Business Ecosystem Modeling for the Scalability of Sharing-Economy Initiatives

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Abstract

Business ecosystem modeling represents the value exchanged among an ecosystem's actors. Reasoning over how those exchanges develop across a planning horizon gives insight into whether the ecosystem can scale. Applications of business ecosystem modeling to sharing economy initiatives, which draw on broad networks of public bodies, firms, and consumers pursuing economic, environmental, and social value together, remain scarce. To address this issue, this paper reports on the application and evaluation of the Continuous Business Model Planning method to a digital kiosk initiative for shared household goods, deployed by a consortium of eight pilot organizations across seven countries in the North Sea Region. We built an as-is model of the Gothenburg case and used it to analyze three to-be operating models ranging from a public utility to a fully outsourced service. We conducted a formative evaluation of the as-is model with the Gothenburg partner and a summative evaluation of the to-be scenario analysis at a consortium workshop with 17 members. Consortium members rated the scenario analysis useful for understanding network complexity and supporting decisions, but requested more guidance in model analysis. The operating models differed in financial value only, since their environmental and social components were computed from quantities held constant across them. The main contribution is four design principles for applying business ecosystem modeling in a multi-actor public-sector setting, derived from the demonstration and its evaluation.

Keywords

Business ecosystem, Enterprise modeling, Scalability, Sharing economy, Case study

1. Introduction

The average European household owns more than 10,000 goods, 80% of which are used less than 3 times per year [1]. Sharing economy initiatives offer an alternative to the traditional consumption paradigm, but their impact depends on surviving beyond the pilot stage as viable services at scale. That requires balancing economic profit, environmental impact, and social benefits [2] across a large ecosystem of public and private organizations and individual consumers.

Business ecosystem models can represent a sharing economy initiative as a set of roles and interactions in which participants exchange tangible and intangible value to achieve economic or social good [3]. Reasoning about how those exchanges develop over time can indicate whether an initiative can scale and support a profitability analysis of the partners [3, 4]. Continuous Business Model Planning (CBMP) is a modeling method that conceptualizes a business ecosystem as a set of interrelated business models, manages the value exchanged among them, and orchestrates the distribution of that value over time [5, 6]. However, applications of business ecosystem modeling to sharing economy initiatives, where much of the value is public and no single party owns the outcome, remain scarce.

Therefore, the following research question is addressed: *How can business ecosystem modeling be applied to analyze the long-term scalability of sharing economy initiatives in terms of economic,*

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environmental, and social value?

In this paper, we report on the application of CBMP to a real-world sharing economy initiative and on its evaluation by model users, following the Design Science Research (DSR) methodology. The case study involves digital kiosks, a form of sharing economy infrastructure, offering shared items such as sports equipment and household appliances. In the studied context, the kiosks were being deployed by eight pilot organizations across seven countries in the North Sea Region [1]. We modeled the as-is model of the Gothenburg case, as it operated at the pilot stage, and used that model to compare three alternative to-be operating models over a 10-year horizon on financial return, on an aggregate strategic mandate indicator, and on end-user satisfaction.

The paper contributes (i) a demonstration of CBMP in a multi-actor public-sector setting, for which the as-is model, the to-be scenario analysis, and the computation logic are published as an open deliverable [7]; (ii) a two-stage evaluation, comprising a formative evaluation of the as-is model with the Gothenburg case partner and a summative evaluation of the to-be scenario analysis with 17 stakeholders across all eight pilot organizations, using constructs from the Method Evaluation Model [8] and the model-quality instrument of Maes and Poels [9]; and (iii) four design principles for applying business ecosystem modeling in a multi-actor public-sector setting, which are derived from the demonstration and evaluation to answer the research question.

The paper is structured as follows. Sect. 2 reviews related work on sharing economy initiatives, business ecosystem modeling, and CBMP. Sect. 3 describes the DSR methodology, used for the demonstration of the models in Sect. 4 and for the evaluation in Sect. 5. Sect. 6 ends with a conclusion and discussion, including the four design principles for applying business ecosystem modeling in a multi-actor public-sector setting.

