WESCi
WIND ENERGY SCIENCE

IMPROVEMENT STRATEGIES FOR THE OFFSHORE WIND POWER INDUSTRY

Contents

The success story in offshore wind is written by Extraversion, Innovation and Knowledge Sharing.

Having held leadership and wind energy specialist positions at wind power research organizations, Stavros has more than 15 years' experience in the areas of business development, continual improvements implementation, and value creation. He was a key member of an executive team that built a successful digital research site that was later acquired by a major research corporation, and he has contributed to best practice standards for the wind power industry. Stavros drives the quality and evolution of Wind Energy Science Research platform. As a wind energy specialist, he focuses on developing expertise and thought leadership through strong commercial engagement and strategy support across the business.

Highlights

Purpose

This research survey aims to introduce a conceptual framework from a Knowledge Sharing and Continuous Improvement (KSCI) perspective, aimed at promoting constructive dialogue, long-term collaborations, and innovation for the offshore wind power industry. Moreover, this document outlines a proposed approach to improving the way the offshore wind power sector shares knowledge and learning going forward.

Design/methodology/approach

The design methodology of the survey included four recommendations related to the offshore wind power sector, where the fundamental scope was to explore the extent to which the sector could improve the way it creates value, shares knowledge, implement lean, lessons learned and overall good practice. The Wind Energy Science Research Platform has led work to address this recommendation over the last 8 months (the study); the results of which are summarized in this report. The statistical community of the research is comprised of 190 persons from the offshore wind power industry and academia.

To additionally support the study (second part), we commissioned four wind power market leaders to address four main aspects:

i. identifying what lessons have been learned in the design, development, construction and operation of offshore infrastructure to date,
ii. assessing ways of improving knowledge sharing in the sector and recommending an approach or a different range of methodologies for doing so,
iii. indicatively quantifying the potential benefits of such an approach in terms of LCOE, CAPEX,OPEX , cost of finance, project design life and,
iv. Identifying opportunities for the sharing of knowledge and best practices, regulatory approaches, and scientific models with regard to protection of the offshore ecosystems (marine mammals, migratory birds)and cultural resources;

Findings

Despite the fact that offshore wind energy sector is a young industry, the CoE mitigation via innovation and continuous improvement methodologies should be a priority to compete with other forms of energy. Applying a knowledge sharing and value creation perspective in the offshore wind industry has hitherto been limited to the academic community. This paper offers a KSCI framework that includes five interdependent and synergistic aspects of reducing CoE – innovation, industrialization, knowledge sharing, continual improvements and stakeholders partnering – to guide the industry towards sources to reduce CoE and establish offshore investments longevity.

Whilst the companies, stakeholders and other parties of this survey participants are by no means exhaustive, the findings illustrate that the majority of the offshore wind power industry seeking performance improvement and concepts optimization should consider dedicating a significant amount of effort toward fostering knowledge sharing, critical thinking, constructive dialogue and value creation.

The study also found that in spite of the growing interest in offshore wind power industry knowledge sharing practices, COE mitigation, its challenges, lessons learned from the past, and performance implications, there is still a dearth of real life continuous improvement-knowledge sharing paradigms and practical implications. If this is the case, it would appear to be a strong limiting factor to the wind power sector generally in terms of absorbing the benefits from the learning and constructive knowledge generated through these initiatives.

The findings of the survey reveal that there is a significant potential for lowering LCOE through either increased production of MWh, novel technologies implementation or through mitigation of costs. A plethora of different prospects are present, especially in respect to collaboration across industry's players to enable innovation. Organizational knowledge sharing seems to be the basis for new developments and strategic innovations. If the industry is to establish and secure an ever solid and more competitive source of energy, they must deliver on partnership and collaboration for strategic innovation and join forces to reach their common objective.

Research limitations/implications

KSCI is a broad research area; thus, the results of this research and the presented framework to reduce the CoE, establish Continuous Improvement and improve Knowledge Sharing is open for further development and discussion.

Practical implications

The research paper provides insights into how the offshore wind power CoE can be reduced through innovation, industrialization, knowledge sharing, continual improvements and stakeholders partnering-including academia co-operation- in the offshore wind energy sector.

Originality/value

This study is motivated by the recommendations that have appeared at the Memorandum of Understanding (MOU) between Denmark and the USA to strengthen cooperation on offshore wind energy projects and the methods-approaches to establish best knowledge sharing practices relevant to offshore wind energy development, operation and maintenance.

ROADMAPPING

The purpose of this survey was to show how knowledge sharing and value creation can support lifetime sustainability of offshore wind installations. According to the findings, it seems that the reduction of offshore wind investments LCOE started to slow down markedly in the course of 2014, indicating that possibly the easy pickings have already been reserved, and now the industry as a whole must – in collaboration with Academia – identify new opportunities for lowering LCOE and establish offshore wind longevity.

Executive summary

Offshore Wind Turbines Are Now The Largest Rotating Systems On Earth

Developments in wind turbine technologies as well as in foundation, installation, access, operation, maintenance and system integration have permitted transformations into deeper waters, further from shore, to reach sites with exceptional wind resource potential. Until 2007, offshore wind plants were installed in water depths below 20m and closer than 30 km from shore. Nowadays, in contrast wind turbines are being installed in water depths up to 40 m and as far as 80 km from shore.

Understanding the importance of knowledge sharing and value creation – along with the underlying business strategies and regulatory trends – will be essential if offshore wind power players are to remain competitive in the years ahead. Not only must firms decide which lines of business remain viable and which technologies are suitable for them, they will also need to understand how to layer the gap between knowledge and secrecy and how to consolidate them in order to generate significant cost savings, produce process efficiencies, improve quality of service, and build a stronger value chain with novel ideas and technologies. Knowledge sharing and value creation are enabling innovative technologies and continuous improvements for the offshore wind power industry.

