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LIFE CYCLE COST AND VALUE OF NORWEGIAN SPORTS FACILITIES

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ABSTRACT

Sports facilities are built to create value for owners and users. In the front end, it is crucial to make decisions based on information about the Life Cycle Cost (LCC) and the possible benefits of the facility. This paper aims to create knowledge about the relationship between the value and LCC of sports facilities. This has been done through literature review, document studies, and workshops.

The construction costs have been compared to the operation and maintenance (OM) costs for 11 sports halls. The results show a ratio between OM and construction costs between 0,1 and 3,7. Diverse aspects could explain this, such as the lack of a standard model for what to include in the OM costs and volunteer work with planning, and OM not counted.

Planning in sports facilities construction often relies on volunteers from the sports clubs, leading to a lack of competence and resources to implement value-centered approaches like the Lean Construction methodology. This paper shows that it is challenging to quantify the value generated by sports facilities, and value is highly dependent on perspective. There is a need for a more systematic way to evaluate the OM cost and the value generated by the sports facilities.

KEYWORDS

Life cycle cost, value generation, lean construction, sports facilities

INTRODUCTION

Projects are generated to create value for owners and users. Diverse types of buildings will contribute to value in various ways. When deciding to start a project, the value and cost must be considered (Ballard & Morris, 2010). In the front end, estimated costs for planning and constructing a facility are often based on the cost of previous projects (Barakchi et al., 2017). Operation and Maintenance (OM) costs should also be considered in the big decisions during the front-end phase. As decision basis for the final decision to finance a project, it is crucial to estimate the Life Cycle Cost (LCC) of the facility, comprising the planning and construction costs, cost of operation and management of the facility, and operation cost of the activity at the facility (e.g., cost of running the hospital activity) (Evans et al., 2004). The LCC, together with an estimate of the value created by the activity in the facility, is important to make the right decision. Life-cycle costs comprise all the expenses incurred during the lifetime of the product, work, or service to have an overview of the complete cost picture.

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Sylte et al. (2017) assessed factors affecting the investment cost of a sports hall and created awareness about these factors to help the future implementation of sports halls. Little research has been found about the size of facility management costs and the relationship between construction costs and operation and maintenance costs. Research shows that due to the gain in health effects, the benefits of sports facilities are three times the construction costs (Strøm et al., 2022). Compared to general building projects, some additional aspects that need to be addressed when constructing sports facilities are under consideration. This includes concerns about a country's vision and objectives for sports and activity in society. However, sports involve a vast pool of conflicting perspectives and stakeholders, e.g., different sports federations, sports clubs, varying levels of knowledge, resources, and financial strength. The different perspectives affect the perception of value and the motivation for value delivery. Also, there is often some amount of voluntary work related to the planning and constructing of sports facilities. So, what reflections do you need to do to create value at sports facilities?

This research aims to elucidate and increase our knowledge about the relationship between sports facilities' construction costs, operation and maintenance costs, and the value generated by them. The following research questions are defined:

- RQ 1: How do the construction costs correlate with the operation and maintenance costs in sports facilities?
- RQ 2: What are vital value considerations when constructing a sports facility?

The study is limited to Norwegian sports facilities. In Norway, many sports facilities are built, with a total building cost of about 500 million USD per year (Sylte et al., 2017). Gaming funds, which is profit from the National Lottery of Norway, partly fund the facilities. The Norwegian government owns the National Lottery, and the gaming funds are distributed by the Norwegian Ministry of Culture and Equality (Norwegian Ministry of Culture and Equality, 2022). The average funding from gaming funds is around 20%. The rest is financed by the municipality, the sports club, sponsors, etc.

METHOD

To answer the research questions, we conducted a literature and document study. In addition, we participated in a workshop organized by the Norwegian Olympic and Paralympic Committee and Confederation of Sports (NIF), where all the sports federations in Norway were represented. In the literature study, we used the databases Oria (Norwegian University of Science and Technology's online university library) and Google Scholar, searching for combinations of "cost, "Life Cycle Cost," "value/benefits," and "sports facilities." Not much relevant literature was found covering the cost, LCC, or value of sports facilities, but we found some literature covering other types of facilities. We reviewed the top 50 hits in the searches to identify relevant literature sources.

