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Perspectives of Stakeholders on Road Procurements

In search of Procurement Aspects using Q Methodology

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Abstract—Nowadays much emphasis is given to innovative procurement in the road construction sector. However, typical discussions about it do not focus on all the stakeholders involved in the process and all aspects. However, one cannot forget that procurement is a complex system, and everyone's perspective is important for success. This paper looks at the worldviews of stakeholders in the road construction industry. The Q methodology is used to analyse the subjectivity of the worldviews. As a result, it is possible to look deeper into the perspectives and to see what each stakeholder sees as most important, and also to compare different worldviews among stakeholders.

Keywords—road procurement, Q methodology, complex adaptive system, stakeholders

I. INTRODUCTION

There is a problem in the road construction sector. And that problem is that the amount of innovation is extremely low [1]. As a consequence, productivity is relatively low as well. The source of the problem comes from a particular market structure in the sector, with only a few procuring partners or stakeholders. The low number of buyers and suppliers has led to a struggle in how to modernise the road construction sector. That question – how do we modernise so that we get the right things? – points out a form of failure, where the buying client becomes responsible for what is delivered, and suppliers are limited in their liberty to innovate.

In order to fix this problem, innovative procurement is recommended [2]. This would give the chance for all parties to offer their best solutions without creating a blockage for innovation. Hence, the buying client stops being the only stakeholder who owns the risks and the suppliers can provide offers with innovation.

To achieve this, one needs to see the procurement process as a system with many stakeholders. But the discussion on procurement in the public sector is often seen from the point of view of the government. In this research, we explore the different perspectives on procurement in the road sector. The empirical studies have been conducted using Q methodology to gain the opinions of the stakeholders in the road construction industry in Sweden about innovative procurement.

The results indicate that stakeholders have different perspectives on the aspects of procurement, such as costs, the amount of innovation, the procurement formal process, market balance and the characteristics of the road. It has been found that every stakeholder in road construction has its own different priorities that are more related to their position and role in the sector.

The rest of the paper is organised as follows: in Section 2, we provide a background on procurement in the road construction sector and why it can help increase innovation. Section 3 mentions some of the current examples of innovative procurement. It also lists the stakeholders that are related to procurement, while Section 4 describes different aspects of road procurement. In Section 5 we describe the Q methodology and its steps to obtain the perspectives of stakeholders on road procurement, and in Section 6 the results of the analysis are presented. Finally, we conclude the paper in Section 7.

II. BACKGROUND

Infrastructure for transportation is of high priority in most of the countries in the world. Infrastructure is a big part of goods logistics, contributes to economic growth, and improves living standards and people connectivity [3]. And infrastructure is not possible without a road construction and maintenance sector.

Road construction and maintenance are performed by a number of stakeholders with each having its own responsibilities and functions. The main stakeholder usually is considered to be a public road administration, which is a government organisation.

As a government representative, the road administration has the responsibility to improve the quality of the sector. This means that it has to be able to change itself, as well as to change other stakeholders in road construction and maintenance. One of the most effective tools to make sure that other stakeholders will change is public procurement [4].

Procurement is an act of buying a product, service or work. Currently, 15% to 20% of the GDP in most countries is obtained using procurement [5]. Government institutions have to use the procurement process if the required service is above a specific monetary value or threshold. In the road sector, this means that almost all need to be procured because the European Union defined the threshold as 134,000 EUR [6] when the average contract for the Swedish road administration is more than 10 million EUR [7].

The procurement process has several steps in it. It starts with defining the needs and developing technical and
functional specifications. Then the criteria for participation in bidding and award criteria are specified. Then the documents are published for the public. Companies who are interested can submit their offers or tenders. The tender that meets all the requirements and has the best offer based on the award criteria is awarded.

Today the major focus in procurement is on the process from the definition of the requirements to awarding the contract to the winning contractor at the end of the procurement service. However, this process functions in the context. And there is an interaction between the process and the context. The context changes depending on the outcome of the process. This is the second order effect that so far has not yet been very well studied.