These knowledge-sharing platforms will not just reduce costs but play important roles in facilitating investors, manufacturers, operators and stakeholders to implement real life scenarios from the lessons learned to produce constructive knowledge and establish high ROI.

The Compliance and Policy Clarity Challenge

Compliance is an enormous and growing challenge for the entire wind power industry, with a plethora of new regulations and support mechanisms scheduled to take effect over the next few years and with the available financial resources under constant pressure.

Large compliance working-groups are currently needed throughout the offshore wind power industry and may still need to grow to establish successful development strategies for the sector.

New technologies that make it easier to automate and outsource complicated compliance obligations could help save firms substantial amounts of time, money and effort.

Competiveness

The LCOE from offshore wind, which averaged about EUR 225 /MWh in 2001, had drastically fallen to approximately EUR 155 /MWh by the third quarter of 2016. Improvements and innovations that supported this cost reduction include offshore-specific turbine designs, tailored offshore wind installation vessels, automatic monitoring systems and advanced offshore electrical interconnection equipment.

The decade between 2006 and 2016, the rated capacity of commercially installed offshore wind turbines increased from 2 MW to more than 6 MW. This significant growth not only improved and optimized the efficiency of the turbines but also resulted in cost reductions across the entire life-cycle from the wind resource assessment prediction to the supply chain efficiency revolution. The paradigms of the Horns Rev 3 and Borssele I offshore wind farms, indicated important cost reductions due – mainly – to increased competition at the developer level for the same site.

Systems Automation

A powerful, real time optimization framework integrated into the automation system may significantly improve the control of wind power plants and transfer Balance of Plant, reliability availability and efficiency to the next level. Automation may also make it cost-effective to offer sophisticated existing services to new markets or fields, and to invest in new services that are not currently viable or practical.

Extraversion and Partnerships

The success story in offshore wind is written by

Extraversion, Innovation and Knowledge Sharing. In a bid to reduce costs and add value, many firms are interested in knowledge transfer, knowledge sharing, knowledge acquisition etc. To an extent, the latest knowledge sharing and value creation platforms already demonstrate the importance of the associated synergies and complementarities of scientific and technological capabilities. Partnership may be equity corporations, contracts, research projects, patent licensing, and so on, to human capital mobility, knowledge management, scientific publications, and interactions in symposiums, seminars, conferences and expert groups.

Structural Change

To date, it has proven difficult for small and highly innovative offshore wind power firms to disrupt the existing regulatory framework. However, a large number of firms and stakeholders are busily identifying the most promising approaches and methodologies to make the best possible development and investment decisions.

One of the biggest challenges for the offshore wind industry is to select policy and involvement instruments that best serve value creation and knowledge sharing. Performance, CAPEX, OPEX and financeability are the most critical factors to ensure business excellence. Nevertheless, a significant number of respondents believe that annual energy production can be increased through innovation in materials (lean, sensitive design) and manufacturing technologies, while some others considering optimum reliability and efficient service of the turbines during operation as extremely critical.

IT concerns such as data privacy and cyber-security are important factors across all stakeholders, as they can be difficult to maintain. However, the key headlines are about integrating data from real life projects – experiences and research studies into the design basis, to enable optimized strategy schemes, innovative concepts and reduced O&M cost. These are all catalysts for competitiveness and further growth.

First Lean, Then Modularization

Lean is generally associated with methods and practices for removing waste and improving flow. The survey findings indicate that several sources of waste found in offshore wind processes stems, mainly from unnecessary delays in supply chain, O&M tasks, manufacturing, costs, modelling and errors. The responses indicated that several offshore wind firms have successfully implemented lean not only in manufacturing but also in support functions such as procurement, engineering, inventory control, scheduling, accounting, and sales. As part of this research, respondents were asked to identify the main reasons why these lean techniques had been successfully implemented or not within their organizations. The top reasons of Lean implementation failure cited by survey respondents involved lack of commitment from leadership (92 percent), no extraversion mindset (75 percent) and no effective management of gains achieved (68 percent). More than 80 percent of respondents said that obtaining commitment from leadership and extraversion (65 percent) were among the main reasons of a lean strategy implementation in their business.

72 percent of our respondents say they expect Continuous Improvement and Knowledge Sharing to significantly metamorphosize the offshore wind as a competitive energy alternative, and will enable its large-scale deployment over the next three decades.

Key Findings

The Regulatory Framework Impact

Despite the global tumultuous economic conditions ought to the financial crisis, the ever-changing EU regulatory framework and the problematic supporting mechanisms, the flood of regulations continues and new technological advancement is expected to take effect in the next five years.

In this survey, 79 percent of all respondents say they expect wind power industry to be severely impacted by regulations within the next 36 months (see Figure 1). This indicates that the industry is about to enter a period of intense regulatory upheaval at the same time that it's being disrupted by an array of technological advancements and innovations. The survey reveals the introduction of technological advances, such as next-generation turbines with larger rotors, tailored made vessels, condition monitoring technologies, advances in site layout optimization and power transmission, as particularly significant.

Moreover, an emphatic 82 percent of the respondents say they expect regulation changes to significantly modify their key assumptions used in calculating the wind power investments LCOE, CAPEX and OPEX (see Figure 2a). Addition to the latter, the cost of finance is a significant factor in increased offshore wind power integration. Especially for investments located in deep waters or in environmentally protected areas the associated higher regulatory costs may impose considerable barriers and even stop certain activities from being used as standards.

