

IS CONSTRUCTION INDUSTRY STILL PERFORMING WORSE THAN OTHER INDUSTRIES?

Jan A. Elfving¹ and Olli Seppänen²

ABSTRACT

It is difficult to find a cross-industry comparison where the construction industry is not one of the worst performing industries. Countless studies demonstrate that the industry is lacking other industries in productivity development and safety. But are we actually comparing apples-to-apples, or, moreover, are there areas where construction industry is performing better than most industries? It is easy to show what does not work but it seems to be harder to show what works. This paper presents some early results of performance measures that large number of leading engineering and construction companies have agreed to measure performance on in the Finnish construction industry. We compare reliability, user experience, sustainability, productivity, and customer satisfaction. Based on this baseline progress in the industry will be followed and also compared to other industries. There are already some interesting points to be lifted, like schedule reliability in Finland seems to be higher than in studies in other countries. Another interesting observation is customer satisfaction and Net Promotor score, where construction industry scores higher than most other industries. Based on the performance measures the paper discusses about industry performance in general.

KEYWORDS

benefits realization, continuous improvement, lean construction, waste.

INTRODUCTION

Construction industry often scores poorly in cross-industry benchmarks. Particularly, the productivity growth shows a depressing picture of the industry. Productivity growth has been flat for many decades, and construction industry has been one of the worst performing industries (Pekuri et al. 2011). At the same time, the lean construction movement, which started three decades ago has produced a vast amount of research, tools and methods and increased our knowledge how to drive improvement. Very successful cases have been reported related to lean methods and in several countries, like Finland, these methods are starting to be mainstream. A new generation of construction managers and engineers are entering the industry, and they have been educated to lean straight from the beginning. So, do we see the impact on industry level?

It is likely that our industry level measurement requires improvement, and we need industry-level progress metrics. Except for some measurements such as financial

¹ Senior Vice President, Skanska Finland, jan.elfving@skanska.fi, orcid.org/0000-0002-7909-6759

² Associate Professor, Department of Civil Engineering, Aalto University, Finland, olli.seppanen@aalto.fi, orcid.org/0000-0002-2008-5924

measures and safety, it has been challenging to compare performance improvement among companies within the industry. Lean and digital tools and methods have not moved the productivity needle yet. Are they moving some other needle that we did not find yet?

To answer this question, the paper has two goals. First, the main aim is to introduce a set of measurements that the industry and academia have agreed to measure and follow in Finnish construction industry. Second, is to review other available metrics which could be used to measure progress, especially those related to customer satisfaction. Many performance measurement methods tend to be waste and productivity driven and less value driven, such as customer satisfaction and Net Promotor Score (NPS). With these metrics, the construction industry scores better than most other industries, and even performs on the best level in some surveys.

The authors intend to report annually the progress of the industry in Finland and want to understand:

- Is the construction industry improving performance in Finland?
- Is construction industry performing worse than other industries?
- Why is the industry scoring high on customer satisfaction, even if it scores low in many other cross-industry performance measurements?
- What is different from other countries

The paper starts with a literature review on existing work on performance metrics, followed by a chapter of typical industry metrics, then presenting the new metrics Building 2030 metrics developed by key players of the Finnish construction industry. We will end this paper with a discussion attempting to partially answer the questions above.

LITERATURE REVIEW

BENCHMARKING INITIATIVES

Previous research includes information on several benchmarking initiatives in different countries. Many studies focus on benchmarking management practices, for example, by comparing companies to their competitors using surveys on project level (Kim 2014; Cha and Kim 2018; Bonilla and Castillo 2020). These initiatives are important because they can be used to convince other companies to do more. The challenge is that they do not represent a sample of all projects but rather those projects which participants have contributed. Therefore, they do not help to answer the question of this study: can we see improvement on industry-level metrics?

Several initiatives have been developed in different countries to come up with holistic performance measurement systems. Costa et al. (2004) described four different performance measurement systems in Brazil, Chile, the UK and the USA. These systems all shared the same aims as our study and aimed to measure construction sector performance. Typical approach was to have a group of companies who agreed to share project-level information and agreed on KPI's which would be reported. Then companies could compare their results with those of their peers. The challenge of these systems included that data could be time-consuming to collect, might not be available in every project (Costa et al. 2004), and restricted membership means that a large part of the industry is left out from the measurement.