Looking at procurement as a part of the context gives an opportunity for improving technologies and knowledge, to provide more space for innovation, and to help to develop the road construction industry. This vision produces new solutions and makes it possible to be more efficient.

The idea, which is proposed in this paper, is to look at road procurement from a point of a complex adaptive system. The complex adaptive system is a system that has [8]:

**Distributed control:** in a fully open system, the buyer controls the process. But in the road sector, there is a limited number of companies who could be interested. In research performed in Sweden, it was shown that the average number of successful bids for road contraction and maintenance is less than three for a procurement project [9]. This allows for construction companies to have at least part of the control in road procurement. This means that road procurement cannot be seen as a system that is controlled only by the road administration, but rather it is a system with distributed control.

**Mutual connectivity:** for proper functioning of road procurement it is important that the stakeholders are mutually connected and can relate with each other in their work. This means that road procurement is a system with a high level of connectivity.

**Co-evolution:** road procurement evolves together with stakeholders. The changes in the procurement process, changes in the market, and changes in materials and the construction process lead to a change in the road construction sector. The changes in the sector also affect stakeholders. And changes in stakeholders change the sector in turn.

The complex adaptive system is complex because it is based on dynamic networks of interactions and the combined output is larger than just the results of individual stakeholders. The complex adaptive system is adaptive because the behaviour within the system is not constant and it adjusts to the needs of stakeholders and also to events that happen in the system. And road procurement as the complex adaptive system cannot be looked only from the perspective of the road administration.

Seeing the road procurement as a complex adaptive system helps to overcome the shortcomings of seeing it only as a process outside the context, and it provides an opportunity to see a procurement as a part of a bigger system that can benefit long-term planning of the sector.

### III. Innovative Procurement

The Swedish Road Administration, similar to most of the other road administrations worldwide, is responsible for long-term infrastructure planning, considering the needs and available resources. In addition, according to their own statement, their purpose is to “increase productivity and innovation forces in the construction industry” [10]. And since they are the main and often the only client in the road sector, they have the tools to lead to this purpose – using innovative procurement. This approach requires that all the parties in the road construction sector take part in an innovation.

There is no one way of making an innovative procurement, and literature offers different ways of doing it [2].

One way is to use materials that are green. Green building materials are materials that reduce the amount of resources needed, reduce impacts from construction or demolition, and are durable or require low maintenance.

Another way is to give priority to more environment-friendly companies during the procurement awarding. However, this mechanism may make the procurement process less equal for all bidders because for a new or small company it will be harder to compete with bigger companies with high levels of sustainability.

One more option is to include life cycle assessment (LCA) as a part of the procurement process. This can be made by bidders as a part of the tender. It is the constructor’s task to make sure that every phase of the procurement is as sustainable as possible. However, this also creates a problem, because different tools can provide different results and lead to not awarding the best tender. Evaluation of the project can be done not only by contractors as part of their bid, but also by the consumer (road authority) as part of an evaluation. This approach works when the number of bidders is not very large.

Mainly the approaches are varied based on the amount of innovation, the tools to measure innovation and the party who is responsible for the innovation. The aspect of who is responsible usually is a hot topic for many solutions. This is due to the fact that any procurement process is a multi-stakeholder process, with typically 4-5 stakeholders.

The most obvious stakeholder is a **road administration**. It is the main consumer in road procurement. The road administration can be a local, state or federal organisation or its function can be distributed among several organisations. Typically, the road administration is responsible for the long-term planning of the transport system and is also responsible for building, operating and maintaining roads.

Besides the road authority, there are solution suppliers. But the supplier is more than one stakeholder, even if it is one organisation.

Consultants or **designers** work on developing road design based on the needs of the road authority. Based on environmental conditions, traffic intensity, design life, the budget and other criteria, pavement design is developed. This
phase allows a certain freedom for innovation, but at the same time all risks need to be evaluated, since the rest of the works rely on the work of this stakeholder.

