Highlights.

Susanne Abrahamsson
President

Creating sustainable growth

The sea is an amazing resource with huge potential and great assets. Some of the assets have not been fully discovered, some are not fully developed, and some assets are not taken care of properly. At SSPA, we have a passion for the ocean and the business opportunities that it offers. Together with our clients and partners, we are creating sustainable growth, today and tomorrow.

Success is the result of balanced optimisation and knowing the client's goals and priorities. With our tools, our collective competence, our integrity and the trust of our clients, we will add value. When we support our clients in wise decision-making using Life Cycle Cost analyses as a tool, we facilitate the understanding of the economic part of the project by building different scenarios in a structured way. For projects involving a long timespan and complex systems or infrastructures, a realistic breakdown of the cost structure helps to make cost drivers more visible.

Innovation is the lifeblood of SSPA, creating new dimensions of performance and opportunities. The energy from the ocean is entering the market and cost-efficiency is a challenge for our clients working with Ocean Energy Converters. When successfully managed, this opportunity can generate multiple environmental benefits and create new jobs.

Sustainable maritime development meets the needs of the present without compromising the ability of future generations to meet their coming needs. In the pristine Arctic area, environmental and safety risks must carefully remain assessed and controlled. Our clients can take advantage of our long and wide-ranging experience and great technical expertise in Arctic shipping and spill prevention, facilitating efforts to ensure maritime transport solutions in a future environment with new ice conditions, sea routes and regulations.

Do not hesitate to contact us with feedback, comments or questions. We hope you enjoy issue 63 of SSPA Highlights.

"To do right from the beginning"

When a ship owner plans to build a new vessel or faces the decision on prolonging the life of an existing vessel, the total costs over time are crucial for making an optimal decision. When a port wants to establish a terminal for alternative fuel, they want to find the balance between the investment and operational costs over time. SSPA has positive experiences from supporting clients in wise decision-making using LCC (Life Cycle Cost) analyses as a tool. The LCC analysis is used to facilitate the understanding of the economic part of the project by building different scenarios in a structured way. This is especially important for projects involving a long timespan and complex systems or infrastructures, where a realistic breakdown of the cost structure helps to make cost drivers more visible. The goal is increased confidence in decision-making.

Why perform an LCC analysis?

We are all aiming to avoid future economic surprises, to "think first" and to make wise decisions. But unfortunately, economic surprises sometimes arise. One of the main reasons for this is that when a new product or system is to be acquired, it is common to investigate only the cost for acquisition, with ownership costs frequently forgotten. Thus, just one part of the life-cycle cost is considered. This well-known problem is often visualised using the famous LCC iceberg, which shows that the acquisition cost is "merely the tip of the iceberg", and that the ownership costs are hidden under the surface, e.g. cost for human resources, training, repair, upgrades and disposal; costs that constitute the largest part of the total life cycle cost in most scenarios.

With an LCC analysis, the magnitude of different costs and their variations can be identified and investigated. The sensitivity of the economic model can be tested and crucial parameters and their interactions with different cost elements can be identified. For example, the number of operational hours can affect the cost for both personnel and fuel consumption. Thus, performing an LCC analysis will create a better understanding of the economic part of the project, ensuring wiser decisions in the long term.

