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Gamifying Project Procurement for Better Goal Incorporation

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Abstract

Many services that we use daily, like healthcare, infrastructures, public transport, education, and others, are provided by the public sector. These services are provided using the project procurement process. In most cases, this process has a highly complex and dynamic interaction. It leads to issues, such as information asymmetry, over-specified tenders, not efficient feedback loops, etc. As a result, projects can rarely match to the objectives of organizations. This work explores the use of participatory simulation to help holistically investigate a project procurement process to incorporate better goals of organizations. Based on case studies from the Swedish road construction field, it can be concluded that participatory simulation is an effective approach to experiment with the effects of project procurement.

Keywords: project procurement, challenges in procurement, participatory simulation, road construction

1. Introduction

Governmental procurement is a process of obtaining goods or services. Procurement accounts for approximately 12% of the gross domestic product (GDP) of developed countries and 16% of the GDP of the European Union [1]. The purpose of the procurement is to stimulate an open market and to provide the best price for the ordered product, works, or services [2]. However, in practice, a procurement process, especially procurement that is a part of projects, can rarely match objectives of organizations [3, 4] because of technical specifications and dependencies on multiple stakeholders that are involved.

Despite the importance of procurement in a business, little work has focused on how changes and adaptations to the procurement process affect the total outcome of the system. Most of the existing studies decompose contracts into smaller, more tractable problems, such as ordering amounts in supply chain management [5]. However, such an approach cannot address the important aspect of agency and complexity in the decision-making process within procurement. To simulate a holistic view of contracts, business models, and decisions, there is a need to develop a different approach that would be able to grasp the complexity in procurement process [6, 7].

In order to achieve this, we suggest to use a participatory simulation to explore to what extent participatory simulation approach may be used for investigation of different issues existing in road project procurement and to evaluate complexity in procurement.

This study is important for several reasons. First, analysis of project procurement on different levels of planning helps to reveal the underlying issues that prevent organizations to maximize the effectiveness of the procurement process. Second, evaluating current methods allows seeing strengths and weaknesses in different methods and helps to use the advantages of participatory simulation to solve these issues. Third, the presented case studies and analysis of their results illustrates how to introduce an approach helps to grip on project procurement.

With the need to change and adapt to new regulations and norms to increase the level of innovation in such systems, there is a need to simulate the procurement process [8, 9]. Models in traditional methods of the simulation are based on close systems where choices of agents are limited. Because of that, these traditional methods do not address the important aspect of agency and complexity in the decision-making process within procurement or they try to decompose contracts into smaller, more tractable problems, such as ordering amounts in supply chain management [5]. To simulate a holistic view of contracts, business models, and decisions, there is a need to develop different simulation approaches, such as participatory simulations [7].

The chapter is organized as follows: in Section 2, we provide a background on project procurement with some common challenges and methods that are traditionally used to address some of these challenges. Section 3 describes a participatory simulation approach and how it can be applied to project procurement. In Section 4, we describe two case studies based on participatory simulation and outcomes from these studies. Finally, we conclude the paper in Section 5.

2. Background

2.1 Project procurement

Procurement is a procedure that governmental institutions need to follow in order to buy goods, services, or work over a predefined threshold. The procurement process comprises several steps [10, 11]. It starts by defining the needs and developing technical and functional specifications. Then the criteria for participation in bidding process and award criteria are specified before the documents are published. Interested companies 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.

Although procurement is well defined on many levels, the procedure still leaves room for making decisions. Project procurement is a type of procurement that is performed as a part of a project to obtain a customized item or service. Such procurement procedures are known as project procurement.

Project procurement is used when there are no off-the-shelf solutions or products [12]. Such items or services often are required in construction projects, product development projects, information system/information technology projects, energy or hydro projects, and maintenance projects [12]. However, a majority of the project procurements are in a road construction sector [13, 14].

Road construction and maintenance are performed by a number of stakeholders with each having its own responsibilities and functions. The main stakeholder is usually a public road administration, which is a governmental organization. They have the responsibility of carrying out projects that typically require road-related works for a period of time from several years to 15–20 years [15]. This makes the procurement stage important since at this stage all works and services that will be performed in the frame of a project are defined.

2.2 Procurement at three levels of planning

Today, the major focus in procurement is on the process from the definition of the requirements for awarding the contract to the winning contractor at the end of the procurement service. However, it is important to view the role of procurement for the organization and to see how procurement fits into the “bigger picture” of an organization and how procurement is managed and planned by the organization. Often, these management tasks can be viewed by three levels of planning: strategic, tactical, and operational [16].

2.2.1 Procurement at a strategic level

The strategic level of planning includes long-term decision-making. It looks at product and process management from a life cycle point of view. In business, project procurement can be seen at a strategic level, when all or most of the project executions are procured and developed by other companies [17].

For example, in the architectural, construction, and manufacturing industries, products or works can be obtained as design-build contracts. In this case, a client is paying for a design, building, or manufacturing and supporting the product or work. It gives more freedom for bidders to look at the product in a holistic way and make improvements from the life cycle perspective [18]. However, it reduces the control level of a client and can create more risks in cases when the company that won the tender does not fulfill all obligations [19].

2.2.2 Procurement at a tactical level

Tactical level focuses on demands and achieving the best end value. Most procurement contracts are made at this level based on best practices and experience of an organization [20].

Usually, procurement at the tactical level is carried out for products or services for an extensive period of time (from 1 to 7–8 years depending on the field) [21]. A big part of the procurement process is done based on existing templates and established guidelines.