2. Related Work

2.1. Sharing Economy Initiatives

Sharing economy initiatives pursue goals beyond financial return [2]. Many projects begin as funded pilots that work and then fail to become permanent services, which urban innovation research treats as a central problem [10]. The barrier is seldom technical. It is rather an organizational matter of how an initiative sustains itself and becomes embedded in routines once the pilot ends [11]. The financial test that is suited for evaluating the viability of a commercial venture does not suffice in case of an initiative whose value is mostly non-financial, so recent work frames scaling readiness as a distinct assessment problem [12]. This problem is particularly critical for sharing and access services, as the rationale for such services is largely environmental and social [13], and the social aim of access can outweigh any direct financial return.

2.2. Business Ecosystem Modeling

Scaling business ecosystems is not a matter of adding volume. Talmar et al. [14] argue that ecosystem growth redistributes who owns the assets, who funds and runs operations, and who carries risk across interdependent actors. An ecosystem has to form, gain legitimacy, and be governed before a service holds together at scale [15], and emerging ecosystems often face a governance void over who participates and who decides [16]. Services involving public and multi-party ecosystems further sharpen the questions of value distribution and shared value [17, 18].

Digital business ecosystems are characterized by heterogeneity, symbiosis, coevolution, and self-organization among actors with diverse interests [19]. A sharing economy initiative has these properties. For example, no single actor controls the outcome: a housing company owns the hardware, a local partner runs operations, a vendor supplies the platform, a city grants the site, and residents supply demand. The actors are interdependent and not always bound by contracts, they coevolve as the service grows, and the value each captures depends on choices the others make. Robustness and scalability are therefore properties of the constellation, which is what makes a sharing economy initiative a suitable

object for business ecosystem modeling. A governing body needs to see how ownership, funding, public value, and financial return are distributed across that constellation over time, under different ways of organizing the service.

Business ecosystem modeling takes the network as a whole, rather than the individual firm with its customers and suppliers, as the unit of analysis [14]. Within the field of Enterprise Modeling, Value Network Analysis represents exchanges as tangible and intangible flows between roles and converts them into an assessment of what each participant gains [3]. The e^3-value line formalizes the same intuition for networked constellations and supports profitability reasoning over the modeled exchanges [4]. Value delivery has also become an established object of analysis in a pattern language for representing value in ArchiMate [20]. Furthermore, the Value Delivery Modeling Language (VDML) is a proposed OMG standard, and recent applications of value exchange analysis include valuation methods for smart grid development [21].

A systematic literature review [22] identified a scarcity of modeling methods for digital business ecosystems and a need for holistic views integrating multiple perspectives. A design method has since been validated in action research [19], and structural models have been used to assess ecosystem resilience at design time [23]. The research in [23, 19] models business ecosystems in terms of actors, their roles, and their goals, which is compatible with modeling from one participant's viewpoint [24].

2.3. Continuous Business Model Planning

CBMP focuses on a model analysis of value delivery within a network as a set of interacting and mutually consistent business models of the participants [5, 6]. A CBMP model names the participants, the roles they take, the values exchanged between roles, and the business models that bundle a role's exchanges. Each exchanged value carries value formulas whose operands are operational variables such as utilization, fee levels, and cost rates, so that reassigning a role or changing an input can be propagated to the outcome measures. Fig. 1 shows the CBMP notation using a case model fragment.

The method supports a computational analysis of value exchange over a planning horizon, so a modeled initiative can be compared across successive states. Phasing makes CBMP distinctive compared to most modeling languages in Sect. 2.2, with the exception of e^3-value profitability analysis which can also distinguish between phases with different transaction volumes, prices, and revenue splits. We selected CBMP for two reasons. First, it represents an initiative as a portfolio of interacting business models held by different legal entities, which is needed to compare different role allocations in the ecosystem. Furthermore, it incorporates non-financial value measures into the same computation as financial returns, which is needed to balance economic profit and social benefits of sharing economy initiatives (see Sect. 2.1).