The data in the document study is collected from the Norwegian web page www.godeidrettsanlegg.no (Gode idrettsanlegg, 2023). "Gode idrettsanlegg" (GIA) can be translated to "Excellent Sports Facilities." The Centre for Sports Facilities and Technology (SIAT) at the Norwegian University of Science and Technology (NTNU), NIF, and the Norwegian Ministry of Culture and Equality finance this web page. Its purpose is to contribute to high-quality sports facilities' building and operation. The web page intends to publish articles, news, information about sports facilities, and tools and guides for successful sports facilities. Notably, "Excellent Sports Facilities" also publishes and presents model sports facilities (MSF). These MSFs are facilities that stand out as exemplary, for instance, in terms of cost, effectiveness, use, innovation, or cooperation between sports. The MSFs are recommended to GIA by the national sports federations to ensure that the best sports facilities from the different sports become MSFs.

Among the data obtained about the MSFs are the construction cost, the operation and maintenance cost, and the facility area. As a result, GIA holds cost data for many MSFs.

Processing of Data

The study has investigated the indoor sports hall facility category, as this category receives most government funding through gaming funds (Norwegian Ministry of Culture and Equality, 2021). The MSFs included in this study are categorized as indoor sports halls by GIA. When conducting this study, we have not further assessed which MSFs can be classified as indoor sports halls. As an example, gymnastics facilities are not counted as indoor sports halls, while indoor sports halls containing gymnastics facilities, among other facilities, are included.

GIA does not obtain information about when the model sports facilities were completed during the completion year, so all construction costs are set to December of the completion year when indexing. This assumption will probably not impact the result significantly, considering the limitations of the data.

The cost data from GIA are given in NOK but are presented in USD for this paper. The exchange rate fluctuates around 10 NOK per USD, so for simplicity, we are using an exchange rate of 1 USD = 10 NOK for all data in this paper.

Tools

The collected data were systemized and analyzed in Microsoft Excel. The indexed construction cost is based on Statistics Norway's construction cost index for residential buildings (Statistics Norway, 2023). The chosen index and inputs are considered the most representative.

Limitations

The collected data has some inconsistency. The information was not easily comparable as different people gathered the information at different times and from various sources. Also, as the data was not initially collected for research purposes, there has been a lack of consistency in how data was gathered. We left out several facilities due to the need for more consistency in the data. However, this ultimately led to more consistent results for comparison.

THEORY

Life Cycle Cost in Construction

A project goes through different stages, from initiation, design, and execution to operation. Project costs are estimated during project planning through these phases (Westkämper et al., 2001). The cost estimates are used as a part of the decision basis at decision gates in the project. Costs related to planning, design, and construction are estimated, often using analog estimation in the early stages of the project (Barakchi et al., 2017). The costs of similar previously built buildings per m2 gross area are often used for estimation.

To make informed project decisions, the focus should be on Life Cycle Costs (LCC), not only construction costs. An LCC calculation considers all costs for a product or service during its life cycle (Miske, 2010). The aim of using LCC is to evaluate the cost-effectiveness of alternative design strategies by considering the potential initial and operational costs incurred over a specified period (Sadliwala & Gogate, 2022). The use of LCC has over 50 years of history and can reasonably estimate the total cost of ownership of construction assets (Sadliwala & Gogate, 2022). Despite its proven utility, successful application and diffusion within the construction domain are scarcely seen (Manewa et al., 2021). According to Sadliwala and Gogate (2022), there needs to be more data available for implementing LCC in construction. Costs of the life cycle should include at least three groups of costs (Miske, 2010): 1) costs for the acquisition of the building, 2) costs for the use of the building, and 3) costs for the deconstruction of the building.

