Evaluating a transport relationship using agency theory

Bente M. Flygansvær (bente.flygansvaer@bi.no), Eirill Bø
BI Norwegian Business School

Abstract
Uncertainties in the performance of transport operations will drive forth different contract types, such as outcome and behaviour based contracts. This paper use agency-theory to understand which type of contract should be implemented in a transport buyer and service provider relationship. In particular we link the contracts to transport price formats. In order to increase efficiency in transport buyer and service provider relationships, we argue that the contracts need to be developed in a collaborative manner. Our empirical data is taken from a case study of collection of waste in two Norwegian municipalities.

Keywords: Transportation contract, agency theory, waste collection

Introduction
Taking care of the environment is becoming a necessary part of business practices in all types of industries. Waste management is one area that has grown significantly within this landscape of sustainable development. To collect products at end-of-life in order to reuse the resources is becoming a significant business, both because of laws that are restricting landfill and requiring alternative handling of waste, and secondly because these resources are becoming attractive products. The concept of urban mining reflects that minerals are extracted from used products at end-of-life in urban areas as well as from natural ores in mines.

The consequence of waste management is that reverse logistics is increasing in scope and scale. The fact that products are moved from landfill solutions to recycling solutions means different type of logistics, including different type of actors involved in the logistics and different types of activities performed. For example, the sorting of waste has demanded changes in the collection systems in number and types of bins, the manner in which transport is organized, the type of vehicles used and how deliveries are supplied to secondary markets. Planning and operating an unsorted waste system is very different compared to waste systems with sorting.

Municipalities increasingly outsource collection of household waste to environmental service providers. Thus, when waste categories increase due to sorting, the challenge of transport planning will also increase. Following from these changes, the municipalities face a higher level of complexity in formulating the contracts with the environmental service providers. The risk is that cost could explode corresponding with the increased complexity in waste products following from the increased level of sorting. In this paper we will therefore draw on agency theory and the relationship between the municipalities as the principal and the environmental service provider as the agent in order to evaluate whether the contracts implemented are efficient. We also draw on
the transport buyer and supplier literature, covering types of contracts used in this area, models for pricing services and collaborative behaviour.

The paper continues first with the literature review. Secondly, we present the empirical study, and the data collected. This is followed by an analysis and the paper is then concluded with a discussion of the findings and suggestions for further research.

**Literature review**

Agency theory explains how work effectively can be divided between two independent actors where specialization benefits are available (Fama and Jensen 1983). This is referred to as the principal-agent relationship, and the focus is to understand how the partners to the relationship can set up a contract to share risks between them (Eisenhardt 1989, Bergen et al. 1992). Thus, there is a hierarchy between the actors, where the one (principal) has the work description and delegate this to the other (agent) who actually performs the task at hand. This work division is the source of the agency problem, because the principal first has a challenge in finding the best agent and secondly making sure that the agent is performing the delegated task satisfactory. Knowing this, the agent may take advantage of the situation in two ways. First the agent may hide information before (ex ante) signing the contract, concealing his or hers real intentions towards the principal. Secondly, the agent may hide his or her action after (ex post) signing the contract and disguising his or her effort for the principal. The principal therefore have to take measures in coping with this asymmetric information.

In our study we are concerned with the ex post situation, where the principal is facing the cost of monitoring (to control whether the agent is cheating) and free riding (to control whether the agent is shirking). Thus, adapting the contract design to the risk situation is how to solve these issues according to agency theory. In an outcome-based contract, the risk of the behaviour is left to the agent, who will be rewarded according to the outcome of the action. This type of contract is relevant when it is difficult for the principal to observe the behaviour of the agent. Alternatively, if it is possible for the principal to observe the behaviour of the agent, a behaviour-based contract is a better adaptation. The agent is then rewarded based on his or her action.

The relationship between a transport buyer and provider can be characterized as an agency relationship (Logan 2000). In particular, Logan (2000) argues that agency theory help answering two questions (1) what the buyer can do to encourage quality service and fair treatment by the provider, and (2) what the provider can do to keep the buyer satisfied and at the same time reach its own outcome goals (p.27). In particular, she identifies types of mechanisms between the transport provider and transport buyer that could be implemented to simulate outcome and behaviour based contracts. However, as in accordance with the agency theory the risk is shifted to the provider in an outcome based contract, and in behaviour based contracts the risk is shifted to the buyer (Logan 2000, Eisenhardt 1989, Bergen et al. 1992).