In previous research, Poels et al. [5] report on the design of the CBMP method and apply it in an industrial case [25]. However, this work does not provide an evaluation of the method's usefulness with end-users in a multi-actor setting where no single party owns the initiative. This corresponds to the research agenda of Sandkuhl et al. [26] in Enterprise Modeling, which identified a gap in that techniques are designed faster than they are actually evaluated. Although evaluation practice has matured since, application studies that evaluate a value-delivery method with its intended users remain uncommon. Richter [27] evaluated a value-oriented method through a case study that assessed the method, notation, and tool support together. We follow that precedent.

3. Research Methodology

3.1. Design Science Research

We follow a DSR approach [28] to apply CBMP to a multi-actor public-sector sharing initiative. As we do not modify the method, this constitutes the application of a known solution to a new problem class, as described by Gregor and Hevner [29]. The DSR artifacts are two instantiations, an as-is model of the initiative and a to-be scenario analysis for reasoning over it. Since CBMP already exists, the design

contribution lies in four design principles for applying business ecosystem modeling in a multi-actor public-sector setting, which we derive from the demonstration and its evaluation in Sect. 6.

3.2. Case Study Demonstration

The case study is embedded in an EU-funded project in which eight pilot organizations across seven countries implement sharing stations for household goods. We took an engaged research stance [30], conducted 16 semi-structured interviews with sharing station stakeholders, and participated in the project's monthly and international partner meetings. This immersion helped delineate the problem context addressed in this paper: the scaling of a multi-actor sharing initiative whose value is largely non-financial. These data provide the context for this research, but a detailed analysis of this preliminary stage is beyond the scope of this paper.

We selected the Gothenburg case, led by the municipal housing company Familjebostäder, on purposive, information-oriented grounds [31]. The Swedish partners were the most advanced in their planning, had a portfolio spanning several types of sharing stations, and were willing to collaborate closely. This portfolio enabled a demonstration that spans more than one kiosk configuration. For this case, we drew on three interviews, conducted before modeling began, which established the context, the actors, and the partner's goals. Further calls during the modeling process clarified and validated the emerging model, and email exchanges supplied specific values on demand. The research team built the model, while the partner supplied inputs.

The demonstration ran in two iterative cycles. In the first cycle, an as-is model of the initiative, as it operated at the pilot stage, was built and calibrated; the second cycle used that model to analyze operating models over a 10-year horizon as to-be scenarios.

3.3. Evaluation Design

Two distinct DSR artifacts were evaluated. The formative stage assessed the as-is model with the case partner in two feedback sessions, checking whether its structure and value assumptions matched the Gothenburg initiative [32].

The summative stage assessed the to-be scenario analysis with a wider end-user community, in a workshop where 17 consortium members rated it on four constructs. Perceived ease of use and perceived usefulness were taken from the Method Evaluation Model [8]. Perceived semantic quality and user satisfaction were taken from the model-quality instrument of Maes and Poels [9]. Each construct was measured using a single item on a seven-point scale, followed by an open-ended question, so that practitioners could complete the questionnaire within the available workshop time. The first author prepared the questionnaire, the first and second authors administered it on paper during the workshop, and the second author transcribed the responses and computed the descriptive statistics. Respondents were consortium members external to the research team, whose responses are summarized in Sect. 5. The artifact they evaluated covered the financial outcomes and the two composite indicators described in Sect. 4.

4. Business Ecosystem Modeling

4.1. As-Is Model of the Gothenburg Initiative

We modeled the Gothenburg initiative using CBMP and its supporting Value Management Platform, commercially available as the StrategyPlanner tool [6]. The as-is model captures the actors, the roles they hold, and the value exchanges in the service as it operated at the pilot stage. It assigns 16 roles across the ecosystem, covering asset ownership, funding, operation, item custody, maintenance, and use. Familjebostäder leads the initiative and the City of Gothenburg acts as the sponsor that enables it.

Gothenburg's sharing economy initiative runs two pilots that differ along the dimensions that matter for scaling. The first pilot offers tools through the Circular Lib Network (CLN), with customized content

and capital expenditure carried by the housing company, starting from two stations. The second pilot offers sports items through Piffl, with standardized content and operating expenditure paid as a service fee, starting from one station. The first is organized as a Public Private Partnership and the second as a Fully Outsourced service. Both draw on the EU grant, which terminates during the planning horizon. Fig. 1 shows a fragment of the CLN pilot model, as the full model is too large to depict here. The Piffl model follows a similar structure. The complete models, with role definitions, the value-exchange structure, and the computation logic behind the outcome measures, are published as an open project deliverable [7]. The full participant network comprises 16 roles and 34 value exchanges.

