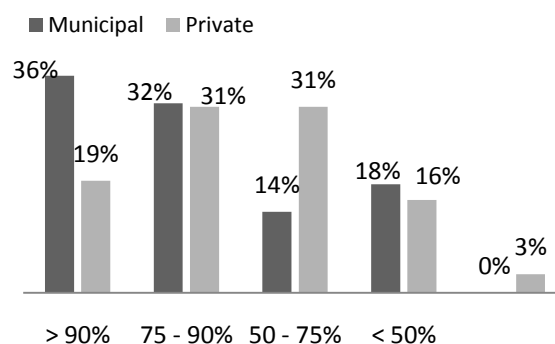


Figure 4-28: Approximate percentage of activities in current year that were part of the maintenance plan done in the previous year

The municipal companies also have a higher degree of detailed plans that are longer than 1 year as compared to the private companies (figure 4-29). However often unexpected situations arise that lead to changes in the maintenance plans as shown in figure 4-30 below.

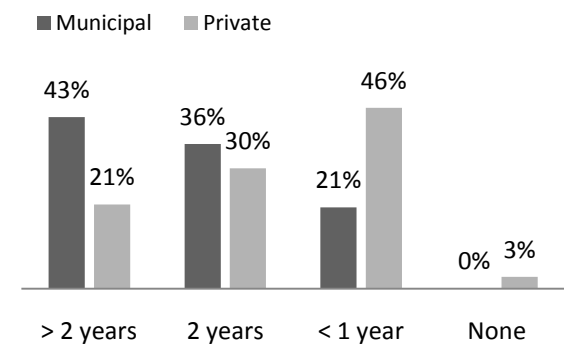


Figure 4-29: The length of the detailed plan

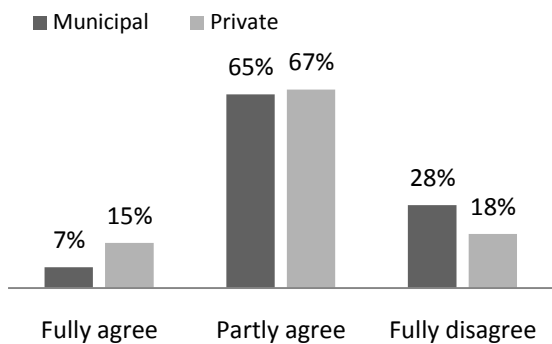


Figure 4-30: Often unexpected situations arise that affect the maintenance plans

Figures 4-31 and 4-32 reveal that delays in purchasing lead to the lack of adherence to the plans in the private companies whereas it is changes in the budget that mostly affect the plans of the municipal companies.

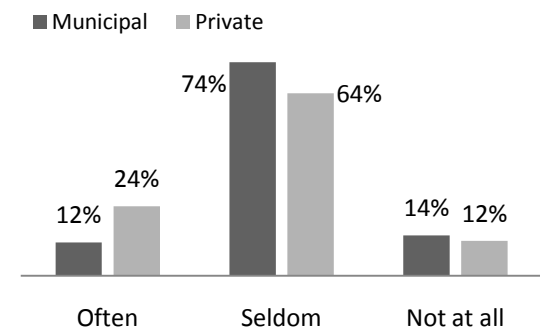


Figure 4-31: Delays in the purchasing process contribute to postponements of maintenance activities

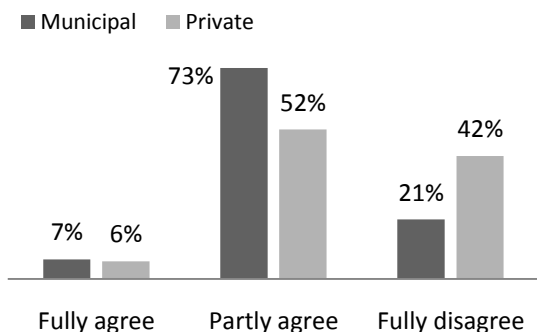


Figure 4-32: Maintenance planning often changes due to changes in the budget and the company's economic situation

There is a higher frequency of annual building inspections in the private companies as well as continuous inspection of components in their houses as opposed to the majority of municipal companies that inspect when the need arises as depicted in figures 4-33 and 4-34.

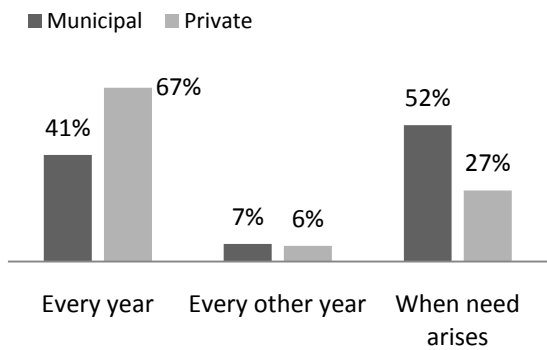


Figure 4-33: The frequency of house inspection

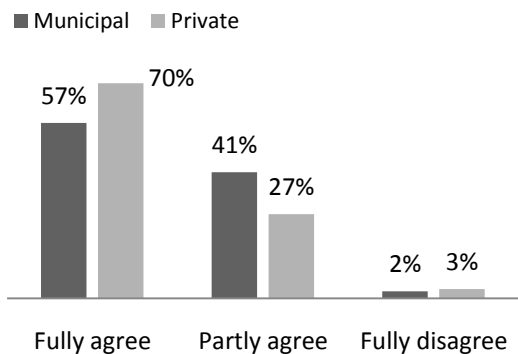


Figure 4-34: The company inspects certain parts in the houses continuously



Whereas the degree of detailed knowledge on the technical standard in the houses is about the same as depicted in figure 4-35, the degree to which the companies document the technical standard in the houses is slightly higher for the municipal companies as shown in figure 4-36 below.

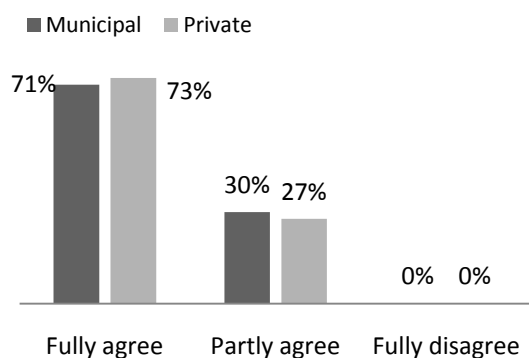


Figure 4-35: The company has detailed knowledge on the technical standard in the houses

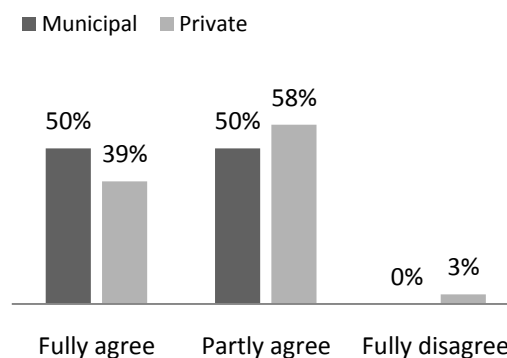


Figure 4-36: The company has well documented information about the technical standard in the houses

According to additional comments from the respondents it is mainly the technical components like the power, ventilation systems, and elevators as well as the roof and the windows that are most inspected continuously.

The results in figures 4-37 and 4-38 show that the age of the building is relied on to some extent in planning the maintenance especially in the municipal housing companies and that a higher percentage of respondents in the private sector fully agree that the uniqueness of every building makes it difficult to predict the life time of different components.

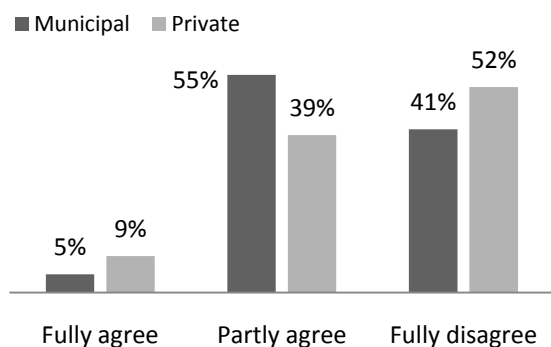


Figure 4-37: The maintenance plans depend more on the building's age than on specific technical conditions

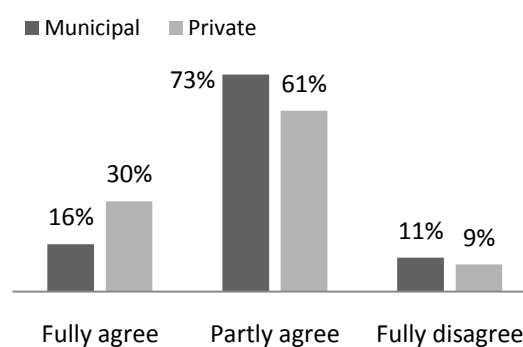


Figure 4-38 The fact that every building is unique makes it difficult to predict the life time of different components

Regarding the extent to which new environmental regulations and a prioritising of energy saving affect the companies figure 4-39 shows that the municipal companies are to a great extent more affected. However a clear majority of the respondents in figure 4-40 do not really agree that in the long term, knowledge will increase so that it will be easier to predict the activities that will be needed.

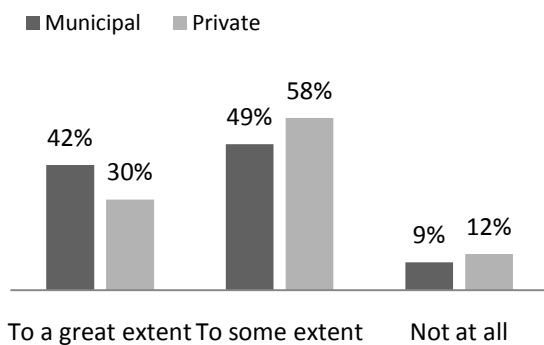


Figure 4-39: Plans have changed due to new environmental regulations and a prioritising of energy saving

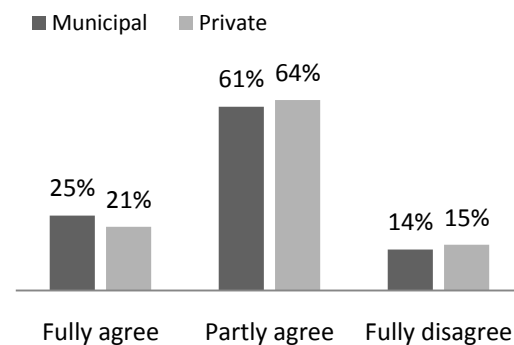


Figure 4-40: With increase in knowledge it will be easier to predict needed activities

There is a clear difference between the categories when it comes to the long term planning of the maintenance activities though on the other hand these same plans are not strictly adhered to due to changes in the economic situation of the company especially in the municipal sector. A company with a higher degree of long term planning will also be liable to change its plans more often due to new regulations. The regular inspection and the occurrence of unexpected incidents that overturn plans might make it rational not to have long term plans at all as seems to be the strategy of the private companies. According to the results close to 90 % of all of the respondents fully or partly agree that the uniqueness of the buildings makes it difficult to predict the life time of the different components. Though the buildings might be unique the components like elevators or ventilation systems are not. El Haram (2002a) proposes a strategy of reliability centred maintenance that in combination with the high level of documentation as well as knowledge of the technical standard in the houses should make it possible to carry out maintenance that is more suited to the particular component and house. This could substantially reduce the occurrence of immediate maintenance and lower the cost levels.

## 4.6 Neglected maintenance

In the sixth part of the questionnaire the respondents in the private sector agree more than their counterparts that there is neglected maintenance in the housing stock in their surrounding geographic area and that properties constructed under the “1 million programme” are going to require considerable efforts from their owners during the coming five years as shown in figures 4-41 and 4-42.

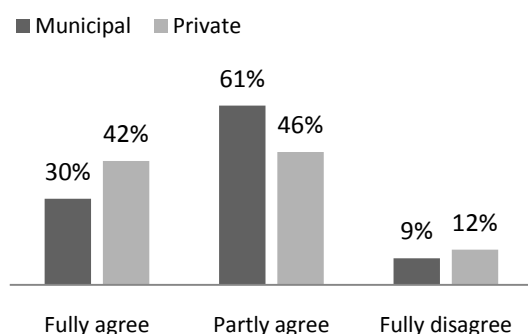


Figure 4-41: There is a lot of neglected maintenance in the housing stock in our region

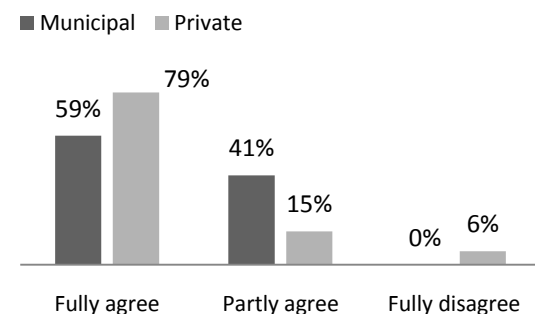
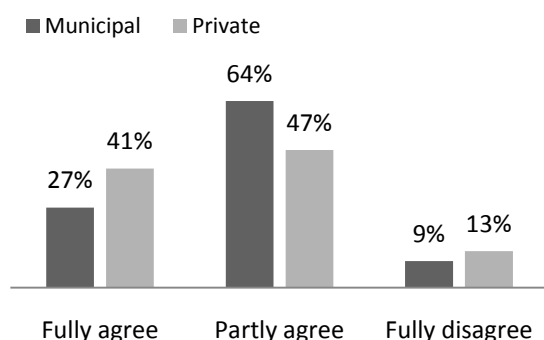
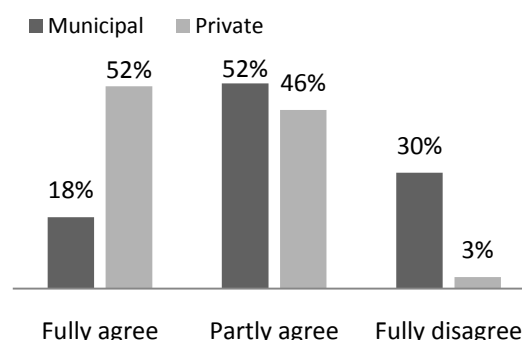


Figure 4-42: There is need to considerably raise the level of activities in “1 million program” housing during the coming five years

According to the full and part agreement responses especially from the municipal respondents shown in figure 4-43, the efforts to maintain properties that were constructed under the “1 million programme” are going to be economically strenuous for the owners. Furthermore, there is a clear majority of the responses in figure 4-44 in which respondents from the private sector are in full agreement with the statement that if the rent control was to be eased the current level of maintenance would increase.



*Figure 4-43: Economical problems due to the increased level of maintenance activities during the coming five years await many owners of “1 million program” housing*



*Figure 4-44: Maintenance activities would be higher if there was less restriction on the rents*

According to responses in the previous section the respondents inspect their buildings regularly and also have well documented information about the technical standard of the houses. Their efforts to maintain are also in level or higher than in comparable companies. The above indicates that neglected maintenance is more correlated to the ownership category than to a specific company. In this section there are clear differences between how respondents in the two categories view the extent and effect of the neglected maintenance with a clearly more dismal opinion of the situation in the private sector. The regulations on rent control allow for an increase in the rent if the standard of the apartment is raised. Thus there might be an inclination not to carry out the identified and needed maintenance but to carry out modernisation, refurbishments and conversion which are activities that will consequently lead to higher returns for the company. Neglected maintenance is therefore not only an economical problem but also a social problem related to rent increases.

## 4.7 Causes of differences between the categories

Figure 4-45 shows the distinct majority of respondents in both categories that fully agree that private housing companies tend to have lower costs in the maintenance of their properties as compared to their municipal counterparts. The municipal respondents attribute this partly to the private companies having a different tenant composition as shown in figure 4-46.

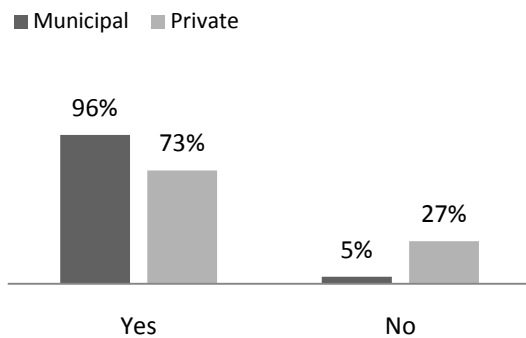


Figure 4-45: Whether private housing companies have lower costs in the maintenance of their properties than the municipal companies

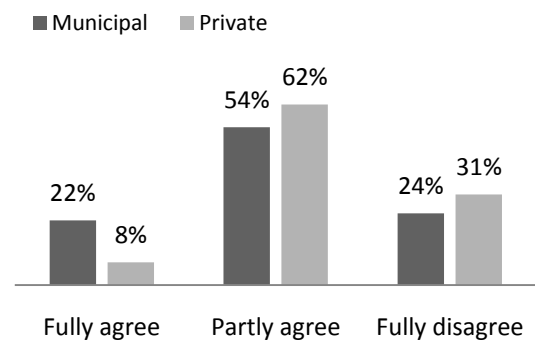


Figure 4-46: The private companies have lower maintenance costs because they have other categories of tenant

On the other hand the private company respondents felt that the cause of the higher costs in the municipal companies was related to their carrying out unprofitable activities as well political and media pressure as depicted below in figures 4-47 and 4-48.

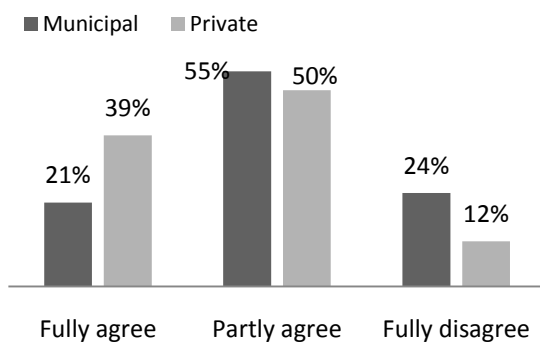


Figure 4-47: The municipal companies carry out unprofitable activities that a private company would not do

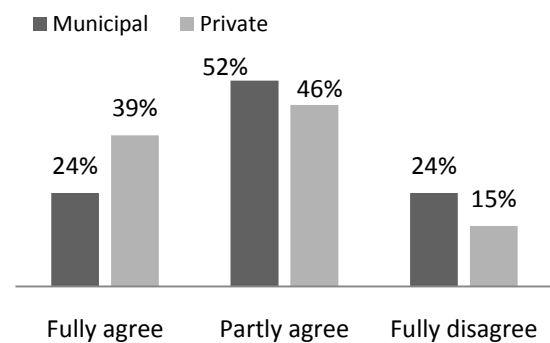


Figure 4-48: The municipal companies are pressurised by politicians and the media to carry out unprofitable activities

A clear majority in both categories fully disagree to the statement that the municipal companies are not as effective in procurement nor do the respondents consider the construction quality of the buildings to be different between the categories as shown in figure 4-49 and 4-50.