One of the largest construction industry based performance metrics database has been collected by Construction Industry Institute, they have since 1996 collect systematically performance metrics. In 2002 published summary report (CII 2002) the database included already 1037 projects with a total installed value of \$54.2 billion. However, some of the data shows that the performance of the industry has actually worsened between 1998-2018. The drawback of this method is that it relies on contributed projects and the companies contributing data are not stable. Less mature companies joining the benchmarking initiative could result in seemingly decreased performance.

INDUSTRY LEVEL METRICS

Industry level macroeconomic labor productivity data show declining productivity. National statistics bureaus are reporting productivity by sector by dividing construction Gross Value Added (GVA) with labor hours. According to Neve et al. (2020), these data are reported slightly differently between countries. Regardless of the actual way of measurement, these industry-level figures have not shown any improvement. Part of the problem is that prefabricated elements are often reported in another industry, so any increase in prefabrication will move both GVA and hours to another more productive industry and just the less productive work remains. (Lehto 2020).

In recent years, net promotor score (NPS) has become popular to benchmark companies mainly within the same industry. It is a widely used market research metric that typically takes the form of a single survey question asking customers' willingness to recommend a product or service to someone else (Reichheld 2003). NPS measurement in construction industry is interesting for several reasons. First, in lean construction literature, there is a good amount of waste related measurement, such Percentage Plan Completed (PPC), inventory, and waiting time but less value³ related performance measures, like customer satisfaction that could be used on industry and even cross-industry level. Second, NPS is easy to collect and to compare companies within the same industry. Third, construction industry scores high compared to other industries. This is unusual, because often in cross-industry comparison of various performance measurements construction industry scores below the average, e.g., safety (TVK 2021) and productivity (Lehto 2020).

A study by Retently (2021), a consulting company, evaluated 35 industries, and construction scored the fifth highest score, NPS 52. In another survey conducted by Pendo (2019), a consulting company, construction industry scored third highest, NPS 27, among 9 other industries. A survey study performed by EPSI, a Swedish based consulting company, shows that new residential construction sector has scored highest rating the last three years over 6 other industries (EPSI 2022). In their latest survey 2021, new residential construction scored 40, and the next highest sector insurance scored 9. Many companies provide NPS measurements, and the above surveys are just randomly selected NPS surveys. It certainly requires more data collection and understanding why construction industry scores higher than other industries.

NPS has been praised for being simple, providing timely data and easy to act on the findings. Traditional customer surveys are complex to process, take too long time before the frontline employees and managers can act on the findings and expensive (Reichheld 2003).

³ See Koskela (2000) for conceptualization of value as the ratio of satisfaction of needs and use of resources.

NPS has can been critized for that it cannot be used as a standalone metric for measuring customer loyalty and customer satisfaction needs to be measured with more than one questions (Keiningham et al. 2007, Zaki et al. 2016). As all surveys-based metrics, also NPS is challenging because organizations rely on the respondents' memory of a service process or a transaction, which may not always be a correct representation of the actual occurrence (Kristensen and Eskildsen 2014).

EPSI has developed its own customer satisfaction rating. This rating considers many other aspects than just NPS, and even this rating ranks the new residential building highest of all other measured industry sectors (Figure 1).