**Material suppliers** provide the materials needed for construction. Although they do not necessarily become involved in the design or construction, they still can contribute to the innovation in several ways. The materials supplier can offer materials that are of a higher quality, that can be reusable without compromising other aspects or that have green labels. Also, they can invest in innovative materials themselves. Besides the materials themselves, the logistics of the materials is another area that can be improved.

**Construction companies** carry out the construction of the road infrastructure, steps like demolishing, preparatory work, putting all the layers, maintenance, etc. Construction work can have different performance results depending on the working plan, the machinery and tools used and the logistics solutions.

One more stakeholder that is less visible is **researchers**. Researchers can have a micro, midi or macro scope, but still they aim to help other stakeholders by improving the current or providing new materials, processes and knowledge.

IV. ASPECTS OF THE PROCUREMENT

The success of an innovative procurement is typically measured by the cost. This can be total cost savings, cost avoidance or return on investment (ROI) [11]. Some other indicators are used as well, although not as often.

In order to determine what aspects road procurement has, a literature review needs to be performed. Several sources have been analysed – documents related to procurement documents, tasks and visions of corporations, key performance indicators, and expert opinions. Based on the literature review results, a number of aspects were found. In addition, the aspects were sorted by frequency and importance. This led to omitting some of the aspects because they were not as common as others. In the end, 11 aspects were chosen for this paper, and each of them is described in more detail below.

**Innovation** is openness to new ideas, methods, materials and products. It is willingness to integrate high-quality research and education with current practices [12]. Although innovation is something that is encouraged by many, it can negatively affect other aspects because of lack of experience with handling innovative solutions.

**Cost** is the main objective of traditional procurement. Auction theory suggests that the winning bid should tend to approach the lowest possible procurement price [13]. Cost also includes cost overruns that occur due to uncertainty related to complex processes during a road’s lifetime [14].

Road **durability** is the ability of a road to withstand wear, pressure or damage. Durability is achieved mainly by using durable materials, but processes like maintenance can affect it as well [15].

**The environment** in this work is defined as the natural world or surroundings that are being affected by the road. This can include both global effects like global warming and local processes. The environment is also affected by the use of natural resources and raw materials. Based on the Commission of the European Communities, road procurement matches two sectors (transport services and construction) out of the 10 Green Public Procurement sectors that have the highest importance in terms of the scope for environmental improvement [16].

A **risk** is an event or a process that may have an impact on functionality or achievement of objectives. Such an impact can have both negative and positive outcomes [17]. However, we are limiting the risks to threats with negative effects. Risks in road procurement can occur at the procurement stage like malpractice or non-effective use of money, as well as risks related to the road.

**Market balance** is stability when there are enough companies that satisfy the demand. This allows new players, but the general structure does not change rapidly.

**Recycling** is a process of reusing, converting waste into reusable material. Recycling improves the LCA of the road and it allows for resources to be saved by using some parts of the current road structure for the new project.

**The procurement process** is a legal framework of obtaining equipment, materials or supplies. Usually, procurement is defined by the government and international organisations like the European Union [18]. The procurement process can vary in different organisations based on their objectives and best practices.

**Safety** is the condition of being protected from the dangers from road design, road construction processes and road users. Safety is important during the road construction for constructors and after for the users like drivers, passengers and pedestrians [19].

A **prediction** is an act of forecasting what might happen in the future. Prediction methods allow calculation of the load of a road for the road administration. They also allow calculation of the behaviour of road materials and its structure.

A **warranty** is a guarantee issued to the buyer promising that the quality of work satisfies the requirements. Typically it also states the penalties for not reaching the needed quality in the form of fees or replacing the service.

Despite the fact that procurement is a multi-stakeholder process with many aspects to it, currently, mainly all procurement frameworks focus only on the buyer (road administration). Some of the frameworks suggest to award winning contracts based on multi-aspect criteria. Nevertheless, in reality multi-aspect awarding criteria are not common due to the fact that often they are less transparent, and so most of the companies are still choosing to award the best contract based on only one aspect (usually cost) to avoid legal risks.

V. Q METHODOLOGY ANALYSIS

This paper aims to look at different aspects of road procurement from the viewpoint of the different stakeholders involved in this procurement.