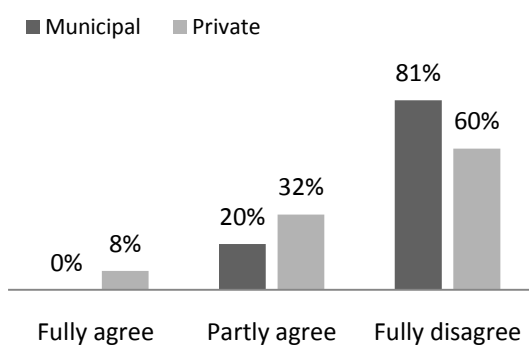


Figure 4-49: The municipal companies are not as good at procurement as the private companies

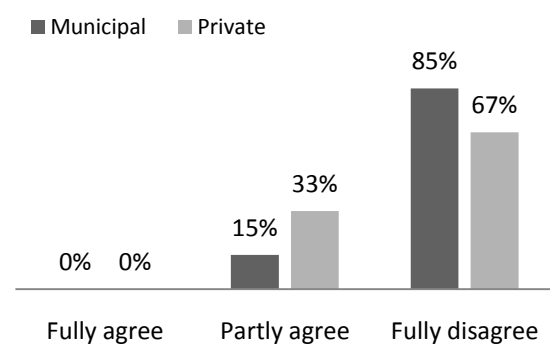


Figure 4-50: The private companies have lower maintenance costs because their houses are better built

Whereas a majority of respondents in the municipal companies consider lower costs in the private companies to be due to private companies accepting lower standards in their houses (figure 4-51), a majority in the private category respond that it is because the private

companies put more effort on continuous activities other than on the scheduled activities (figure 4-52).

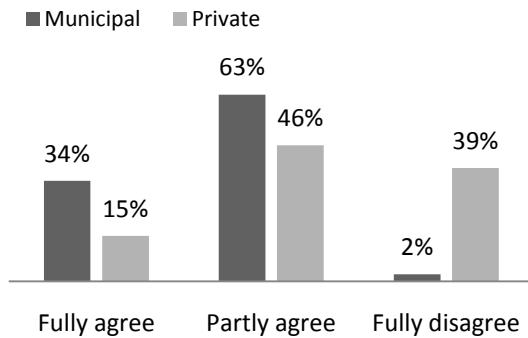


Figure 4-51: The private companies have lower maintenance costs because they accept a lower standard in their properties

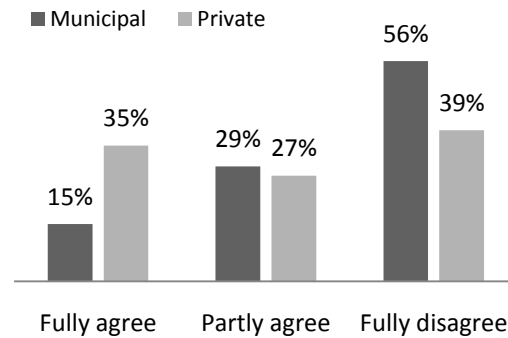


Figure 4-52: The private companies have lower maintenance costs because they put more effort on continuous activities

The statements in this section summarise many of the factors that affect maintenance costs that were found in the literature review above. Of interest is the difference in perception as to the particular factors that have an effect on a particular category. The respondents discard a difference in housing construction as well as procurement disabilities for the municipal companies. Otherwise a majority of all the respondents agree or partially agree to the rest of the statements in which the effect of political influence and unprofitable activities on the maintenance costs of the municipal companies are ranked high. This is similar to the finding in Boverket (2006 pg 9) that many municipal governments use the municipal housing companies as a social political tool.

## 4.8 Summary

A majority of the respondents have been employed in the same company for a long time and can be considered as knowledgeable. The greatest differences in the number of respondents who fully agreed with a statement from the respective category were revealed to be:

### Municipal:

- activities are classified more as maintenance
- all of the efforts to maintain are not accounted for
- the maintenance effort is higher than in comparable companies
- there is more centralised management
- there are long maintenance plans and the company adheres to them
- increasing preventive maintenance will lead to higher profits
- the lower costs in the private sector are mainly due to the private companies accepting a lower standard

### Private:

- there is a higher degree of demarcation between planned and immediate maintenance
- vandalism is a major cause of immediate maintenance
- there is a higher frequency of inspection
- maintenance would increase if the rent control was eased
- municipal companies have high costs because they carry out unprofitable activities
- municipal companies have high costs because of pressure from politicians and media

How the activities are classified as well as the demarcation between planned and immediate maintenance play an important role in the differences in maintenance costs. There is also a clear difference in the planning horizon as well as flexibility in changing the plans. The rent control is also given as a major factor together with the belief that political pressure raises the maintenance costs in the municipal companies. However as no interviews were carried out the econometric analysis in the next section utilises the maintenance costs actually reported by the companies in analysing the magnitude of these factors.

## **5 The econometric analysis**

### **5.1 The regression variables and equations**

The focus of the econometric analysis is on properties built or renovated between the years 1961 to 1975 during the period in which the Swedish government embarked on a program to construct 1 million dwellings in mainly high rise blocks. These properties have comparable age and construction characteristics and the data is analysed at company level with little consideration for where they are located. The private companies are active in the same local markets as the municipal companies but many of them have a wider geographical diversification. From the results of the survey above a number of variables were chosen for the analysis.

#### **The variables**

MTNC: This is the reported yearly maintenance costs per square meter and is the dependant variable in all of the equations estimated.

TYPE: The type of ownership category is revealed in the survey above as having an effect on the reported maintenance costs. This is taken as a dummy variable for ownership category in the regression model where 0 is municipal and 1 is private. The coefficient is expected to have a negative sign as a change from municipal to private ownership is expected to lead to lower costs.

HSNG: The maintenance needed is expected to increase as buildings get older. The amount of housing in 2006 that was built (or reconstructed) during 1961-1974 (termed “aged housing” in this study) as a percentage of the annual total rental space is used as a proxy for the aged housing in the portfolio for each year 2004 to 2007<sup>4</sup>. The so called “value year”<sup>5</sup> is the basis used here. The information on value years was accessed through a subscribed property consultancy service<sup>6</sup> as many companies did not include it in their reports. Only information for the year 2006 was available but housing portfolios in the surveyed companies have not been so liquid and it is assumed that this number is representative and close to constant for the whole period being analysed. The coefficient on aged housing is expected to have a positive sign.

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<sup>4</sup>It is given as a ratio of the total rental area so as to create some annual variation over the period under study

<sup>5</sup> The value year is used in Swedish property taxation to denote a building’s age with consideration for renovations and additions.

<sup>6</sup> [www.datscha.com](http://www.datscha.com)

RENT: In the survey and in Klingenberg & Brown (2006), the low level of maintenance is blamed on rent control. Therefore a change in the rent is expected to have a positive effect on the maintenance costs reported<sup>7</sup>.

AREA: Large companies are expected to have some advantages in their maintenance activities due to economies of scale and the total rental space under the company's management is used as a variable in the model. The coefficient is expected to be positive.

POLITIC: According to the survey political interference raises the maintenance costs of the municipal housing companies. However the same is not true for the private companies. This variable attempts to model the effect of politics through the use of the voters register in the particular municipality. The political party in the model was chosen at random in this case the ratio of social democratic votes in the municipal elections of the year 2002. This coefficient is expected to be positive for the municipal companies using the interaction variable POLITIC\*TYPE.

SOLVENCY: The private company's profit requirements have been given as a cause of their low reported maintenance costs. The company's reported solvency as a ratio of the total area is used here to model for the dividend policy of the company as an increase in the company profits will increase the equity and solvency unless disposed off through investments or other payments. Municipal housing companies with a non-profit policy might be expected to spend more on maintenance.

The data is given per m<sup>2</sup> except for the "housing" and solvency which are percentages. In addition, the natural logarithm is used for all of the variables in the equations except for the ownership category.

### **The equations**

The analysis was based on three equations in which the first equation was to estimate the size of the effect of politics, the rent level as well as the age and size of the properties under management on the maintenance cost level reported. In the second step the explanatory variables in the first equation were interacted with the ownership category in order to capture the difference in slopes between the different categories. This was expected to further highlight the effect of political influence on the municipal companies. The third equation was aimed at estimating the impact of profits on maintenance costs. However, as profit was considered to be endogenous to maintenance costs, a 1 year lag of solvency was used as a proxy of the profit as shown in the equations below.

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<sup>7</sup>Swedish rent control regulations stipulate that maintenance activities should not lead to a change in rents and thus this variable is exogenous to reported maintenance costs.

$$\ln MTNC = \beta_0 + \beta_1 TYPE + \beta_2 \ln HSNG + \beta_3 \ln RENT + \beta_4 \ln AREA + \beta_5 \ln POLITICS + e_{it} \quad (A)$$

$$\ln MTNC = \beta_0 + \beta_1 TYPE + \beta_2 \ln HSNG + \beta_3 \ln RENT + \beta_4 \ln AREA + \beta_5 \ln POLITICS + \beta_6 \ln HSNG * TYPE + \beta_7 RENT * TYPE + \beta_8 \ln AREA * TYPE + \beta_9 POLITICS * TYPE + e_{it} \quad (B)$$

$$\ln MTNC = \beta_0 + \beta_1 TYPE + \beta_2 \ln HSNG + \beta_3 \ln RENT + \beta_4 \ln AREA + \beta_5 \ln POLITICS + \beta_6 \ln HSNG * TYPE + \beta_7 RENT * TYPE + \beta_8 \ln AREA * TYPE + \beta_9 POLITICS * TYPE + \beta_{10} \ln SOLVENCY + \beta_{11} \ln SOLVENCY * TYPE + e_{it} \quad (C)$$

## 5.2 The data

Private housing companies in Sweden account for just more than 1/3 of the total housing space on the rental market and with a stock that is slightly older than that of the municipal housing. The older stock is on average in more central and attractive housing areas with higher rent levels whereas a larger part of the municipal stock is located in areas built during the Swedish government's "1 million dwellings program" in 1964-1975. According to the Swedish Property Federation, (2002) the private housing companies have also constructed more than their counterparts since the mid 1980s. Despite the older housing, the maintenance costs in the private rental housing sector are on average lower than those in the municipal housing sector as shown in appendix 2.

Table 5-1 and 5-2 below present the descriptive statistics of the companies in the study. The private housing companies have lower costs and higher rents. They also have a lower ratio of housing with a value date between 1961 and 1975. However the average area under management is about the same for both categories.

Variable	Unit	Observations	Mean	Std. Dev	Minimum	Maximum
MTNC	SEK/m <sup>2</sup>	25	111.9	93.0	20	351
HSNG	%	32	31.3	22.4	11.4	72.8
RENT	SEK/m <sup>2</sup>	26	961.9	374.3	176	1388
POLITICS	%	32	33.9	8.5	16.1	45.7
SOLVENCY	%	26	7.0	9.2	1.0	32.6
PROFIT	SEK/m <sup>2</sup>	25	755.2	685.6	-183	1977
AREA	1000m <sup>2</sup>	28	951.7	627.4	202	2059

Table 5-1 Descriptive Statistics *PRIVATE*

Variable	Unit	Observations	Mean	Std. Dev	Minimum	Maximum
MTNC	SEK/m <sup>2</sup>	29	169.4	52.7	41	326
HSNG	%	32	39.2	20.7	5.2	74.3
RENT	SEK/m <sup>2</sup>	30	858.6	134.4	728	1382
POLITICS	%	32	38.2	3.4	32.1	42.4
SOLVENCY	%	30	2.8	1.8	1.0	6.4
PROFIT	SEK/m <sup>2</sup>	29	52.2	107.4	-307	364
AREA	1000m <sup>2</sup>	30	953.0	456.9	245	1672

Table 5-2 Descriptive Statistics *MUNICIPAL*



### 5.3 The regression results

Equation (A) above was adjusted to include SOLVENCY before the estimation in (1) below and after the Prais-Winsten estimation shown in (2) a backward elimination process that tested a variety of interaction variables was used leading to equation (3) in the results<sup>8</sup>. A Prais-Winsten estimation of this equation is also presented in (4). In the process the dummy for politics as well as the lag on solvency were completely dropped out of equation (3) and (4). The p-values presented in the Prais-Winsten equations are for the F-test that was applied to test for joint significance of those variables that exhibited insignificant t-values<sup>9</sup>. The Prob > F values for the reg estimations were all 0, 00. There were 54 observations in each of the equations.

	(1) Reg estimation		(2) Prais estimation		(3) Reg estimation		(4) Prais estimation	
	coefficient	t-value	coefficient	t-value	coefficient	t-value	coefficient	t-value
Intercept	-5.881	-5.13	-5.552	-4.40	11.222	2.04	7.954	1.94
TYPE	-0.468	-3.32	-0.435	-2.16	-26.00	-4.39	-21.45	-4.25
lnHSNG	0.181	2.41	0.179	2.01	0.175	1.93	0.222	2.43
lnRENT	1.328	5.91	1.194	5.48	-0.816	-1.05	-0.298	-0.59
lnAREA	0.105	1.09	0.140	1.36	0.046	0.45	0.019	0.18
lnSOLVENCY	-0.236	-2.47	-0.202	-1.49	0.284	1.63	0.237	1.31
lnPOLITIC	0.118	0.23	-0.070	-0.14				
lnHSNG*TYPE					0.792	4.04	0.633	2.61
lnRENT*TYPE					2.739	3.39	2.109	3.91
lnAREA*TYPE					0.437	2.12	0.411	1.75
lnSOLVENCY*TYPE					-0.623	-2.63	-0.590	-2.37
F-test (p values)				0.01				0.19
R <sup>2</sup>		0.68		0.89		0.81		0.87
D-W				1.52				1.32

Table 5-3: The results of the econometric analysis

In equation (1) the coefficient on the dummy TYPE is negative and statistically significant indicating that a change from municipal to private ownership will lead to a decrease in maintenance costs of about 37 per cent<sup>10</sup>. All of the coefficients except lnAREA and lnPOLITIC, the proxy for political influence, are statistically significant at the 5% confidence level. A 1 per cent change in rent is expected to lead to approximately the same change in maintenance costs whereas the same increase in managed total area leads to a much lesser change in maintenance costs per m<sup>2</sup>. On the other hand whereas an increase in HSNG, the ratio of aged housing in the portfolio will increase maintenance costs, an increase in SOLVENCY leads to lower maintenance costs reported.

Equation (2) attempts to correct for serial autocorrelation in (1) and the results indicate that the coefficient on TYPE is still negative and statistically significant indicating a decrease of about 35 per cent in reported costs due a change from municipal to private ownership. However in this estimation though the coefficients for lnSOLVENCY, lnAREA and lnPOLITIC are not statistically significant the analysis of variance (F-test) on these three variables reveals that together they can explain part of the maintenance costs even if the individual effect cannot be singled out.

<sup>8</sup> It was not possible to estimate equations (B) and (C) above as they were intended.

<sup>9</sup> See page 6 above

<sup>10</sup> Due to MTNC being in logarithmic form whereas TYPE is not.

In equation (3) the effect of the ownership category on maintenance costs was magnified and it provided the largest significant change in the reported costs. This equation estimates the effect of interaction variables which indicate the difference in slopes between the different categories. The results indicate for example that there is a larger positive effect due to HSNG on the costs reported by the private companies than in the municipal companies. This effect is even more amplified in relation to RENT. But unlike the interaction variables, all of the non-interaction variables except for TYPE are insignificant at the 5% confidence level. An attempt to correct for serial autocorrelation leads to equation (4) in which the coefficients for  $\ln\text{HSNG}$  and TYPE are significant as well as  $\ln\text{HSNG}*\text{TYPE}$ ,  $\ln\text{RENT}*\text{TYPE}$  and  $\ln\text{SOLVENCY}*\text{TYPE}$ . However as indicated by the Dick-Watson statistic for this equation which is 1.32 serial autocorrelation cannot be ruled out as affecting the size and signs of the coefficients in the result.

## 5.4 Analysis of the results

This analysis is based on the results in equation (2) which are deemed to be corrected for serial autocorrelation as indicated by the D-W statistic of 1.52. A cross section time series analysis of the data collected confirms that the ownership category has substantial effect on the reported maintenance costs and according to the results a unit change in the rents leads to an even higher positive change in the maintenance costs reported. It can be argued that in the opposite situation there will not be any maintenance at all if the rent is kept constant<sup>11</sup> leading to a higher degree of neglected maintenance and abandonment as discussed in Klingenberg & Brown (2006).

The negative sign of the coefficient on solvency in equation (2) can possibly indicate an increase in the equity or dividend payment at the expense of maintenance costs. The magnitude of the coefficient on  $\ln\text{HSNG}$  is smaller than that of  $\ln\text{SOLVENCY}$  and  $\ln\text{RENT}$  which is consistent with the low priority that the age of a building commands in maintenance planning, according to the survey above indicating more economical considerations in the maintenance strategy adopted.

The variable depicting political influence was statistically insignificant. Municipal companies are not as geographically diversified as their private counterparts and particulars of the municipality could be utilised to a larger extent in modelling the local conditions affecting the companies. In this study, the private companies were chosen at random and though an attempt was made to match them with municipal companies in similar locations their geographic diversification leads to a need for better data collection before the political influence can be modelled in this way.

## 6 Conclusion

The post World War II housing stock in Sweden, like in many other European countries is at an age where a lot of maintenance effort is required. Various reports have shown that the level of maintenance is below what it should be and various reasons have been given as to why. One of these is the profit requirements of the companies. The municipal companies are instituted under a non-profit policy while the private companies need to pay out dividends. That the ownership category plays a major role in the maintenance costs reported is also confirmed in the results of the analysis.

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<sup>11</sup> In nominal terms

There are a large number of factors that affect maintenance costs as revealed in the literature review. The survey confirmed a number of factors that are important to address in an effort towards efficient and cost effective maintenance that could narrow the difference in maintenance cost levels between the private and the municipal housing companies.

