Addressing Stakeholders Needs in Infrastructure Asset Management

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Abstract. The key objective of asset management is to provide value with assets. Value is by nature a subjective concept, and no single uniformly valid framework for assessing value exist. What is of value for an organisation depends on the operating context and needs to be established considering the relevant stakeholders. Theoretically, this is unique for every organisation. Yet, similarities exist between organisations operating within the same context, providing an opportunity for some standardization. In this paper we explore the potential of providing a good starting point based on experiences in infrastructure asset management. Based on theories for decision making a common value framework would be useful in cost benefit analysis. To establish the elements of this value framework it is possible to use a reversed stakeholder analysis approach so the that more than the usual suspects (shareholder, client, employee, legislator/regulator) and a very minimal set of values (financials, safety, compliance and reputation) can be addressed. Based on the 6 capitals model we developed an extensive list of values that provide a 360° view on the world along with their associated objectives and indicators. In order to provide a pragmatic starting point, we reduced this long list to a set of risk indicators that still captures the essence of that broad view and covers a significant portion of decision problems in the public domain. We demonstrate the useability of such a limited set with a practical application in determining the social value of cycling.

Keywords: Infrastructure asset management · Decision making · Stakeholders · Value framework

1 Introduction

The key objective of asset management is to provide value with assets. It is explicitly stated so in the definition of asset management as provided in the ISO 55000 series (ISO, 2014a, ISO, 2014b, ISO, 2018) but can also be recognized in earlier efforts to formalize the concept of asset management, like PAS 55 (BSI, 2004a, BSI, 2004b) or the definition of terotechnology (Thackara, 1975). However, the concept of value has changed over time. Where terotechnology focussed on economic value, PAS 55 included the concept of risk and ISO 55000 used value as an abstract concept to be defined by the organisation practicing asset management. However, value is not defined

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(let alone quantified) in ISO 55000:2014, though reference is made to stakeholder needs and organisational objectives[1].

In a way it is beneficial that no definition on the quantification of value is provided. Value is by nature a subjective concept, and no single uniformly valid framework for assessing value exists. What is of value for an organisation depends on the operating context and needs to be established considering the relevant stakeholders. Even within an organisation the quantification of value may differ, if there are significant differences in the encountered stakeholders. In project management it is therefore quite common to undertake a separate stakeholder analysis (Project Management Institute, 2017) Yet, the lack of a unified value framework is also a missed opportunity from a societal perspective. Organisations that operate in the same institutional context (e.g. region or country) often encounter the same or at least very similar stakeholders. This suggests their value frameworks should also be highly similar (Wijnia, 2016). Using a common framework would allow for better alignment of the marginal benefit of investment portfolios and thus provide better total societal value (Tengs et al., 1995). Furthermore, it would help prevent unintentional destruction of value by missing a known interest, for example in single value programs like circularity. Both benefits would be very relevant for infrastructure[2] asset management (either by dedicated operator or (local) government), given their diversity in asset portfolios and organisational objectives. Finally, having a simplified framework would be of benefit to organisations starting with value based asset management.

In this paper we explore the potential for a more standardised starting point for addressing stakeholder needs via a value framework. First we will provide some background for infrastructure asset management and value based decision making. Secondly we will discuss pragmatic way of categorizing the stakeholders into several groups, with each group having some typical interests and importance. To safeguard coverage of all potential we will match this pragmatic understanding with a more theoretical reference model. This has been populated with values, objectives and indicators currently in use in infrastructure asset management in two iterations. To provide a pragmatic starting point we simplify this long list into a limited basic set that still provides a 360 degree view on the world. The value of such a limited set is demonstrated in a case study on motivating investments in promoting cycling, a common decision problem for many countries and cities. The paper concludes with a summary of the findings and recommendations for further development.

2 Background

2.1 Context

The results as presented in this paper were developed over years of experience with decision making in infrastructure asset management in the Netherlands, United Kingdom and Belgium to name a few. Infrastructure asset management is atypical for a number of

[1] ISO 55000 and ISO 55001 are currently undergoing revision with a target publication of mid to late 2024 and a definition of the concept of value is foreseen. The quantification of value will still be up to the organisations themselves.