Since the views of stakeholders are subjective, a method that deals with subjectivity or qualitative data is needed. One
such method is Q methodology [20]. The main purpose of this methodology is to study the subjectivity of viewpoints. It collects both qualitative and quantitative data and gives good results, even when based on a small data pool.

Q methodology is used to systematically study subjectivity, a person’s viewpoint, opinion, beliefs, attitude, etc. [21]. It is used in many fields, such as political and communication sciences, psychology, medicine, education and media, to name a few. Often it is done using the opinions of specialists in the specific field in order to understand their opinions better. Hence, Q methodology is well suited for investigating the subjectivity of road procurement.

The basic process of Q methodology starts with developing a set of statements or opinions on the topic of research. After, each participant sorts these statements based on how well he/she agrees or disagrees with each of the statements. The sort is saved and is analysed.

Typically, the Q methodology analysis divides the participants into factors (groups) and gives typical sorts of each of the factors. In this paper we keep the original groups, since we know to which stakeholder group each participant belongs. We also introduce a way to analyse this average sort in order to understand the procurement aspects better.

Each statement for this work is made based on two aspects. Since there are 110 combinations of two different aspects, the number of statements needs to be reduced. However, not all of the links exist in the system, so the total number can be reduced. The literature suggests having up to 50 statements so that it is easier to sort them. So, the statements that deal with links that do not exist in the system and some of the links that are already well researched in the literature are omitted from the final set. As a result, 43 statements are used.

Statements are defined mainly using the structure “Aspect A influences aspect B”; for example, “Green procurement leads to innovation” and “Warranty on a road reduces the costs over the road’s life cycle”. Some of the statements have a similar structure with extra aspects, like “Tenders should be awarded based on both projected costs and CO2 emissions”. These cases are combined with extra checking questions such as “Contracts should always be procured for the lowest costs”. There are some statements that offer similar opinions from different angles: “Changes in the market balance between the different major contractors are a risk for the Swedish Road Administration” and “Changes in the market balance between the different major contractors are a risk for contractors”.

The total number of times that each of the aspects is mentioned in the statements is shown in table 1.

### Table 1: Aspects with the number of statements in which each aspect occurs

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Number of statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation</td>
<td>14</td>
</tr>
<tr>
<td>Cost</td>
<td>11</td>
</tr>
<tr>
<td>Durability</td>
<td>9</td>
</tr>
<tr>
<td>Environment</td>
<td>7</td>
</tr>
</tbody>
</table>

During the experiment, the participants are required to place each statement into one of seven categories (strongly disagree/agree, disagree/agree, slightly disagree/agree, neutral). The number of statements that can be in each group is specified (forced-choice condition). In this way, the participants have to pay closer attention to the statements because decisions on their placement are very important due to the limitation of spots. The number of statements in each group (see figure 1) is similar to a normal distribution, but is more equalised to give more freedom for the participants to tell which statement is more or less important.

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Slightly disagree</th>
<th>Neutral</th>
<th>Slightly agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

*Fig. 1. Q sort response matrix*

Specialists from stakeholder groups were chosen. The main criterion for selecting the participants was that they had to work within the procurement process. In total, 13 experts participated.

When the answers from stakeholders were obtained, results were calculated. Statements in each column had a value from -3, for strongly disagree, to +3, for strongly agree (with 0 as neutral).

For each stakeholder group a sort was found as an average based on the sorts that were carried out by the experts who were in this stakeholder group. As a result, four sorts were generated, one for road authority, one for construction companies, one for material suppliers and the last one for researchers. These sorts allowed us to see how each of the groups as a whole evaluated the statements. It is hard to make a conclusion based on an entire sort, but it does provide a good insight into what people think based on statements that were mostly agreed and disagreed upon.