2.2.3 Procurement at an operational level

Operation level focuses on day-to-day operations. Although procurement is rarely done for single operations, much work related to procurement can be seen as operational [22]. It can include micromanagement of works or services, working with reports, or change minor procurement documentation such as report formats for the next procurement process.

2.3 Challenges in procurement

The procurement process is not limited only to the procurement stage [23], especially dealing with procurement at strategic and tactical levels. Procurement procedure influences the execution of works, increase dynamics in the market, and eventually, they are changing ground for next procurement processes. This indicates that procurement is a complex system [5, 24]. Looking on project procurement as a complex system allows identifying some issues in this type of procurement [25, 26].

2.3.1 Information asymmetry

Information asymmetry occurs when some stakeholders have more material knowledge than the other stakeholders have. Usually a procuring stakeholder has more information than is available in the documentation [27, 28]. It can include work-related data from previous or similar projects that can be beneficial for other stakeholders. It can also be some more expectations of what the final product or service should be like. On the other hand, companies can have access to more technologies, materials, methods, or systems than they are willing to reveal in their tenders, for example, due to secrecy. This behavior, although being business and competition driven, leads to nontransparent relationships and often to less profitable deals [29]. It also creates an imbalance of power in transactions that leads to a negative influence on the market's balance.

Information asymmetry at the strategic level leads to solutions that do not satisfy all the needs of the client because not all needs were properly documented. At tactical level, information asymmetry can challenge performance due to the lack of bigger vision from companies. At an operational level, it can create problems with right executions of all regulations and reporting systems.

2.3.2 Slow and time-consuming process

The procurement procedure can affect the speed of completion. The procurement procedure itself might be very time-consuming [30]. This is especially true for procurement at the strategic level. The time between the first involvement of procurement managers in a project to the beginning of the construction work can take several years. At the early stages of the procurement process, some time is spent on preparation of specifications, the scope of work, and other terms. Usually some of the previous contracts can be reusable for these purposes; however, each set of documentation ends up being unique as it is based on individual projects. Once all is ready, request for tenders are launched with submission period of 2–8 months for more typical types of projects as for technical consultants or maintenances and even longer for building- or design-build-type contracts. After the winning contract is announced, sometime is usually reserved for negotiations and appeal. Some projects do not start immediately after but have time for companies to prepare for the start of the work. Better distributed control in the field, better connection and communication during the process of procurement, and better adaptation to the needs can make this process faster.

2.3.3 Over-specified tenders

Specifications are an important part of any tender—they help to understand what the final product or service must do. But in the same time, determining specifications is not a trivial work.

Specifications can be classified as technical and functional. Functional specifications describe what the product needs to deliver from the user's perspective. Functional specifications are in most cases considered to be more preferring. However, having only functional specifications may lead to difficulties in controlling monitoring and evaluating the product or service. Therefore, there is a need for technical specifications that describe the details and characteristics of the needed project. Technical specifications decrease openness for innovation and alternative solutions. A proper balance between technical and functional specifications is essential to avoid over-specified tenders [31]. In reality, this balance is hard to maintain because of the different goals of different stakeholders [32].

Over-specification usually is less a problem at a strategic level; but, it can be a huge issue at tactical and especially at operational levels.

2.3.4 Feedback loops

Feedback loops exist between two elements that are interconnected and that affect each other. Feedback loops are important because they show the success of project procurement compared to the outcomes [33]. For proper feedback, it would be important to analyze a set of very similar projects. However, in the case of project procurement, it cannot be done. All projects are unique, and even two similar projects may have two totally different outcomes. In addition, it takes a long time to see the outputs of the contract. Some contracts in road constructions industry can be up to 15–20 years long, thus, making the analysis of input and output variables almost impossible.

Feedbacks work in most cases well at an operational level, but at strategic and tactical levels, it is often major issues with feedback loops. At strategic levels, feedback loops hardly exist, while at tactical levels, they either nonexisting or interpretation of feedback loops happens rarely.

2.4 Traditional approaches to challenges in procurement

Several approaches exist to address some of the challenges in procurement, where each approach aims to target different scope or perspective of the issues.

2.4.1 Financial metrics

Financial metrics look on a project from the economic point of view to help to evaluate what decisions are successful and which are not. These metrics, like cost-benefit, return on investment, a total cost of ownership, can be very effective in different projects [34, 35]. However, they are more useful to determine the effectiveness of the project itself, to determine if the organization needs to own a product or it can be rented, and to determine a need to do procurement in general. Financial metrics also can be used effectively at an operational level. But they are less effective when there is a need to evaluate how good procurement is at tactical or strategic levels. Also financial metrics are not meant to include complexity that comes from communications between stakeholders because it is impossible to transform these communications into monetary values [36].

2.4.2 Simulation

A simulation uses a model to imitate real processes in the real world in a safe environment over a longer period of time. Simulation often gives a very good understanding of feedback loops, and it is a good tool to look at how the system changes over time [37]. However, a good simulation requires a good model that includes all possible interactions between stakeholders and consequences that are coming from these interactions. Although this is mostly possible, it can be extremely time-consuming, and it does not include coevolution processes in the model.

Simulation can be an effective tool for contracts for the purchase of supplies [9], where the contracts are more typical and the scope of the problem is not a holistic approach but rather figuring optimal ordering amount and reordering times. Hence, simulation of procurement at a strategic level almost never is performed because of the complexities and absent of a real system.