These companies do not operate on equal terms at all times as can be exemplified by the law that covers procurement financed by public funds. Nevertheless this study reveals not only differences in categorisation of concepts as well as the level and demarcation of maintenance planning but also the use of the maintenance budget as an accordion to be squeezed or stretched according to the economic situation in the municipal sector.

The responses received in the survey raise the question of whether there is an incentive for the private companies to account for all of their costs better than the municipal companies and how the higher efforts to maintain the portfolio are paid for by the municipal companies, in those cases where these efforts are not fully accounted for. This isolates the question of a possible principal agent problem as external influence seems to be the major cause of the differences between maintenance costs within the groups. Borg and Lind (2006) confirm that the company management differs considerably between the categories with political boards in the municipal housing companies but also with more written directives from the owners, even if these directives differ much in quality.

The gap in maintenance costs between the categories is explained as due mainly to tenant composition and the acceptance of a lower standard in the private sector, according to municipal respondents, or the influence from the media and politicians according to the respondents in the private sector and a majority of respondents in the public sector that partly agreed with this. Nevertheless, the clear difference in the maintenance planning and demarcation of the concepts should not be ignored as these two factors directly affect the way the maintenance will be accounted for in the reports. Thus the high dependence of reported costs on the ownership category points to a need for a more uniform and consistent classification of the activities carried out.

Answers to questions concerning the inspection frequency and intensity as well as classification of activities lead to the possible conclusion that the question of neglected maintenance might not be as bad as portrayed. The companies have different business aims and a low level of maintenance does not imply that it is neglected but a conscious strategy to maintain only what is broken. On the other hand the high degree of long term planning in the municipal sector as well as adherence to the plans might lead to more maintenance than necessary due to the replacement of still functional components. The expected problems related to the costs within the coming five years could thus be exaggerated.

Though the data in the regression analysis was limited to only 8 financial reports from each sector, they provide an appreciation of the magnitude of how much a change from one category to the other will affect the costs reported. The results of the survey help to strengthen the conclusion that housing companies in the two categories act differently and not always in an efficient manner as would be expected in the maintenance of similar and comparable properties. The gap between the categories would even be greater in case the municipal housing companies accounted for all of their maintenance efforts.

In the effort to develop cost efficient housing maintenance and to highlight the exact level of neglected maintenance there is reason to further study the issue of whether there is any need at all to have a separate categorisation of maintenance activities from investment activities. By removing the need for arbitrary accounting the exact level of activities will be revealed.

The limited size of the sample and the lack of transparency and uniformity in the financial reports constraints the research efforts in this study however research is needed towards a clearer and more transparent classification of maintenance activities with the purpose of not only reducing the gap between the reported maintenance costs of the companies but also increasing the comparability in the branch. This will help to isolate external influence in the management of the companies especially in the municipal sector.

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## Appendix 1: The questionnaire

### *Introduction*

The purpose of the questionnaire is to get information that will be used in the research on maintenance strategies and levels as well as differences between the private and the municipal housing companies. The questions are constructed in such a way that they can easily be answered and are about among others, the company, categorising of activities, and the size of the activities as well as maintenance planning. The questionnaire requires between 10-15 minutes.

All of the responses are going to be treated confidentially.

### *Part 1: The company and the respondent*

1:1 The company name

1:2 Your position in the company

1:3 How long have you been employed in the company o 0-1 year; o 1-5 years; o > 5 years

### *Part 2: Categorising concepts: How different activities are categorised in the company*

Below are a number of statements. What is your point of view?

2:1 The company's economical situation determines what is classified as investments or maintenance

o Fully agree; o Partly agree; o Fully disagree

2:2 The size of the activity determines the classification

o Fully agree; o Partly agree; o Fully disagree

2:3 The cost determines the classification between operation and maintenance

o Yes; o No

2:4 The company demarcates between planned and immediate (acute) maintenance

o Fully agree; o Partly agree; o Fully disagree

2:5 How would you normally classify the following activities? (e.g. investment, maintenance, repair)

- Façade renovation
- Changing the pipe system
- Changing the roof
- Changing the ventilation system

### *Part 3: The size of the maintenance levels*

3:1 The company's efforts to maintain the portfolio are higher than accounted for

o Fully agree; o Partly agree; o Fully disagree

3:2 The company's efforts to maintain the portfolio are in the level of comparable companies

o Higher; o Same; o Lower

3:3 Increasing the maintenance efforts will lead to long term profits

o Fully agree; o Partly agree; o Fully disagree

Comment: Are there any particular activities you think of?

3:4 The tenants are prepared to pay more if the maintenance level is raised

o Fully agree; o Partly agree; o Fully disagree

Comment: Are there any particular activities you think of?

3:5 Immediate maintenance is related to normal failure that is predictable

o Fully agree; o Partly agree; o Fully disagree

3:6 Immediate maintenance is related to unexpected technical problems

o Fully agree; o Partly agree; o Fully disagree

3:7 Immediate maintenance is related to vandalism

- o Fully agree; o Partly agree; o Fully disagree
- 3:8 Immediate maintenance is related to tenant demands
  - o Fully agree; o Partly agree; o Fully disagree
- 3:9 Immediate maintenance is often higher than budgeted for
  - o Fully agree; o Partly agree; o Fully disagree
- 3:10 It would be profitable to put more resources on preventive maintenance so as to reduce the immediate maintenance
  - o Fully agree; o Partly agree; o Fully disagree
- 3:11 In case of tougher times with lower profits maintenance efforts will probably be reduced
  - o Fully agree; o Partly agree; o Fully disagree

*Part 4: The maintenance organisation*

- 4:1 Maintenance planning and decisions are taken at a central level
  - o Fully agree; o Partly agree; o Fully disagree
- 4:2 External providers are used for inspection of the properties
  - o To a great extent; o To some extent; o Not at all
- 4:3 External service providers are used for maintenance planning
  - o To a great extent; o To some extent; o Not at all
- 4:4 External service providers are used for purchasing
  - o To a great extent; o To some extent; o Not at all
- 4:5 External service providers are used for the execution of large scale activities
  - o To a great extent; o To some extent; o Not at all
- 4:6 External service providers are used for execution of repairs and small scale activities
  - o To a great extent; o To some extent; o Not at all

*Part 5: The maintenance planning and strategies*

- 5:1 The company has a general plan that covers
  - o 10 years or longer; o 5 – 10 years; o < 5 years; o None
- 5:2 The company has a detailed plan that covers
  - o > 2 years; o 2 years; o < 1 year; o None
- 5:3 The approximate percentage of activities in current year that were part of the maintenance plan done previous year are
  - o > 90%; o 75 - 90%; o 50 - 75%; o < 50%; o There was no plan
- 5:4 Often unexpected situations arise that lead to changes in the maintenance plans
  - o Fully agree; o Partly agree; o Fully disagree
- 5:5 Delays in the purchasing process contribute to postponements of maintenance activities
  - o Often; o Seldom; o Not at all
- 5:6 Maintenance planning often changes due to changes in the budget and the company's economical situation
  - o Fully agree; o Partly agree; o Fully disagree
- 5:7 The company has detailed knowledge on the technical standard in the houses
  - o Fully agree; o Partly agree; o Fully disagree
- 5:8 The company has well documented information about the technical standard in the houses
  - o Fully agree; o Partly agree; o Fully disagree
- 5:9 The company inspects the houses
  - o Every year; o Every other year; o When need arises
- 5:10 The company inspects certain parts in the houses continuously
  - o Fully agree; o Partly agree; o Fully disagree

Comment: In case you agree above, which components are inspected continuously?



- 5:11 Maintenance plans have been changed in the past five years because of new environmental regulations and a prioritising of energy saving  
☐ To a great extent; ☐ To some extent; ☐ Not at all
- 5:12 The maintenance plans depend more on the building's age than on specific technical conditions  
☐ Fully agree; ☐ Partly agree; ☐ Fully disagree
- 5:13 The fact that every building is unique makes it difficult to predict the life time of different components  
☐ Fully agree; ☐ Partly agree; ☐ Fully disagree
- 5:14 In the long term, knowledge will increase so that it will be easier to predict the activities that will be needed  
☐ Fully agree; ☐ Partly agree; ☐ Fully disagree

*Part 6: The maintenance planning and strategies*

- 6:1 There is a lot of neglected maintenance in the housing stock in our region  
☐ Fully agree; ☐ Partly agree; ☐ Fully disagree
- 6:2 Many owners of properties constructed under the "1 million program" are going to need to considerably raise the level of their activities during the coming five years  
☐ Fully agree; ☐ Partly agree; ☐ Fully disagree
- 6:3 Many owners of properties constructed under the "1 million program" are going to face economical problems due to the increased level of maintenance activities during the coming five years  
☐ Fully agree; ☐ Partly agree; ☐ Fully disagree
- 6:4 Maintenance activities would be higher if there was less restriction on the rents  
☐ Fully agree; ☐ Partly agree; ☐ Fully disagree

*Part 7: The maintenance planning and strategies*

- 7:1 Swedish private housing companies tend to have lower costs in the maintenance of their properties than the municipal companies  
☐ Yes; ☐ No
- 7:2 The private companies have lower maintenance costs because their houses are better built  
☐ Fully agree; ☐ Partly agree; ☐ Fully disagree
- 7:3 The private companies have lower maintenance costs because they have other categories of tenants  
☐ Fully agree; ☐ Partly agree; ☐ Fully disagree
- 7:4 The private companies have lower maintenance costs because they put more effort on continuous activities  
☐ Fully agree; ☐ Partly agree; ☐ Fully disagree
- 7:5 The private companies have lower maintenance costs because they accept a lower standard in their properties  
☐ Fully agree; ☐ Partly agree; ☐ Fully disagree
- 7:6 The municipal companies carry out unprofitable activities that a private company would not do  
☐ Fully agree; ☐ Partly agree; ☐ Fully disagree
- 7:7 The municipal companies are pressurised by politicians and the media to carry out unprofitable activities  
☐ Fully agree; ☐ Partly agree; ☐ Fully disagree
- 7:8 The municipal companies are not as good at procurement and therefore each order becomes more expensive for them  
☐ Fully agree; ☐ Partly agree; ☐ Fully disagree

## Appendix 2: Maintenance costs in the two categories 1995 -2005

Year	Municipal housing companies	Private housing companies
1995	84	76
1996	83	77
1997	90	84
1998	91	84
1999	94	83
2000	102	86
2001	105	81
2002	151*	128*
2003	158*	125*
2004	168*	147*
2005	192*	141*

*Maintenance costs (SEK/m<sup>2</sup>) for the municipal and private housing companies<sup>12</sup>.*

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<sup>12</sup>Operation costs are included in the period 2002-2005 Source: Boverket (2002, page 83) and Hyresgästföreningen (2007)

### Appendix 3: Factors affecting maintenance levels found in the literature review

[illegible]

# Paper 4

**Managing special purpose properties:  
A case study of the current practises in the state,  
county and industrial companies in Sweden**

Henry Muyingo

Stockholm 2009

**Building and Real Estate Economics  
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# **Managing special purpose properties: A case study of the current practises in the state, county and industrial companies in Sweden**

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## **Abstract**

The purpose of this paper is to ascertain the current strategic property management practises in the state and county government sector as well as in some industrial companies in Sweden based on data that was collected through a questionnaire that was sent to managers in the companies.

The results indicate that the degree of property ownership in the surveyed companies is high and that the probability of the leasing market increasing in the coming five years is very low. The government sector has a higher level of adherence to set maintenance plans as well as longer pay back duration on investments. Classification of activities as maintenance or investments differs with the government companies leaning more towards maintenance than investment in their accounting. According to the respondents there was very little neglected maintenance in the industry in contrast to the government sector especially in the counties. Furthermore, the maintenance plans in the public sector were shorter than those in the private sector.

Unlike earlier studies that have analysed the government sector or the industrial sector this paper presents a unified and clearer indicator of some factors that lead to the differences in the way the property is managed in the county and state governments as well as in industrial companies in Sweden.

**Keywords:** Property management, special purpose property, public property maintenance

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# **1 Background and aim**

Large scale production of goods or services requires space which can be in the form of small fragmented premises like leased administration offices or large units like hospitals or factories that are specially constructed for the occupier. A few studies (Allard and Holmquist, 2003; Bejrum, 1999; Jonsson, 1997; Sundvik and Jändel, 1997) have analysed property management in the industrial sector in Sweden. However there is a lack of a detailed study of the strategic property management in the government sector in comparison to the industrial sector as noted by Brunes and Lind (2008).

The aim of this essay is to quantitatively, by means of a questionnaire study, analyse the underlying factors behind the similarities and differences in the securing and management of the special purpose property under national and county government ownership as well as in industrial manufacturing companies in Sweden.

The focus of the study is on the management of special purpose properties that have been at the disposal of the government/company for some time and the options available in the consideration of future space requirements. Newly established businesses or entities are not covered in this paper.

## **2 Method and delimitations**

The paper starts with a brief presentation of the main issues in property management in general and for special purpose properties in particular. Thereafter the results and analysis of the empirical study are presented. A few concluding notes end the paper.

The study is based on a questionnaire survey mainly on issues on special purpose property management discussed in Brunes and Lind (2008) and Lundström (2000). The questionnaire was carried out in the spring of 2009. The study intended to cover the 3 national government companies/agencies specialised on property management, all of the 18 county governments plus the regions of Skåne and Västra Götaland, as well as 15 manufacturing companies.

Answers to the web-based questionnaire were sought from 2 respondents in a managerial position with direct responsibility for the properties in each company, or in some cases from each regional/division representative in the company. A total of 13 counties, 2 regions, 6 industrial companies and the 3 national companies provided responses. A reminder was sent out two weeks after the initial request bringing the total individual responses to 40 out of a possible 71.



The six-section questionnaire consisted of 36 close ended questions as well as Likert scaled response format questions that were used to elicit structured answers on how the organisation chose to secure the availability of its required premises, how the division of responsibilities is structured between the organisation and the operative units involved (internal or external), some details on the property management of both the leased and owned space, how the maintenance concept is demarcated and, on a few questions concerning a prediction of the future space management. Most of the questions were in form of statements that could be answered either as fully agree, partly agree or disagree. The respondents also had an opportunity to make extra comments on a few questions. However, since in some cases there were several respondents in an organisation and with an array of probable answers, it was not possible to give preference to one individual in the same organisation. Nevertheless as over 80 per cent of all of the respondents had been with the same organisation for over 5 years they can be considered to be well knowledgeable about the strategic management of the special purpose properties under their care. Therefore the individual responses have been taken to be representative of management policies within the production category such as national or county government. The survey was conducted during the spring of 2009 and due to the turbulence in the market at the time the response rate in the industrial companies was lower than in the other categories. The results should therefore not be taken as mirrors of the categories but more as an indicator of different situations in which the companies operate.

The statistical analysis programme SPSS was used in the tabulation and analysis of the answers which were recorded as a percentage of respondents in each category that answered the statement. The questionnaire was written and administered in Swedish. A translated version is provided in appendix 1.

### **3 Property management - The main issues**

#### **3.1 Introduction**

Traditionally large organisations have owned properties specially constructed for their particular business. Mergers and takeovers further increased the total space under management. On the other hand changing demographics and recessionary situations have led to a need for divestment or the possibility to co-share space with other types of organisations (French et al. 2002). Strategic property management aims at balancing the question of how the needed space is to be secured, maintained, increased or disposed of in a cost effective manner. The business of property management is a mixture of decisions and actions.

Lundström (2000, p 15) lists the following:

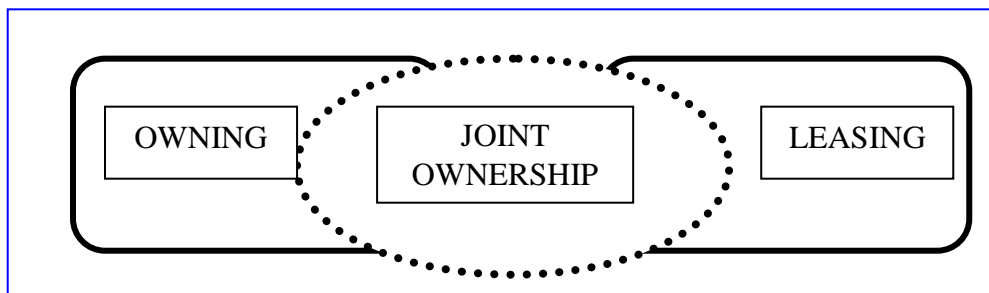
- Demarcating the company's business goals and geographical as well as business diversification
- Deciding on the extent of real investments like new or re-construction needed or selling off of properties.
- Choosing the structure and mix of the financial portfolio that will cover the actions decided on
- Decisions that affect the level of the net operating income like rent levels and choice of management service levels and providers
- Strategic decisions that affect the cash flow as well the company's trademark and goodwill. This includes the choice between internal or external management as well as information flow between interested parties

- Actions to secure the availability and reliability of the required space like short and long term maintenance as well as the provision of support services like cleaning, security etc.

Property owned for investment purposes or risk diversification needs to be traded at some time which puts the focus on the market cycle. However for special purpose properties the focus is on the business and goals of the company which determines the amount of space needed for optimal production. Thereafter there are a number of options as to how the premises can be secured. This can be done either through:

- direct ownership of all the properties (specially constructed or purchased)
- partial ownerships through a joint venture arrangement after creating a property company separated from the operations company
- sale and leaseback - whereby the properties are sold and then leased from the investor under various contract terms and lengths
- divest and outsource – which is similar to the sale-lease back transaction but with the company fully leasing and not retaining any in-house property management.

Securing property availability can be seen as a decision making process in rights related to the space used. These rights might be linked to security factors like who can have access to the premises as in the case for prisons or research premises, or to questions of flexibility to vacate the premises. A wide range of contractual options from direct ownership at one extreme and all out leasing at the other provide just enough space without the underlying issues due to ownership or leasing.



*Figure 3-1: The rights imbedded in different forms of securing availability*

## **3.2 Securing availability: To own or not**

### **Owning**

Changing demographic factors, tight government budgets and deregulations within the area of provision of services that are under the responsibility of the local and county governments have seen an increase in the volume of vacant government owned space or that occupied by non government tenants (French et al. 2002; Lind and Lindqvist, (2005). A changed tenant structure might tip the core business of the property organisation from that of providing support duties to that of external tenant satisfaction. This in turn has in a number of cases led to a necessary restructuring of some of the property portfolios in situations where it is rational to switch from property ownership to leasing so as to avoid managing the tenant relationships. The switch entails decisions to consider which can be illustrated as in figure 3-2.