To be able to evaluate an entire sort for each group, the values of the aspects are calculated based on how the statements were sorted. In this way, the value of each of the statements was assigned to a related aspect. The results were normalised to be compared with other stakeholder groups. As a result, we used a matrix of 11 aspects by 4 stakeholders as seen in table 2.
TABLE 2. ASPECTS MATRIX WITH THE EMPHASISED HIGHEST AND LOWEST IMPORTANCE OF EACH STAKEHOLDER GROUP

<table>
<thead>
<tr>
<th></th>
<th>Road Administration</th>
<th>Construction Companies</th>
<th>Material Suppliers</th>
<th>Researchers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation</td>
<td>0.61</td>
<td>0.91</td>
<td><strong>1.00</strong></td>
<td>0.5</td>
</tr>
<tr>
<td>Cost</td>
<td>0.7</td>
<td>0.00</td>
<td>0.38</td>
<td>0.12</td>
</tr>
<tr>
<td>Durability</td>
<td>0.42</td>
<td>0.18</td>
<td>0.24</td>
<td>0.38</td>
</tr>
<tr>
<td>Environment</td>
<td>0.59</td>
<td>0.82</td>
<td>0.76</td>
<td>0.69</td>
</tr>
<tr>
<td>Risks</td>
<td>0.34</td>
<td>0.55</td>
<td><strong>0.00</strong></td>
<td>0.58</td>
</tr>
<tr>
<td>Market balance</td>
<td>0.82</td>
<td>0.55</td>
<td>0.48</td>
<td><strong>1.00</strong></td>
</tr>
<tr>
<td>Recycling</td>
<td>0.37</td>
<td>0.82</td>
<td>0.28</td>
<td>0.23</td>
</tr>
<tr>
<td>Procurement process</td>
<td><strong>1.00</strong></td>
<td>0.73</td>
<td>0.59</td>
<td>0.42</td>
</tr>
<tr>
<td>Safety</td>
<td>0.51</td>
<td>0.09</td>
<td>0.48</td>
<td><strong>0.00</strong></td>
</tr>
<tr>
<td>Prediction</td>
<td>0.61</td>
<td><strong>1.00</strong></td>
<td>0.59</td>
<td>0.81</td>
</tr>
<tr>
<td>Warranty</td>
<td>0.00</td>
<td>0.45</td>
<td>0.34</td>
<td>0.38</td>
</tr>
</tbody>
</table>

VI. RESULTS

The aspect matrix shows which stakeholders are more focused in their work. It does not show in any way what can be ignored or omitted by stakeholders.

A. Road administration

TABLE 3. IMPORTANCE OF ASPECTS FOR THE ROAD ADMINISTRATION

<table>
<thead>
<tr>
<th>Procurement process</th>
<th>Market balance</th>
<th>Cost</th>
<th>Innovation</th>
<th>Prediction</th>
<th>Environment</th>
<th>Safety</th>
<th>Durability</th>
<th>Recycling</th>
<th>Risks</th>
<th>Warranty</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.00</td>
<td>0.82</td>
<td>0.70</td>
<td>0.61</td>
<td>0.61</td>
<td>0.59</td>
<td>0.51</td>
<td>0.42</td>
<td>0.37</td>
<td>0.34</td>
</tr>
</tbody>
</table>

The highest value for the road administration is for their worldview on the procurement process. This includes how technical and functional specifications are defined, how award criteria are formulated, how attractive the project is for potential bidders and other processes related to procurement. The highest value here is due to the fact that the procurement is a step when the road authority declares what is needed. All future mistakes of the road authority trace back to the procurement process. Thus, it is important for them to make sure that the procurement has the highest priority.

In second place for the road authority is market balance. Healthy competition between a few strong companies and a number of smaller ones provides the needed balance and security for the road authority. This means that there is always someone who can do the job and also competition motivates innovation within construction companies.

The procurement process and market balance are essential for the road authority to do their function. These are followed by costs, innovation, prediction, environment and safety. These aspects are important, but are not vital for the road authority, especially since we are speaking about innovative procurement. These aspects are the areas that are developing long term, are more general for all projects and can be treated like standards rather than issues that need to be discussed for each procurement project.