2.4.3 Game theory

The game theory looks at cooperation and conflicts in competitive environments. Much research in game theory field is focused on how people interact [38, 39]. Similar to simulation, game theory requires a good knowledge of all possible scenarios that can happen during the procurement. Based on this knowledge, the best solution is suggested. In the case of public project procurement, it is impossible to determine all possible scenarios and to properly define boundaries between different scenarios. It is quite common that two almost identical projects end up with one being a success, while the second fails.

In order to evaluate the success of the project procurement, the approach has to be able to see procurement holistically as a complex adaptive system.

3. Participatory simulation approach

3.1 What is a participatory simulation?

A participatory simulation, or gaming simulation, is an approach based on modeling and simulation of the real world. It uses real participants to recreate behavior and decisions in the system [40–42]. The combination allows participants to learn about the modeled system, prototype new solutions, experiment with policies, and design other changes to the system. Geurts et al. [43] states in his work that participatory simulation is a “safe environment to test strategies in advance, and can help decision-makers to create several possible futures. The players build the future conditions of the system step by step by moving from the current reality to a new vision.”

A participatory simulation combines benefits of modeling and simulation with participatory methods as seen in **Figure 1** [44]. As a simulation, participatory simulation is based on a model of existing or nonexistent reality (reference system). The model is based on interdependent variables that help to formulate connections and flows in the model. It provides users with feedback on how the model changes over time. It might include decision support systems such as optimization. Also participatory simulation can be done on macro-, midi-, or microlevels. But at the same time, the participatory simulation includes “soft elements” [45]. As a method,

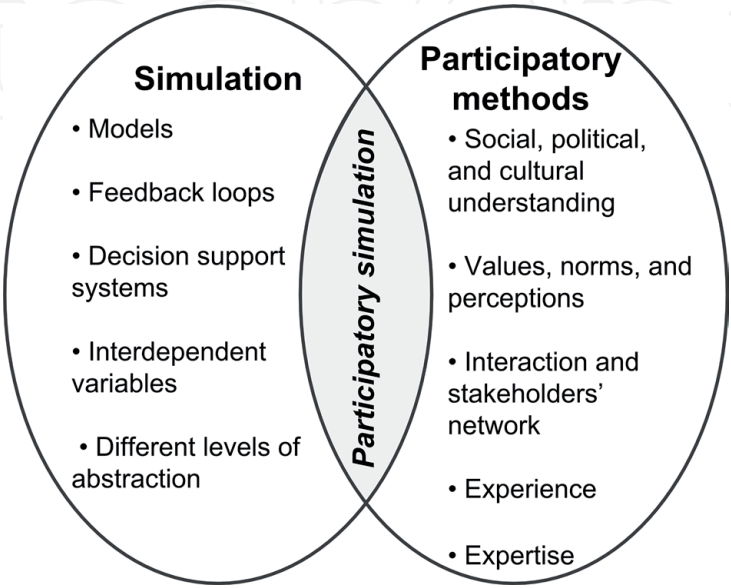


Figure 1.
Place of participatory simulation.

that involves real people, participatory simulation can handle better when the reference system deals with social, political, and/or cultural aspects. Participatory simulation allows working with value systems of participants and their perceptions. It also makes possible to investigate interaction patterns between participants. As a participatory method, it allows also to bring experience and expertise of people into the model.

3.2 Steps of participatory simulation

Although the development steps of the participatory simulation are different based on different objectives that are considered, the main elements are seen in **Figure 2**.

The participatory simulation starts with an identification of goal(s) and building proper **design** of the simulation. **Roles** indicate different types of players with their functions. **Rules** regulate what actions are allowed or forbidden. **Objectives** specify purpose and goals for participants during the simulation. **Constraints** limit a range of freedoms that participants have. Additionally to participatory simulation design, each session is affected by state and context. **State** refers to design variables, such as a number of teams or size of start budget. The **context** is related to other variables that may be relevant to the session, for example, background information of participants.

Participants are engaged in each session. Often participants are expected to have some knowledge about the system or the problem. As a result of the sessions, these participants gain some experience by participating in the simulation and by discussing the model after the session. At the same time, game produces qualitative and quantitative data, such as decisions that participants made, time that it took to make these decisions, statistic how participant performed in comparison with other participants, comments that participants made, level of stress, etc.

3.3 A participatory simulation approach for procurement

In the case of participatory simulation of procurement, the approach design is largely depended on the planning level: operational, tactical, or strategic. Each type of planning will have a different degree of realism or abstraction, and a solution will range from specific changes to a general direction where change should go (**Table 1**).

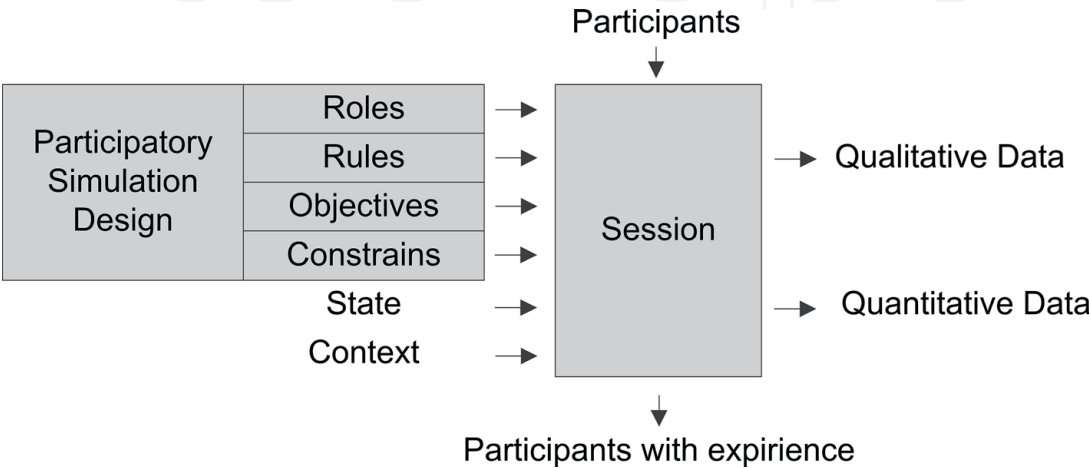


Figure 2.
Inputs and outputs of a participatory simulation session, based on [41].