[2] Infrastructure is meant here to cover both road, rail, utilities and the like as well as public spaces and other (semi) public facilities (sports, cultural, recreational).

reasons (Herder and Wijnia, 2012). Most relevant with regard to the concept of value is that the most significant impacts occur outside of the infrastructure operator. Value (for themselves) is created by the users of the infrastructure, sometimes at the cost of external effects like noise and pollution. Value creation may be threatened by incidents which also may have a safety impact. As a result, there is a skewed distribution of cost and benefits. Adding to the complexity is that infrastructure is often heavily constrained, both in budget and space. Furthermore, the users are typically anonymous, potentially resulting in unexpected or undesired usage. Given that failures are highly visible, the field has a high reliance on (monodisciplinary) norms and standards to prevent liability in case of accidents. Combined this results in organisations with an asset or aspect focus on value delivery (the infamous silos), whereas the stakeholders typically have an integral value experience. In such a segmented operating environment a large potential for suboptimal decisions exist, for example by very low yielding expenditure to spend the full budget of the department, or even net negative projects by simply ignoring impacts outside the focus area for symbolic policies.

2.2 Theories on Decision Making

There is no objective criterion to determine if the right decision is made. Decisions are about value, and value is inherently subjective. A good decision is what the decision makers regard as a good decision. Decision science therefore is unavoidably about preference elicitation. In short, there are three major internally consistent theories on decision making, though many hybrids exist (Merkhofer, 1987). Each of the theories has its own set of axioms, assumptions and procedures. Decision Theory helps individual decision makers in combining a number of partial preferences into a total preference, Social Choice Theory focusses on the combination of the preference of many individuals into a group preference, and Cost Benefit Theory considers the net contribution to total wealth. Table 1 summarizes their characteristics with regard to value.

Table 1. Concept of value in different decision theories after Merkhofer (1987)

	Cost Benefit Theory (CBT)	Decision Theory (DT)	Social Choice Theory (SCT)
Conceptual basis	Economic efficiency	Axioms of individual choice	Axioms of social choice
Method of analysis	Comparison of aggregated value of estimated consequences of alternative actions	Determination of logical implications of alternatives, information and preferences of decision maker	Derivation of group decision from acceptable mechanisms for incorporating individual preferences
Concept of value	Total monetary equivalent as determined by economic actors in a free market	Responsibility of decision maker, objective is consistency	Social preference derived from "equitable" synthesis of preferences of impacted parties
Perspective	Technical (impersonal)	Individual	Group/social

It is important to realize that none of these methods is fundamentally better than the others. From a decision engineering viewpoint however it is relevant to consider what theory works in what context. This can be understood with help of the risk escalator (Klinke and Renn, 2002). Most decisions are routine based without explicitly addressing value impacts, e.g. by working with (technical) thresholds. Only in case the routines do not provide an accepted answer, a more elaborate analytic method may be used. The first step of the escalator is typically a social cost benefit analysis in which external (non-financial) effects are monetized. If external effects cannot be reasonably valued a priori, Decision Analysis provides methods for valuation a posteriori by comparing potential decision outcomes directly. In case the values are ambiguous (direction of improvement not agreed), a Social Choice approach may be more useful, as it allows establishing the combined preference of all stakeholders without having them quantify their value concept.

It is also worth noting that there are differences between repeated decisions (e.g. policies and programs) and unique decisions (e.g. projects). Repeated decisions have to consider stakeholders as an abstraction as the actual stakeholders are different for every decision. The values needed to represent their interests are the perceived general preference of that abstraction. In that sense it is conceptually close to the monetization of external effects as used in cost benefit theory. Unique decisions on the other hand may require addressing individuals and their preference. Building a good relation with local community or even individual local residents can greatly reduce disruptions or even improve the smoothness of operation (e.g. if their private property may be used). The scope of this paper is the repeated decision, as that is where a uniform value framework can improve asset management efficiency.