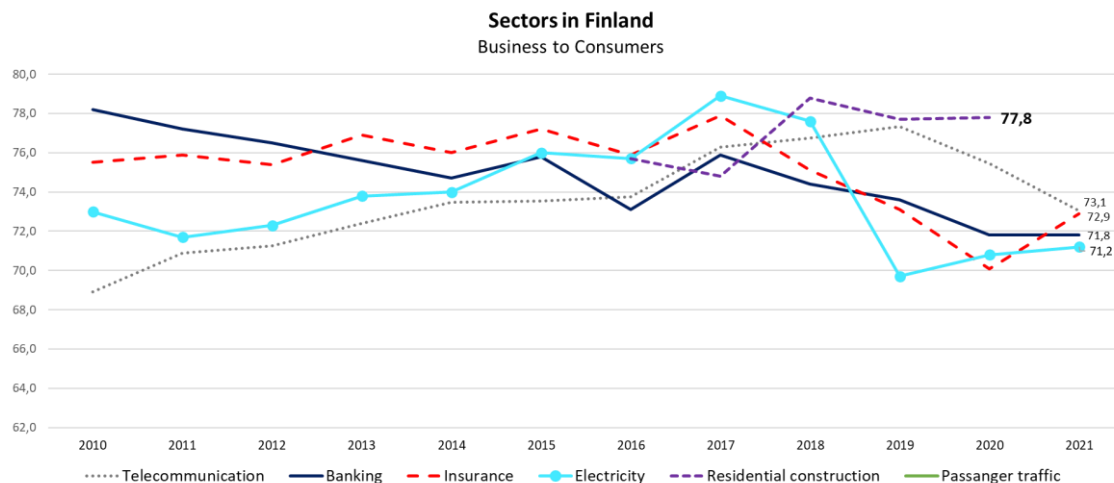


Figure 1. Customer satisfaction in various sectors in Finland (EPSI 2022)

METHOD

To come up with metrics acceptable for Finnish construction industry, a design science approach was used. Design science leads to artifacts which help solve real-life problems in their context and can be applied in daily practice (Voordijk and Adriaanse, 2016). The first step was to review industry metrics typically collected in Finland. Then a group of companies co-created the performance metrics in collaboration with the researchers. The developed metrics were validated by collecting data from construction sites.

Building 2030 is a consortium of 21 companies and Aalto University which has developed a vision for the Finnish construction sector in 2030 and works towards implementing it. The CEO's of participating companies agreed to benchmark industry performance by sharing project data which Aalto University compiles and uses to calculate industry metrics which are not available in other, publicly collected industry data sources. The metrics were defined based on the five themes of the published vision of the companies. Construction companies should be seen as highly reliable partners, buildings should be user-centric, all decisions should be guided by sustainable development, construction sector should generate value for the customer and construction employers should be seen as inspiring (aalto.fi/en/building-2030, accessed 11.2.2022). Some of the themes already had publicly collected information but especially project-level information was lacking.

The metric development started by reviewing the data companies had available on project level and by making proposals to the CEO's of companies. The metrics were

iterated with the CEO's of companies in four quarterly meetings until the companies agreed on the metrics and were ready to provide data for the study.

The metrics were developed so that companies had data available in their internal records on project level and could be used to measure project-level performance and its improvement from year to year. The approach is similar to earlier initiatives in other countries, but the focus on setting measurable targets and aligning the KPI's with the vision of the group is novel. The group represents a large part of construction volume in Finland, including 6 of the 10 largest companies.

RESULTS

INDUSTRY METRICS TYPICALLY COLLECTED IN FINLAND

In Finland, general contractors typically measure performance on project and company level. On project level typical measurements are cost, profit, schedule, changes in scope, quality, safety, environment, and stakeholder satisfaction. On company level, there is a large range of both leading and lagging measurements that take place. However, most of them are for internal use and company specific and are thus never made public. Therefore, it is challenging to compare cross-companies or industries how well the company or industry is performing.

Relatively few measurements are made public. These are mainly financial related performance measurements such as revenue, changes in revenue, profit, changes in profit, and various other financial KPIs. Besides financial performance some companies report safety, e.g., Lost time accident rate, and environmental performance, e.g., climate impact or carbon reduction. Also, NPS has increased its popularity. The simplicity and easiness to collect are probably the reasons why so many companies have chosen to report the NPS score instead of a broader customer survey results with multiple questions. "One question" is easier to communicate, to compare and to report to the stakeholders than a large set of questions. Even in "standard" customer satisfaction surveys every company tend to tweak the standard set of questions with company specific questions, making them incomparable. However, as the literature review indicates, regardless, whether a single question is asked (such as NPS) or a larger set of customer satisfaction questions, construction industry seems to score higher than other industries in Finland.

METRICS DEVELOPED BY THE BUILDING 2030 CONSORTIUM

Table 1 shows the metrics developed by the consortium. Defect related data and accidents are reported on company level but the share of projects with zero defects and zero accidents could be an even more important metric because it was a generic observation by the participants that quality defects and accidents tend to focus on certain projects and when lean implementation spreads, the projects with zero defects and zero accidents should get more common. The share of collaborative contract forms was considered a good indicator of more user-centric design and construction. Sustainability metrics readily available on project level include the recycling rate and which energy and environmental certification is applied by the project. Related to productivity, construction duration measured from top of foundations to commissioning was considered a stable enough metric by project type that it could be used as an estimate of process flow improvements, and share of direct work by workers could be used to measure the improvements in operations flow. Electrical and plumbing tasks were selected for analysis because they are tightly connected to other tasks and there are often disputes

about productivity of these trades. All the other metrics can be reported by participating companies except the share of direct work which requires additional studies to evaluate improvement. When systems such as indoor positioning get more common, the share of direct work could be replaced by uninterrupted presence in work locations (Zhao et al. 2019) which could be scalable measured.