Types of planning	Scope
Operational	Document scope
Tactical	Project scope
Strategic	Holistic scope (e.g., LCA scope)

Table 1.
Different scopes for project procurement participatory simulation based on different types of planning.

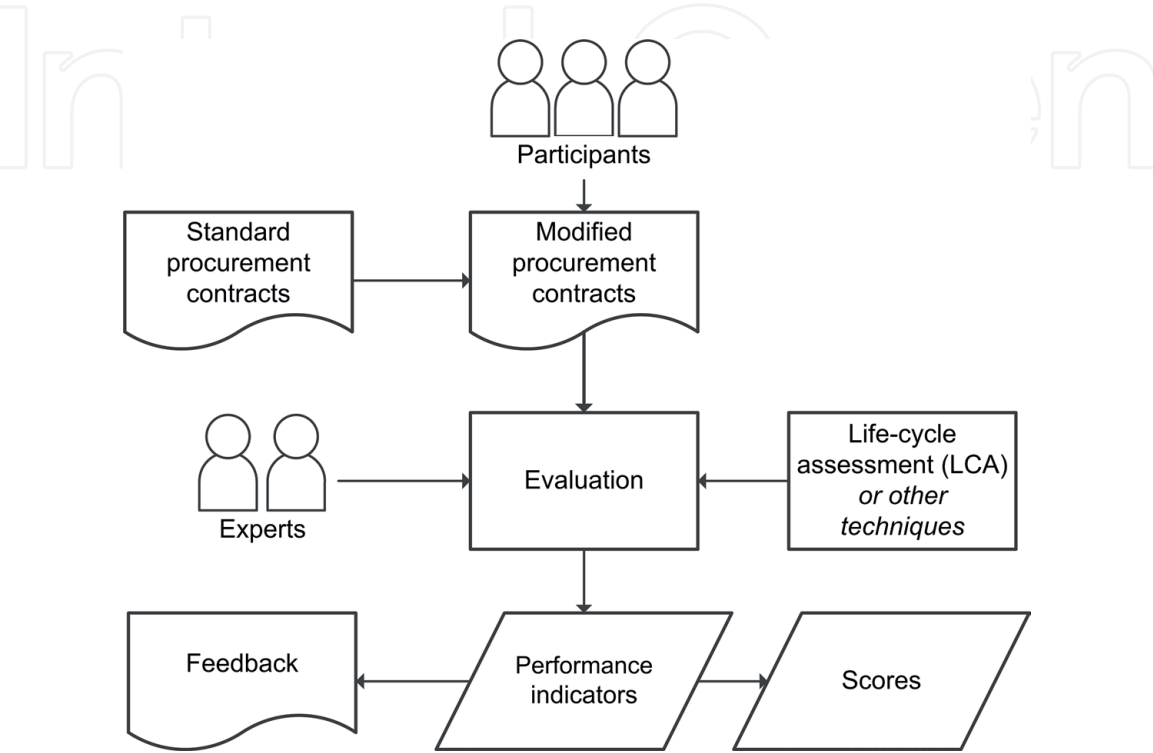


Figure 3.
Participatory simulation design.

On operational level, the focus is on an individual document or a small set of documents. It can be a specification document or description of the bonus system for performed work or any other document that affects the outcome. Participatory simulation, in this case, can help to determine how changes affect the final outputs.

Participatory simulation on a tactical level allows experimenting with the entire project. Such a project can be procured for technical consultants or procuring road maintenance. The outcome of such type of participatory simulation can be a better understanding of strength and weaknesses of business models for such types of projects; it can identify bottlenecks and documents or set of documents that need deeper evaluation.

Also participatory simulation allows looking beyond the individual type of projects on a strategic level. This gives an opportunity to analyze a set of projects in a more holistic way. For example, at this level, we can look at a combination of rural and urban projects or from road design project to road maintenance. Results from the approach at this level give an overlook on current practices in general and help to see how well different projects actually cooperate one with another.

Participatory simulation design depends on a type of planning, but generally can be as seen in **Figure 3**. The type determines what documents should be included in the design and what is the main objective.

Roles for these experiments mainly should reflect important stakeholders—transport administration employees, technical consultants, researchers, construction

companies, material suppliers, etc. Roles also can include specialization such as project leaders or procurement managers. Roles are determined by potential choices that can be done in during the session.

Rules describe what documentation can be changed and what type of communication is allowed. In a case when a session has several rounds, rules can describe if the rounds are inner dependent (participant continue to round 2 on the results from round 1) or rounds are independent from one another.

Objectives specify purpose that participants have to strive to achieve in the session. It can be typical objectives based on a type of planning, such as to build a road within a limited budget. In this case, a participant or a team of participants with the lowest budget and sufficient quality can be considered the winners.

Constraints limit what participants are allowed to change and what must be kept. Often on an operational level, final solutions have to be more concrete, and they must include many legal and management aspects. So participants have constrained on what has to be included in their final results. On the other hand, the strategic level solution can be almost without any constraints to give a chance for participants to be fully creative and innovative.