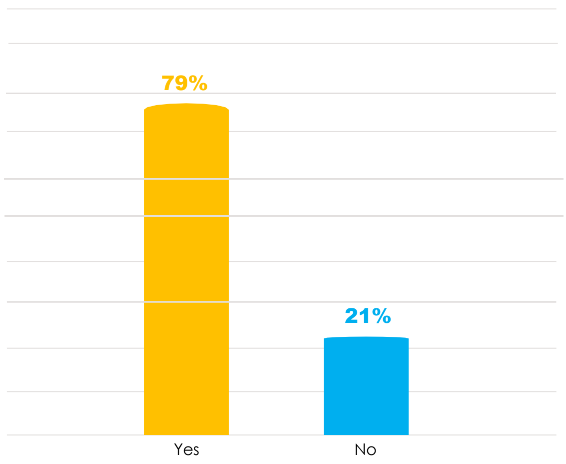


Figure 1: Do you expect regulatory framework changes to severely impactwind powerbusinessinthenext 36 months?

In a knowledge-based world, it is the aptitude and capability of firms to produce, transfer and embrace constructive knowledge patterns that can result in long-term gains arising from a more efficient allocation of resources and performance improvements. This reflects the ongoing changes in wind power systems technologies. The continual improvements are not stereotypes, but dynamic interactions that effectively arrange resources and produce innovative tools and services based on knowledge creation and sharing.

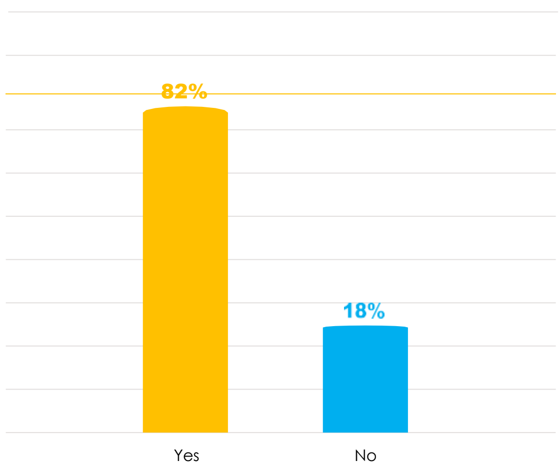


Figure 2a: Do you expect regulation changes to significantly modify your key assumptions used in calculating the LCOE?

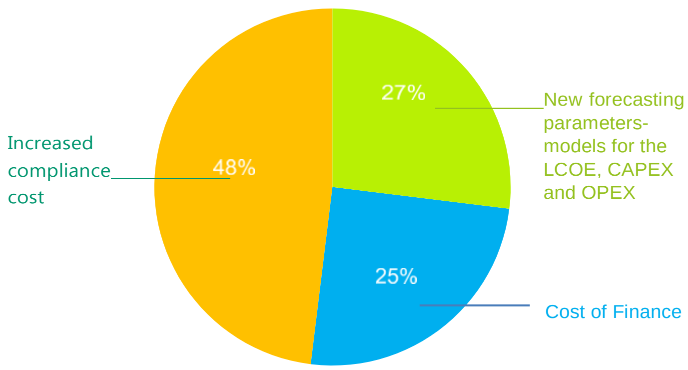


Figure 2b: If you answered yes, how?

"Give me a place to stand and with a lever I will move the whole world"
Archimedes
Book of Histories
(Chiliades) 2, 129-130

The Principal Concern: Data Secrecy

In terms of specific regulations, data secrecy is the top concern of 30 percent of respondents (see Figure 3a). This makes sense given that although most researchers and wind energy experts agree that data sharing is the scientific and ethical ideal, there exists a general skepticism regarding making their data publicly accessible.

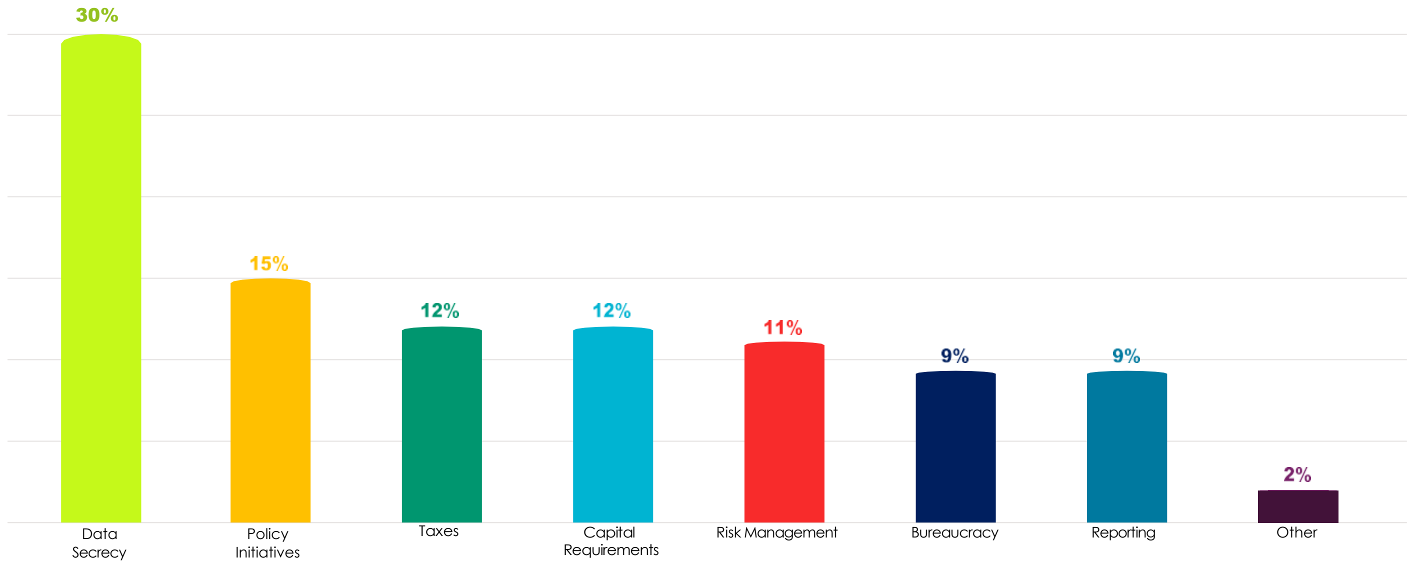


Figure 3a: Which area concerns you the most?