The cost of building procurement includes all planning, design, and construction expenses. The Norwegian standard NS3453 states what costs should be included in a cost estimate for a building (Standard Norge, 2016). Included should be all the costs related to the building, installations (e.g., electrical, HVAC, etc.), outdoor works, general expenses (planning costs, design costs, project management costs), special costs (plot costs, VAT, furniture, etc.), expected additions and project owner reserves. Final costs should count all the costs related to the building according to the NS3453 and will also include the impact of the uncertainties and use of contingencies. For sports facilities, Sylte et al. (2017) show a variation in construction costs for sports halls, where costs depend on the project delivery model, location, project ownership, and whether the sports hall is part of a school project. By monitoring the construction costs of sports halls in Norway, SIAT has discovered that these costs have grown over time (Sylte et al., 2017).

According to the International Facilities Management Association (IFMA), the costs for the use of a building, the *facility management costs*, or operation and maintenance costs (OM) used as an expression in this paper is associated with a maintenance cost, replacement cost, janitorial cost, cost of moves, indirect cost, utility cost, life safety cost, support and project costs (security, space planning, and employee amenities), and financial indicators (lease, fixed assets, and operation, among others) (Islam et al., 2019; IFMA, 2023).

Lee (2012) shows that multiple studies investigated the ratio of relative costs in owning and using a commercial office building. With a construction cost of 1, Evans et al. (2004) found operation and maintenance (OM) costs to be 5 over the lifespan of the building, while Hughes et al. (2004) found the ratio to be 0,4, and Ive (2006) found the ratio to be 1. The business operation costs are shown to be considerably higher, from 200 (Evans et al., 2004), 12 (Hughes et al., 2004), and 15 (Ive, 2006) times the construction costs.

VALUE GENERATION

Values and Value

A value focus is essential in Lean theory. The report from Lauri Koskela from 1992 was, in his effort to conceptualize the Lean production philosophy for construction, one of the first to emphasize how important customer value is in construction projects (Koskela, 1992; as cited in Tillmann & Miron, 2020). In the Transformation-Flow-Value generation (TFV) theory, eliminating non-value-adding activities (waste) is the main principle for the flow view. The value generation view is about creating value for the customer by fulfilling requirements, with the principle of eliminating value loss (achieved value compared with the best possible value) (Koskela, 2000).

There is ambiguity related to the term *value*. Due to the lack of a commonly accepted definition, the concept of value is associated with some confusion. As a response, a comprehensive definition of the value term for a Lean Construction context was presented by Drevland et al. (2018) through nine tenets. In this definition, they maintain that values (plural) and value (singular) differ. Values are essential for guiding someone's evaluative judgment. In contrast, value is the outcome of an evaluative judgment based on knowledge and driven by values. Similarly, Tillmann & Miron (2020, p. 107) state that "values are related to core beliefs, morals, and ideas, while perceived value is related to a judgment of an object by a subject."

Organizational values possess several values that make up a value system. These characteristics make it difficult to isolate for analysis. This contrasts with personal values, which are values possessed at an individual level and are, therefore, easier to isolate (Schwartz, 1992; as cited in Bourne & Jenkins, 2013).

According to Aadland and Askeland (2019), values create the intentional basis for actions, the direction for actions, and the basis for interpretation in evaluating actions. This ultimately means that all actions are based on values. There is a saying that every well-written villain is a

hero of their own story (Vogler, 1992). All actions – good or "evil" - are first and foremost based on the practitioner's perspective, who performs actions based on their values.