State and context are often defined closer to the experiment day, and they influence variables around the game. Such aspects can be the employment of participants and their role in the game. The **state** describes aspects as a number of teams, number of participants in the team, and what is the balance in scoring between the main objective and creativity. **Context** is dealing more with variables regarding participants themselves and the venue. Are we inviting to play only transport administration employees or someone from business too? Do transport administration employees have roles as transport administration employees or as a business (role reverse)? If someone from the business is invited what is his or her incentive during this experiment? Was session too short/long and participants felt pressure because of that? All of these variables affect the sessions' results but also give richness to the gained experience. Typically, sessions are repeatable with the same participatory simulation design, but state and context are always different.

4. Case studies

To show the application of a participatory simulation approach for project procurement, two case studies are selected. Both cases are related to road project procurement. However, the first case is about road construction from a life cycle perspective, while the second case is focused only on road maintenance procurement and is focused more on the details of a contract. These cases were chosen to show how the approach can be applied for a different level of planning and what outcomes can be expected.

4.1 Redesigning procurement contracts for the entire life cycle

4.1.1 Overview

Most of the work in road construction in Sweden is procured by Swedish Transport Administration (STA). Although there are multiple types of procurement contracts that they do on daily bases, one of big challenge they have is related to the procurement of technical design of roads, procurement of road construction, and procurement of road maintenance. STA occasionally tries procuring all these steps as one big project, but such results are not always successful due to high risks.

However, the current state also has issues, because final products end up with too high life cycle costs.

The purpose of the participatory simulation was to address some of the issue related to the need for redesigning procurement contracts with a strong focus on the life cycle. There was a need for an environment, where Swedish Transport Administration can think and discuss incentives in the procurement process that they offer to a business to improve the situation, as well as discuss dilemmas why some attempts to solve this resulted successfully, while other attempts were less effective than traditional approaches.

4.1.2 Participatory simulation design

To successfully reach objectives for this type of problem, it requires going beyond typical procurement contracts. Thus, a strategic level was selected for this case. At this level, it is important to let participants be more creative and focus on the bigger picture rather than small individual details. The main focus of this session was to build the best road within a limited budget. This would include typical procurement of two technical consultants, procurement of road construction, and procurement of two rounds of road maintenance. Participants could choose design-build contracts, build-maintain contracts, design-build-maintain contracts, and individual contracts, dividing into lots or any other strategy to make sure that costs for the life cycle of a road are the lowest. The expert-based model supported evaluation of the decisions and produced outcomes. To achieve it, the model was developed as seen in Figure 4.

It was only one **role** for participants—Transport Administration. Participants needed to use all their experience and knowledge to act in the best interests of the company. They needed to make all decisions regarding the contracts themselves, meaning that in some moments they had to act as project leaders, in other moments as procurement managers, and in some moments as a board of directors.

Rules for this case were straightforward—participants were allowed to make any changes in procurement strategies and documents that they wanted to achieve the goal. They had access to real developed and still developing business models of Swedish Transport Administration. They were given premade standard procurement documentation based on internal documentation and already published calls of tenders as found at Tender Electronic Daily (TED), an online official journal of the EU, dedicated to European public procurement. Some other rules specified that participants were not allowed to communicate with their competitors during the session.

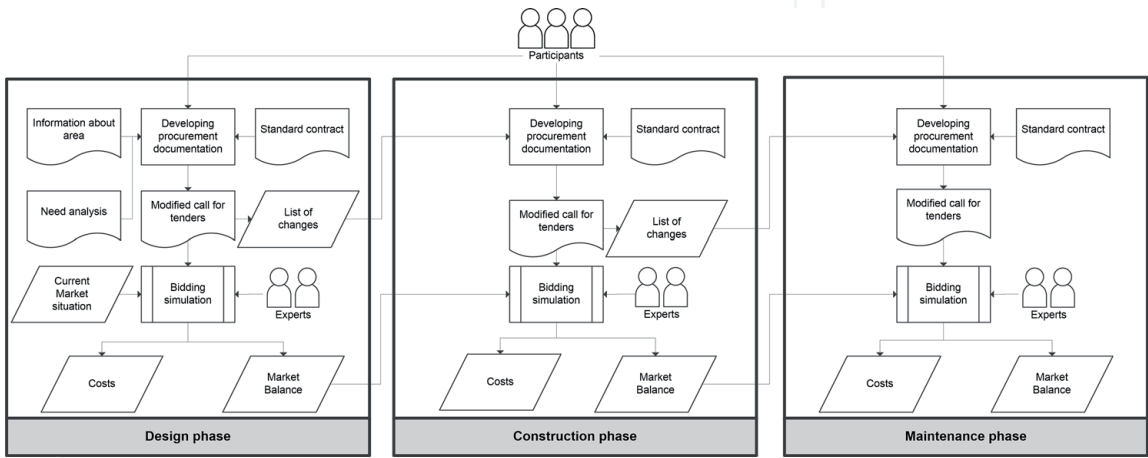


Figure 4. Participatory simulation design for the case of redesigning procurement contracts for the entire life cycle.

They had access to “a market” (represented by an expert in the field) to procure services and works. In this case, participants had to work based on information gained from the market.

The **objective** of the simulation was to build the best road for the price with a limited budget. A lifetime of the road was given as 15 years, which is a reasonable length of the road before it requires major fixing. A definition of “the best road” intentionally was not given since it was another question about what characteristics road should have to be considered of good quality. Based on the objective, scoring system was developed as well. The scoring system provides a feedback system and helps participants to be more involved in the process. Mainly, the scoring was based on the total price of the entire road life cycle; however, some extra points were given if participants were able to address innovation, as it is one of the big priorities for the organization.