This unwillingness of sharing information stems from various reasons such as the fear of being accused for mimicking ideas, ethical concerns, lack of knowledge sharing culture and motivation, etc. Since withholding information can prevent or delay the progress of science or technology in more ways than one, should it be considered a practice of systematic misconduct? The majority of the respondents (Figure 3b) replied yes (76%) to this question, 15% replied no and only 9% had no opinion.

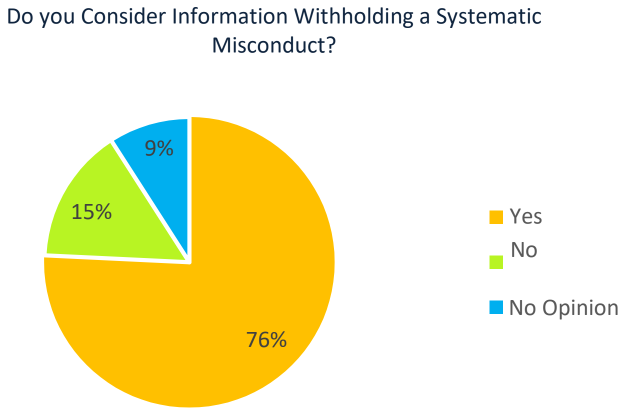


Figure 3b: Do you Consider Information Withholding a Systematic Misconduct?

Yet, one may wonder, how information misconduct is defined particularly for the offshore wind power industry? Misconduct means '' untruth, falsification, fabrication, or even plagiarism in recommending, proposing, performing, or reviewing continual improvement methodologies and practices, or expressing unwillingness to share and report research results-findings." This is just one definition of misconduct and it covers the scenario wherein researchers and wind power professionals indulge in unethical practices while conducting and publishing their research or even their observations, opinions and remarks from their participation in wind power projects. A key finding from this survey was that as information or knowledge cannot be shared there is a lack of clarity and transparency and thus, data secrecy.

The consequences of not sharing the knowledge acquired are many and far reaching. According to the results of this survey, respondents reported that information withholding slowed the progress of continual improvements and best practices implementation in the offshore wind development and operation. Moreover, data secrecy seems to epitomize a negative effect on value creation and organizational dialogue between employees, managers, policy makers and stakeholders made it difficult to produce viable results, and foster innovation. Therefore, it probably would not be wrong to consider withholding of information a significant barrier for the further growth and development of the offshore wind power industry.

Industrial and academic researchers are compelled to share their data or provide supplementary information on their research for scientific journals like Elsevier, Springer, and IEEE, while a significantly large number is open to share their information with colleagues and fellow professionals. To holistically investigate this topic, data requests were sent to 150 authors of articles in offshore wind power who stated that 'data are available upon request.' However, only 40% of them provided the requested data after constant requests. Such behavior where researchers or experts adopt data secrecy without suitable reason may dramatically change not just how continual improvements can be implemented, but the Offshore Wind Development Conceptual itself.

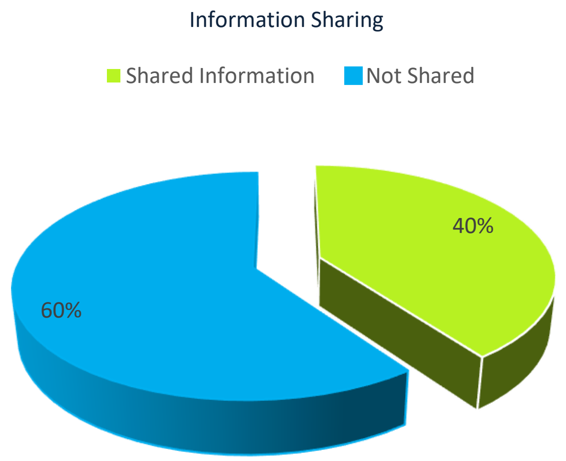


Figure 3c: Researchers Information Sharing Percentage

The Whole Truth and Nothing But The Truth

The statement that "most published research findings are false" is not just a pseudoscientific or conspiracy theory. Almost twelve years ago a famous epidemiologist from the Stanford University named John Ioannidis published a paper which appeared to be one of the most widely cited research paper ever published in the scientific journal community.

In his 2005 scientific paper, Dr Ioannidis wrote: "Published research findings are sometimes refuted by subsequent evidence, with ensuing confusion and disappointment for most research designs and for most fields."

He argued that there is increasing concern that in modern research, false findings may be the majority or even the vast majority of published research claims, and that the high rate of non-replication (lack of confirmation) of research findings is a result of the convenient, yet inaccurate strategy of claiming conclusive and reliable research findings.

Approximately 70 out of 190 individuals of this survey said that invalid empirical analysis (with quickly debunked findings) is a common phenomenon in fast-moving fields of research like the offshore wind. This has been well-known as the Proteus Phenomenon after the Greek god Proteus, who was capable of changing his shape and appearance.