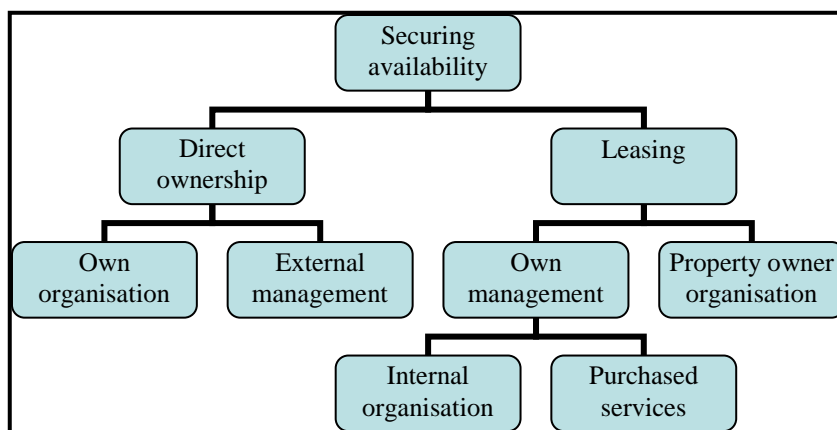


Figure 3-2: Managing the property – factors to consider

The role of special properties is to support the business goals of the company or institution and therefore the choice to retain ownership of the properties will depend on the nature of the business. Among the reasons for retaining direct ownership is the need to have control over arduous and sensitive production processes as well as securing the premises against industrial espionage (Sundvik and Jändel, 1997). Another reason according to Devaney and Lizieri (2004) who are quoted in Tipping and Bullard (2007) is desiring to carry on the tradition of owning even when it would be profitable not to do so.

## Leasing

Industrial firms as well as governments can secure premises through disinvesting themselves of their properties and opting to lease the required space. Special purpose premises might be retained in-house whereas the general purpose premises like administration offices are leased. The decision to lease will depend on a number of factors such as the fact that it might be economically advantageous and profitable for the production unit not to own its premises.

This can be due to:

- ◆ Need to release capital:

Large manufacturing firms and governments have over time acquired large portfolios of property held at historic cost values. The rise in market values over the years has led to substantial capital reserves whereby leasing offers the opportunity to unlock value from the property and to stabilise occupation costs, as well as increasing management efficiency and economies of scale through concentrating the buying power (Dixon and Pottinger, 2006).

- ◆ Flexibility

Leasing offers the flexibility of occupation for the organisation which can negotiate various lease terms with options to expand, exit or repurchase. On the other hand retained ownership offers the option to sell the property at a future date and also to carry out needed changes without lots of negotiations. Flexibility can be seen as a balance between the cost of insuring against future property related risks to the business and the expense due to negotiating complex contracts that cover most of the situations that might arise (Brunes and Lind, 2008)

- ◆ Risk aversion

This can be seen as a part of the flexibility mentioned above, and/or insurance against risks due to ownership, and statutory directives like environmental requirements that might make it too expensive for a small organisation to carry out

- ◆ Taxation advantages

The possibility to take advantage of different taxation rates related to properties under long term leases being accounted for as financial assets etc

◆ Quality in service to core business

The competence provided by external operators due to a focus on their core business is appreciated and there will be synergies accrued from leaving property ownership to property companies

◆ Streamlining the organization

Internal management aspects and structure will be streamlined according to the model that best suits the organisation. The possibility of better carrier advancement in the specialised company might serve as an incitement which might lead to higher efficiency

◆ Political decisions

Changes in government tax shelters and policies such as compulsory competitive tendering make it imperative to change the property strategy (Gibson, 1994).

◆ Lower costs for the premises

A property company is better suited to manage its core business of property ownership. Economic factors dictate that it will only be possible to sell a property if the buyer values it more than the seller. Therefore the company can only retain ownership if it can utilise or manage the property in a manner superior to that of the potential buyer. This could be as a result of differences in the operating, maintenance and reconstruction costs due to economies of scale of the investor. It could also be due to an agreed or unintentional reduction in the quality of service provided and/or acceptable standard or simply because the investor has another maintenance strategy based on how they gauge the risks and consequences of component failure. Property ownership involves taking strategic risks in determining the remaining life of components, the costs to take care of the potential failures, the market changes and subsequent value losses. By selling the property portfolio these risks are transferred to the investor. Statutory rules regulate the depreciation rate to apply on government owned properties. This provides an advantage for the private investor who can use a much longer period and therefore ask for rents that are below those demanded by the organisation. The investor also presumably has a higher competency to determine the technical risks as well as potential costs to rectify or insure against them which leads to a lower required rate of return (Brunes and Lind, 2008).

### **3.3 Managing the properties: To retain in-house or outsource**

Securing the availability of the premises for production also entails the separate question of whether the properties are to be managed internally or outsourced to an external service provider. According to Lindholm, (2004 p 11) real estate management can be separated into three: asset management, property management and facilities management. Asset management focuses on the profitability of the business, while in property management the technical manager concentrates on the building and its equipment. Facilities management on the other hand is about the space and services supporting, the occupant of a workplace in his/her work or the company's production.

Strategic property decisions are best solved internally while routine activities can be left to external providers (Manning et al (1997)<sup>1</sup>). Outsourcing works best for functions that can readily be provided by established suppliers as they are usually routine and well delineated as well as being measured and managed at arm's length which makes maintenance activities good candidates for outsourcing. In a survey of Swedish and UK process industry companies Bröchner et al, (2002) found 76-100% of the building fabric maintenance to be outsourced.

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<sup>1</sup> Cited in Lundström (2000)

Outsourcing might be seen as a sign of corporate capability and efficiency (Kadefors and Bröchner, 2004), but a careful analysis of the factors that might lead to differences in the maintenance costs due to organisation form is crucial for each company before a decision can be done. Lundström (2000), Bruner and Lind (2008) present a number of factors that affect the choice between one form and the other:

◆ Economies of scale

An organisation specialised on facility management might provide maintenance services at a much lower cost than the small internal organisation would due to economies of scale like specialised equipment for supporting a rarely needed but expensive activity or the provision of uniform high quality services to a portfolio spread over a wide geographic area.

◆ Economies of scope

A large specialist firm provides services to many clients and can afford to maintain a larger organisation that attracts and supports as well as provides career incitement for its staff. Economies of scope may also provide well needed experience that leads to better risk analysis and its management which invariably leads to lower costs.

◆ Purchaser competence

The service purchasing staff in the organisation will benefit from knowledge transfers due to exposure to external competition as well as competencies. The external providers that are brought in because of their knowledge and experience can quickly come up to speed on new concepts and revolutions thus raising the general knowledge level in the organisation.

◆ Increased cost consciousness

Negotiations during the contract process clearly indicate the price for different activities that previously might not have been appreciated or understood under internal management which leads to an increase of cost consciousness in the company. However, the perceived cost savings can also be due to the purchaser accepting a decrease in the quality of the service provided. It could also be due to a difference in maintenance strategies whereby the provider is less risk averse and can wait longer before carrying out certain activities<sup>2</sup>.

◆ Risk diversification

In situations where the organisation quickly needs to make changes in its operations outsourcing may provide the organisation with flexibility related to the ease of downsizing in the number of staff without complicated labour law related negotiations.

◆ Fear of loss of critical information and skills

Outsourcing invariably leads to loss of information on the operation and maintenance of the properties. It might prove to be extremely costly to build up this information base after the dismantling of the internal organisation. Long relations to the same provider further strengthen the reliance on outsourcing due to a weakening of the negotiation position of the service purchaser as well as the reduction in innovative creativity as economies of scale might make it be more profitable for the provider to carry out uniform processes.

◆ Quicker decision making

Keeping an internal maintenance organisation can provide the advantage of quicker decision making as opposed to having to renegotiate detailed contracts with the provider.

◆ Security aspects and reliability in the production process

Reliability and security is crucial in a number of special purpose properties which might be a reason against outsourcing as the organisation prefers to retain in house the control over access to the premises.

An overview of the relevant literature can be found in appendix 4.

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<sup>2</sup> Bruner and Lind (2008 p 15)

## 4 Results of the survey

### 4.1 The sample size

A total of 27 companies and 69 persons in the different categories were contacted for the survey with a response rate of over 40% as shown in table 4-1 below.

Table 4-1: The respondents

	County (C)	Industry (I)	State (S)	Respondents (C)	Respondents (I)	Respondents (S)
Total Sent	19	15	3	38	15	16
Completed	14	6	3	21	6	8
Not completed	0	0	0	3	0	2
Not answered	5	9	0	14	9	6
% response	74%	40%	100%	55%	40%	50%

Of the 40 persons that took part in the survey, approximately 70 per cent of them were property managers and 20 per cent were directors that were also responsible for properties. The majority of the respondents had also been employed for over 5 years in the companies.

In appendix 2 all the results are presented.

### 4.2 The company's property portfolio

Nearly all or a great deal of the properties in the companies surveyed are specially constructed. The county and state companies own all of their special purpose premises whereas the industry companies own up to 67% of these premises. Even a majority of the non-specialised premises such as offices and general purpose premises are under ownership though the degree is again less in the industry than the government sector as shown in figure 4-1 and 4-2 below.

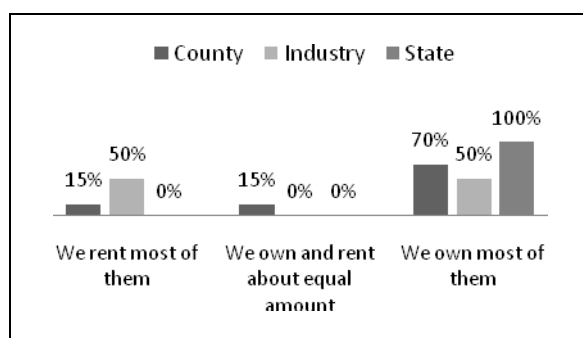


Figure 4-1 Office premises

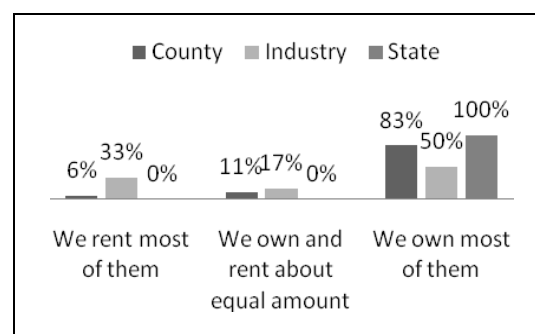


Figure 4-2 Other general premises

Brunes and Lind, (2008) present a list of advantages accrued to either owning or leasing premises and the survey reveals a difference in the categories in the perception of these advantages. Respondents in the state companies concede to a much higher degree than their counterparts in the other categories, that owning leads to shorter decision chains. The ratio of those that fully agree to the statement on ownership providing access to important property related information increases to a majority in all of the categories.

The level of full conviction that owning provides an opportunity to open for external competition is least in the county and highest in the state companies. It decreases even further to about 15 % in all categories regarding the statement on leasing providing the flexibility to manage the costs for the premises as shown in figure 4-3 and 4-4 below.

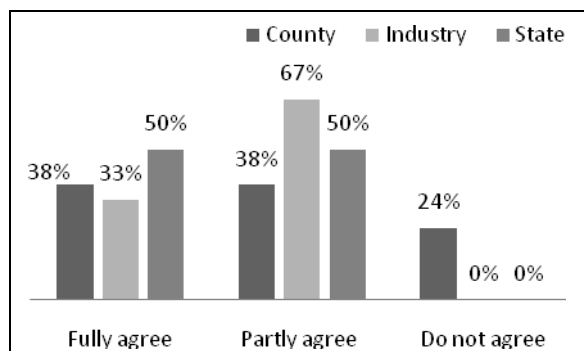


Figure 4-3 Ownership provides opportunity to open the management to competition

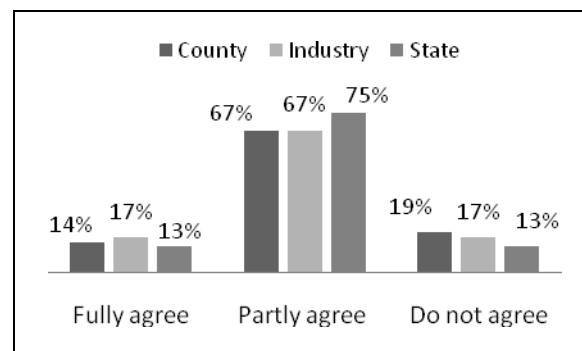


Figure 4-4: Leasing provides flexibility in relation to costs for the premises

A majority of the respondents especially in the industry companies only partly agree that leasing reduces the risks due to market changes. But there is a clear majority (63%) in the state companies that leasing provides the opportunity to focus on core business though the county and industry respondents only partly agree to this to 62% respective 83%. Though given as a reason in Brunes and Lind (2008), leasing is not seen as leading to lower costs in any of the categories even though the degree of partial acceptance slightly varies in the figure below.

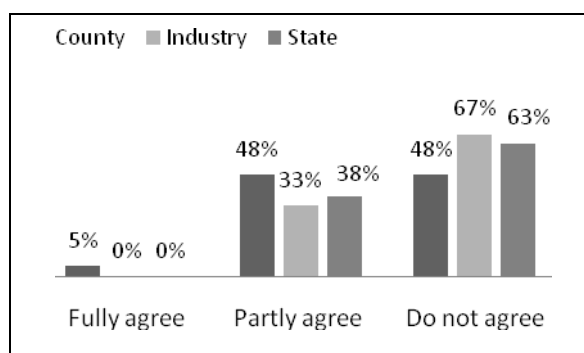


Figure 4-5: Leasing provides lower costs

The type of business of the companies under survey requires special properties as operations include hospitals, prisons, factories and others. Thus it is to be expected that the degree of specially adjusted premises is high as confirmed in the results. That the degree to which they are owned or rented varies across the type of premises and category is in part due to the level of maturity of the rental market in the area as well as the specific requirements of the company as noted in Kadefors and Bröchner (2004). A mixture of ownership and leasing of premises as exhibited by the industry ensures the possibility of having control over sensitive production premises while leasing the less sensitive premises. On the other hand not all counties have a property market that can satisfy the demand for rental properties of the right size and character. This raises the degree of ownership in these locations. The advantages of leasing accrued to one company will differ from those in another economic and for a well trimmed organisation there might not be any more cost cuts as exemplified by the rejected statement on lower costs due to leasing.

### 4.3 Decision making about the properties/buildings/premises

There is a higher level of centralisation of acquisition and adjustment of premises in the county as compared to the state and industry in which the production department heads might be allowed to procure as well as to order for adjustments in their premises. On the other hand property related matters are represented in the company top management more in the industry companies than in the government sector companies as shown in figure 4-6. The level of centrally decided division of responsibilities regarding the property related issues is least in the industry and highest in the county as shown figure 4-7. Regarding the question on whether the company only leases its operation premises results show that this is true for only 6% and 17% of the county and industry companies respectively and none in the state companies.

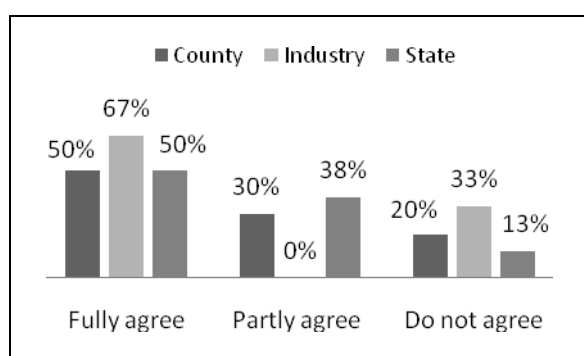


Figure 4-6 Questions concerning properties and premises are represented in the company's top management

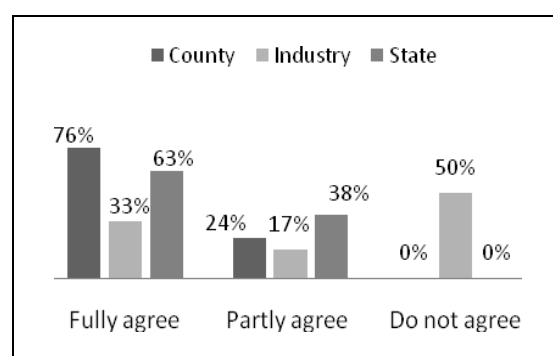


Figure 4-7: A detailed centrally determined policy regulates property related responsibilities

There is a clear difference in the categories in how the responsibility for the premises is taken care of with a more production oriented strategy in the industry as compared to centralised decision making in the government sector. The diversity of services and clients in the county is reflected in the centralised administration which also draws advantage of the economies of scope.

### 4.4 Property management of the owned buildings

The way the premises are managed and the activities accounted for vary in the categories. The county companies have a subsidiary or particular department from which the rest of the organization leases its premises unlike in the state and industry companies that were surveyed. The state companies, which are property companies, do not have such subsidiaries at all<sup>3</sup> and they also have a much lesser degree of outsourcing as compared to the non-property companies in the county and industry categories. The results further indicate that the decision between in-house or outsourcing of services is to a majority left to the property manager in all of the categories.

How the companies demarcate and categorise various activities is of interest as this affects the accounting for the activities and complicates comparison of cost of different activities. The economic situation of the company appears not to have a major effect on whether the activities are classified as investments or maintenance even though responses show that it partly does so more in the counties than in the other categories. The cost level on the other hand, is used to denote activities as operation or maintenance in about 25 per cent of the

<sup>3</sup> The results indicated such a subsidiary but this is due to divergent responses within the same state company.



responses received in all of the categories and the size of the activity appears to play some role in classification in industry other than in the other categories according to the results below

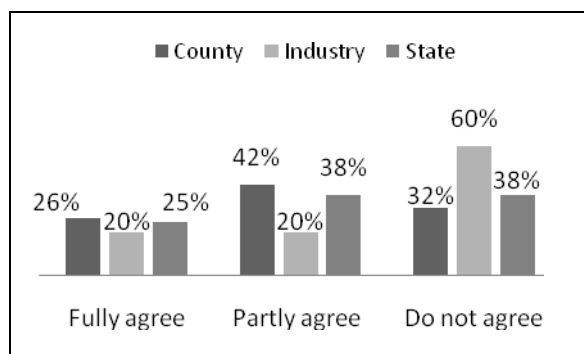


Figure 4-8 The cost determines the demarcation between operation and maintenance

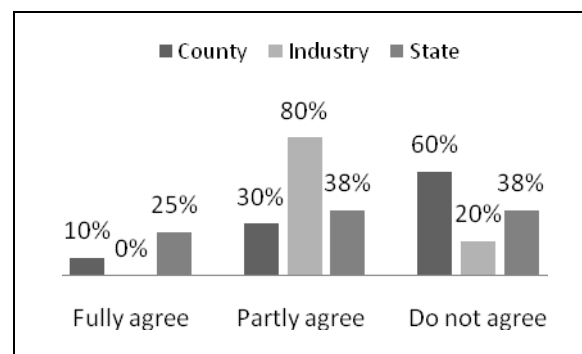


Figure 4-9 The size of the activity determines the classification between investment and maintenance

All of the county companies maintain a distinct demarcation between planned maintenance and acute maintenance while this is at 80% in the other categories. Results also show that immediate maintenance is to some degree, higher than budgeted for especially in the state and county companies but not in the industry companies.