Uncertainties tied to a transport operation are many, and contribute to the information asymmetry between the transport buyer and provider. The mechanisms put to play in the relationship to cope with these uncertainties will determine the contracts’ success. A classic mechanism in the transport buyer and provider relationship is the price format of the transport operation. Logan (2000) discusses how transport traditionally has been outcome based, where a delivery have been compensated with a fixed rate. However, she also points to the fact that a transport contract may be behaviour based, if a provider is compensated for a unit price according to driven length, cubic loaded, time spent for driving, loading and unloading. In line with agency theory, the need for information and risk taking is different across these price formats. In a fixed
rate situation, the risk is high for the transport buyer and low for the transport provider, and the need for information is low for the provider and high for the buyer. As an example for the price per trip format, the consequence of a low fill rate will influence the buyer, because it means a high transport cost per unit. For the provider, it does not matter when they get the trip covered, because they get paid regardless of how much load the truck has. It is important for the buyer to continuously measure the fill rate and calculate the real cost per bin. In a price per unit, the situation is reversed. The per unit price format, leaves the risk high for the provider and low for the buyer, and need for information is high for the provider and low for the buyer. As an example for the price per bin format, the consequence of a low fill rate will influence the provider, because a low fill rate means a low income per trip. They need to be sure that the number of bins calculated in the price per bin is correct. If they calculate with more bins on a trip than they actually fulfils they will loose money. The figure below taken from Brynhildsvoll (2011) illustrates the relationship between price format, the division of risk, and the need for information.

![Figure 1: Model showing price formats with different risk profiles](image)

In most agency models the efficiency is evaluated from the principal point of view (Bergen et al. 1992). However, the model of price formats as discussed above also illustrates that the two situations of outcome and behaviour based contracts is trading off advantages between the transport buyer and provider. Either it is the buyer that has high risk, and a need to collect information, or it is the transport provider. These features of a relationship are typically recognizable in what is called the arms-length relationship type (Hoyt and Huq 2000, Crèmer 1995). In an arms-length relationship the output is viewed as given, and gains on the one negotiating partner is typically achieved at the loss of the other partner. Hammervoll and Bø (2010) states that the typical way to work with transport service providers is in an arms length relationship, where there is no particular interaction between buyer and provider, and the price is used as the communication platform. This is in accordance with the classical market thinking,
where transactions are conducted ‘sharp in by clear agreement and sharp out by clear performance’ (MacNeil 1974).

However, there are also uncertainties in the transport buyer and provider relationship that is not ‘hidden behaviour’ as such but based on changes in circumstances, assumptions or the situation. One such situation could be cost of fuel, which is dependent on exogenous factors. Rather than being stuck with a contract that is obviously damaging to the relationship, both the buyer and the provider would have an advantage in an increased level of collaboration (Hammervoll and Bø 2010, Logan 2000). A collaborative relationship is where there is a high level of interaction between a buyer and a provider, and typically it will move the relationship from a situation with asymmetric information to a situation with a higher level of symmetric information. However, it is not straight forward to secure collaboration in a relationship, and Hammervoll and Bø (2010) argue that overcoming the transparency problem is an important prerequisite to a collaborative transportation arrangement. The transparency problem is argued to be overcome by communication and trust, and Hammervoll and Bø (2010) find that a decision support tool (a spreadsheet) where the transport agreement is monitored is effective in doing so. Thus, the transport operation is dependent on some form of documentation to secure the necessary level of information for both the principal and the agent.

In this paper we address the fact that a contract in a transport buyer and supplier relationship can have different risk profiles, but that this risk profile will not be static over the contract duration period. The relationship will therefore be characterised with a win-loose profile, if the typical agency theory outcome and behaviour based contracts are implemented. Such situations can easily strain relationships, which in worst case can result in bankruptcy. However, if the contract is given a collaborative based profile, the risk will be balanced in the transport buyer and provider relationship over the contract duration period. The advantage is a higher level of satisfaction in the relationship, and a viable business operation for the future.