3 Stakeholder Analysis

A common approach is to plot stakeholders in the power-interest grid (Ackermann and Eden, 2011, Maj, 2015) and rank them on their importance (a combination of the impact on them and the power they can exert). Stakeholders are often split into 4 quadrants as shown in Fig. 1, with the associated management strategy. The needs of the most relevant stakeholders then can be integrated in the value framework used for decision making.

However, it is important to realize infrastructure operators may have hundreds of internal and external stakeholders, of which some 50–100 are often identified in a first session. Assessing all of them for their interests that perhaps should be included in the value framework is beyond the capacity of most asset managers. The interests analysis therefore is often limited to stakeholders with significant power, the players and context setters. This limitation is also suggested by the management strategy in the diagram. Typical stakeholders in these categories are shareholders/councils, clients, other internal departments, employees and legislator/regulators. The associated values for this group of usual suspects is often limited to financials, safety, compliance and reputation, i.e. the impacts hard to ignore in asset management decision making.

For the participants of such a stakeholder analyses this result is often somewhat disappointing. First of all, the limited list is often not specific for the organisation, and could have been copied from a reference model. This makes the exercise seem like a

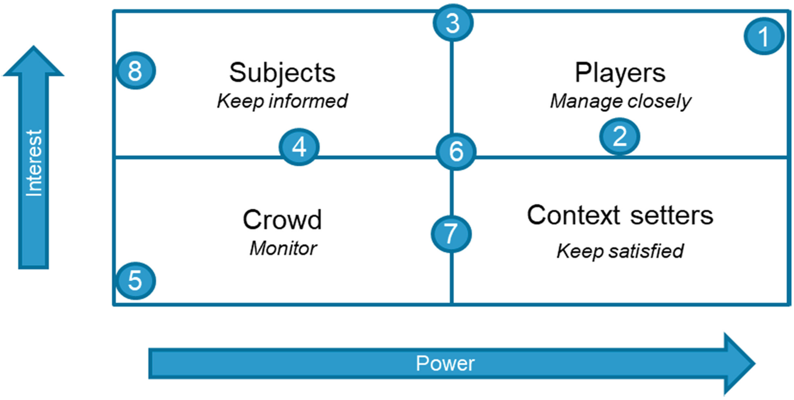

Fig. 1. Power interest grid after Ackermann and Eden (2011), Maj (2015). The numbers represent the stakeholder groups of Table 2.

waste of time. Secondly, government is (or should be) typically also concerned with the not so powerful, especially if they are negatively impacted. This thinking would also expand to all organisations genuinely interested in implementing a 360° world view into their decision making.

Table 2. Grouping stakeholders by their interest

ID	Stakeholder group	Stakeholders for public domain	Perceived Interest
1	Decision makers	Legislators/regulator Board/council	Affordability Happiness of users
2	Partners	External: Utilities, rail, highway,. Internal: Social & city development	Maintainability of assets Attractive city Quality of life
3	Primary users	Residents, workers, companies, commuters	Useability Working, clean and safe
4	Secondary users	Tourists, visitors	Experience
5	Undesired Users	Criminals, vandalism	Stealth, being undetected
6	Indirect stakeholders	Environmental pressure group Local community	Sustainability Quality of life Quality of environment
7	Financers	EU, central/regional government Local sponsors	Compliance Being visible
8	Suppliers	Contractors, knowledge institutes	Work

In an effort to get a broader view we typically have the participants categorize the stakeholders into several groups that have similar interests (as perceived and understood by the participating asset managers). A typical result of such a categorization is shown in Table 2. The IDs have been plotted in Fig. 1, to demonstrate that these groups cover more than just the top right quadrant. The list of stakeholder groups also proved to be a useful starting point for new stakeholder identification sessions. The reversed approach essentially allowed the participants to build on acquired knowledge and add their own specific stakeholder interests.