Durability, recycling and risks are located close to the end of the list for the road authority because they are mostly what construction companies are in charge of rather than the road authority. Of course, there is shared responsibility, but in practice these aspects are less important than the previously listed aspects of procurement.

The last for the road authority is warranty. This is due to the fact that warranties are issued by the construction company in case something does not work properly.

In general, the road administration mostly agreed with the statement “A shift from technical to functional requirements will lead to innovation”. The reason here is that the technical requirements of procurement do not give freedom for bidders while functional requirements provide such freedom. The second most agreed about statement is “The safety of the road workers of the contractors is an important risk for the road administration”. The high value here can be explained by remembering that the road administration is a public organisation and its responsibility is to the public, including workers. The third highest value is for the statement “The most innovative contractor will increase its market position significantly”. The road administration wants innovation and wants to work with a company that can offer it.

The most disagreement is for the statement “The safety requirements of the road administration take out all incentives to innovate for contractors”, because the experts believed that safety is not a blockade to innovation, but the opposite – innovation can and should increase safety. Similarly, the statement “Green roads will never be a reality if the road administration keeps the same requirements on durability” is disagreed upon, because these aspects are not mutually exclusive. Another statement with which most of the experts disagreed is “The warranty on pavement life takes out all risks for the road administration”, because of the market dynamics and legal issues, construction companies could be incapable of fulfilling their promises and then the risk transfers to the road administration.

Other information that helps us to understand better the road administration’s perspectives is to see which aspects have similar and different responses compared to other stakeholders (see table 4). These data come from looking at how closely the statements were sorted, comparing between pairs of stakeholders.

TABLE 4. COMPARISON OF THE IMPORTANCE OF THE ASPECTS BETWEEN THE ROAD ADMINISTRATION AND OTHER STAKEHOLDERS

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Construction companies</th>
<th>Material suppliers</th>
<th>Researchers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most agree</td>
<td>Market balance</td>
<td>Cost</td>
<td>Innovation</td>
</tr>
<tr>
<td></td>
<td>Innovation</td>
<td>Safety</td>
<td>Durability</td>
</tr>
<tr>
<td></td>
<td>Prediction</td>
<td>Market balance</td>
<td></td>
</tr>
<tr>
<td>Most disagree</td>
<td>Environment</td>
<td>Prediction</td>
<td>Recycling</td>
</tr>
<tr>
<td></td>
<td>Warranty</td>
<td>Risks</td>
<td>Safety</td>
</tr>
<tr>
<td></td>
<td>Recycling</td>
<td>Innovation</td>
<td>Risks</td>
</tr>
</tbody>
</table>

The road administration and construction companies agree on market balance, because they are the ones who actually keep this balance. The agreement on innovation and prediction shows that there is good communication in the field and construction companies have a vision on these aspects, which is supported by the road administration.
However, the disagreement on the environment, warranty and recycling shows that the stakeholders have different strategies on these aspects. One example of the differences is the statement “Greenhouse gasses can be reduced by 50%”, which the construction companies were positive about, while the road administration disagreed with it. This could mean that constructions have technologies that can achieve this, but the road administration is not aware of it, or that the road administration has a large vision that is limited not only by the construction process, but also by maintenance. Another statement which was sorted differently is “Tenders should be awarded by both projected costs and CO2 emissions”. While the road administration agreed on this, the construction companies slightly disagreed with it. This could be caused by current business models.

The road administration and material suppliers mainly agree on the properties of the road (safety and durability) while the methods (prediction, risk management and understanding of innovation) are not seen similarly.

The road administration and researchers agree on innovation most of all. This shows that they have a good understanding on what is needed and can be achieved. The agreement on market balance is because the work of researchers is not limited to cooperation with the road administration, but also cooperate with the market. The rest of the aspects related to research are explained by the field in which the experts belong and could present some bias.