When asked to classify some given activities such as façade renovation and the change of the roof as investment, maintenance or repair the results which are presented in appendix 1 show that there are differences in classification not only across the activities but also across the categories. Whereas the industry companies classify a lot as investment the respondents in the county companies categorise most of the activities as maintenance as shown in figure 0-1 and Figure 2 in appendix 3.

There are differences too in how the companies analyse the profitability of their activities as shown by the responses that reveal that the government sector uses a required payback duration that lies between 11-20 years as compared to the much shorter period of 5-10 years in the private sector when large reconstructions are carried out. On the other hand the general long term maintenance plans in the industry companies are on average 5-10 years in comparison to the county and the state companies that have plans that are less than 5 years. Despite the state companies having a higher degree of detailed short term plans that are less than 1 year they also adhere less to the plans as shown in figures 4-10 and 4-11.

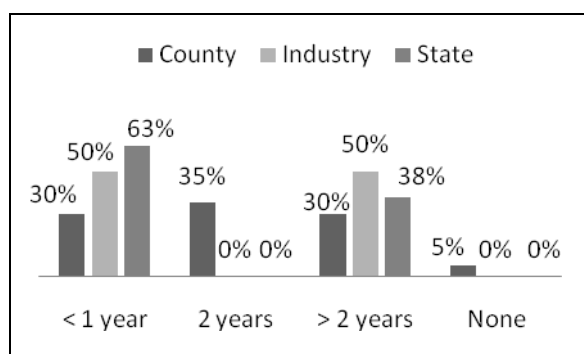


Figure 4-10 The period covered by the detailed short term maintenance plans

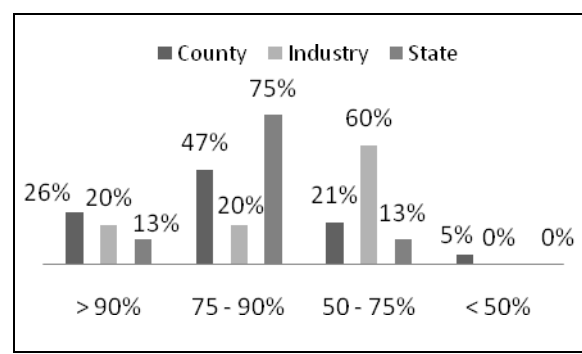


Figure 4-11 Percentage of activities in 2008 that were part of the maintenance plan done in 2007

New environmental regulations and a prioritising of energy saving are partly the reason that maintenance costs have increased in the past five year according to the survey. A majority of the respondents fully or partly agree that there is a substantial amount of neglected maintenance in the properties in most of the companies in the respondents' branch though not as much in their own properties and less so in industry as shown in figure 4-12 and 4-13.

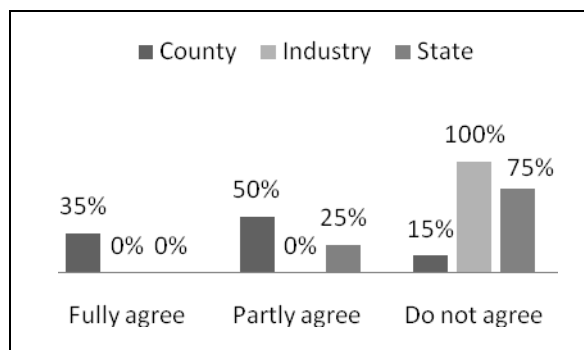


Figure 4-12 There is a lot of neglected maintenance in the properties in our company

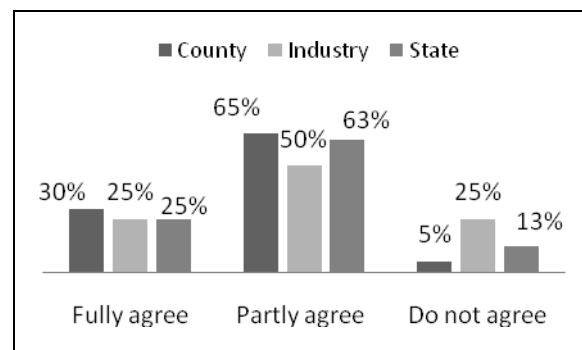


Figure 4-13 There is a lot of neglected maintenance in the properties in most of the companies in our branch

The high adherence to set maintenance plans as indicated by the results from the government sector is bound to lead to over-maintenance of some properties or building components at the same time as a diversion from the plans is seen as neglected maintenance. The question of how activities are classified and accounted for is crucial in order to have a comparable overview of the cost level of the company as there is a greater degree of classification as maintenance in the public sector than in the private sector. These results, on adherence to set plans and differences in classification, are similar to those from another survey that compared the property management in the public municipal housing companies and rental housing companies in the private sector in Sweden (Muyingo 2009). The longer payback duration that is used in the public sector, county and state companies, implies a lower yield requirement as compared to the industrial sector thus affecting the comparison of efficiency in how the properties are managed and maintained.

## 4.5 Property management of the leased buildings

The average contract length for the leased properties is 5 to 10 years in the counties and industry. The state companies on the other hand, own most of their properties but also rent out at contracts stretching up to 25 years. 80% of the respondents in the industry and 70% in the county fully agree that they have clear policies on how responsibilities related to the leased premises are delegated. However this is so in only 50% of the state companies.

Standard contracts are used to a higher degree in the government sector than in industry when signing lease contracts and in demarcating liabilities in regard to activities in the leased premises and regarding how the leased premises are managed, a clear majority of the responses show that the specialised competence of an external service provider is not the most important factor when choosing the management strategy nor is the level of satisfaction with a service provider affected by the cost level only as shown below.

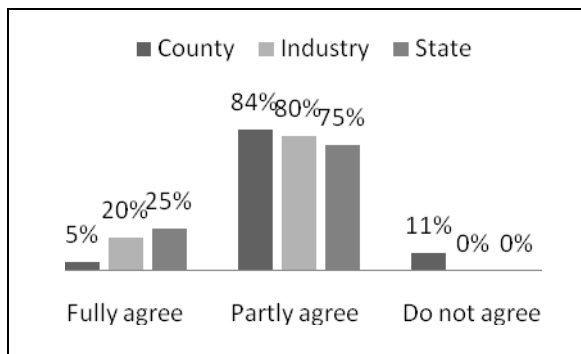


Figure 4-14 The most important factor about external providers is their specialised competence

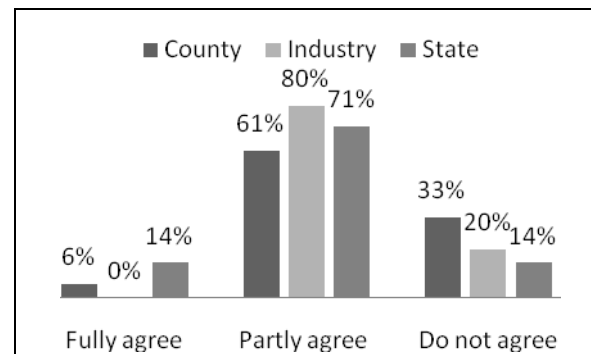


Figure 4-15 The cost level affects satisfaction with the cooperation

When searching for rental premises the fact that a number of support services are coordinated under the same landlord does not affect the choice in the county companies as much as it does in the industry companies. The results also show that there are differences between the categories in regard to the utilities that are included in the contractual rent. Heating and water are included in the lease contracts of the public sector companies whereas they are exclusive for industry. On the other hand electricity and cooling are not included in the lease for any of the categories.

As noted in Lundström (2000) and Brunes and Lind (2006) lease contracts can be drafted in a number of ways for a variety of reasons such as cost reductions and increased competence. Each contract can be seen as a transfer of risks due to ownership and other factors mentioned in 3.2 above. The use of standard contracts presents a degree of transparency and reduces the possibility of principle agent problems due to a less knowledgeable party. Though the counties are spread over the whole country they provide a relatively similar service which simplifies the use of standard contracts in comparison to the industrial companies. The 5-10 year lease durations reported in the companies in the county and industry sector which do not have property management as core-business, provide a flexibility and opportunity to regularly see over the portfolio at the same time as securing the availability over a period that is long enough to provide stability but without the disadvantages of ownership as mentioned in Brunes and Lind (2008).

## 4.6 Predictions about the next 5 years

According to the respondents the level of specially adjusted premises is not going to decrease in the companies in the coming five years and a majority in the state companies fully agree that the premises are going to be more flexible in the future a belief that is only partly agreed to by a majority of the respondents in the county and industry as shown in figure 4-16 and 4-17.

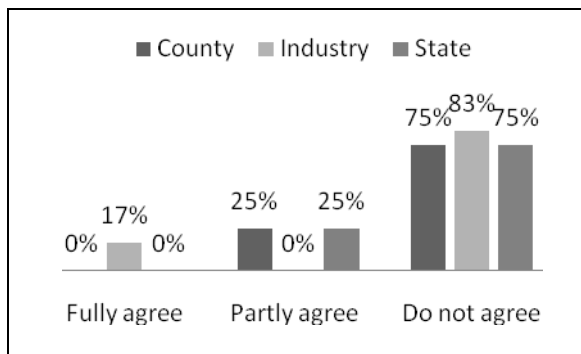


Figure 4-16 In 5 years time we will have a lower proportion of special purpose premises

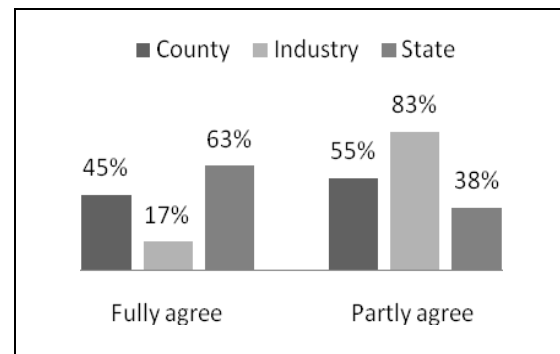


Figure 4-17 In the future, premises are going to be more flexible

The length of the contracts is not expected to increase in any of the categories nor is the level of leasing expected to increase in industry or state and only partly in the counties. However a higher percentage of respondents in the public sector than in the private sector would appreciate some more competition in the market for service providers so as to raise the level of competition.

The results of the survey indicate that though the need for special purpose premises is not going to decrease the probability that the lease market for these properties will be expanding in the near future is minimal. However other services and contract forms can be developed around the special properties that are expected to become more flexible especially in the public sector.

## 5 Concluding remarks

Demographic changes and revolutionary manufacturing processes have led to a need to reorganise the way that the needed space in traditionally large organisations can be secured, maintained, increased or disposed of in a cost effective manner. Leasing has thus become a viable option for non-strategic premises. The way the properties are managed has also undergone a renaissance with an increase in external service providers. However in order to reap the advantages accrued to the various options there has to be a knowledgeable purchaser of the service.

A number of similarities and differences in the management of properties under the three categories are discernible from the survey.

- The companies secure their production premises mainly through the high degree of ownership, and the level of leasing both now and in the future is not expected to increase in any of the categories. However the level of leasing might be affected by a lack of alternatives due to an immature market in some of the geographical locations. This factor should therefore be taken into consideration in further studies on the subject.
- There are clear differences between the private and the government sectors in the demarcation of concepts and how activities are classified. The results of the survey are consistent with earlier results showing that whereas the public sector classifies more as maintenance the private sector capitalises more of the costs and accounts for the activities as investments.

- There is a higher degree of centralisation in the government sector companies than in the industry, but the level of subcontracting of services is about the same in the county and the industry. This can be explained by the difference in the business of the companies. The core business of the state companies is property management as opposed to county companies that to a great extent are daughter companies under a centralised government organisation.
- According to the respondents there is more neglected maintenance in the government sector especially in the county companies than in the industry. Of particular interest is the perception of neglected maintenance in the branch as high but low for the own company. This leads to the question of how the concept of neglected maintenance is defined and the source of the neglected maintenance. There is a tendency for the public sector to have set long term maintenance plans which they adhere to. Should maintenance be considered as neglected if the plan changes and the scheduled activity is put up for a later date? Or should it be considered as neglected in case the budget is not enough to cover the scheduled activity? That the responses from industry point at a lack of neglected maintenance indicates a definition that is economical in nature whereby the focus on investment returns allows the company the liberty to discard a planned activity in case it is not profitable. In that case it is no longer neglected but discarded.
- There is a distinct difference in the pay-back duration used by the government sector and the one in the industry sector. This in effect lowers the effectiveness of the government sector as the lower required rate of return allows the government sector to have more activities that appear to be profitable. Maybe the problem to worry about should not be that of neglected maintenance in this sector but that of unprofitable maintenance that should not be carried out. This might also just explain why more activities are classified and dealt with as investments by the industry and not by the county or state companies.

A lot of factors come into play during the decisions on how to secure the availability and maintenance of premises necessary for production and effective special purpose property management. However the divergence in classification of activities even within the same category and company is problematic as it complicates comparison of activities and services provided as well as benchmarking and it should be given appropriate attention by the managers. Many of the results above are similar in principle to those found during a comparison of public and private housing sector presented in Muyingo (2009). This similarity in answers goes to show the great need to use the same well defined concepts in order to benchmark and develop more efficient management strategies.

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## Appendix 1: The questionnaire

### *Introduction*

The purpose of the questionnaire is to get information about property maintenance strategies used in industrial companies and those in the public sector. The questions are constructed in such a way that they can easily be answered in about 10-15 minutes.

All of the responses are going to be treated confidentially.

### *Section 1: The company and respondent*

1. The company name
2. The company's main business
3. Your position in the company
4. How long have you been employed in the company
  - o 0-1 year; o 1-5 years; o > 5 years

### *Section 2: The company's property portfolio*

5. To what extent are the buildings/premises/properties which you use specially adjusted for the company operations?

o Nearly all premises o A great deal of them o A small amount of them o  
Mainly general purpose

6. Which of these statements are true for your company: Note that several answers are possible at the same time:

- Office premises:
  - o We rent most of them o We own and rent about equal amount o We own most of them
- Other general premises (e.g. industry premises, storage, etc)
  - o We rent most of them o We own and rent about equal amount o We own most of them
- Premises that are specially adjusted for our operations
  - o We rent most of them o We own and rent about equal amount o We own most of them

7. Below are a number of statements on owning vs. leasing special purpose premises. To what extent do you agree with the statements?

- Ownership leads to shorter decision chains
  - o Fully agree o Partly agree; o Fully disagree
- Ownership provides the opportunity to open the management to competition
  - o Fully agree o Partly agree; o Fully disagree
- Ownership provides access to important property related information
  - o Fully agree o Partly agree; o Fully disagree
- Leasing provides lower costs
  - o Fully agree o Partly agree; o Fully disagree
- Leasing provides lower risks due to market changes
  - o Fully agree o Partly agree; o Fully disagree
- Leasing provides flexibility in relation to costs for the premises
  - o Fully agree o Partly agree; o Fully disagree
- Leasing provides the opportunity for the company to focus on core business
  - o Fully agree o Partly agree; o Fully disagree

*Section 3: Decision making about the properties/buildings/premises*

8. Those that are responsible for the different operations have greater freedom to acquire and adjust the premises to their needs

☐ Fully agree ☐ Partly agree; ☐ Fully disagree

9. There exists a detailed centrally determined policy that regulates the division of responsibilities/liabilities between the central administration, the property department (or equivalent) and those responsible for operations when it comes to decisions about the premises

☐ Fully agree ☐ Partly agree; ☐ Fully disagree

10. The company's top management contains a particular person who is assigned the responsibility for questions concerning properties and premises

☐ Fully agree ☐ Partly agree; ☐ Fully disagree

11. In case your company only leases its operation premises answer YES here and you will be directed straight to section 5.

☐ Yes; ☐ No

*Section 4: Property management of the owned buildings*

12. The company has a subsidiary/ separate division from which other departments lease their premises

☐ Fully agree ☐ Partly agree; ☐ Fully disagree

13. The operation of the premises is managed through:

☐ Partly through external provider ☐ Only our own staff ☐ Only external providers

14. The choice between in-house and external providers is determined by:

☐ A central policy ☐ Property management ☐ Operations management ☐ Other

- If "other", how is the choice made?

15. The company's economical situation and budget determine what is classified as investments or maintenance

☐ Fully agree ☐ Partly agree; ☐ Fully disagree

16. The size of the activity determines the classification

☐ Fully agree ☐ Partly agree; ☐ Fully disagree

17. The company demarcates between planned and immediate (acute) maintenance

☐ Yes; ☐ No

Do you have any other demarcation?