4 From Stakeholders Interests to Indicators

A further step towards streamlining the process was aligning these perceived interests with a more fundamental theoretical understanding of value. Inspiration for such a foundation can be found in several sources, ranging from the 3 perspectives in triple bottom line reporting (Elkington, 1999) to the 17 Sustainable Development Goals of the United Nations (United Nations, 2017). We used the Six Capitals model of Integrated Reporting (IIRC, 2021, Wijnia, 2022) as a starting point, as that seemed to provide the right balance between simplicity and completeness. However, as the term Capital did not seem to resonate well with our target group of infrastructure asset managers we renamed it to Value Domain.

For values to be used in (social) cost benefit analysis (the preferred approach for explicit value based decision making), they must be quantifiable by means of value measures. Development of such a value framework typically involves a number of iterations to align what should be measured with what is actually measured. A first iteration was conducted in a project for developing a value framework for the (extended) UK Water industry (UKWIR, 2022). In this project a longlist of some 500 different value measures (indicators) with their associated desired outcomes (objectives) used by the industry were collected from public documents. In reviewing the longlist many were found to be redundant (i.e. in use by more than one organisation) and the list could be filtered down to some 170 unique indicators. These indicators had some 50 objectives associated with them, about one objective for every 3 indicators. These objectives could be linked to the 6 value domains directly, though an additional layer would help in the overview. We therefore introduced the intermediate value level (see Fig. 2 for the structure) with three values per value domain. The distribution of objectives and indicators over these values suggested some unbalance, and an additional 30 indicators were added to cover the gaps. The resulting value framework thus consisted of 4 tiers: 6 value domains, 18 values, 50 objectives and 200 indicators, as published in the aforementioned report. The layered structure of the value framework also allows for usage in different contexts. The indicators would be required for Cost Benefit Analysis and reporting, but in Decision Analysis and/or Social Choice objectives, values or even only value domains may suffice. Just acknowledging that there is more than just the single value of interest can be enough for a meaningful dialogue of asset managers with their stakeholders.

5 Refining the Value Framework

In a second iteration the water industry value framework was assessed against its universal applicability for more diverse asset bases. This iteration was conducted in redeveloping the value framework for the asset management department of the city of Rotterdam[3]

[3] Presented in a workshop at the 2022 annual conference of the Dutch Chapter of IAM, 22 June 2022, Vrouwenpolder, the Netherlands.

Table 3. Value domains, values and objectives in the reference value framework

Value domain	Value	Objective 1	Objective 2	Objective 3
Financial	Affordability	Efficient use of monetary resources	Operating within budget limits	Fair prices
Financial	Stability	Healthy finances	Correct administration	Managed risks
Financial	Flexibility	Budgetary discretion	Asset liquidity	Managed opportunities
Manufactured	Useability	Functional match with needs	Assets work as designed	Accessibility
Manufactured	Quality	Additional benefits (looks, comfort)	Being undemanding	
Manufactured	Resilience	Robustness	Redundancy	Multifunctionality
Intellectual	Data Stewardship	Data reliability	Data accessibility	Data security
Intellectual	Governance	Systematic and structured work	Full documentation	Transparency
Intellectual	Creativity	Continual improvement	Generation of new knowledge	Innovative culture
Human	Health and Safety	Safe and healthy working practices	External safety	Perceived personal safety
Human	Empowerment	Education and personal development	Being informed and involved	
Human	Wellbeing	Sufficient income	Access to basic services	Commercial & cultural services
Social	Trust	Compliance	Employee integrity and respect	Being a trustworthy partner
Social	Responsiveness	Constructive stakeholder dialogue	Local differentiation	Consensus/consent
Social	Inclusivity	Include special interest groups	Representativeness of the organisation	Cultural diversity
World	Sustainability	Limit climate change	Reduce use of depletable resources	
World	Quality of environment	Clean environment (air, water, land)	Darkness & silence	
World	Viability of ecosystems	Nature	Biodiversity	

and covered a highly diverse asset base (13 different portfolios with more than 270 high level types of assets).