Table 1: Metrics agreed by Building 2030 consortium

Theme	Metric	Notes
Reliability	Zero defects at commissioning	Zero defects (0/1) (all punchlist items fixed before commissioning)
	Zero accidents	Zero accidents (0/1)
	Finished on schedule	Original internal schedule + any time extensions
	Finished on budget	Original internal budget + any change order adjustments
User centric	Collaborative contract form	IPD, Alliance, collaborative project management contract etc.
Sustainability	Recycling rate	% of waste recycled (= not burned or taken to disposal area)
	Energy classification A or B	A & B are the best classifications in Finland
	Environmental certification	Leed, BREEAM, Joutsenmerkki, RTS
Productivity	Construction duration	From top of foundations to commissioning (excluding earthworks and foundations). Correlated with project type and construction budget
	Share of direct work	Measured with time-and-motion studies / work sampling of electrical and plumbing tasks (mandatory breaks removed)

The baseline performance of Building 2030 companies was evaluated based on projects completed in 2020. Companies were asked to supply details of a sample of their projects that finished in 2020, separately for residential, commercial and infrastructure projects. 58 projects with a total value of 1,1 billion EUR were supplied by five different construction companies. The average size of projects were 10,2 MEUR for residential projects, 26,2 MEUR for commercial and 0,5M for infrastructure projects. The researchers instructed the companies to take a random sample of completed projects but could not ensure that sampling guidelines were followed. There were so few infrastructure projects supplied that their results are not included in the results below.

The results are shown separately for residential and commercial projects below. Commercial projects turned out to be a too heterogeneous group and will be subdivided to several project types such as offices, retail, hospitals etc. in the next rounds of data collection. The need to do this can be seen when correlating project budget with project durations. Figure 1 shows the scatterplot for residential and Figure 2 for commercial buildings. There is no correlation with commercial buildings and a very strong correlation for residential buildings.

Table 2: The first measurement in 2020

Metric	Residential	Commercial
Zero defects at commissioning	41,7%	25,8%
Zero accidents	70,8%	35,5%
Finished on schedule	83,3%	80,6%
Finished on budget	50%	51,6%
Collaborative contract form	16,7%	51,6%
Recycling rate	70,3%	74,5%
Energy classification A or B	63%	48%
Environmental certification	0%	19%
Construction duration	Average 66,1 weeks (strong correlation to project size, see Figure 1)	Average 66,8 weeks (no correlation to project size)
Share of direct work	21% (electrical and plumbing tasks based on a time-motion study of 2 projects)	20% (electrical and plumbing tasks based on a time-motion study of 2 projects)