18. The cost determines the classification between operation and maintenance

☐ Fully agree ☐ Partly agree; ☐ Fully disagree

19. How do you normally classify the following activities?

- |                                 |  |
|---------------------------------|--|
| a. façade renovation            | <input type="radio"/> Fully agree <input type="radio"/> Partly agree; <input type="radio"/> Fully disagree |
| b. change of roofing            | <input type="radio"/> Fully agree <input type="radio"/> Partly agree; <input type="radio"/> Fully disagree |
| c. change of ventilation system | <input type="radio"/> Fully agree <input type="radio"/> Partly agree; <input type="radio"/> Fully disagree |
| d. change of pipe system        | <input type="radio"/> Fully agree <input type="radio"/> Partly agree; <input type="radio"/> Fully disagree |

20. When large scale renovations and/or reinvestments of the owned premises are carried out what break even duration is used in the calculation

☐ < 5 yrs; ☐ 5 – 10 yrs; ☐ 11 - 20 yrs; ☐ > 20 yrs



21. Immediate maintenance is often higher than budgeted for  
☐ Fully agree ☐ Partly agree; ☐ Fully disagree
22. The company has a general plan that covers  
☐ 10 years or longer; ☐ 5 – 10 years; ☐ < 5 years; ☐ None
23. The company has a detailed plan that covers  
☐ > 2 years; ☐ 2 years; ☐ < 1 year; ☐ None
24. Approximate percentage of activities in 2008 that were part of the maintenance plan done in 2007  
☐ > 90%; ☐ 75 - 90%; ☐ 50 - 75%; ☐ < 50%; ☐ There was no plan
25. To what extent do you agree with the statements below?
- Maintenance costs have increased in the past five years because of new environmental regulations and a prioritising of energy saving  
☐ Fully agree ☐ Partly agree; ☐ Fully disagree
  - There is a lot of neglected maintenance in the properties in our company  
☐ Fully agree ☐ Partly agree; ☐ Fully disagree
  - There is a lot of neglected maintenance in the properties in most of the companies in our branch  
☐ Fully agree ☐ Partly agree; ☐ Fully disagree

*Section 5: Property management of the leased buildings*

26. What is the usual duration for the leases you sign for your rented operation premises
27. The company has a clear policy on who does what in relation to the leased premises  
☐ Fully agree ☐ Partly agree; ☐ Fully disagree
28. To what extent are standard contracts used when renting premises?  
☐ To a great extent; ☐ To some extent; ☐ Not at all
29. To what extent are standardised lists used when demarcating responsibilities/liabilities in relation to activities in the rented premises?  
☐ To a great extent; ☐ To some extent; ☐ Not at all
30. To what extent do you agree with the statements below?
- The most important factor about external providers is their specialised competence  
☐ Fully agree ☐ Partly agree; ☐ Fully disagree
  - The choice of a particular landlord depends greatly on the fact that a number of support services are coordinated under the same provider  
☐ Fully agree ☐ Partly agree; ☐ Fully disagree
  - The cost level affects how satisfied we are with the cooperation.  
☐ Fully agree ☐ Partly agree; ☐ Fully disagree
31. The rent includes:
- Heating ☐ Yes; ☐ No
  - Electricity ☐ Yes; ☐ No
  - Water ☐ Yes; ☐ No

- cooling ☐ Yes; ☐ No

*Section 6: Predictions about the situation in the coming 5 years*

32. In 5 years time we will have a lower proportion of special purpose premises  
☐ Fully agree ☐ Partly agree; ☐ Fully disagree
33. In the future, premises are going to be more flexible  
☐ Fully agree ☐ Partly agree; ☐ Fully disagree
34. In 5 years time we will be leasing more  
☐ Fully agree ☐ Partly agree; ☐ Fully disagree
35. In 5 years time we will have longer durations on the premises we rent  
☐ Fully agree ☐ Partly agree; ☐ Fully disagree
36. It would be good with more participants in the market in order to raise competition  
☐ Fully agree ☐ Partly agree; ☐ Fully disagree
37. Do you have anything else you wish to add?

## Appendix 2: Results of the questionnaire

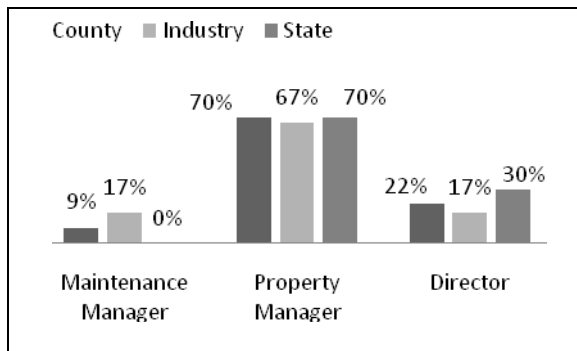


Figure 0-1 Your position in the company

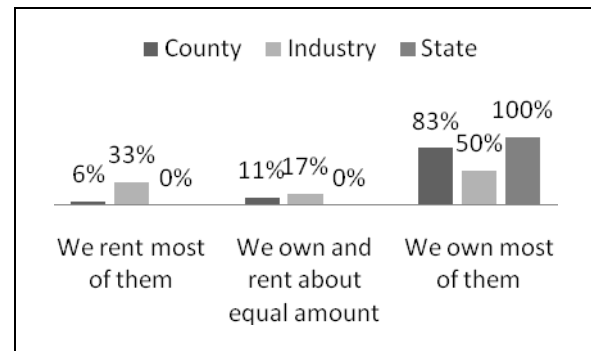


Figure 0-5 Other general premises

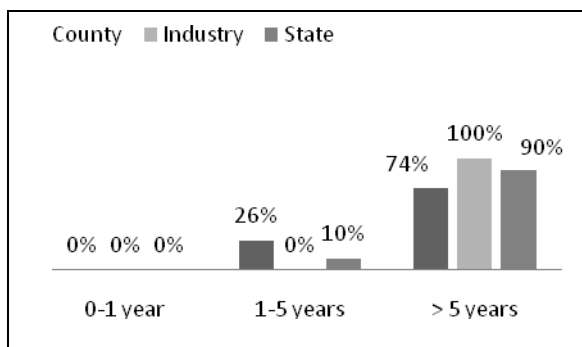


Figure 0-2 How long have you been employed in the company

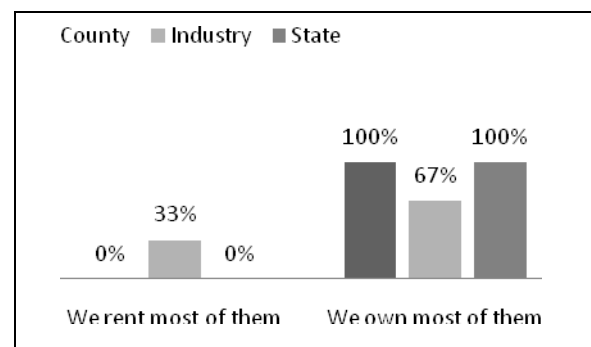


Figure 0-6 Premises that are specially adjusted for the company's operations

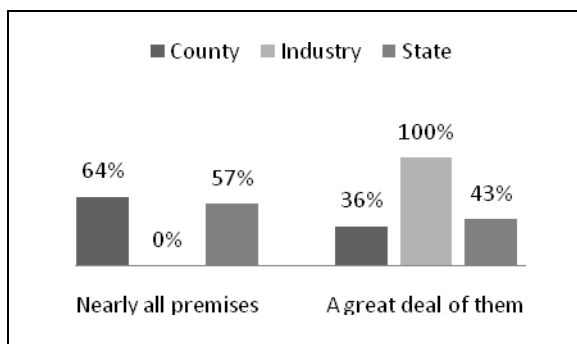


Figure 0-3 Extent to which buildings/properties used for the company operations are specially adjusted

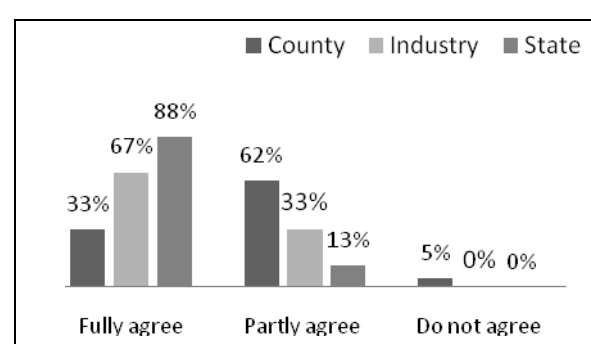


Figure 0-7 Ownership leads to shorter decision chains

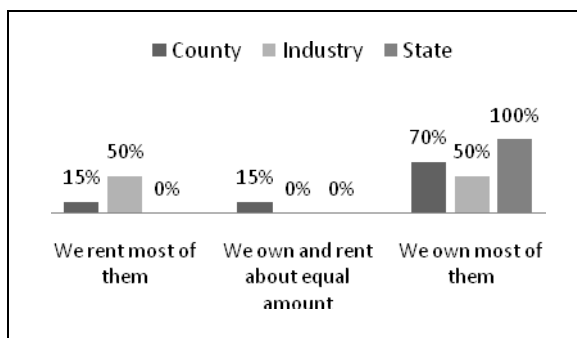


Figure 0-4 Office premises

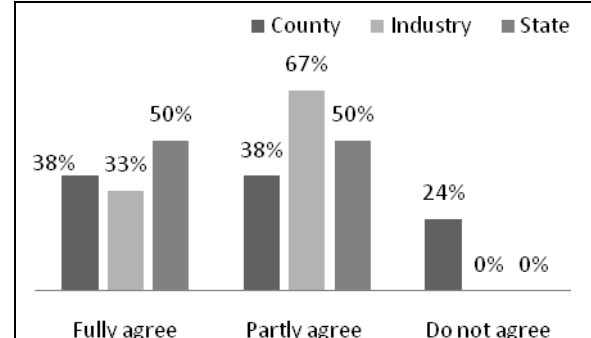


Figure 0-8 Ownership provides opportunity to open the management to competition

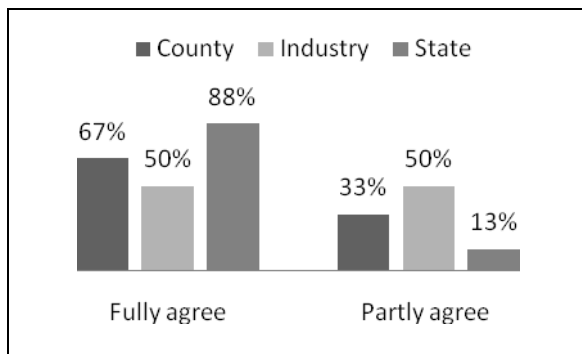


Figure 0-9 Ownership provides access to important property related information

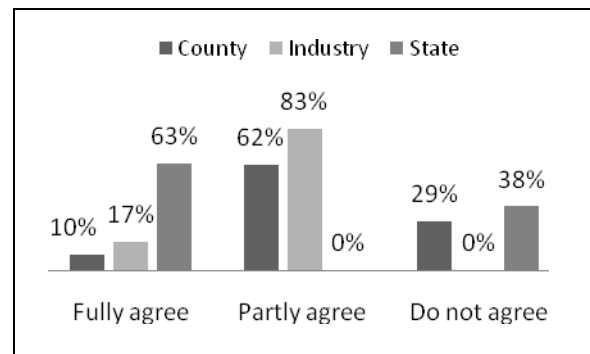


Figure 0-13: Leasing provides the opportunity for the company to focus on core business

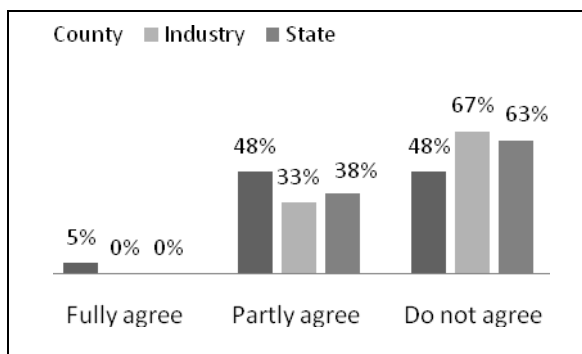


Figure 0-10: Leasing provides lower costs

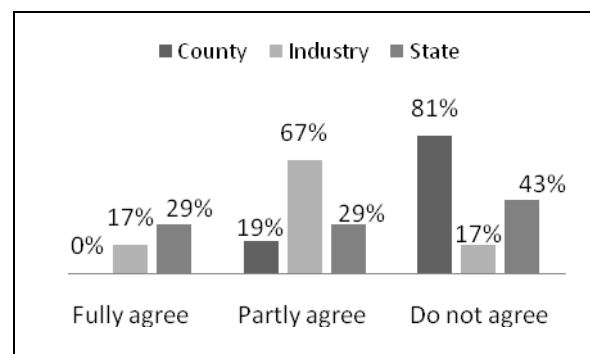


Figure 0-14: Those that are responsible for the different operations have greater freedom to acquire and adjust the premises to their needs

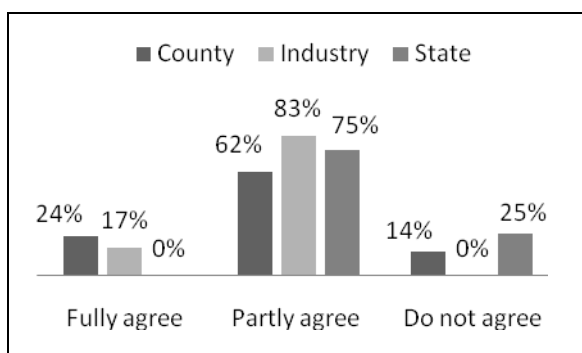


Figure 0-11: Leasing provides lower risks due to market changes

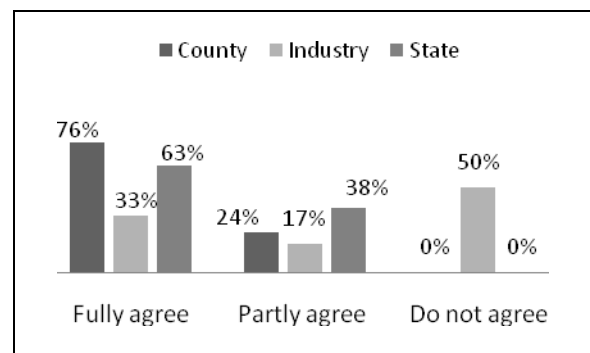


Figure 0-15: A detailed centrally determined policy regulates property related responsibilities

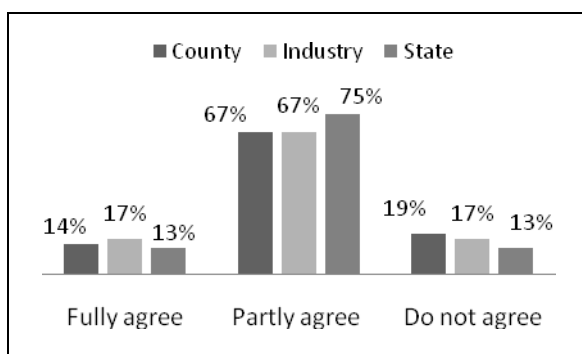


Figure 0-12: Leasing provides flexibility in relation to costs for the premises

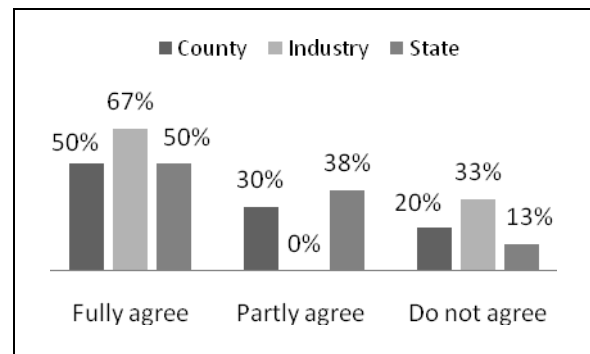


Figure 0-16 Questions concerning properties and premises are represented in the company's top management

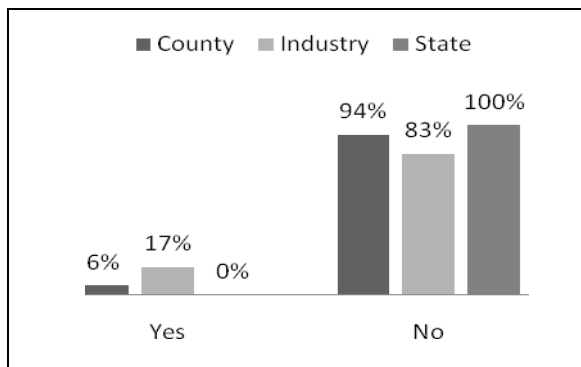


Figure 0-17 Company only leases its operation premises

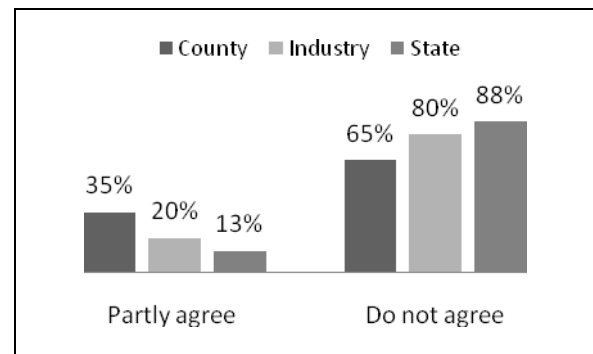


Figure 0-21 The company's economical situation and budget determine what is classified as investments or maintenance

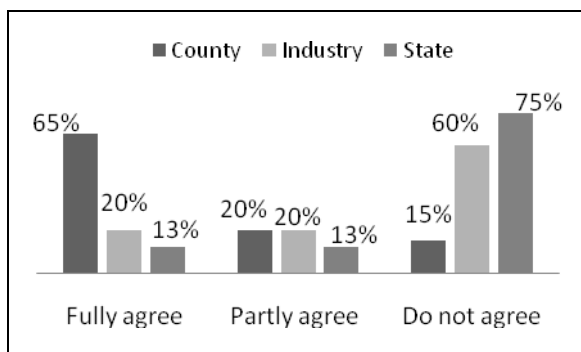


Figure 0-18 The company has a subsidiary/separate division from which other departments lease their premises

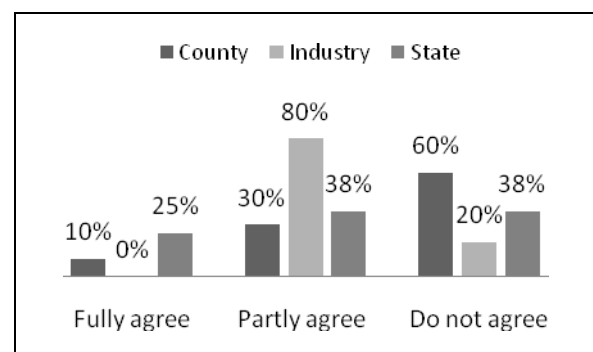


Figure 0-22 The size of the activity determines the classification

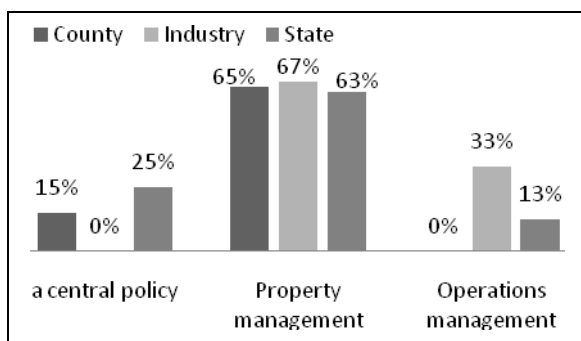


Figure 0-19 Who determines the choice between in-house and external providers

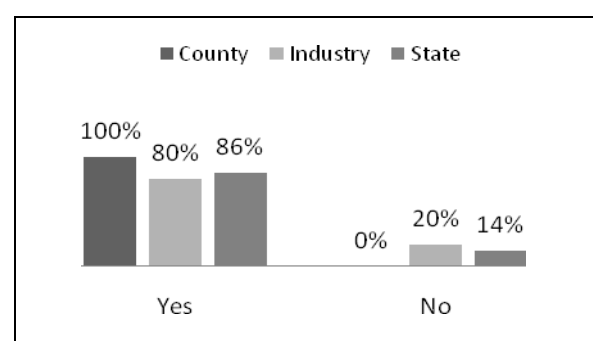


Figure 0-23 The company demarcates between planned and immediate (acute) maintenance