In the iteration more than 20 strategy and vision documents were reviewed, which resulted in some reformulation of values and objectives, addition of a number of indicators for the human and the social domain, and condensation of several detailed indicators into more overarching ones (e.g. several emissions into a general pollution measure)[4]. In Table 3 the resulting (translated and paraphrased) reference model is shown up to the level of objectives. To give a feel for the total reference model we have included a value tree for the value domain "World" in Fig. 2.

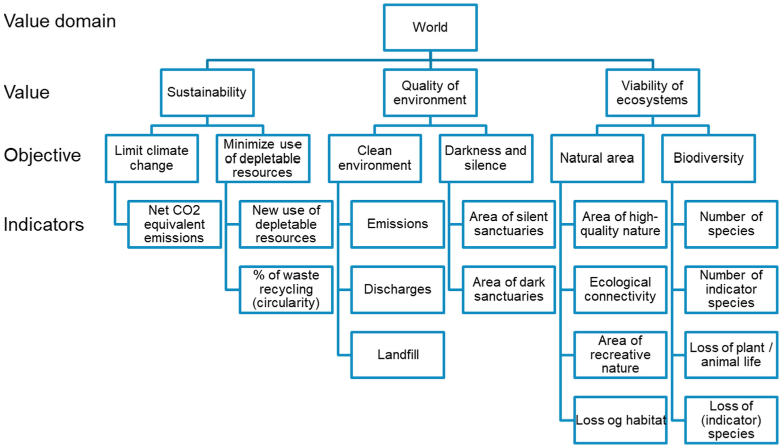

Fig. 2. Value tree for the value domain World

6 Suggested Basic Set of Indicators

Even though the full model should cover virtually all issues that can be encountered in decision making for infrastructure asset management, a value framework containing 200 indicators is way too large to be practicable. In our experience, for most individual decisions a handful of indicators is good enough to reliably distinguish between alternative interventions, though the set varies over the decisions. To cover a reasonable fraction of the decisions an organisation faces, a least common multiple would be needed. That common ground is presented in Table 4. This basic value framework tends to provide a good starting point for most decisions. The presented indicators can be assessed and monetized with relative ease, allowing for a social cost benefit analysis. These 16 indicators still cover all value domains and thus gives a 360° perspective on the world, though it may not hold all nuances. The focus on negative impacts is chosen to allow alignment

[4] The overall number of elements remained more or less the same: 6 value domains, 18 values, 55 objectives, 210 indicators.

Table 4. Basic framework for addressing stakeholder needs

Value domain	Value	Objective	Indicator
Financial	Affordability	Efficient use of resources	Financial waste (damages, unplanned costs, lost income,…)
Manufactured	Useability	The assets are in good health	Lost production (volume, value, hours)
Manufactured	Useability	The assets are in good health	Loss of remaining life (above normal ageing)
Intellectual	Data Stewardship	Data security	# security breaches
Intellectual	Data Stewardship	Data security	# data loss/leakage
Human	Health and safety	Safe and healthy working practices	# work incidents (including unsafe situations/actions)
Human	Health and safety	Safe and healthy working practices	Sick leave rate
Human	Health and safety	External Safety	# external incidents
Human	Health and safety	External safety	# Health damage
Human	Wellbeing	Perceived personal safety	# breaches weighted by severity
Social	Trust	Compliance	# Compliance incidents
Social	Trust	Being trustworthy	# Negative press
World	Sustainability	Limit climate change	Net CO2 equivalent emission
World	Quality of Environment	Clean environment (air, water, land)	Volume/mass of emissions, discharges and waste
World	Quality of Environment	Clean environment (air, water, land)	# pollution incidents
World	Quality of Environment	Darkness & silence	# disturbance incidents

with in the reference risk matrix (NEN, 2009) that has been used by many infrastructure operators in the Netherlands. A next step could be to expand this basic model with indicators for measuring positive impacts, e.g. indicators for wellbeing.