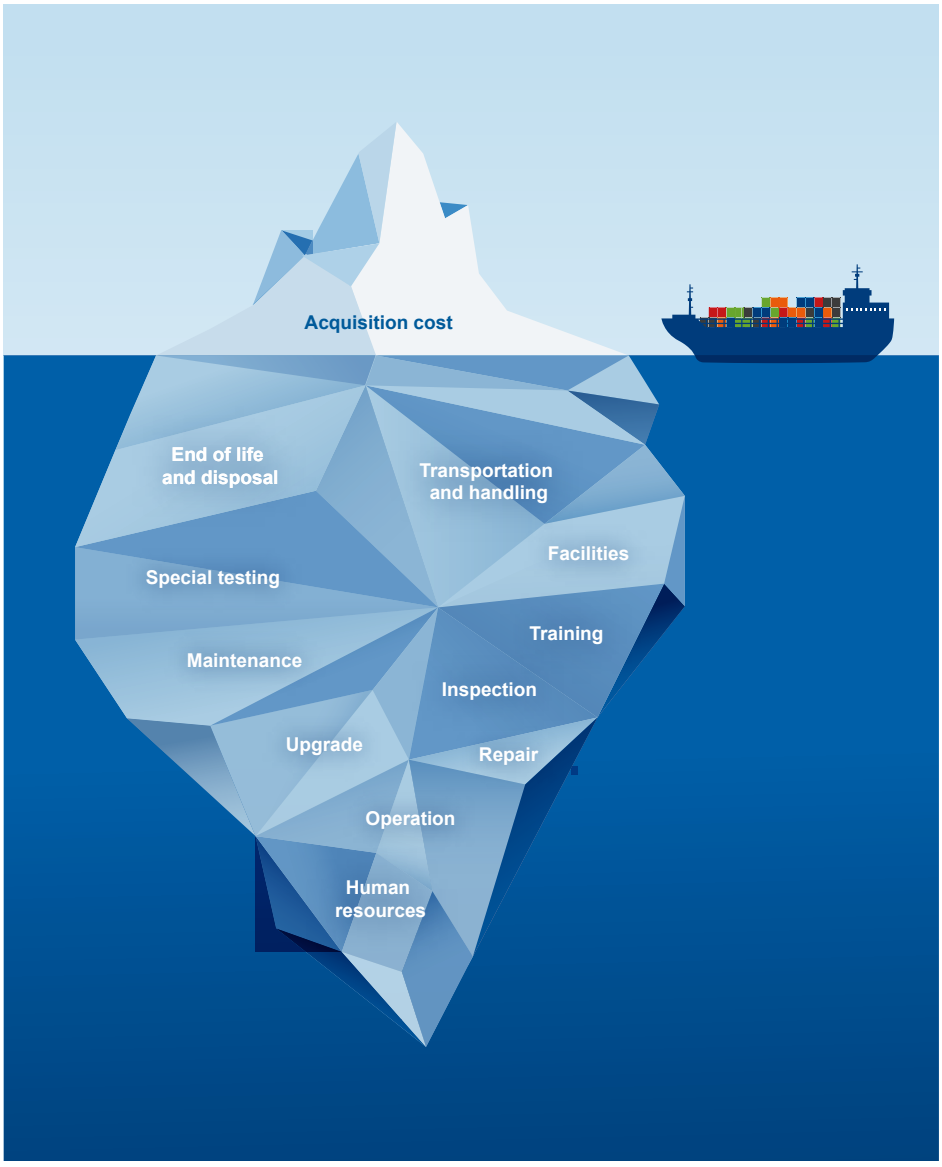
Another aspect worth considering is that decisions made early in a project have a major impact on the total cost of the project. Decisions made during the planning and design phases set many of the prerequisites for the investment, operational and support phases. Hence, even though the operation and support phase might seem far away, it is important to address the economic issues of these phases already during the planning phase. An early LCC analysis might give a rough estimate and have a lower accuracy, but studies have shown that the results are still useful as decision support.

Furthermore, multiple decision supports are developed for a project, tradeoffs have to be made and a costlier solution might have to be selected due to safety restrictions or for a specific technical reason. But if an LCC analysis has been performed, the important cost elements are identified and the decision is based on the best available knowledge. In this case, the LCC report is a valuable part of the overall documentation.

Benefits from an LCC analysis

At SSPA, the LCC methodology is based on an international IEC standard. We perform the LCC analysis systematically by building an LCC tree based on the system life cycle defined by four stages: acquisition, operation, support and termination. Focusing on one stage at a time, and breaking down the cost structure in detail, will minimise the risk of omitting a relevant cost element. To ensure the quality of the breakdown, several different competences at SSPA are involved, but SSPA emphasises the importance of the client participating actively in the process.

During the process of analysing the LCC,



The systematic approach given by LCC methodology can help identify the cost elements easily omitted, i.e. the unseen ownerships costs below the surface.

cost drivers will be identified, enabling the customer to be proactive. Actions can be taken in order to minimise the LCC, and it may be that a substantial sum of money can be saved. Correspondingly, cost elements with only a minor impact on the LCC are also identified. This information can help the project to prioritise and focus on issues that matter in the long term.

An important part of the analysis is performing a sensitivity analysis to test the robustness of the economic model. Varying the magnitude of individual parameters to analyse the effect on the total LCC will identify the parameters that have a major impact. These parameters (perhaps operational hours or fuel consumption per energy unit) must be well defined for the project to prevent economic surprises in the future. It may also be a good idea to monitor these parameters in order to keep track of the costs throughout the service life of the system.