B. Construction companies

| TABLE 5. IMPORTANCE OF ASPECTS FOR CONSTRUCTION COMPANIES |
|---|---|---|---|---|---|---|---|---|
| 1.00 | 0.91 | 0.82 | 0.82 | 0.73 | 0.55 | 0.55 | 0.45 | 0.18 | 0.09 | 0.00 |

Construction companies chose different ranks from those made by the road administration, with prediction being at the top of the list. Prediction determines how well a construction company will be able to fulfill a project’s requirements. Better results mean lesser unplanned costs and higher productivity. Thus, prediction becomes dominant, which is also seen here.

Innovation follows prediction. Since the road construction market is not large with only several companies, it is important to be better than the competitors. Prediction definitely contributes to this, but so does innovation. It also increases the chance to be awarded the contract and affects other aspects as well.

The environment and recycling are in third position. This shows that construction companies are aware of them and keep them as some of their top priorities. Next is the procurement process because it is a way of obtaining their contracts. The procurement process is important for both applying for new contracts and keeping track of current ones.

Construction companies deal with risks, keeping an eye on the market situation, providing services as part as warranties, etc. These tasks are important, but are not unexpected. Most of the companies have a good plan to work with these aspects.

Durability and safety are low because they mainly depend on the requirements in the procurement request for tenders. The same applies to cost. Typically cost can be well defined by using, for example, a cost-benefit analysis.

The statement that has been mostly agreed and disagreed upon also shows this perspective on road procurement. Most agreed upon is the statement “Greenhouse gasses can be reduced by 50%”, as mentioned previously. Other statements that had been ranked highly were “The prediction methods for the durability of pavements need to be improved” and “A shift from technical to functional requirements will lead to innovation”. These statements, along with the accompanying comments, show that construction companies see the importance of the prediction methods and the importance of improving the processes in general. So, an approach that would benefit the system would be for the road administration not to make the decision on how the road should look by themselves, allowing for the process to be more open to all stakeholders (by defining more of the functional requirements).

The same thought shows the statement which was most disagreed upon by all the construction companies. The statement is “The safety requirements of the road administration take out all incentives to innovate for contractors”. The second lowest statement is “Contracts with the lowest costs stimulate innovation”, which shows that despite the fact that companies are ready to innovate, the current practice of awarding just based on price does not motivate the desire to innovate. The third statement which was mostly disagreed upon is “Projects that require a warranty never result in more durable roads”. This deals more with the practices and was mostly uniformly disagreed upon by all the stakeholders.

In general, construction companies are likely to agree with material suppliers about costs, safety and recycling, while disagreeing about prediction, risks and durability, as seen in table 6.

| TABLE 6. COMPARISON OF THE IMPORTANCE OF THE ASPECTS BETWEEN THE CONSTRUCTION COMPANIES AND OTHER STAKEHOLDERS |
|---|---|---|---|---|
| Stakeholder | Road administration | Material suppliers | Researchers |
| Most agree | Market balance | Safety | Prediction |
| Most disagree | Environment | Risks | Recycling |

The construction companies also agree with the researchers on prediction methods, innovation and market balance. However, the most different opinion is on recycling, the environment and the procurement process.
C. Material suppliers

TABLE 7. IMPORTANCE OF ASPECTS FOR MATERIAL SUPPLIERS

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Innovation</th>
<th>Environment</th>
<th>Procurement process</th>
<th>Prediction</th>
<th>Safety</th>
<th>Market balance</th>
<th>Cost</th>
<th>Warranty</th>
<th>Recycling</th>
<th>Durability</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>0.76</td>
<td>0.59</td>
<td>0.39</td>
<td>0.48</td>
<td>0.48</td>
<td>0.38</td>
<td>0.34</td>
<td>0.28</td>
<td>0.24</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>

The material suppliers gave the highest priority to innovation. The material suppliers are the smallest stakeholder group, and hence, the ability to provide products with better characteristics than the competition is critical. And the characteristics can be improved based on innovation. The environment aspect is in second place. This might be related to them closely working with material mining, and so the effects on the environment are more direct than for any other stakeholder.

The procurement process, prediction, safety, market balance and cost follow. The procurement process, market balance and cost deal with the connections between the stakeholders, and prediction and safety deal with the service of the material suppliers. Warranty, durability and risks are more related to the use of materials, rather than the materials themselves.