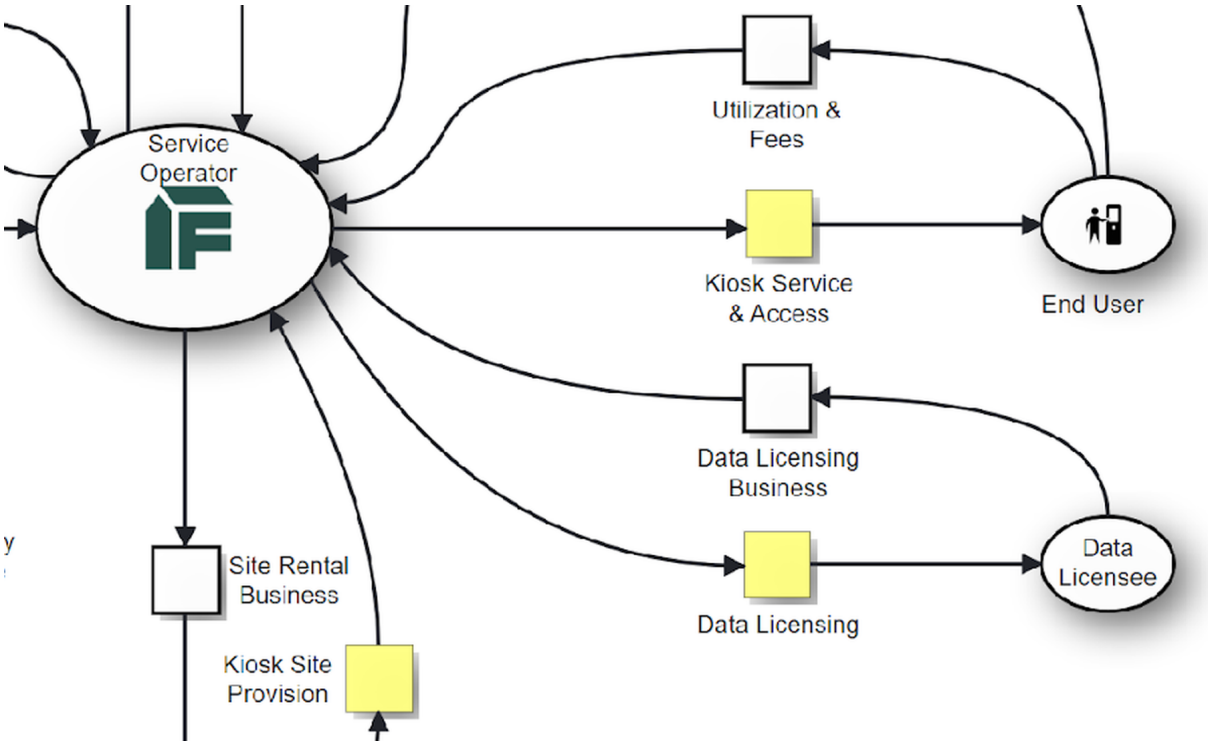

Figure 1: Fragment of the as-is model of the CLN pilot, as produced in the tool. Ellipses are roles and squares are the values exchanged between them; yellow shading is a tool convention marking a value that has been elaborated as a value proposition. The Service Operator offers Kiosk Service and Access to the end user and receives Utilization and Fees in return, and licenses usage data to a Data Licensee. Each exchanged value carries a formula over operational variables, which is how a change in role allocation propagates to the outcome measures.