Pitfalls to be addressed

There are of course pitfalls with the LCC analysis, but if you know the pitfalls, you can compensate for them. In SSPA's experience, by focusing on both the pros and cons of the LCC analysis method, you get a strong analysis tool that provides good decision support. One of the more common pitfalls with an LCC analysis is that people tend to take the analysis results numerically. They see the estimated LCC value as the truth, as a real sum that can go straight into the budget. Here it is important to remember that LCC is used for estimating future costs that are of course unknown and uncertain, and the results are therefore only indicative estimations. The results can be used for comparisons of either different alternative solutions or the magnitude of different cost elements.

Another pitfall is starting with the intention of describing all available cost elements using the model. But since reality is complex and there is an almost infinite number of interactions between the cost elements, this will often result in a model that is too complex and therefore difficult to grasp. It is important to try to make the model as simple as possible (while still including all important cost elements). This will both save time and give results that can be interpreted.

It may also be difficult to verify the calculations in the model, partly due to the long timescale and a complex reality. In some cases, you would have to wait 30 years before a "real" LCC could be obtained and even then it would only be an approximation. It is therefore important "to do right from the beginning" and to ensure that the right competence is involved in the analysis. Competent participation in the analysis is the best success factor!

When making assumptions and delimitations during the process, the accuracy of the model might be affected. It is therefore important to maintain the balance between the accuracy of the input data and the level to which the cost elements are broken down. The aim should be for the accuracy of both the input data and the model to be good enough to provide useful decision support.

Once the analysis is completed, there is still a pitfall to be addressed. There is a risk that subsequent changes in prerequisites, design or production will not be implemented in the LCC model, making the LCC results outdated. To avoid this risk, SSPA recommends that the LCC analysis be updated regularly throughout the project.

LCC analyses for greener road ferries – an example

During 2015, SSPA performed a systematic study on behalf of the Swedish Transport Administration (STA) to evaluate possible strategies to make a substantial saving in carbon dioxide emissions and energy use for STA's road ferries (see the article "Greener yellow ferries" in an earlier issue of SSPA Highlights).

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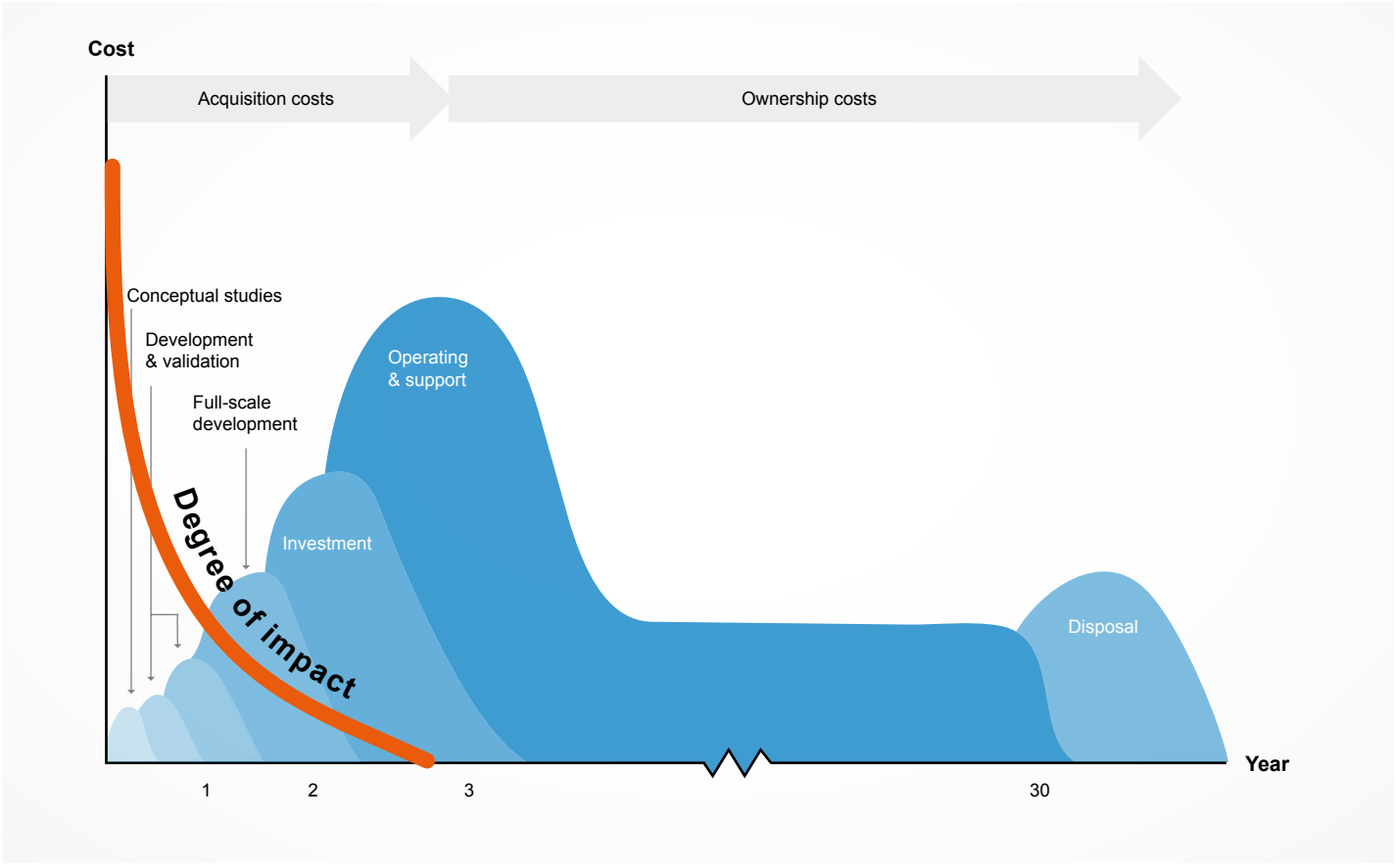