**Empirical study**

The study is based on a project conducted to evaluate the transport effectiveness in collection systems in Norway (Bø et al. 2012). The data for this paper is taken from this project, and includes two cases. In both cases the transport function is outsourced, and the transport buyer - provider relationship have demonstrated change over the contract duration period. The case study is considered as a relevant method, as we study a contemporary phenomenon in its real life context (Yin 2003, Eisenhardt 1989).

The cases are taken from the context of collection systems for household waste in Norway, and limited to kerbside systems. In Norway, municipalities have responsibility for household waste, and decide on type of collection system for their inhabitants within their jurisdiction. Accordingly, the choice of systems varies between municipalities. Our choice of cases is two municipalities, referred to as Case A and Case B. In both cases there is a relationship between the municipalities as a buyer of transportation services and an environmental service provider. The municipalities developed a transport specification, and the service provider have tendered for the transport contract according to this specification. Below we describe the cases in further detail, and perform an analysis of the cases according to risk and price format. The cases are analysed using a transport calculation model.

In case A the collection is based on a system of four bins, and constitutes four fractions. This means that the waste is sorted in one bin for food waste, one bin for residual waste, one bin for paper waste, and one bin for plastic waste. The collection is outsourced to an environmental
service provider who is responsible for physical collection of waste from households. The service provider uses a waste compression truck which runs on biogas. The trucks are two-chamber, and divided in order for one chamber takes food waste (30%) and the other takes residual waste (70%). Residual and food waste are collected every two weeks, while paper and plastic waste is collected every third week, using the same trucks, with expected 70% paper and 30% plastic. The routes are planned according to capacity, and the trucks run until they are filled. The waste is delivered to four locations, one for each type.

In case B the collection system is based on a dual bin system, and is a mix of the systems of separate and optical sorting. The waste is sorted in four fractions, of which three are subject to optical sorting. The three coloured waste bags are sorted in one bin, and the second bin is for paper waste. The types of fractions are food, plastic and residual waste sorted into the waste bags, and paper is sorted directly into the bin without any colour coded bag. The collection is outsourced to environmental service providers. The municipality is divided into four different waste areas, and two service providers share the areas between them. Both companies are using waste compressing trucks which run on biogas. The trucks are adapted to the type of bins or containers, and have one chamber. The waste is co-collected in the same transport, but with a reduced compression level in order to not break the waste bags. The waste is delivered to a sorting facility where the waste bags are separated before they are transported further to separate reprocessing.

Analysis

In both cases the municipalities (the principal) have agreed on a fixed price per bin as a transportation fee to the service provider (the agent). Our assumption is that it is possible to calculate the cost per kilometre and further calculate a trip price, and the most important factor in both cases is how many bins you can pick up on one trip, the fill rate (Rushton et al. 2006). In both cases there were uncertainties concerning the fill rate. In neither of the cases did they know the exact volume of waste from each household each week. In addition, there is seasonality at play (variation in volume over time), for example there is low volume in the summer time due to holiday season (when people are travelling), and high volume in Christmas time (when people increase their consumption). The volume is also characterized with a downward trend, as there is continuous focus on waste reduction e.g. packaging, food. Our example will demonstrate that a full truck can consist of 800 bins one week, and 1100 another week. It is not expected that there will be a similar trip each week. As the number of bins will vary (due to variation in volume), it follows that the distance will vary. The truck driver then has to drive to the location of delivery when the truck is full, and the distance and hence cost will vary for every trip. The question in our cases is whether the assumed fill rates were correct and under what circumstances they could be different.

In case A they used a two chamber truck based on the assumption that the amount of waste had a spilt of 70/30 % (residual/food and paper/plastic respectively). They had no experience with volume and compression levels prior to the contract period. Therefore, the fill rates had to be estimated and the transport fee per bin was calculated based on this assumption. The municipality assumed that it was possible to fill the truck with 550 bins of each waste types, which meant 1100 bins on each trip. An important uncertainty was the volume of each waste type, and the compression levels. And, the experience demonstrated that food waste as an example had a lower compression levels than expected (food waste had higher water content than anticipated, and water is not possible to compress). The consequence in practice was that if the
chamber for food waste was filled before the chamber for residual waste the service provider had to drive to the location of delivery even if there was available capacity in the vehicle.

In case B they used a truck with on chamber and low compression because they combined three waste types in one bin (high compression can ruin the bags). They picked up residual, food and plastic waste all together in different coloured bags from the same bin, and had separate trips for collection of paper waste. They assumed a possible fill rate of 619 bins when they picked up the combined waste. In accordance with case A, this could also vary depending on volume delivered, and the fill rate would be different for each trip.