The model incorporates non-financial value alongside financial value through a Strategic Mandate Score that aggregates six weighted components: environmental impact and social cohesion at 25% each, trust and quality of neighborhoods at 15% each, and financial health and risk and asset management at 10% each. An End User Satisfaction indicator aggregates six pillars: three concern the offer, namely whether the right items are stocked, their condition, and the price paid by users; three concern the service, namely how the kiosk is operated, how problems are resolved, and how well the app works. Each pillar is represented by a normalized sub-score computed from operational inputs such as utilization, stockout delay, and fee levels. This indicator is distinct from the user satisfaction rating reported in Sect. 5. The components and weights were derived from the context interviews, which captured the partner's stated goals, and the partner confirmed them before the scenario analysis. They are therefore a modeling choice grounded in the priorities of a single partner, and the scenario analysis is conditional on them. The model also represents a legal constraint that shapes the different scenarios. It distinguishes end-user fees, which are compensation for a commercial service and are restricted for the city and the housing company under Swedish municipal law, from site rental, which is compensation for the use of public property and is permitted. Consequently, which actor may collect which type of revenue differs across operating models.

4.2. To-Be Scenario Analysis

From the as-is model, we developed three alternative to-be operating models: a Public Utility, a Public Private Partnership, and a Fully Outsourced service. We developed these three as generic options that other cities could adopt, whereas the as-is models are specific to Gothenburg's starting point. Under the Public Utility model, the city takes over ownership and operational costs from the housing company; under the Public Private Partnership, both are transferred to a local partner; under the Fully Outsourced model, to a provider company. Table 1 summarizes the modeled role allocation. Day-to-day operations are assigned to a local partner under both the Public Utility and Public Private Partnership models. Under the Public Utility model the city therefore pays for operations that a local partner carries out, so the public option still needs an operator. Moreover, the city cannot collect end-user fees or data revenue under the Public Utility model, whereas a partner or provider can. The legal constraint therefore manifests as a difference across the alternatives.

Table 1
Role allocation across the three alternative operating models.

Role	Public Utility	Public Private Partnership	Fully Outsourced
Enables initiative	City	City	City
Owns kiosks and inventory	City	Local partner	Provider
Covers operational costs	City	Local partner	Provider
Day-to-day operations	Local partner	Local partner	Provider
Fees and data revenue	No	Possible	Possible

We simulated each model over 40 quarters: a nine-quarter pilot and validation phase, which includes the EU grant period, followed by a 31-quarter scaling phase. Four transition paths were modeled: from the CLN pilot to each of the three operating models, and from the Piffl pilot to the Fully Outsourced model, because scaling an outsourced service in a viable way involves purchasing additional capacity. Each path was varied along two axes, the payment model (monthly fee, pay per use, or an initial free period) and the content focus (customized or standardized items). The resulting scenarios were analyzed from the perspectives of the housing company, the city, the local partner, and the ecosystem as a whole.

Two assumptions govern the scenario analysis. First, the deployment trajectory of extra kiosks is fixed per path, so a model that generates more revenue does not thereby fund faster growth. Second, the utilization rate is held constant across operating models within each period (at 1,311, 1,902, and 2,640 bookings per kiosk per month at the three reporting points, see Fig. 2). Demand is thus exogenous to how the service is organized and priced. This is a strong assumption, since the models differ in whether users are charged at all. It favors the models that charge, which gain revenue without losing users, and it means that cost per use varies on the cost side only.

Table 2 and Fig. 2 present the year-10 financial outcomes. The Public Utility model runs a quarterly deficit of about €119k with the highest cost per use at €1.68. Legal limits on what the city may charge constrain its revenue, so the deficit is a revenue effect rather than a demand or cost effect. The Fully Outsourced model results in a combined quarterly deficit of about €28k, as the provider retains the end-user fees. The Public Private Partnership is the only model that reaches financial viability at scale. It does so by allocating the surplus to the partner, who earns roughly €376k per quarter, while the city approaches break-even, with a net cost of about €5k. The cost per use is also the lowest at €0.15.

We show one calculation in detail. Cost per use divides the quarterly Total Mandate Cost by the bookings the network delivers per month. For the Public Utility at 2035-Q4 the model holds a Total Mandate Cost of €146,377, 2,640 bookings per kiosk per month, and 11 kiosks. Dividing the quarterly cost by three gives €48,792 per month over $2{,}640 \times 11 = 29{,}040$ bookings, which yields €1.68 as cost per use. A financial analysis focused on the city alone would show the Public Private Partnership as yielding a near-zero outcome, while leaving the destination of the surplus invisible. This distributive perspective is one of the key benefits of modeling the ecosystem.