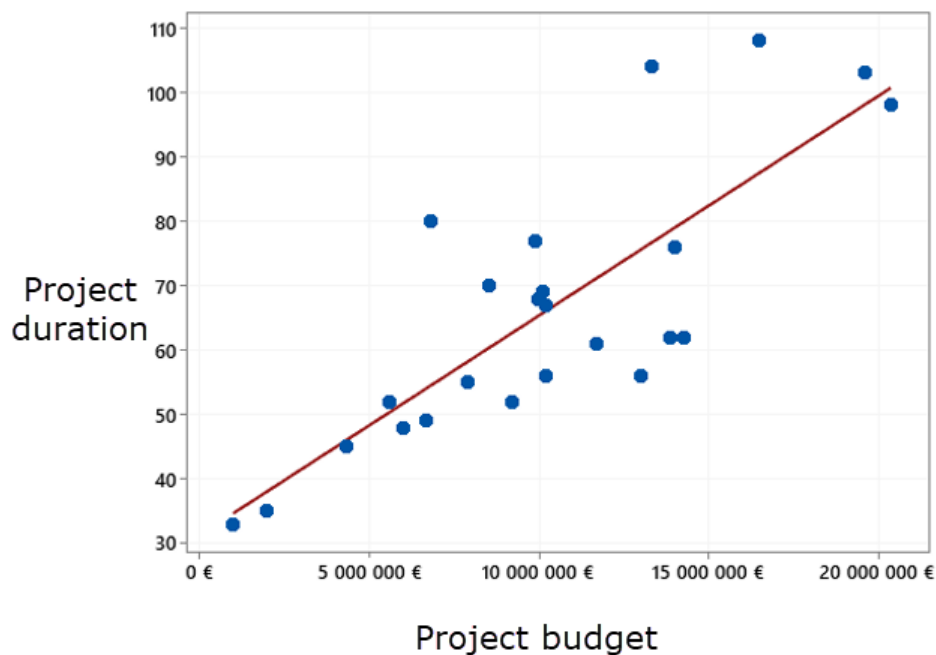


Figure 1: Project duration vs. budget for residential projects

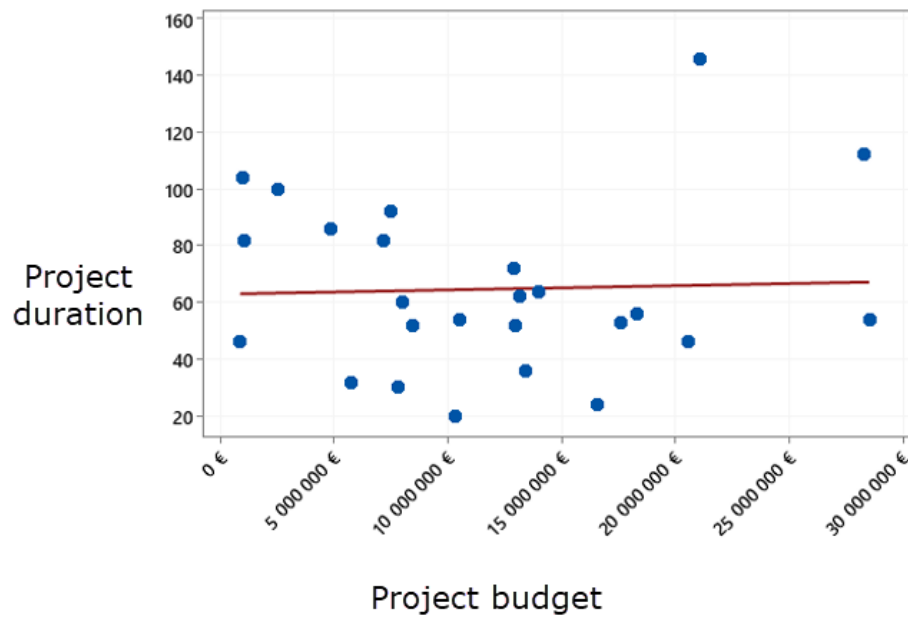


Figure 2: project duration vs. budget for commercial projects

Based on the results of the 2020 projects, the group set targets for the industry for 2030. All reliability measures should improve towards 100%. The share of collaborative contract forms in complex commercial projects should reach 80% by 2030. The target for recycling rate was set at 90%, which is better than car manufacturing today (at 87%). Energy classifications A and B should reach 80% of all projects and at least 50% of projects should be environmentally certified. Project durations should be decreased by eliminating waste in the process. The target for an average residential project was set to be 40 weeks (currently 66 weeks), adjusted by project budget. In other words, the target is to move the regression line of Figure 1 down. The target for commercial projects will be set after more detailed measurements in 2021. The share of direct work of electrical and plumbing tasks should increase to 40% (with mandatory breaks removed from data). The next round of measurement is ongoing and the participating companies have committed to implementing lean and digital methods to keep improving project-level performance consistently.

DISCUSSION

IS CONSTRUCTION INDUSTRY IMPROVING IN FINLAND?

Koskela and Koskenvesa (2003) introduced Last Planner to Finnish construction industry already in 2002, since that several companies have reported (e.g., Elfving 2021) about company specific lean deployment. Lean Construction Institute (LCI) Finland was founded 2008, it has active members widely from owners, engineering firms to contractors. Since 2015, Aalto University have significantly invested in lean construction research and education, spearheading with the Building 2030 program, where members represent about 40% of the Finnish construction market. There is no doubt that the awareness and knowledge of lean in construction has significantly increased just measured by how many people have been trained in internal company trainings, through

LCI Finland and the academia. Another indicator of the maturity of industry can be the shift of contract models, from transactional to relational. The use of alliance or integrated project delivery contract model was over 10% of the total building volume in 2020, being only few pilot projects 10 years ago (LIPS and Lean Construction Congress 2021). However, the question is, has the construction industry improved performance in Finland? Short answer, probably but except for safety, there is lack of data to show results.