The core principles of Lean Construction are adapted from production theory. The ultimate goal of LC can be described as generating value for the customer and avoiding non-value-adding activities (i.e., waste) (e.g., Koskela, 2000; Bertelsen, 2001; Tillmann & Miron, 2020). Woodruff (1997) argues that, when generating customer value, one takes the perspective of an organization's customers by delivering a product based on the customer's needs. Projects, however, are complex one-off events characterized by multi-stakeholder environments. Thus, multiple perspectives exist (Tillmann & Miron, 2020). So, who is the customer in a construction project? The term *customer* is closely related to what is referred to as a *stakeholder* in project management literature and may refer to everyone affected by the project, not only the paying customer (Drevland & Tillmann, 2018). Based on the stakeholder typology from Mitchell et al. (1997), Drevland and Tillmann (2018) identify four *definitive* stakeholders, i.e., stakeholders possessing all three stakeholder attributes in a project (power to impose, legitimacy, and urgency): the owner, the designer, the builders, and the society at large.

With the condition that projects are systems for value delivery, Drevland and Tillmann (2018) explore the question of whom value should be delivered to in a project and that the question is a matter of value philosophy. They argue that the key to deciding whose value matters lies in understanding the motivation for the value delivery and identifying three causes for value delivery:

- **Transactional motivation:** Centers around a formal transaction between two or more parties.
- **Selfish motivation:** Any action a party takes to exploit contractual ambiguities, motivated by greed, self-preservation, or interest in maintaining a good relationship or reputation for future business.
- **Altruistic motivation:** Delivering value, not by formal transactions or for egoistic reasons, but for altruistic reasons. Corporate Social Responsibility, for instance.

The definitive stakeholders will always matter, and their motivation is mainly transactional. Value delivery is based on selfish or altruistic motives when going beyond formal contracts and regulatory constraints.

A cost-benefit analysis contributes to a solid, transparent, and comparable decision basis for politicians and other decision-makers when evaluating different concepts (DFØ, 2018)– highlighting the effects of alternative solutions before a decision makes it easier to choose the best solution for society. When performing cost-benefit analyses, the benefits and the costs must be quantified. Not much is written about quantifying the value of the benefits of sports facilities other than by (Strøm et al., 2022). They claim that the health gained from sports facilities is three times the cost.

FINDINGS

CONSTRUCTION COSTS CONCERNING OPERATION COSTS OF SPORTS FACILITIES

The research is based on the facilities presented in Table. The facilities are, as accounted for, indoor sports halls. They generally consist of a multi-purpose court intended for basketball, handball, and volleyball but are also usable for other sports, such as futsal and floorball. Further, some facilities have separate rooms or courts for other sports, such as archery, gymnastics, sport climbing, table tennis, fitness, spinning, dancing, and fencing. In addition, the facilities offer wardrobes, toilets, common areas, spectator stands, conference rooms, and kiosks.

The different projects, their construction cost, operation and maintenance (OM) cost, usable floor area (m^2), and construction cost per m^2 are given in TableTable 1. The construction costs vary from approximately 6 to 47 million USD. The operation and maintenance costs range from about 65 000 to 880 000 USD per year. The construction cost per m^2 is divided by usable floor area, which was found to be the best representative area in a sports hall. The costs for deconstructing the facilities are non-existing and, therefore, not included in the study.

Table 1: Data from the MSFs

Facility Name	Indexed construction cost [USD]	OM cost [USD/year]	Usable floor area [m²]	Construction cost per m² [USD/ m²]
Utleirahallen	9 019 144	265 000	3 580	2 519
Hønefoss Arena	14 192 361	100 000	12 000	1 183
Sjulhustunet	24 164 973	200 000	7 700	3 151
Harestua Arena	16 863 992	210 000	4 700	3 588
Lislebyhallen	15 518 750	64 252	3 460	4 485
Bugårdshallen og Sandefjord bueskytterhall	6 188 621	455 179	8 283	1 238
ROS Arena	8 975 165	230 000	3 500	2 564
Bærum Idrettspark	47 392 620	880 000	16 200	2 925
Hyllestadhallen	6 649 378	70 900	2 880	2 309
Volda Campus SpareBank1 Arena	21 955 921	390 000	11 200	1 960
Glommasvingen skoleanlegg	6 293 162	96 408	2 080	3 026