7 Practical Application

As mentioned in the introduction, the final goal of a common value framework is to improve decision making by aligning investment portfolios on their marginal social return and avoid unintended loss of value by ignoring values originally out of scope. A practical example on how to achieve these final goals with the basic set of values can be

Table 5. Value of additional cyclists after Decisio (2017) and Goudappel Cofeng (2018)

Indicator	Consideration	Impact	Annual equivalent value
Lost production	Every additional car in rush hour adds 10 min delay. Delay is valued on average at €10 per hour	200* 10 min = > 33,3 h	€ 333
CO2 emissions	Reduction 150 g/kilometre CO2 valued at € 100/tonne	3000*0,15*1/1000 = 0,5 tonne	€ 50
Sick leave rate	Cyclist need less sick leave (up to 50%). Conservative estimate 1 day per year Cost of sick leave € 400 per day (average FTE cost € 80,000 per year	1 day	€400
Safety incidents	Fatality risk on bicycle about 10 times higher per km than car. Fatality valued at M€ 3	3000 km results in an additional fatality every 25000 years	-/- €120
Net value			**€663**

found in establishing the added value of additional cyclists. Many countries and cities around the world are committed to reducing their carbon footprint (i.e. CO2 emissions) and have embraced cycling as a way to achieve this goal given that it reduces the emission per passenger kilometre to virtually zero. However, in absolute terms the impact is much less. Combined with the relatively low monetary equivalent value (price per tonne), it means that initiatives to promote cycling often struggle with funding. The budget claim thus typically is supported with additional qualitative arguments: reduced congestion, reducing the environmental impact (required space, air quality, noise) and improving the health of the population. What is often not mentioned and may be used to challenge the initiative is that cyclists are more vulnerable in traffic, especially in cities without proper cycling infrastructure. Even by only using a small number of indicators from the basis set a much broader view on the total societal value of additional cyclists[5] can be developed. In Table 5 some numbers for the Dutch context are collected for a cyclist replacing 3000 car kilometres per year (200 days * 15 kms travel distance).

[5] Such a marginal net value allows for the selection of an efficient portfolio of interventions: those that cost less per additional cyclist. This is in contrast with the current practice of assigning a budget and only using qualitative (= unquantified) objectives.

The results of such a quantification can be a surprise to policy makers. First of all, the increased safety risk would offset the benefit in sustainability. Only quantifying CO2 thus would leave the policy vulnerable to opposition based on the safety impact. To improve safety additional investments would be needed, but the programs are already struggling for budget. Fortunately, CO2 reduction is by no means the most important benefit. Both the reduced production loss due to congestion and the reduced sick leave rate due improvements in the general health of cyclists are about an order of magnitude more important. Given the high net benefit it should be no problem to fund additional investments in the cycling infrastructure. Over all values it may even be amongst the best infrastructure investment options a city has. However to see this it is necessary to consider multiple aspects at the same time which can be difficult in highly compartmented organisations. A common value framework helps in crossing boundaries between de compartments.

8 Conclusion

Infrastructure asset managers often struggle with quantifying the value impact their assets and investment programs have on their stakeholders. This complexity is often addressed by technical standards and compartmented organisations and budgets, Unfortunately this results in suboptimal decision, with low yielding or even net negative interventions. In this paper we presented a pragmatic approach for addressing stakeholder values in a common value framework. By clustering the stakeholders into groups with similar interest a more thorough analysis of these interest can be made, and peculiarities of specific context can be addressed. Aligning these interests with a more fundamental theoretical model for value allows for more awareness of the impacted values. The resulting reference model consists of 6 value domains, 18 values, 50 objectives and some 200 indicators. In practice, not all indicators are needed though. With a limited set of less than 20 indicators a 360° perspective can be maintained for a reasonable fraction of the decisions. Such a basic framework can help to cross borders and achieve a better understanding of the total value impact. This was demonstrated by the evaluation of the societal value of an additional cyclist. The basic framework currently is limited to negative impacts. To include indicators that could measure positive impacts further research is needed.

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