In order to take the industry to the next level, we need to have fact-based information to evaluate whether we are progressing as an industry. It would have been interesting to see how the industry performed 20 years ago against Building 2030 performance metrics. Unfortunately, there is no data available. The base line is currently set, now it is important to annually continue with the measurement and follow the development. Even more, to act on the measurement results and help companies to improve. The commitment of the CEO's of participating companies to participate and direct the benchmarking effort and implement actions that move the needle is key.

The authors believe that the construction industry is improving performance, and through collaboration with industry and academia and successful anecdotal case studies, there is enough knowledge to get to the next level. The authors intent to report annually the performance indicators for the Finnish construction industry to see whether the performance improvement is limited to few projects or can we observe effects on industry level.

IS CONSTRUCTION INDUSTRY PERFORMING WORSE THAN OTHER INDUSTRIES?

It has taken a long time to establish comparable performance metrics within the construction industry, and it is even harder to measure the construction industry against other industries. Financial measures are not as simple as they may look like, because the risk profile of the industry and companies needs to be also considered. In productivity and safety, we are clearly below average. On the other hand, as earlier mentioned, some of the productivity improvement may not be seen in the statistics because they are recorded elsewhere. Customer satisfaction, and particularly NPS sticks out. Why is construction industry performing so well in NPS? Are we more customer focused than we tend to believe? Does the nature of our industry enable us to understand customer needs better than in many other industries? Or are the expectations so low for our customers that it is easy to meet and exceed them? These would be interesting future research questions to explore and in the best case other industries could learn from us. It is evident that industry must improve productivity and there is plenty of opportunity. The industry needs to also bring up and talk about customer satisfaction; how it captures the requirements, generates the value and how it measures the value (Koskela 2000). Here we may perform better than others.

WHAT IS DIFFERENT FROM OTHER COUNTRIES

Finland is an interesting test bed for industry level studies, because the market is fairly small, thus it is possible to reach a critical mass. The industry players are relatively keen to collaborate within research and development and are used to work together. Finally, there is already 20-years of experimenting with lean in the industry, which gives a good knowledge base to spring off. The other Nordic countries may have similar characteristics, however, the larger the industry becomes, the more challenging it may be to reach the critical mass and common performance indicators.

One metric that immediately raises questions is the schedule performance measured by the consortium. Over 80% of projects finished on time (adjusted for any time extensions). This is much higher than typically reported in international studies. Finland has a long history of implementing location-based management, focusing on the risk management angle, where time buffers are used to prevent cascading delays (Kenley & Seppänen 2010). Are the time buffers too large? How do the Finnish projects compare to other projects of similar scope? There is a large effort to shorten cycle times and eliminate time buffers in Finland through takt production. Will the high reliability of schedules suffer or stay the same? Or are there tradeoffs that are made in Finland with respect to budget, safety or quality? The proposed metrics attempt to capture and evaluate these trade-offs on industry level.

CONCLUSIONS

Lean methods were introduced two decades ago to the Finnish construction industry, during the years the pace has gradually increased and the last six years it has been hard to find a mid or a large sized project that does not apply some of the lean concepts. However, it has been difficult to evaluate if the industry has improved. The research set out to introduce a set of benchmarking measurements that the industry and academia have agreed to report annually in Finland and to review other industry-level metrics in use. The first measurement results highlighted that the project types generally used in reporting are not granular enough for comparisons to be made. In future, more detailed project types will be used. Even if the reporting was not enough granular, the CEO's of companies were able to use the results to set goals for 2030 and commit to annual measurement and scrutiny of results. Some early insights include the high share of Finnish projects that are completed on time. An interesting finding was also that the customer satisfaction of construction industry is on the same or higher level than other industries. For other metrics more data will be needed to understand if the Finnish construction industry is performing better or worse than others. The data collection of 2022 metrics is in progress, and it looks promising. Yet, it is too early to say if the industry has improved compared to previous year. The real success of the measurement will be tested in the future if the industry and academia together can learn and improve the baseline results. Therefore, it is vital to continue collecting and sharing as comparable as possible data for a longer period. Also, to perform industry-level comparisons to other industries and other countries using similar metrics.

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