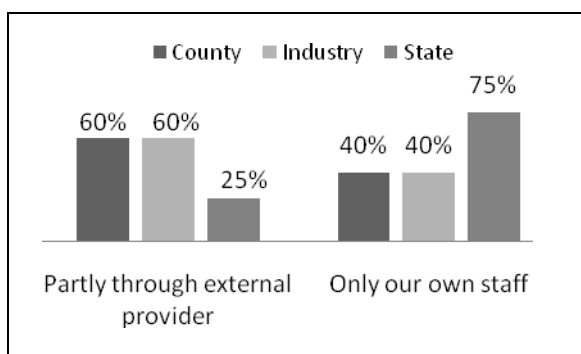


Figure 0-20 The way the operation of the premises is managed

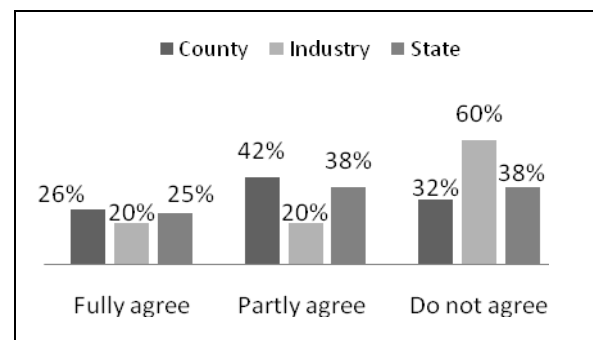


Figure 0-24 The cost determines the classification between operation or maintenance

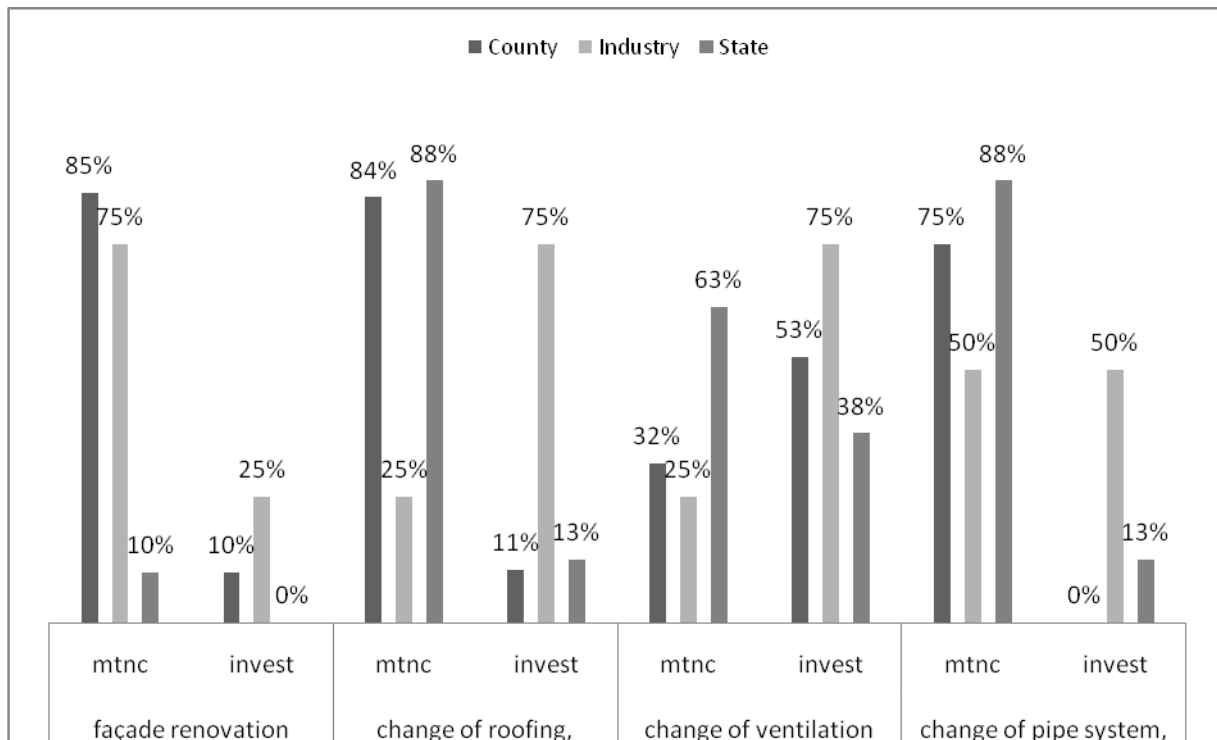


Figure 0-25 Classification of different activities as maintenance or investment across the activities

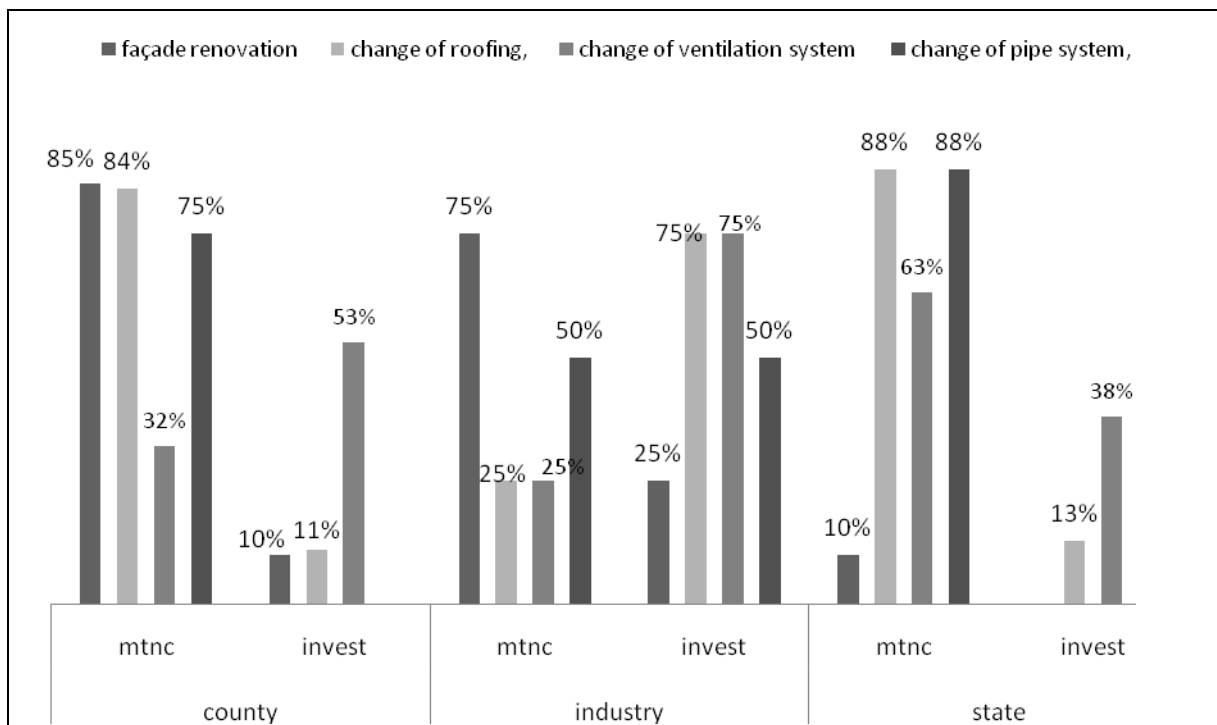


Figure 0-26 Classification of different activities across the categories

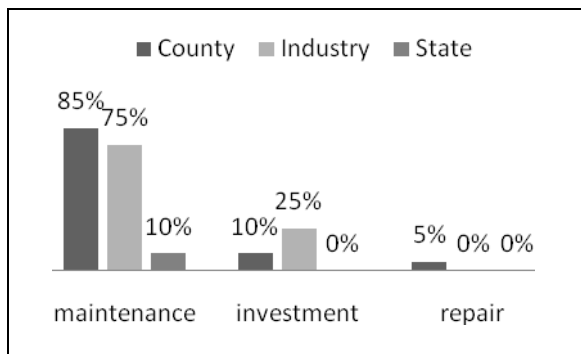


Figure 0-27 Classifying façade renovation

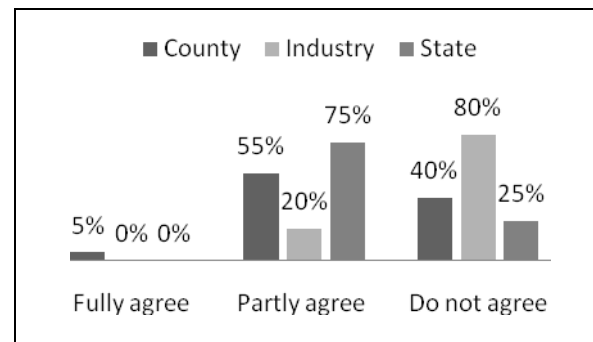


Figure 0-31 Immediate maintenance is often higher than budgeted for

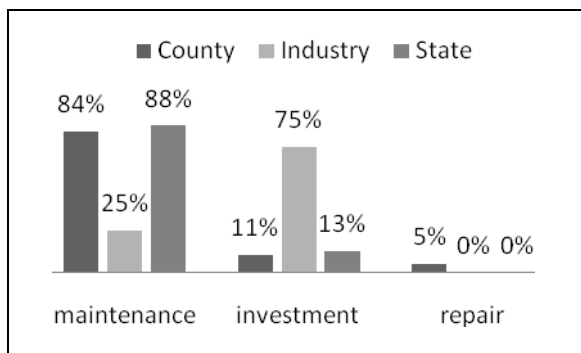


Figure 0-28 Classifying change of roofing,

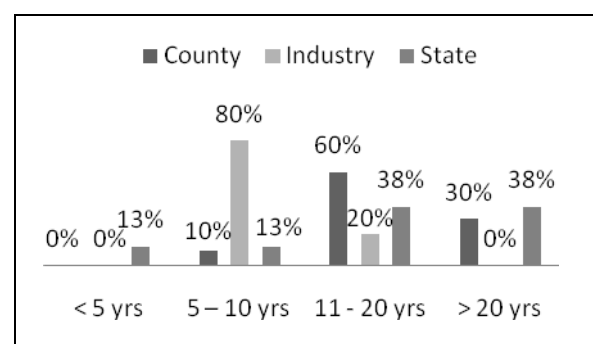


Figure 0-32 Break even duration used in the calculation when large scale renovations and/or reinvestments are carried out

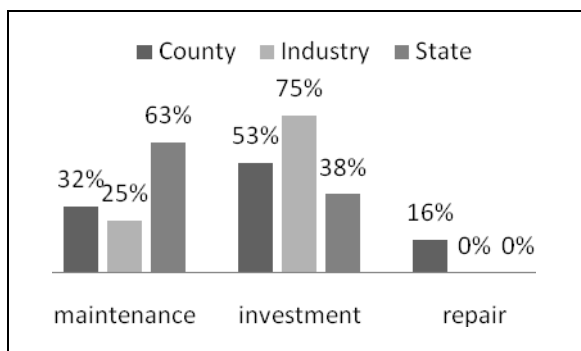


Figure 0-29 Classifying change of ventilation system

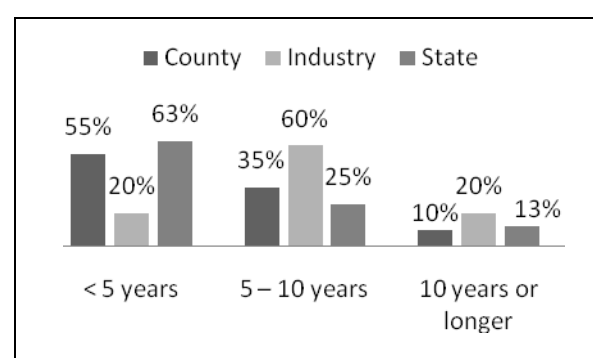


Figure 0-33 Period covered by the company's general maintenance plan

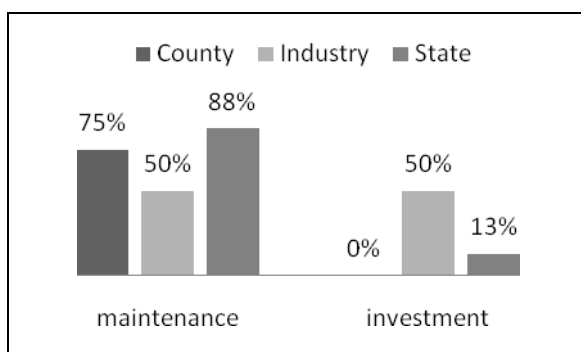


Figure 0-30 Classifying change of pipe system

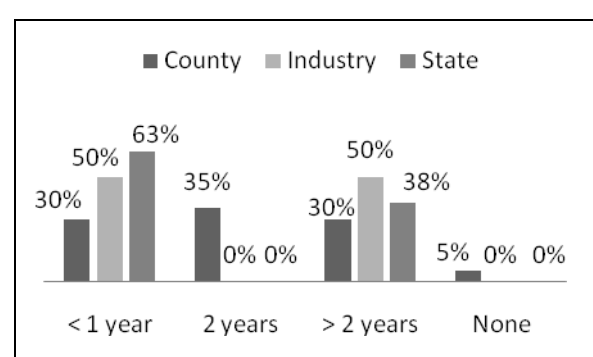


Figure 0-34 The period covered by the detailed short term maintenance plans

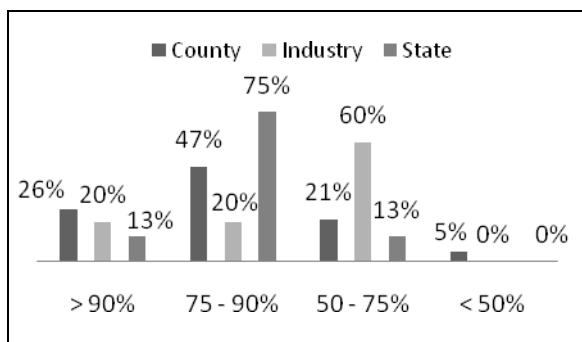


Figure 0-35 Approximate percentage of activities in 2008 that were part of the maintenance plan done in 2007

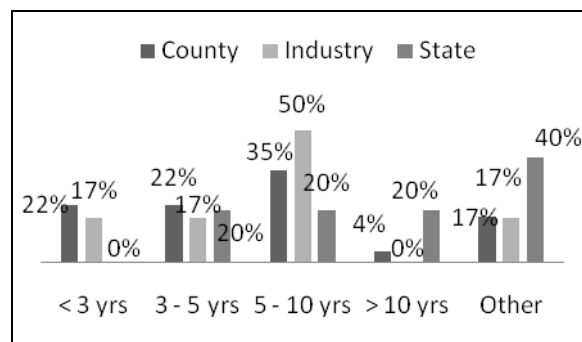


Figure 0-39 The usual duration for the leases of the rented operation premises

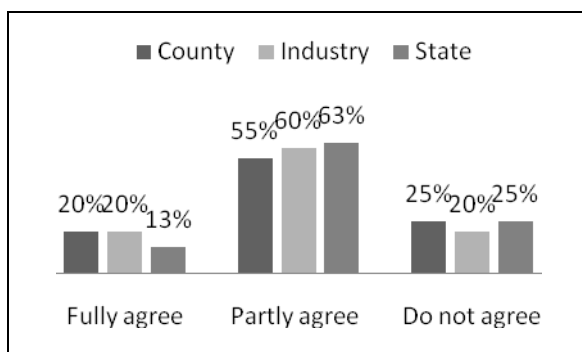


Figure 0-36 Maintenance costs have increased in the past five years because of new environmental regulations and a prioritising of energy saving.