Constraints were minimal. Participants were not limited in what they can change and type of changes it could be. The only constraints were of ethical issues—participants had to be honest in their dealings.

Several **states** were defined in the session. First of all, the participants played in teams. There were four teams where each team had 2–3 participants. The session took 1 day that included 6 hours of participation time, discussion after, and few breaks during the day.

Nine **participants** were selected for this simulation (five men and four women). They are employees of procurement and strategic departments of Swedish Transport Administration, who worked in the road construction field from 18 to 34 years and have good knowledge of project management, procurement processes, and Swedish Transport Administration’s strategic goals. Teams were organized naturally based on who preferred to work with whom.

4.1.3 Results

Two teams (team A and team B) produced full design-build-maintain projects where all design, consulting, and construction on maintenance responsibilities are part of procured work and services. Still, team A decided to focus more on increasing innovation in processes and materials; team B worked on increasing interest in the market for the project. Both teams have decrease number of technical specifications and remove many documents from the standard set that is used for a request for tenders to increase transparency.

The third team, team C, decided to develop a design of road using in-house experts rather than procure it and then combine building and maintenance together. In their building-maintenance documentation, they tried to have more functional specifications.

Team D procured each work process individually. However, they decided not to follow the approved by the organization guidelines but instead used their experiences as working as entrepreneurs to focus only on important elements (**Table 2**).

All changes were done by editing standard contract templates. Most of the changes included removing parts of contracts as seen in **Figure 5**, or even removing some documents completely, and also by adding some guidelines on what needs to be expanded.

The total costs without any changes were calculated as 110 million dollars. However, teams had a game budget of 80 million to stimulate creative thinking. Team A had the lowest results with total costs of 71 million, team B was second with 75 million, and team D was with 78 million. Team C went over the budget with 88 million dollars, but even this was way under the original costs.

In the discussion after the exercise, participants indicated that success for this type of projects required more collaboration with business partners. One participant said: “We focus on the life cycle cost to find the lowest possible LCC. Then we

	Team A	Team B	Team C	Team D
Number of participants	2	2	2	3
Average work experience in the field	26 years	24.5 years	29 years	27.3 years
Proposed solution cost	71 million dollars	75 million dollars	88 million dollars	78 million dollars
Solution cost comparison to base cost*	Improved by 35.5%	Improved by 31.8%	Improved by 20%	Improved by 29.1%
Main strategy	Design-build-maintain project	Design-build-maintain project	Each work process procured individually	Design by in-house experts and build-maintain project
Final score**	89 points	86 points	81 points	85 points

*A base cost for a project with no changes is 110 million dollars.

**A final score for a project with no changes is 50 points. The teams aimed to maximize their final score.

Table 2.
Information and results from the redesigning procurement contracts for the entire life cycle.

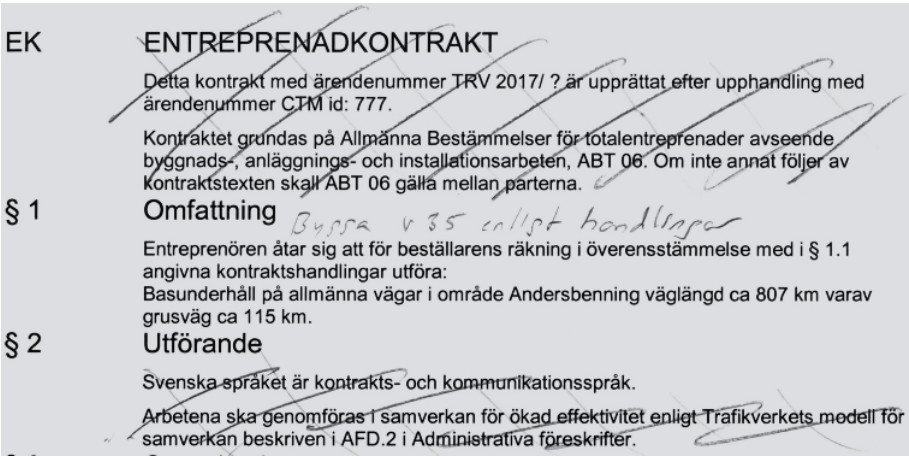


Figure 5.
Example of some changes by team A in documents describing some administrative information.

thought that we want to invite suppliers for early involvement, to write the specifications and to make the whole contract as good as possible. And we would like to bring suppliers early because they have huge knowledge.” Also they emphasized that there is need to be more open to the plans and information.

At the same time, some of the current issues where identified. One of the biggest issues was how to deal with over-specified tenders. One participant mentioned: “Sometimes it is a fact that we standardize too much, and does it really matter if the noise barriers are different in the north than in the south of Sweden? No, it does not matter. What matters if they are working or not?” Some other issues were identified as a lack of information about some important aspects, for example, how successful were the completed projects, while for some other aspects are too much information and regulations. As one participant mentioned: “One of the issues is that we have all these business models. We are talking about them all the time everywhere. But in reality, we just speak about the same complexity and uncertainty, just presented in different ways. And as a result, we have three or more different solutions for exactly the same problem.”

In general, participants had a positive experience with some advice and suggestions on how to address this type of contracts. One participant said: “I also think that it was good to think outside the box. We don’t dare to think like this, because we hear every day: ‘you cannot do that, you cannot do that, you cannot do that.’ Nevertheless, we tried to do it now freely!”