The material suppliers mostly agree with the statement “Green procurement leads to innovation” as well as with the statements “The most innovative contractor will increase its market position significantly” and “The contractor that is best in predicting the pavement life cycle will dominate the market”. These statements show that the aspects of innovation, green procurement, market balance and prediction are also dominant for this stakeholder.

The statements that the material suppliers mostly disagreed with are “The durability of a road is the largest risk”, “Changes in the market balance between the different major contractors are a risk for contractors” and “The warranty on pavement life takes out all risks for the Swedish Road Administration”. All of these statements deal with the risks, and different sources of risks.

The material suppliers have a similar opinion on the procurement process, cost and innovation to that of the researchers, as seen in table 8. At the same time, the aspects prediction, risks and warranty are seen differently.

TABLE 8. COMPARISON OF THE IMPORTANCE OF THE ASPECTS BETWEEN THE MATERIAL SUPPLIERS AND OTHER STAKEHOLDERS

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Road administration</th>
<th>Construction companies</th>
<th>Researchers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most agree</td>
<td>Cost</td>
<td>Cost</td>
<td>Procurement process</td>
</tr>
<tr>
<td></td>
<td>Safety</td>
<td>Safety</td>
<td>Cost</td>
</tr>
<tr>
<td></td>
<td>Durability</td>
<td>Recycling</td>
<td>Innovation</td>
</tr>
<tr>
<td>Most disagree</td>
<td>Prediction</td>
<td>Prediction</td>
<td>Prediction</td>
</tr>
<tr>
<td></td>
<td>Risks</td>
<td>Risks</td>
<td>Risks</td>
</tr>
<tr>
<td></td>
<td>Innovation</td>
<td>Durability</td>
<td>Warranty</td>
</tr>
</tbody>
</table>

VII. CONCLUSION AND DISCUSSION

Road procurement is one of the means by which the government can promote innovation in the road infrastructure sector. Most of the studies conducted so far have looked at procurement mainly from the view of the government. But such results give only a part of the picture because each procurement process involves more than just merely the government – it is a multi-stakeholder process. Furthermore, procurement is also a multi-issue topic, since the effects extend beyond the cost, quality or environment to the long-term structure of the sector and innovation potential, for instance. This is especially true in sectors like the road sector, where the market consists of very few clients (governmental bodies mainly) and an oligarchy of suppliers. Thus, there is a need for work to evaluate procurement as a multi-agent process with a number of different aspects.

This paper tested a method to enable us to look at different aspects of the procurement from the perspective of different stakeholders.

Q methodology was used in this work since the aspects of perspectives cannot be described as facts, but rather as subjective worldviews. And this methodology is a mixed-method approach that allows working with opinions and subjectivity.

Interviews were conducted with experts from different companies in Sweden. The number of statements was balanced to be sufficient for each of the aspects and not to be overcomplicated for the participants. This allowed us to analyse the data based on their occupation, creating an aspect table for each of the stakeholders and interpreting the results.

Based on the obtained results, we can see that the perspectives of the different stakeholders are not the same. The first thing that was observed was that every stakeholder had its own aspect with the highest priority, which corresponded to their role and duties. The road administration mostly focused on the procurement process that can be explained by the fact that they are the buyers and the procurement process is their way to obtain the needed services. The construction companies focused on prediction methods, and the material suppliers gave priority to innovation. Both are road construction-related and thus were more important to the stakeholders who actually build roads. Comparing the replies of the stakeholders, we were also able to see that some aspects were similarly ranked across the stakeholders (for example, the road administration mostly agreed on market balance, innovation and prediction, as did the construction companies), and some aspects were disagreed upon. Thus, we can conclude that the procurement process should indeed be observed from the complex adaptive system approach to gain a better understanding of the processes within it.

The interpreted results can be used in various ways, for example, to give insights into how collaboration in procurement can be improved based on each stakeholder’s priorities and focus. In return, improved collaboration allows changes to be made in procurement in a way that all the parties are satisfied.
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REFERENCES