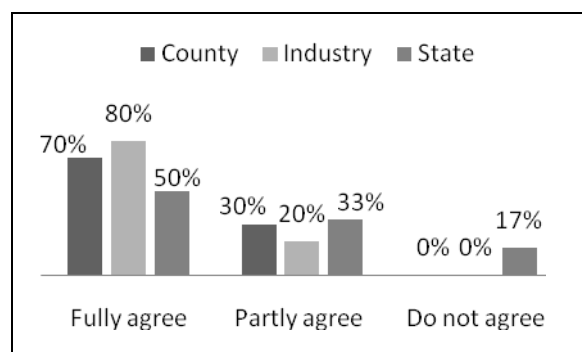


Figure 0-40 The company has a clear policy on who does what in relation to the leased premises

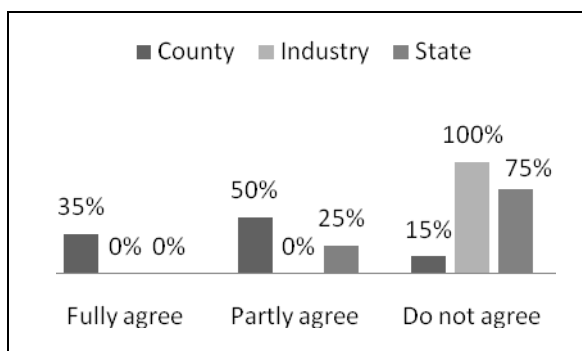


Figure 0-37 There is a lot of neglected maintenance in the properties in the company

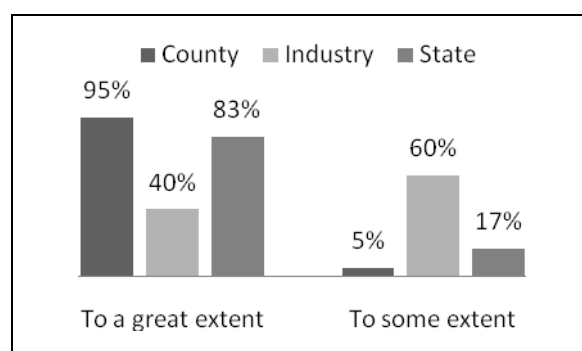


Figure 0-41 Standard contracts are used when renting premises

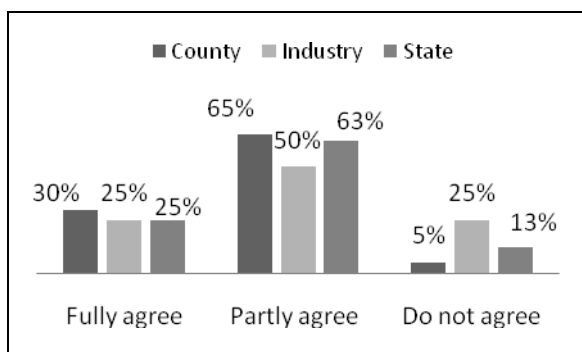


Figure 0-38 There is a lot of neglected maintenance in the properties in most of the companies in the branch

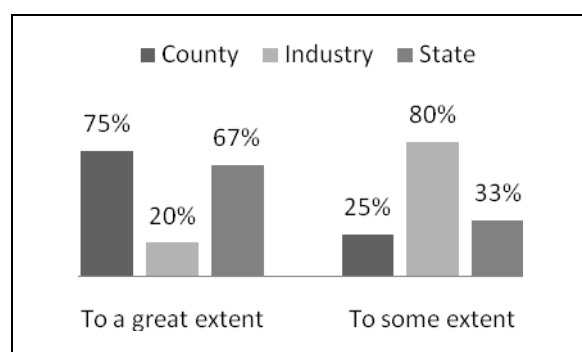


Figure 0-42 Standardised lists are used when demarcating responsibilities/liabilities



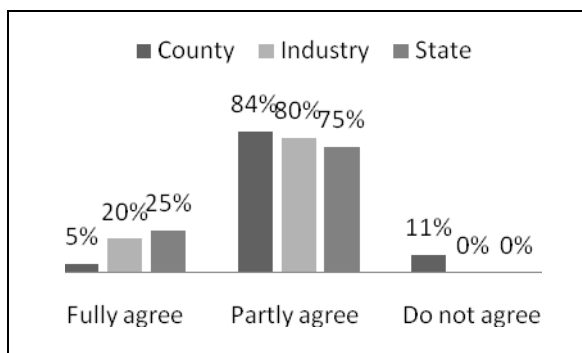


Figure 0-43 The most important factor about external providers is their specialised competence

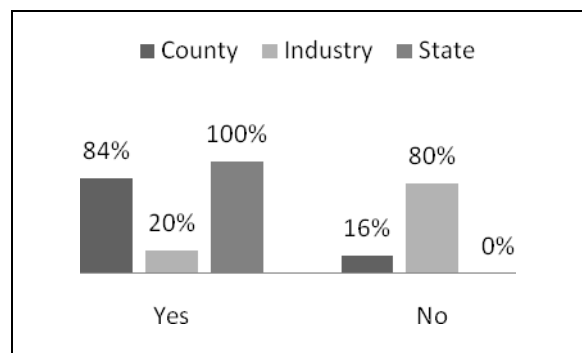


Figure 0-47 heating is included in rent

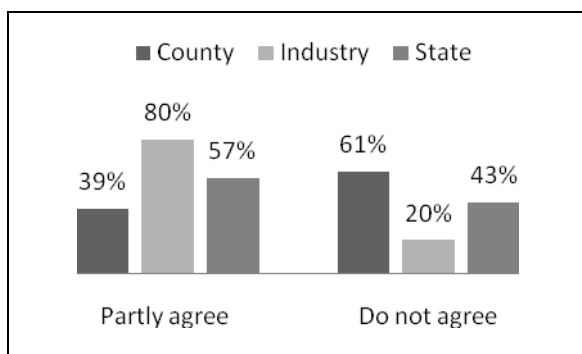


Figure 0-44 The choice of a particular landlord depends greatly on a number of support services being available under same provider

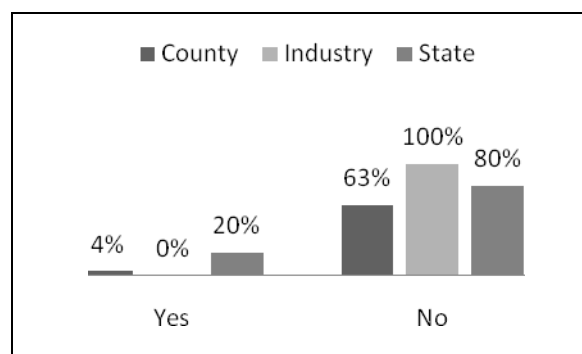


Figure 0-48 electricity is included in rent

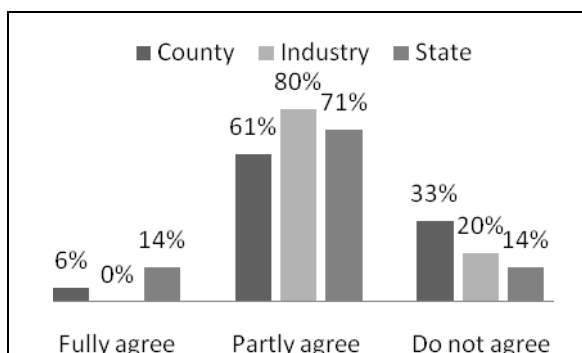


Figure 0-45 The cost level affects how satisfied we are with the cooperation.

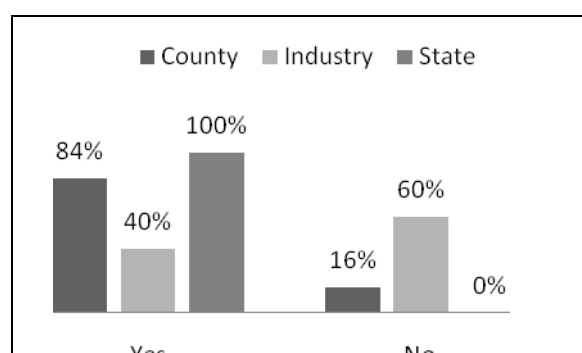


Figure 0-49 water is included in rent

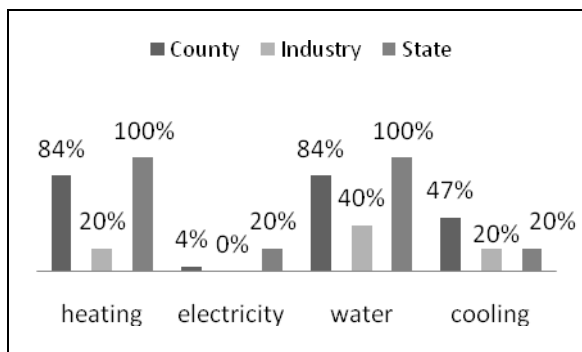


Figure 0-46 Agreement that utilities are included in the lease rent

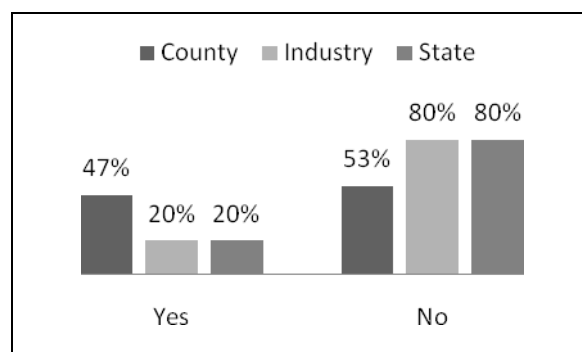


Figure 0-50 Cooling is included in rent

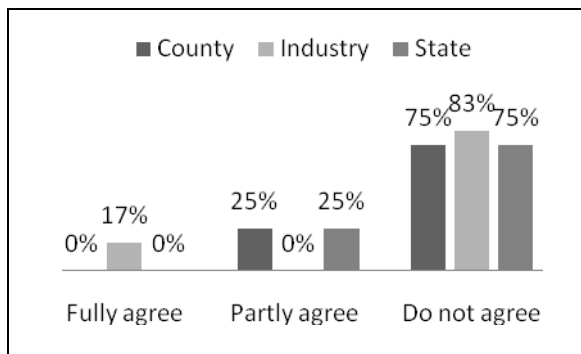


Figure 0-51 In 5 years time we will have a lower proportion of special purpose premises

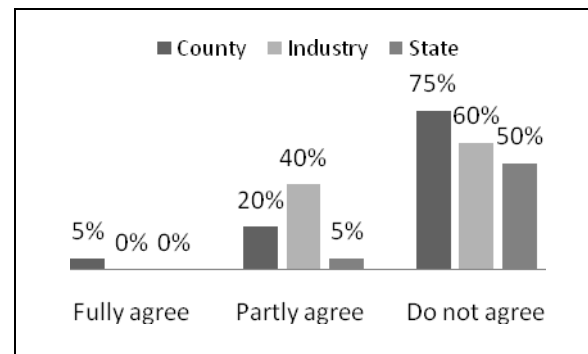


Figure 0-54 In 5 years time we will have longer durations on the premises we rent

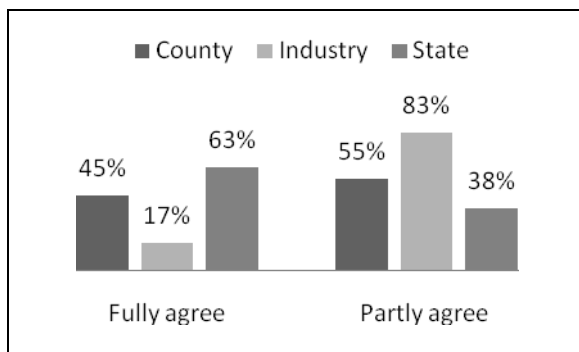


Figure 0-52 In the future, premises are going to be more flexible

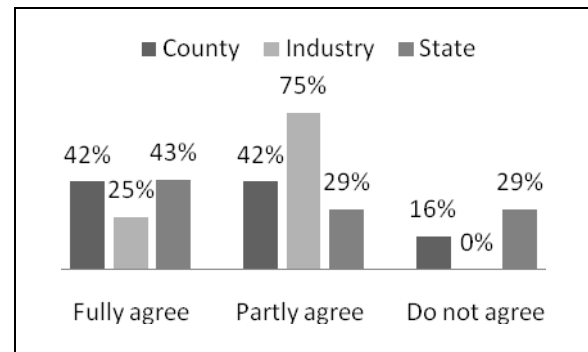


Figure 0-55 It would be good with more participants in the market in order to raise competition

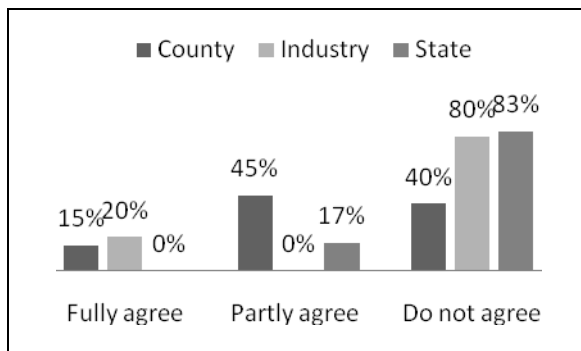


Figure 0-53 In 5 years time we will be leasing more

## Appendix 3: Classification of activities by the companies<sup>4</sup>

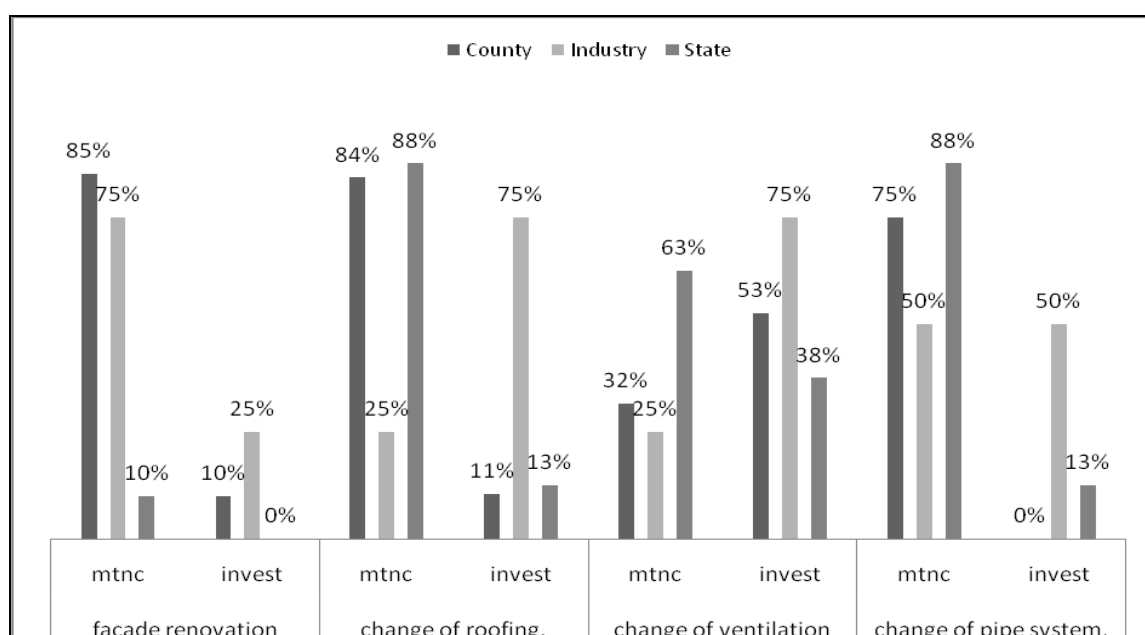


Figure 1 Classification of different activities as maintenance or investment across the activities

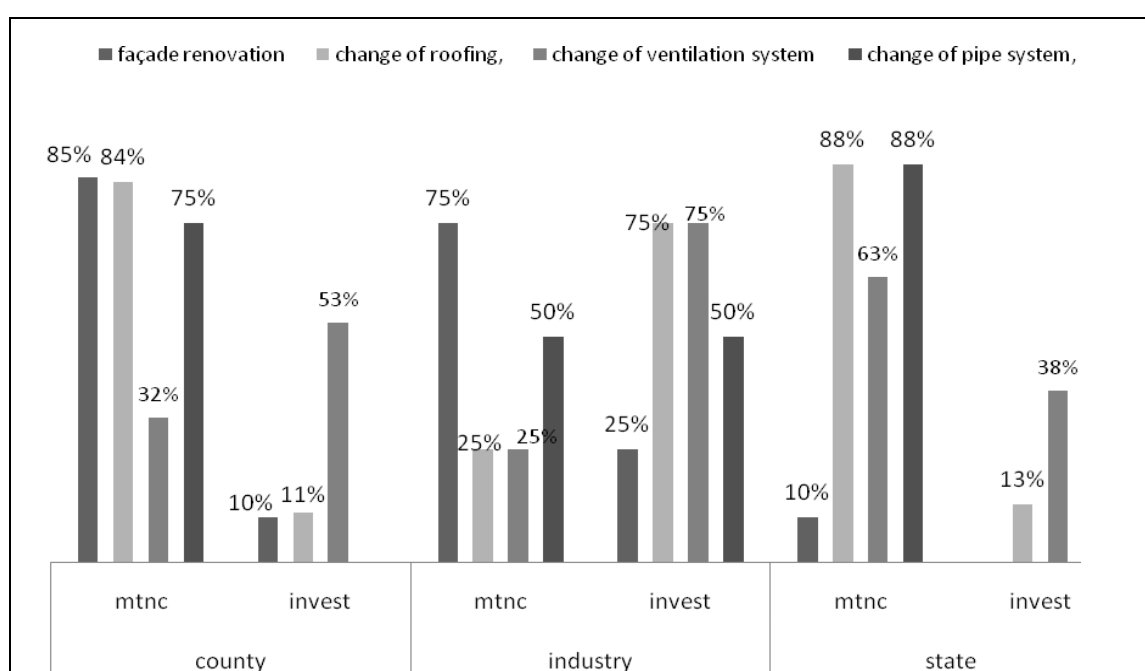


Figure 2 Classification of different activities across the categories

<sup>4</sup> Classification as repair was often 0 % and was dropped from the diagrams for clarity.

## Appendix 4: Summary of literature mentioned

Author	Title	Comment
Allard and Holmquist (2003)	Fastigheter i industriföretag – äga eller hyra	MSc Thesis studying decision to own or rent in 8 international companies in Sweden Presents strategies on the maintenance of public properties.
Bejrums H (1999)	Se om sitt hus. Strategi för underhåll av offentliga fastigheter	Questionnaire response from 285 municipal companies + 4 sale lease back case studies
Brunes and Lind (2008)	Äga eller hyra verksamhetslokaler? Strategier för konsekvensbedömning och beslut	Analyses country differences in support services outsourcing. In-depth interviews of 6 companies .
Bröchner et al (2002)	Outsourcing facilities management in the process industry: A comparison of Swedish and UK patterns	Analyses benefits and problems of REP. In-depth interviews of 10 companies.
Dixon and Pottinger (2006)	Lessons from real estate partnerships in UK. Drivers, barriers and critical success factors	Analyses effect of colocation in public buildings of non government parties. RICS Report
French et al (2002)	Whose property is it anyway? A review of the use of local authority property by third parties	
Gibson (1994)	Strategic Property Management - How Can Local Authorities Develop a Property Strategy	Instructive paper on developing a property strategy Descriptive paper that analyses reforms in public sector real estate.
Lind and Lindqvist (2005)	Real estate management in the Swedish public sector	MSc thesis work with comparisons of facilities management in Finnish municipal councils and 6 other countries
Lindholm (2004)	Public facilities management services in local government - international experiences	
Lundström (2000)	Fastighetsföretagets organisation – Valet mellan egen regi och entreprenad	Course literature in corporate property management
Kadefors and Bröchner, (2004)	Building users, owners and service providers: new relations and their effects	Descriptive paper that discusses consequences and decision processes
Roulac et al, (2004)	Corporate strategic decision making - A comparative analysis of companies in the industrial and non-industrial sectors	Empirical study on CREM. 27 in-depth interviews of 11 industrial and 16 non-industrial companies Descriptive report on what public authorities can learn from industrial property management. In-depth interviews of 9 large industrial companies in Sweden
Sundsvik and Jändel, (1997)	Näringslivets fastighetsstrategier.	Review paper on models applicable to ownership of operational property and reasons behind each.
Tipping and Bullard, (2007)	Sale-and-leaseback as a British real estate mode	