Of the respondents who believe that Proteus effect is to blame for inaccurate research findings on the wind power industry, 78% of them think that lessons learned; knowledge transfer and collaboration are the fundamental cornerstones to transform tacit knowledge to explicit knowledge and foster innovation.

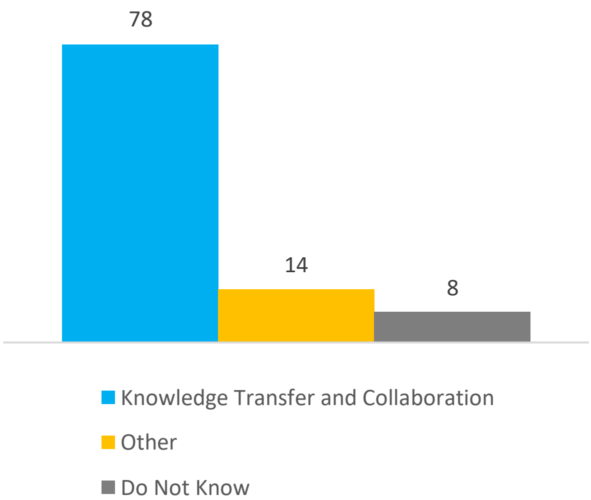


Figure 3d: How to mitigate the Proteus Effect in Offshore Wind Power research activities?

Regulatory Framework: A Critical Concern

Many areas of the existing regulatory framework cause the off-shore wind industry concern, ranging from trade transparency and tax systems reforms to capital requirements and irregularities between domestic and international directions. While the regulatory, policy and institutional reforms are significantly important to improve risk sensitivity, simplicity and competitiveness, all together they reveal the variety and scale of regulations that offshore wind power firms have to comply with and prepare for.

Managing this synergistic interactions of regulatory risks is further complicated and often problematical, because markets and policies vary considerably in their requirements. Again, technology has the potential to help knowledge transfer, innovation and value creation.

Renovating Compliance

The findings suggest, that implementing and integrating the latest technologies would not be enough to allow the offshore-wind industry to overcome the cost reduction challenges along and within every phase of the value chain. Continual innovation allows further technological development to meet market needs, mitigate risk and establish projects feasibility.

Toward the realization of offshore wind energy as the renewable energy source of choice – regulatory compliance is key. However, the cost-reduction potential mitigation, including learning curves, engineering valuations, and other means of synthesizing knowledge ae considered particularly important.

INVESTORS VERSUS TRADERS: REGULATIONS

Eighty-seven percent of respondents say they expect regulation reformations to drastically impact their business within the next 24 months. By breaking down the results proved that this is the opinion of 73 percent of traders and 84 percent of investors (Figure 4). Thus, investors seem to be quite alarmed about the impact of regulation reformations on their business over the next 24 months than the traders.

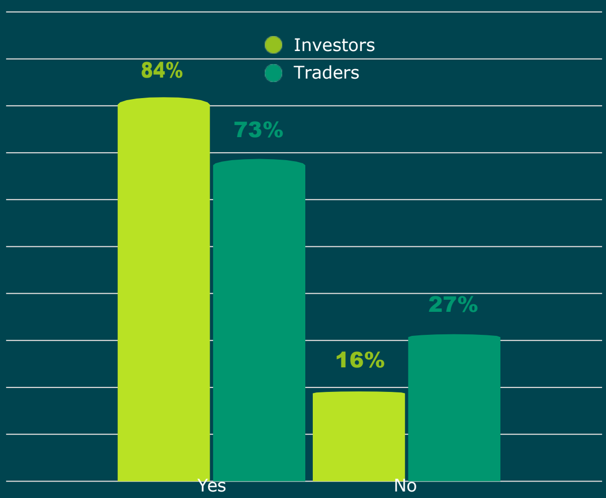


Figure 4: Do you expect regulation reformations to severely impact your business in the next 24 months?

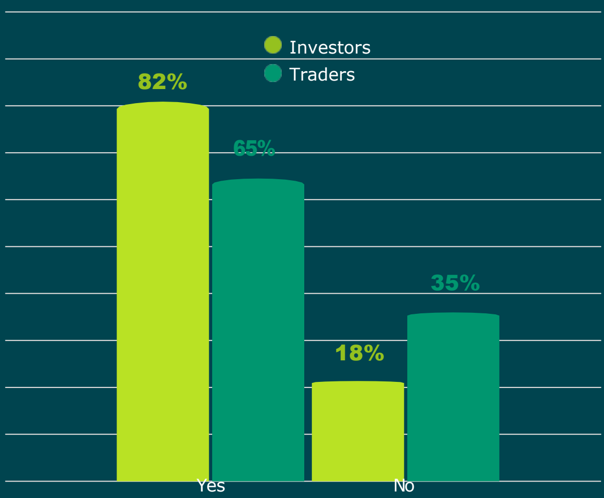


Figure 5: Do you expect regulation reformations to significantly change your LCOE mitigation model?

Almost two-thirds of the traders (65 percent) feel that regulation reformations will significantly change their revenue model (Figure 5). An empirical hypothesis is that this high percentage indicates that, traders believe that stricter regulations and standards are a significant threat to trade activities.

An even higher percentage of investors (82 percent) feel that regulation reformations should significantly impact the LCOE percentage reductions, indicating that LCOE reductions might be achieved with a more flexible and effective regulatory framework.

The survey findings suggest that the economic and financial feasibility of both groups could be dramatically reduced by stricter regulation and law mechanisms. Moreover, the effect could be fast as both expect a severe impact within 24 months due to the economic uncertainties and ever-changing policy regulations. Investors involved in high-risk offshore projects dependent upon problematic regulation, difficult to predict capital requirements may be particularly vulnerable to change.