Table 2
Year-10 outcomes per quarter for the three alternative operating models.

Model	Primary revenue source	Cost per use	Quarterly outcome
Public Utility	None	€ 1.68	€ 119k deficit (city)
Public Private Partnership	End-user fees and data	€ 0.15	€ 376k profit to the partner, city € 5k deficit
Fully Outsourced	Provider keeps fees, housing company collects rent	€ 0.43	€ 28k deficit (combined)

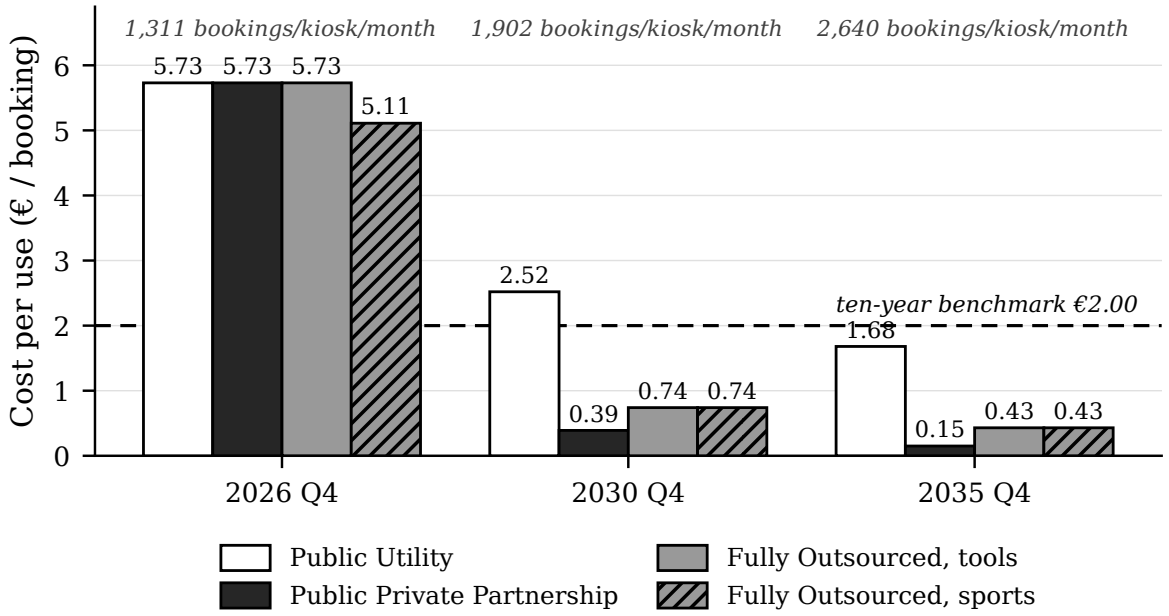

Figure 2: Cost per use at three points in the planning horizon, by scenario. Utilization is held constant across scenarios within each period.

Financial health is only one of six components of the strategic mandate, weighted at 10%. Therefore, Table 3 also reports the Strategic Mandate Score and the End User Satisfaction indicator at year 10. Both are model outputs, computed in the tool from the value formulas described in Sect. 4, and not survey scores. No operating model performs best on both dimensions. The Public Utility model scores lowest on the mandate and highest on satisfaction, whereas the Public Private Partnership shows the opposite pattern. Both patterns can be traced to the same legal constraint. Because the city may not levy end-user fees, residents pay nothing under the Public Utility model, which raises the financial accessibility component of satisfaction to its maximum while reducing the financial health component of the mandate to its minimum. Thus, the legal constraint that limits the city's ability to generate revenue also results in the highest financial accessibility for users. The environmental and social components do not differentiate between the models because they are computed from utilization and the number of kiosks, both of which are held constant across models in each period. The scenario analysis therefore discriminates only between components that respond to the allocation of payments and revenues. The three models thus reflect different trade-offs rather than a single ordering of the scenarios, and the analysis makes these trade-offs in the scenarios explicit rather than resolving them.