4.2 Improving existing procurement for road maintenance

4.2.1 Overview

Maintenance contracts are seen as a type of contracts with the lowest amount of innovation and that raises many concerns of the Swedish Transport Administration. Maintenance contracts are highly standardized across entire Sweden, and they contain a large number of technical specifications and regulations on how maintenance has to be carried out. An average number of bidders is around two to five offers per request for tenders.

The main objective of a participatory simulation was to determine what elements need to be changed to make maintenance contracts more attractive for the contractors. The problem here was that contracts cannot change too much due to high requirements for the quality, but they cannot stay the same because a number of bidders are too low.

4.2.2 Participatory simulation design

The design for such a simulation needed to include the entire scope of the project to identify where bottlenecks are in the system. Hence, the tactical level was chosen for the design. Since maintenance contracts are extremely standardized, it was chosen to build an entire experiment on one of the existing maintenance contracts. A combination of expert-based model and an analytical model was used in this simulation as seen in **Figure 6**.

All participants again had only one **role**—Transport Administration. The **objective** was to develop three cycles of project procurement (each cycle takes 4–6 years in real life). Participants needed to reduce their costs by at least 20% comparing to real prices. Scoring was done mainly based on price, but a set of other parameters (quality, environment, innovation, number of bidders, etc.) was used as smaller friction for scoring.

The **rules** were that contracts have to feel real, meaning that participants needed to produce procurement documentation that can be published even in a real situation. Quality of roads and market situation were inner connected between rounds.

Participants had some **constraints** on time (each round lasted 2 hours and they had to publish a request for tender in the end), on documentation (all important documents had to be included), and on a budget (prices could not go more than 20% comparing to real prices).

The session was split into five 2-hour-long meetings, where the first meeting was an introduction and the last one was a discussion. Three meetings in between were three session rounds. Eight participants were selected (three men and five women), who played in teams of two with totally four teams. All participants were employees of Swedish Transport Administration, who work together in maintenance procurement department in one of the regional offices.

4.2.3 Results

Most of the teams decided to go with minimum changes, mainly editing some structures of the files to make them more readable. Some suggested adding extra

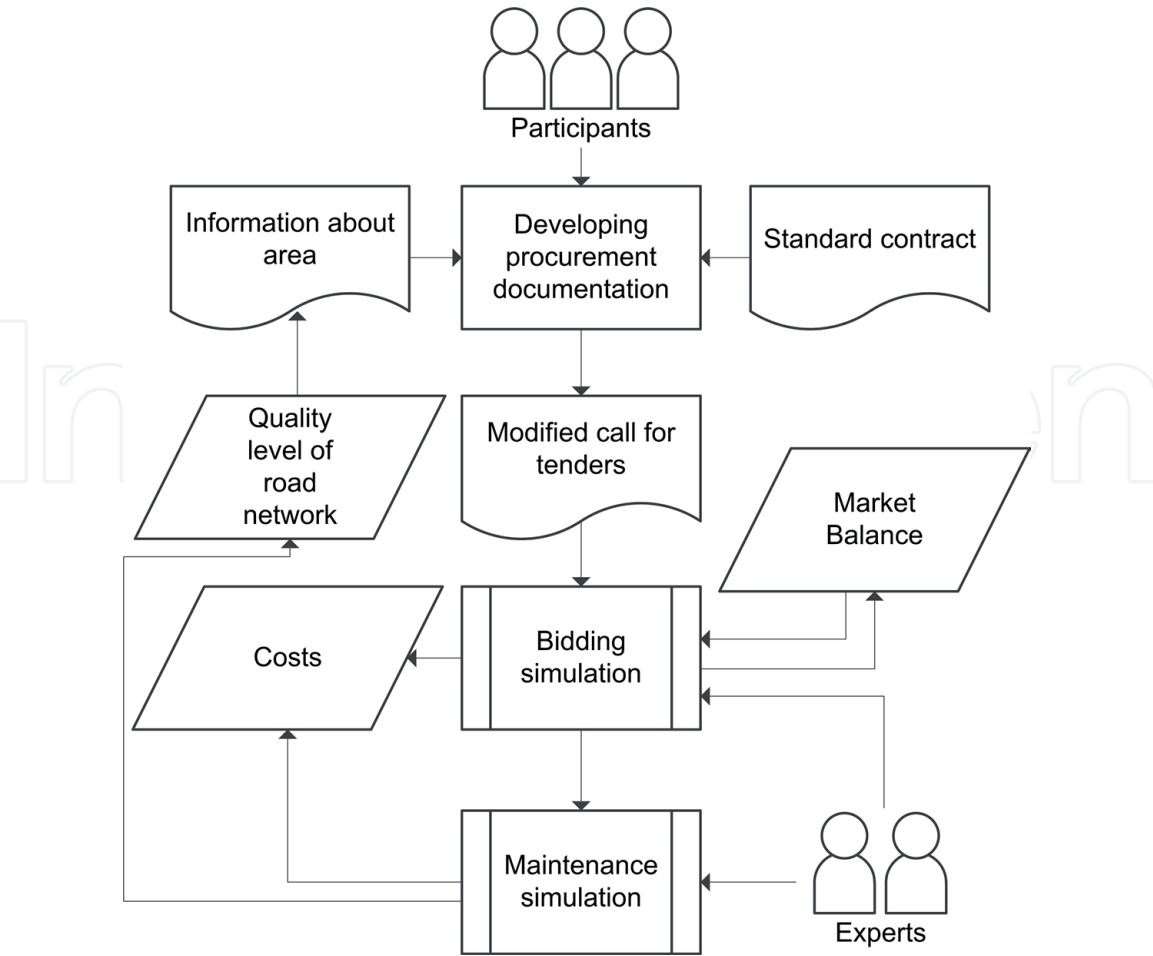


Figure 6.
Participatory simulation design for the case of improving existing procurement for road maintenance.

incentives, such as bonus system for good performance. One team tried to invest more money during the first cycle to improve the quality of the road network, and then spend less to just maintain achieved high quality (**Table 3**).