The findings on this part of the survey have implications for administrative and organizational decisions regarding how a reliable and flexible a framework can be important to foster transparency and improve value creation.

Exploring Key Issues and Alternative Models

The survey results revealed that offshore wind projects have suffered from, and been adversely impacted by, a wide variety of challenges and difficulties across project life cycle – from early stage design issues through to environmental assessment, installation, supply chain and O&M. Figure 6 graphically depicts typical issues which interviewees mentioned. However, the main scope of the study was to consider the potential for improvement in the way in which the offshore wind sector creates and shares knowledge, taking into account a more structured framework and also through facilitating collaboration between industry and academia.

A key finding from the results evaluation was that knowledge sharing influences the organizational performance from various aspects, such as management, decision, and operation. Therefore, R&D may be regarded as an important dimension to provide insights on potential solutions and establish value creation. The process of R&D implemented by a team or a number of teams (collaboratively) not only produces knowledge but also promotes the dialogue and communication among different workforces and divisions.

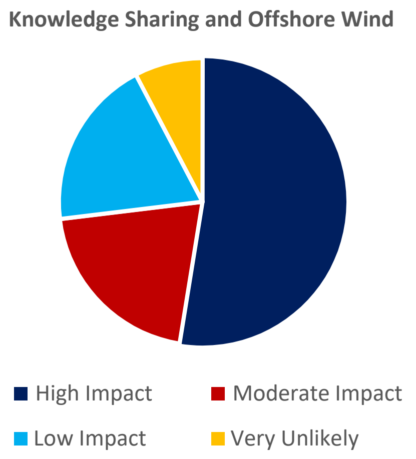


Figure 6b: What is the degree of impact of knowledge sharing on the offshore wind project concerns?

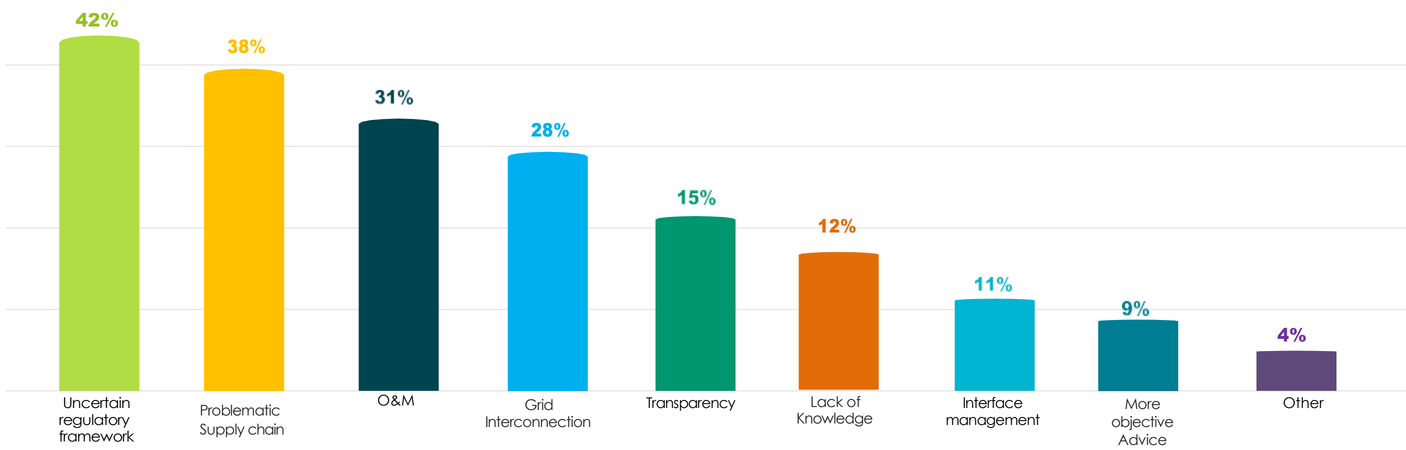


Figure 6: Which one is the most significant issue identified as adversely impacting offshore wind projects?

The concept of fit in strategy research from Dr. Venkatraman (1989) proposed several alternative models for investigating the impact of third variable as a means of exploring contingency relationship. Utilizing the centric idea behind Venkatraman's study, a series of questions were asked to the respondents to assess the importance of knowledge sharing - as the third variable - on each of the most significant issues associated with the development of offshore wind projects.

For each issue, they were asked, "How likely is this risk to materialize during the next project?" and "What is the estimated impact (beyond just economic consequences) for the offshore project if this risk were to materialize?

The answers ranged from 1 ("very unlikely" and "low impact", respectively) to 5 ("almost certain" and "high impact", respectively). Respondents were given the possibility to leave the answer blank if they felt unable to provide an informed answer ("don't know"). A simple average for both probability and impact for each of the offshore risks was calculated on this basis (Figure 6b).

Add Value with Knowledge Sharing

A substantial 84 percent say that they expect knowledge sharing practices to impact their businesses (see Figure 7). This suggests that a very large percentage of the offshore wind power business activities could be improved, and high risk management tasks currently performed by people could be upgraded or replaced by technology. Moreover, the sources of modeling uncertainty and error could be also significantly reduced to establish an affordable, reliable, sustainable and modern renewable source of energy.