VALUE IN NORWEGIAN SPORTS

To answer what they value in Norwegian sports, we have done a document study on reports from NIF. The findings we present are valued from the top level in Norwegian sports. However, as there are many sports organizations to satisfy, it must be acknowledged that the wide variety of sports leads to many different perspectives that need to be pleased in the construction of sports facilities. In 2019, NIF collaborated with the sports federations in Norway and committed to a set of goals, strategies, and measures for the future. These decisions were presented in two reports, one for constructing sports facilities (NIF, 2019a) and one for sports policies (NIF, 2019b). The reports represent a shared understanding and agreement on which direction sports policies and sports facility construction should take in Norway. The intention was to agree on a set of goals, strategies, and measures to guide the sports federations when they make their own strategic decisions. NIF aims to work for equal opportunities for all to perform sports after their own needs and desires without being victims of unreasonable discrimination (NIF, 2019b). A strategy for achieving this purpose is presented with a vision, business idea, strategic efforts, overall objectives, and fundamental choices. These are given below.

- **Vision –** "Sporting joy for all."
- **Mission –** "Everyone should experience sports, coping, and development in the safe and sound sporting community."
- **Strategic efforts –** A set of strategic priorities for the coming years.

    - Lifelong sports – work for an inclusive and diverse community with outstanding quality to facilitate everyone to be a part of a sports community for as long as they want to.
    - Better sports teams – work for democratic, open, and honest organizations, where voluntary work, which is at the core of many sports teams, should be experienced as a safe and meaningful community.
    - More and better sports facilities – build sports facilities where desired activities can be performed. More predictable economics and environmental efforts during the whole life cycle of a sports facility.
    - Better elite sports – Norway should have world-class athletes and teams. More efforts in helping young talents reach the highest levels.
- **Overall objectives –** "Get more people involved – for longer" and "More new medals."
- **Fundamental choices –** A set of organization- and activity values to guide and improve the sports' work in the coming years.
    - Playful – A sports community where playful curiosity is not neglected.
    - Ambitious – Ambitions about development in sports and organizations for a better society.
    - Honest – Fair play. E.g., no cheating, corruption, or drug use, and equal competition conditions.
    - Inclusive – A community where everyone is seen, feels safe and cares for each other. A community where everyone feels joy and can participate on their level. Everyone is worth the same.

The overall intention for Norwegian sports is to make society better. Thus, it cannot be isolated from the society it is a part of (NIF, 2019b). This means facilitating activities in sports federations but also activities outside the federations' core affairs. In summary, the intention is to create a physically active society with a community sharing excellent sports values. Integrating the sustainability goals from United Nations (2023) is an essential part of this strategy. In collaboration with the sports federations, NIF launched a sustainability strategy based on the UN sustainability goals (NIF, 2023). They decided on five prioritized focus areas anchored in the abovementioned goals, strategies, and measures. The focus areas and associated sustainability goals are presented below:

1. Lifelong sporting joy and healthy sports (SG 3 – Good health and well-being)
2. Inclusiveness, diversity, and equality in sports (SG 5 – Gender equality & SG 10 – Reduced inequalities)
3. Ethical and forward-looking development (SG 17 – Partnerships for the goals)
4. Responsible use of resources (SG 12 – Responsible consumption and production & SG 13 – Climate action)
5. Green sports facilities (SG 12 – Responsible consumption and production & SG 13 – Climate action)

DISCUSSION

The first research question was, "How do the construction costs correlate with the operating expenses in sports facilities?". The construction costs in the study vary from 1200 USD/m^2 usable floor area to 4 500 USD/m^2. We see that still considering sports halls for similar activities, the costs vary a lot. This was also shown by (Sylte et al., 2017), who explained these variations by different project delivery systems, location, project ownership, and whether the

sports hall is part of a school project. What is included in the construction costs is well defined by the Norwegian Standard (NS3453), but this standard is not consistently used when cost information is provided. This may impact the findings. For instance, it varies whether buying the plot is included (sometimes the plot is given by the municipality for free), and the amount of outdoor work varies. The same goes for the ground conditions. Further, the degree of precision and rounding differs between different MSF cost data. Lastly, as construction costs lack dating, we assumed that the cost is the final cost for the project owner at completion.