Distribution of LCC over different stages of the life cycle of a product. Decisions made early in a project have a major impact on the total cost for the project.

Future battery costs are now expected to be lower than anticipated at the time the study was carried out. An additional study with focus on battery cost has therefore been performed for the STA.

In effect, this is a sensitivity study with a specific goal: can an electrical propulsion system of either hybrid type or using 100% battery power have an equal or lower LCC compared to today’s diesel mechanic ferry over a period of 20 years? If so, when will the break-even point occur?

Variability in the following parameters was included in the LCC calculations:

- battery cost
- energy cost (shore electricity and diesel)
- exchange rates (USD to SEK and EUR to SEK)
- allowable depth of discharge for the main battery
- number of cycles on the main battery to 80% of original capacity

Four vessel concepts were evaluated and compared:

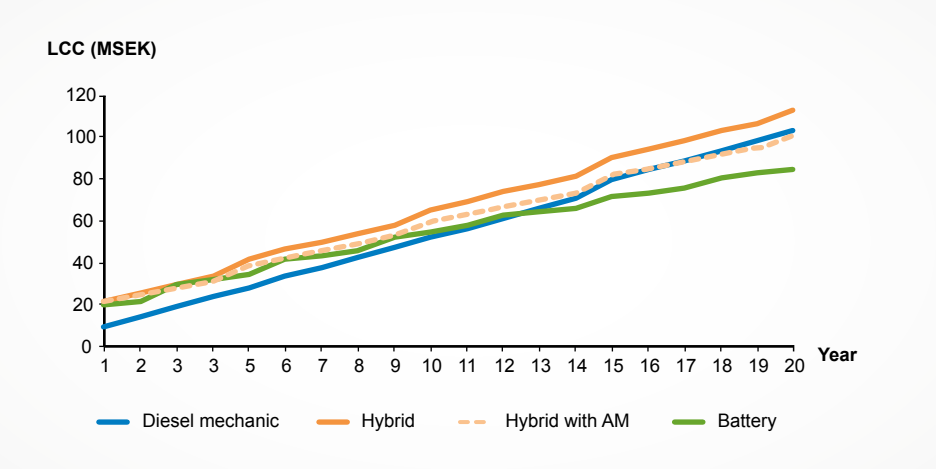
1. The reference case, diesel mechanic propulsion (Diesel mechanic)
2. A hybrid electric vessel without auto mooring systems (Hybrid)
3. A hybrid electric vessel with auto mooring systems (Hybrid with AM)
4. A purely battery powered vessel with auto mooring systems (Battery)

Competent participation in the analysis is the best success factor for verifying the model.