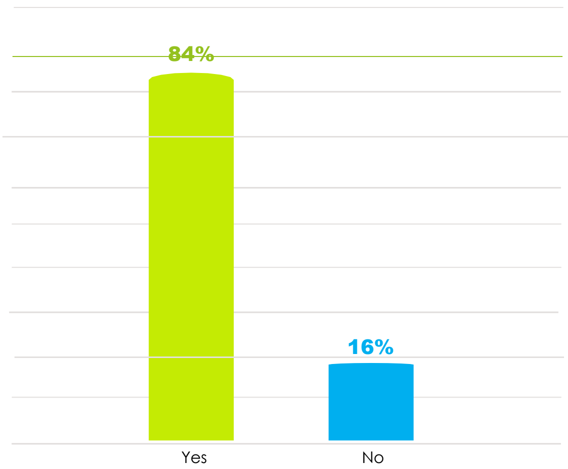


Figure 7: Do you expect knowledge sharing to impact your business?

KT Help Employee Engagement, Ensure Less Rework and Mitigate Project Duration

Knowledge transfer is often associated with job training and mentoring for some of the respondents. However, the results indicate that a percentage of the respondents appear to be aware that knowledge transfer can shorten the time the organization spends in changes, ensure less rework, help employee engagement and foster creative thinking. This also indicates that the offshore wind power sector is likely to experience significant levels of disruption as a large number of firms and organizations introduce new technologies (Lean, Agile, remote monitoring etc) that begin to augment or replace existing ones.

A significant majority of respondents also expect technical knowledge transfer to reduce offshoring, new-system implementation, reorganizations, and big project lifecycles (reduce project duration) - see Figure 8.

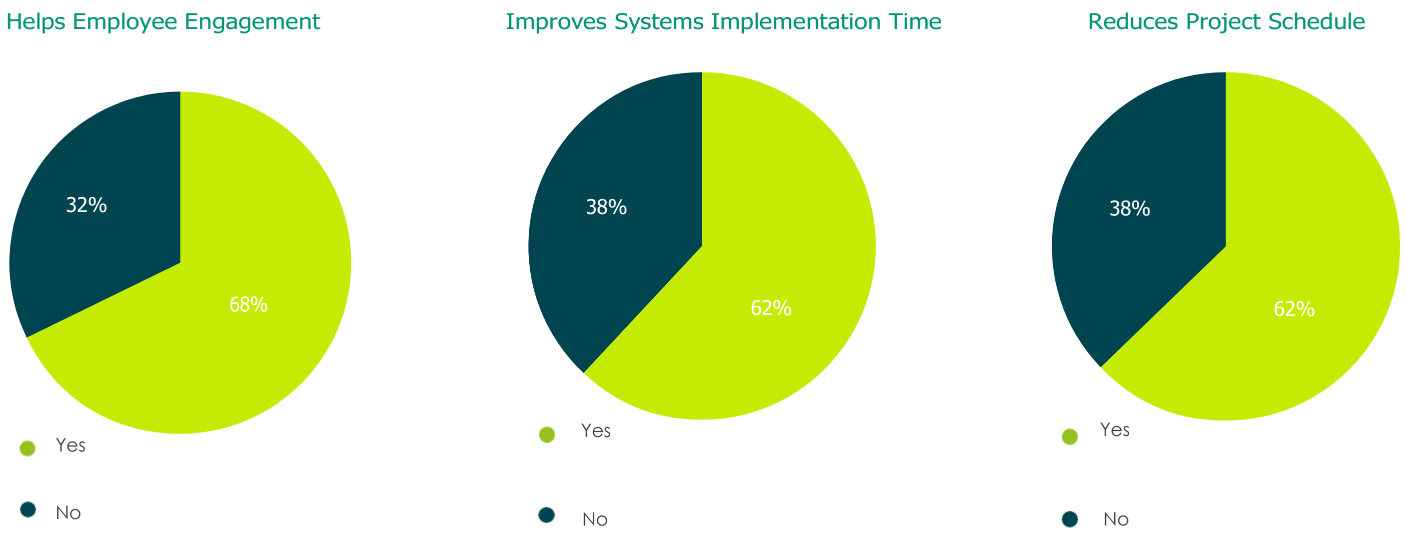


Figure 8: Do you believe that technical knowledge transfer…?

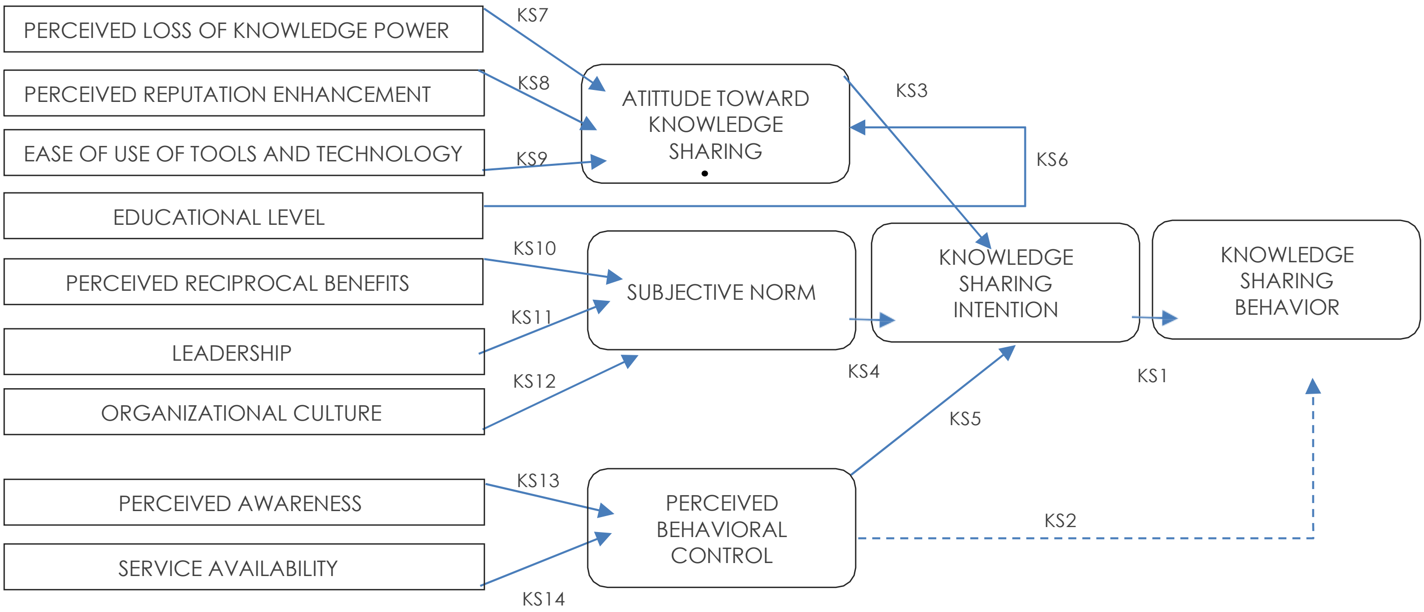
Knowledge Transfer Addresses Common Business Challenges