When it comes to the correlation between the operation and maintenance costs (OM) and the construction costs, the results are presented in Figure 1. Figure 1 displays a correlation between the construction and the OM costs but also offers a considerable variation in annual operation costs vs. construction costs. Through previous research, Lee (2012) shows that total OM costs over the lifespan of a building compared to the construction costs vary from 0,4 to 5 times the construction cost. Using a lifespan of 50 years and a discount rate of 4 % (DFØ, 2018), the average ratio of OM costs compared to construction costs is 0,4. The ratio varies from 0,1 to 1,6. Considering without discount rate, the average ratio of OM costs compared to construction costs is 1,0, from 0,2 to 3,7. We see a lower ratio of OM compared to construction costs for some of the sports halls than the findings in Lee (2012). However, we can see findings at the same level, depending on the assumptions used to calculate the ratio. One explanation for the variations could be that it is not very well defined for sports halls what to include in the operation and maintenance costs. For instance, OM cost may be given for the specific part or the whole facility.

Figure 1: Construction Cost Compared to Operation and Maintenance Cost.

Furthermore, OM cost may be given with or without interest and amortization, value-added tax, or insurance. The complexity of the OM costs is also increased because many sports facilities are operated and maintained partly by the municipality and partly by the sports club. As a result, the OM costs are spread over multiple budgets, decreasing the probability of correct amounts being provided to GIA. The International Facilities Management Association (IFMA, 2023) has defined what to include in facility management costs, where the following should be included; maintenance, replacements, janitorial, cost of moves, indirect cost, utility cost, life safety cost, support and project costs, and financial costs. More unity should be implemented in sports halls regarding what to include in the OM costs.

The motivation for value generation in sports facilities depends on the perspective. Even though the sports federations cooperated with NIF to create a set of overall goals, strategies, and

measures, as well as a plan for sustainable efforts, their different perspectives will affect their perception of value. Thus, the motivation for value delivery is effectively affected.

Transactional motivation: The Norwegian Olympic and Paralympic Committee and Confederation of Sports is Norway's largest voluntary organization (NIF, 2019b). Voluntary work is the cornerstone of Norwegian sports and hereby of planning, constructing, and operating sports facilities. The sports club must rely heavily on volunteers to get the work done, especially during planning and operating the facility. Sometimes also during construction, but professional contractors most often do construction with a contract with the actual municipality or sports club. Often the sports clubs manage the project execution themselves, as they are the facility owners. Consequently, this leads to variations in knowledge and experience in planning, design, and construction, depending on whether a person with construction competence is privately volunteering for a particular club. Some municipalities offer free use of the sports halls for the sports clubs; some sports clubs need to pay. An important observation is that not paying for the construction will influence users' or clubs' relations to requirements and cost.

Selfish motivation: The value delivered in sports facilities depends on the stakeholder perspective – any sports federation like to see its sport lifted to appease current members and attract new members. Sports federations might, for instance, compete for governmental funding to build a sports facility or to optimize a shared sports facility for their sport. They might have contrasting perceptions of how the space is best utilized. This can lead to one of the federations exploiting an unclear situation to generate value for their activity at the expense of other sports or activities. In those cases, the sports federation does not necessarily have bad intentions but rather a selfish motivation for value delivery. Still, such an opportunistic value approach might neglect an opportunity for a more holistic approach that could generate more value for the overall purpose of Norwegian sports, as stated in the vision and strategies from NIF.