Consortium participants also mapped the opportunities and challenges of each operating model, working in breakout groups of six to seven people (see Table 4). The mapping reveals a tension that is not captured by the financial analysis. The only financially viable model depends on a local operator who might be difficult to find, potentially unavailable, and requiring skills that candidate organizations may lack. The analysis therefore exposes a tension between financial viability and operational feasibility.

Table 3
Year-10 strategic mandate and end-user satisfaction by operating model, as computed by the model.

Model	Strategic Mandate Score	End User Satisfaction
Public Utility	4.75	5.53
Public Private Partnership	6.81	4.53
Fully Outsourced	6.39	4.53

Table 4
Opportunities (+) and challenges (−) in scaling identified by consortium members, by operating model.

Model	Financial / economic	Organizational	Technical	Regulatory
Public Utility	Budget constraints (−), costs mixed into urban development budgets (−)	Community building (+), employability (+), collaboration across departments and social institutions (+), staffing (−)	Operational maintenance (−)	Use of public space (+), data sharing (−), competition with local business (−)
Public Private Partnership	Requires enough users at the right price (−), scaling of the social enterprise (+)	Local operator often does not exist (−), operator skills (−), partner types include libraries and student businesses (+)	Tested in practice (+)	City cannot take income (−), city cannot compete with companies (−), public procurement (−)
Fully Outsourced	No funding and no income once the grant ends (−)	Vendor lock-in (−), no control over the service (−), public interest at stake (−)	No technical responsibility (+)	GDPR (−), public procurement (−)

5. Evaluation

5.1. Formative Evaluation of the As-Is Model

The two sessions with the Gothenburg partner, in which the project manager participated throughout, joined by colleagues from the innovation and sustainability department, changed the model in three ways. First, they corrected the allocation of revenue: we had modeled the provider as earning per use under the outsourced arrangement, which it does not do in this case because the housing company cannot collect end-user fees to pass on. This is one of the main constraints that differentiate the three operating models in Sect. 4.2. Second, they supplied operating costs that we had not previously included, such as the pay rate for the person responsible for inspecting returned items. Third, they added activities that we had not represented at all, such as neighborhood events used to promote a station, which incur costs and generate measurable interest.

5.2. Summative Evaluation of the To-Be Scenario Analysis

Seventeen consortium members representing all eight pilot organizations rated the scenario analysis on four constructs, each measured with a single seven-point item followed by an open-ended question (Table 5). The items asked whether the analysis was easy to understand and use, useful for improving understanding, a correct and complete representation of the initiative, and satisfactory in supporting information needs for planning decisions. Given the single item per construct and a limited sample, we report descriptive statistics only. All four means exceed the scale midpoint, and no participant rated any construct below 3.

Table 5
Consortium member evaluation of the analysis (seven-point scale, higher is more favorable).

Construct	n	Mean (1–7)	SD
Perceived ease of use	17	5.00	1.00
Perceived usefulness	17	5.76	0.66
Perceived semantic quality	17	4.94	0.83
User satisfaction	16	5.56	0.89

The open-ended responses offer additional insights. Regarding perceived usefulness and user satisfaction, participants highlighted the value of seeing the entire ecosystem at once: a visual representation of all parties and the advantages and disadvantages of each option, the loops and flows, and a model that can be expanded and built upon. One participant noted that the model opens up discussion and should be introduced at the beginning of a project; another valued it for making the rules explicit. Nevertheless, two participants qualified their responses by describing the analysis as premature or too complex.

Responses concerning perceived ease of use differed on whether the model's complexity was perceived as a limitation or as a faithful representation of the domain. Some participants found that it contained too much information and too many actors, while one observed that the analysis is inherently complex and does not necessarily need to be easy to use. Regarding perceived semantic quality, four participants gave a neutral assessment, citing the absence of empirical project data at this stage or a lack of relevant experience. Among the others, one participant confirmed the model from a financial perspective, while another identified the Public Private Partnership as the most viable option.