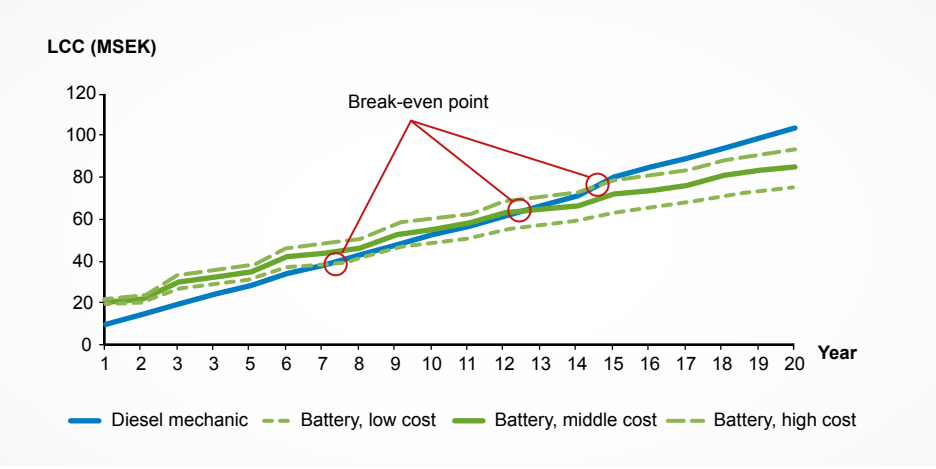
The first step in the analysis was to calculate the LCC for all four concepts using a baseline case where the parameters were set to the most probable value. The results showed that the diesel mechanic concept had the lowest acquisition cost, and for the other three concepts the acquisition costs were almost equal. Calculating the accumulated LCC showed that the hybrid concept had the highest LCC, whereas the ”Battery” concept had the lowest. The ”Hybrid with AM” concept had a higher LCC than the diesel mechanic concept for most of the period, with the break-even point occurring in year 17.

The conclusion from this part of the analysis was that the two hybrid concepts were of lesser interest, and these two concepts were excluded in the further study.

The next step in the analysis was to investigate the sensitivity of the LCC results. This was done by creating two new scenarios: one scenario where the average battery cost was reduced by 30% and another where the cost was increased by 24%. (The battery costs for the two scenarios were based on a cost estimate performed in the study.) The accumulated LCC was calculated and the result showed that even with the higher battery cost, the ”Battery” concept still has a



The accumulated LCC for four different concepts of propulsion.



The accumulated LCC for the "Diesel mechanic" and "Battery" concepts. The LCC for the battery concept is given for three different scenarios: low, middle and high battery cost.

lower total LCC. The difference between the two scenarios is when the break-even point occurs, at 7.5 years and 14.5 years respectively.

The answers to the questions from STA are thus: yes, an electrically powered vessel can have lower LCC compared to a diesel mechanic ferry. The break-even-point, the payback time, is between 7.5–14.5 years depending on the future cost development for batteries when using the baseline values for the other investigated parameters.

To give an even better understanding of the economic conditions described by the LCC model, the sensitivity of three other parameters were investigated:

- If the battery cycle life was prolonged by 100%, the total LCC for the battery concept was decreased by 10%.
- Varying the cost for diesel by 25% up or down, the total LCC for the diesel mechanic vessel changes by 10% (up or down).
- The LCC calculations indicate that the tax on shore power is a parameter with a major impact on the total LCC. Larger vessels currently get a tax reduction on used shore power, imposing the same tax reduction for road ferries will decrease the LCC by 12%.

The results from this study are only valid for the specific ferry concept and route studied.

Can we assist you when faced with similar choices for new investment, rebuilds or retrofits? Please contact us so we can discuss your specific needs.

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Project Manager. Received his MSc in Naval Architecture from the Royal Institute of Technology (KTH) in 2001. He joined SSPA in 2008 after seven years working for the Swedish Defence Materiel Administration (FMV) as a specialist in above-water signature reduction. He now focuses on early concept design and general naval architecture issues with a special interest in energy management, fuel choices and driveline concepts with smaller environmental footprints.

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Project Manager Integrated Logistics Support Madleine graduated with a PhD in Oceanography from the University of Gothenburg in 1997. She has been working with ILS, Integrated Logistics Support, since 2000 – first spending 13 years at Saab AB and then moving to SSPA in 2013. In 2014, she developed a methodology for implementing LCC in ship projects at SSPA. The methodology has been used in the EU project BB Green and in a project concerning greener road ferries, and is currently being used for new icebreakers for the Swedish Maritime Administration.

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