The question is what kind of contract to choose under these circumstances, as the uncertainty will influence the risk. Both municipalities decided on an outcome based contract with a price format per bin. The risk is thus placed with the service provider. To demonstrate the effect in our cases for such contracts, we have made an illustration with simulation taken from case A. The cost per kilometre including profit was 60.2 NOK. The cost for a specific trip (based on the 550 households) is calculated to 107 kilometres * 60.2 NOK/km = 6.439 NOK. In this contract the municipality paid the service provider per bin so the cost per bin was set to 6439 NOK / 1100 bins = 5.85 NOK/bin. If number of bins decreased due to the mentioned uncertainties, for example to 800 bins, the real cost per bin would be 7.08 NOK, a cost increase of 21%. With the outcome based contract, the risk is left with the service provider. If they calculate the price per trip with a higher number of bins than collected, this will provide a financial loss; in this example at 21%. This is shown in figure 2 below.

![Figure 2: The relationship between transport cost and number of bins per trip](image)

A behaviour based contract on the other hand, would pay 6439 NOK per trip, independently of the fill rate. For the service provider this is a low risk arrangement. However, the principal would incur an unnecessary high cost per bin.

**Discussion**

The risk in a transport agreement is for the buyer (principal) to pay a premium price and for the service provider (agent) to incur financial losses. In agency theory, it is assumed that the risk
The profile is different for the principal compared to the agent (Eisenhardt 1989). The principal is assumed to have a risk neutral position, whereas the agent is assumed to be risk averse. Following this argument in our transport buyer and supplier relationship we may confirm these positions. The goal for both municipalities was to pay a price that covered the actual cost including a decent profit to the environmental service provider. The environmental service provider on the other hand, wants to prevent any financial losses, but still seek to possibilities for a premium profit.

In a transport buyer and provider relationship like discussed in this paper, there will be a selection of risk. We have discussed the price format. The first risk is to calculate a correct price, and a second risk is the variation in the transport arrangement that will influence the cost level. Our paper demonstrate that the two contract types like behaviour based and outcome based contracts shifts the risks between the two parties. The challenge of asymmetric information comes into play (Bergen et al. 1992). Thus, there will be a possibility for the partners to exploit the situation to their advantage, which may be detrimental to the relationship. It is therefore our argument that the transport buyer and service provider need to take steps to introduce a mechanism in the relationship that levels out the sharing of information to secure symmetry. Typically in transportation, such reduction of risk involves measuring input variables that are essential for the transport cost, like number of kilometres and how many bins per trip. Such measures will typically vary during a year. To do this properly, the service provider needs to invest in an IT system with e.g. GPS and PDAs in the trucks. Using an information system it is easy to register number of kilometres per trip and how many bins. In case A and B they had no IT system to support their measurement. Thus, the necessary information had to be registered manually by the truck drivers. Such manual registration of transport data is in practice too challenging and time consuming.

We argue that a better solution than shifting risk back and forth between a transport buyer and supplier, is to establish a collaborative based contract. Such a contract is more transparent, meaning that you need to calculate the cost of each trip every time. The contract will then be based on flexible pricing. This means that the service provider needs to register each trip with the number of kilometres and bins. A contract like this is based on trust between the transport buyer and the service provider, where a well developed information system will encourage transparency and reduce risk (Hammervoll and Bø 2010). We conclude our argument by combining the contract types and price formats in figure 3 below.
Future research and limitations

Several suggestions for future research arise from the present study. First, further detailing of transportation contracts with different risk profiles is apparent. There are a number of risk factors involved in planning a transportation operation, and understanding how this impact a transport buyer and provider relationship is of vital importance. Especially, one of the most important risk factor in transportation contracts is fill rates. There is clearly a need for better measures of transport and to establish routines that automatically feed such information into IT systems. Secondly there is a need for a more transparent detailed cost calculation, including fixed and variable cost and a picture of all the time processes multiplied with the driver salary. Thirdly there is a need for technology and tools for measurements, the effect of an IT system should be considered in the future.

An acknowledged limitation of this study is that it is focused on only two cases. Nevertheless it is likely to believe that other transport buyer- provider relationships will experience similar contract considerations.

Bibliography