Majority of participants commented about needs for STA to be more open with its preferences. One person said they need to “get away from the speculative prices on certain works that leads to over or under-production because of how the contractors calculate prices.” Other person mentioned: “we must make the structure of the contracts easier to understand both for Swedish Transport Administration and for contractors.”

Some other comments indicated that this issue will have certain costs, especially in the beginning. One participant commented: “A focus on the increase of the contractors to make innovation possible by increasing costs.” Another comment about team strategy was: “We took away a lot of documents and we open up and made a lot of risks on STA, but it was needed to be done.”

An issue of standardization was discussed in this case study as well. As one participant said: “We’ve standardized contracts for many years and done it very well and got a really good national governance, but now, maybe, we have to move on and open up a bit to get that difference into the contracts based on conditions at the geography.”

Participants also were keen on using participatory simulation approach. One of the participants commented on experience after the session: “I think there are a lot of ideas at a regional or a local level. To evaluate them in terms of the success one can ask ‘What’s the worst that can happen?’”

	Team A	Team B	Team C	Team D
Number of participants	2	2	2	2
Average work experience in the field	11.5 years	7.5 years	13 years	16.5 years
Proposed solution cost	33.2	35.6	35	30.3
Solution cost comparison to base cost*	Worsen by 3.8%	Worsen by 11.3%	Worsen by 9.4%	Improved by 5.3%
Main strategy	Reduce the risk of the contractor and increase degrees of freedom	Provide more incentives for innovation	Push for innovation, support new technology, and improve customer dialog	Restructure entire contract, provide better economic incentives
Final score**	116 points	101 points	113 points	123 points

* A base cost for a project with no changes is 32 million dollars.
** A final score for a project with no changes is 80 points. The teams aimed to maximize their final score.

Table 3.
Information and results from the case of improving existing procurement for road maintenance.

4.3 Summary of case studies

Two case studies were selected to demonstrate how a participatory simulation approach can address issues with project procurement. It was observed that participatory simulation helped in:

- Achieving assigned objectives of each case
- Experiencing effects of information asymmetry
- Facing results of the fast-paced procurement cycle
- Addressing issues of over-specification
- Making an analysis of feedback loops
- Working in an open environment without punishment for risk-taking

An objective for each case was achieved. Participatory simulation created an environment in which participants could discuss safety problems and concerns and experiment with different solutions. This approach helped in allocating some bottlenecks and providing scenarios for how they can be resolved in real life. Even more, the models could be easily adapted for other objectives as well.

The participatory simulation also helped in explaining the reasons and dangers of information asymmetry. Some benefits of open information were defined, and sources of the issue were discussed.

Another benefit of this approach comes from the fast pace of simulation. Performing the entire procurement cycle from the need of definition to tender award in only a few hours instead of several months helped to have a unique

perspective on the procurement process. It helped to find some issues and to think more outside the scope of just an individual project.

Problems of over-specification were raised up both during simulation sessions and after in discussions. Participants acknowledged issues that came from too many specifications and standardization policies.

An opportunity to have more feedback than just a final price helped to focus on some aspects of a procurement process that typically are ignored.

In general, it was observed that the open environment during participatory simulation without punishment for risk-taking allowed more creative and constructive solutions and discussion. Similar outcomes are hard to achieve in the real world due to the nature of the work.

5. Conclusions

Project procurement is common in fields where systems are large-scale and complex, and they require good planning before any changes can be implemented. These complexities often lead to a situation in which the procurement process, especially when part of a project, can rarely match the objectives of organizations. It is often related to information asymmetry in the sector, slow procuring process, over-specified tenders, and poor feedbacks. Traditional methods that are used in this field can help to some extent, but they cannot address all issues since they do not evaluate project procurement holistically.

An effective approach to look at the whole system proved to be participatory simulation. Two cases are described in order to explore how this participatory simulation approach can help to investigate different issues that exist in road project procurements.

The first case was focused on redesigning procurement contracts for the entire road life cycle. Participants needed to develop procurement contracts for a road from cradle to grave, including procurement of consultants for design, procurement of construction works, and procurement of maintenance. Participants had full freedom to make any changes they wish.

The second case was about improving current contracts for road maintenance. Participants needed to modify a standard procurement contract with the aim of a long-term increase in innovation. Participants had to use current work procedures, but they were free to change documentation that was attached.

In both cases, participatory simulation helped to determine the bottlenecks of the system and produced outcomes that could be used to develop guidelines for further changes in the real system. It also allowed experimenting with different policies and business models to see what solutions are more suitable for different situations. Based on case studies, we can conclude that the effects of different strategies and policies in project procurement can be observed and researched using participatory simulation.

Participatory simulation allows for investigating procurement processes on different levels of planning to search for bottlenecks and underlying issues. This approach also deals well with common challenges in procurement, providing an environment where participants can experiment and gain feedback within a short period of time. Based on these findings, this approach can be used to study the institutional, governance, social, and contractual setting of project procurement. The challenges and issues discussed in this work are not specific only to the road construction sector, and the proposed solution can be used in other fields as well that deal with the complexity of the procurement process.

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