Another question that needs answering is if mass sports or elite sports are prioritized at the sports facility. Mass sports and elite sports may have conflicting perspectives. Some sports teams have athletes competing at both the elite level and amateur or mass sports level. The Norwegian football club Rosenborg, playing at an elite level, used known Lean principles to create value for the local community. They assisted local football clubs at the mass sports level with funding and competence, intending to help them develop the next local superstar to play for Rosenborg (Malvik, 2022). In this case, the end goal shows signs of selfish motivation. However, the cause was also charitable. Value for elite sports clubs like Rosenborg is usually to win trophies and entertain the local community, which is easier to achieve by using talented (local) players. Moreover, the value of local sports clubs is to facilitate higher participation and be an arena for development and growth.

Altruistic motivation: As mentioned above, NIF is Norway's largest voluntary organization. There is much altruism tied to this voluntarism. Planning and construction of sports facilities often depend on club members or other interested people's voluntary spirit. In Norway, this is most visible on the mass sports level through sports club members or parents of members selling cake or toilet paper. However, it can also be seen at the elite sport level. For instance, supporters make supporter effects (tifos, mosaics, flags, etc.) or songs for their teams' home matches. One extreme example of voluntary work in elite sport is the German football club Union Berlin's supporters, who spent their free time and holidays working on a new modern stadium after the German Football Federation (DFB) threatened to close their old stadium for not meeting the security requirements. In total, 1600 volunteers put in an estimated 90 000 hours of work to save the club 2 million euros in construction costs (Hessler, 2009). The close-knit sports community fortified the already unique supporter culture in and around the club. It shows that even the construction of sports facilities can bring value to society through shared altruism and voluntary work.

Besides comprehensive efforts from NIF to facilitate sustainable endeavors in the construction of sports facilities, there is also demands from the government and the general public. Still, projects are not imposed a sustainable strategy, and the actual implementation of a sustainable approach is a matter for the owners of the sports facilities (usually the sports teams). Thus, the effort put into sustainability is tied to altruistic motivation. Generating value for the user is an elementary component of a sustainable strategy (Malvik et al., 2021). Therefore, a sustainability strategy is inevitably interrelated with value generation. One should ensure that the sports facility covers the needs and requirements put forward by the user and is aligned with the values NIF presents in its vision and strategies.

Strøm et al. (2022) show that the benefits of sports facilities are three times the investment costs, where health effects are counted. We have shown that sports facilities give different types of value or benefits. To do a quantitative cost-benefit analysis, we need to be able to quantify the facilities' value or benefit. The values pointed out above are not easily quantifiable. This is a central challenge when identifying the ratio between sports facilities' value and LCC.

CONCLUSION

This research is aimed to increase the knowledge about the relationship between the Life Cycle Cost of sports facilities and the value the facilities generate. We have investigated the relationship between construction costs, operation and maintenance costs, and value generated by the sports facilities by looking at sports halls.

Regarding the cost of sports halls, both the construction cost and the operation and maintenance costs vary greatly. Also, the ratio between the OM costs over the lifespan of the buildings and the construction costs varies from 0,1 to 3,7, depending on assumptions in the model. How to calculate the construction costs follow a Norwegian standard, while what to include in the OM cost is not standardized. A standard for what to include in OM cost needs to be developed. When much of the work in sports facilities is done by volunteers, it will still be unclear how to count it in a model elucidating LCC.

Diverse types of value are discussed regarding the value the sports facilities generate. A vital issue is that it is not easy to quantify the value generated by a sports facility. The value depends on your perspective if you are the owner, designer, builder, or the society at large. For sports facilities, the owner is most often the sports clubs or the municipality. Transactional motivation is, of course, necessary for the municipality or the sports club due to what often is limited funding. But stakeholders in sports clubs are highly driven by selfish motivation. Decisions during planning and construction are much driven by selfish motivation. However, we also see a lot of altruistically motivated actions in work with sports facilities at any level through the immense amount of volunteer work.

Some attempts are made to identify the cost-benefit ratio of sports facilities. However, more defined rules about estimating construction costs, quantifying operation and maintenance costs, and quantifying value must be in place. A recommendation for further work is to make a standard for what to include in the OM costs. Also, methods need to be developed to standardize what value parameters to include and how to quantify them.

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