Three concrete requests recurred in the responses. Three participants indicated that they would have preferred to receive introductory material before the session to help them prepare. Three asked for the model's vocabulary to be better explained, since terms such as value proposition and business model have specific meanings within the notation. One participant requested a larger working surface, such as a wall-sized print or a smartboard, so that the model could be enlarged and examined during discussion. None of the participants requested changes to the model itself. In summary, applying a business ecosystem model developed with one partner to a wider group of stakeholders who were not involved in the modeling process required an onboarding step that the CBMP method does not currently prescribe.

6. Discussion and Conclusion

We demonstrated CBMP on the Gothenburg digital sharing-economy initiative and evaluated the as-is model formatively and the to-be scenario analysis summatively. Poels et al. [5, 25] developed CBMP for settings in which an organization plans its own business models and reported on the practice from the modelers' perspective. This study extends that research by reporting on the users' perspective in a setting where no single party owns the initiative and much of the value is non-financial.

The evaluation supports the perceived quality of the CBMP analysis, conditional on appropriate modeling support. Mean ratings of the summative evaluation exceeded the scale midpoint on all four evaluation constructs, and consortium members valued the ability to see the entire ecosystem and its trade-offs in a single representation. None requested changes to the model, but they asked for introductory material and guidance on the model's vocabulary.

In answer to the research question, the demonstration and its evaluation yield four design principles for applying business ecosystem modeling in a multi-actor public-sector setting. None requires a change to the CBMP method, and each follows from a specific point in the case:

1. Model the initiative as several co-existing business models held by different legal entities, so that alternative role allocations can be compared. CBMP supports this configuration, but no published application had used it. It follows from the comparison of operating models in Sect. 4.2.
2. Aggregate environmental and social components alongside financial return in the value placed at

the center of decision support. In this case environmental impact and social cohesion carry half the weight of the mandate indicator and financial health a tenth (Sect. 4).
3. Model the ability to generate revenue as an actor-dependent constraint, since a public body may not levy end-user fees for a service that is legally classified as commercial. The partner surfaced this constraint in the formative evaluation (Sect. 5).
4. Make the value components that should discriminate between scenarios respond to the role allocation. Here the financial components of the two composite indicators moved in opposite directions across the alternatives and revealed a trade-off between the city's mandate and users' access. The environmental and social components, computed from quantities held constant across the alternatives, did not separate them (Sect. 4.2).

Some limitations bound these results. The demonstration rests on one case partner who provided input on and confirmed the composite indicators and their weights, so the scenario analysis primarily reflects that partner's priorities. In addition, the scenario analysis produces point outcomes without sensitivity analysis, while demand is exogenous and held identical across models that differ in whether users pay. The summative evaluation used one item per construct and 17 respondents, four of whom gave a neutral semantic quality rating due to a lack of empirical project data or experience. Although respondents were external to the research team and the open-ended responses are reported, the evaluation was not independent of the method's authors. We therefore make this potential bias explicit through the disclosure of interests. Furthermore, we measured perceptions during the evaluation rather than decisions taken, and therefore make no claim that any partner has yet chosen an operating model in practice on the basis of the CBMP analysis. Finally, The design principles are derived from a single case and have not yet been evaluated as generic principles.

The following options require future research. First, the composite indicators were specified by the modeling team and not derived from measurement literature. Validating a construct as a reflective latent variable in a survey does not automatically validate a composite measure of that construct based on utilization rates and fee levels. As the business ecosystem modeling literature offers little guidance on how to bridge that gap, developing such measurement guidance is interesting for future research. Second, the legal context shaped the scenarios and appeared in the model only through its consequence, a revenue flow one actor may not receive. Representing legal and policy constraints as explicit modeled elements is therefore an option for future business ecosystem modeling methods.

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Declaration on Generative AI

During the preparation of this work, the authors used Claude (Anthropic) in order to: check grammar and spelling, paraphrase and reword, and check terminology consistency. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

Disclosure of Interests

Henk de Man and Theodoor van Donge are the founders of VDMbee, which develops the StrategyPlanner tool used in this study, and the project budget includes a paid consultancy and licensing arrangement with VDMbee. Geert Poels and Ben Roelens are co-authors of the CBMP method that this paper applies and evaluates. Michal Hron declares no competing interests.

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