Knowledge sharing replicates the expertise, wisdom and tacit know-how of every organization and sector including offshore wind. A comprehensive and effective knowledge transfer strategy, is a fundamental parameter for a large number of the respondents. Since knowledge sharing behavior is determined by the intention to share, a Perceived Behavioral diagram has been provided to holistically assess the factors associated with the personal views of an individual about the expected availability or unavailability of important sources and prospects that could facilitate or hinder knowledge sharing.

Empowering Leadership in Management Team: Effects on Knowledge Sharing, Efficacy, And Performance Optimization

How the empowering leadership can positively related to both knowledge sharing and team efficacy, which, in turn, both positively related to performance optimization.

Acad. Manag. J., vol. 49, no. 6, pp. 1239–1251, 2006.
Abhishek Srivastava, Kathryn M. Bartol and Edwin A. Locke



KS1 - A high level of intention toward knowledge sharing leads to great knowledge sharing behavior.

KS2 - A high level of behavioral control toward knowledge sharing leads to great knowledge sharing.

KS3 - A favorable attitude toward knowledge sharing increases the intention to share knowledge.

KS4 - A high level of subjective norm that supports knowledge sharing leads to the increased intention to share knowledge.

KS5 - A high level of behavioral control toward knowledge sharing intensifies the intention to share knowledge.

KS6 - High education level positively affects the knowledge owners' attitude toward knowledge sharing.

KS7 - Perceived loss of knowledge power negatively affects a knowledge worker's attitude toward knowledge sharing.

KS8 - A perceived improvement in reputation positively affects a knowledge worker's attitude toward knowledge sharing.

KS9 - Perceived ease of use positively affects the attitude of stakeholders toward knowledge sharing.

KS10 - Perceived reciprocal benefits positively affect a knowledge worker's attitude toward knowledge sharing.

KS11 - Leadership support has a significant positive effect on the subjective norm to share knowledge.

KS12 - Organizational cultures have a significant relationship with knowledge sharing behavior.

KS13 - Awareness positively influences PBC toward knowledge sharing.

KS14 - High service availability positively influences a knowledge worker's PBC toward knowledge sharing.

KNOWLEDGE SHARING INTENTION AND KNOWLEDGE SHARING ATTITUDE

When it comes to knowledge transfer, a high percentage of offshore wind experts expect value creation and innovation to impact their business.

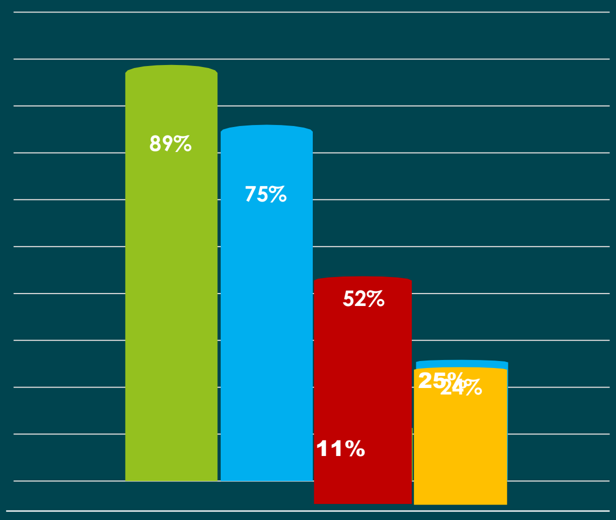
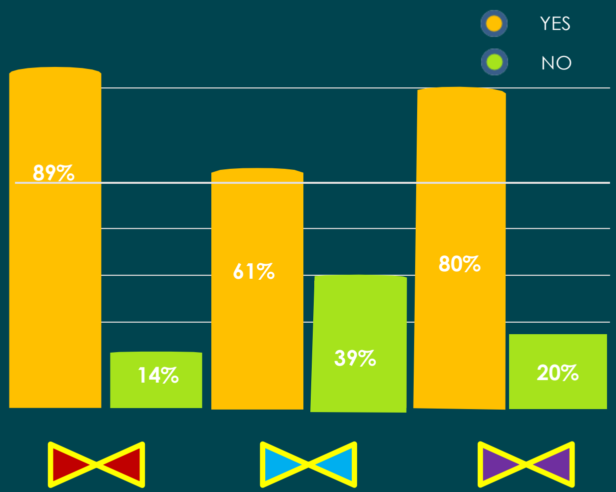


Figure 9: Likert scale responses in Knowledge Sharing

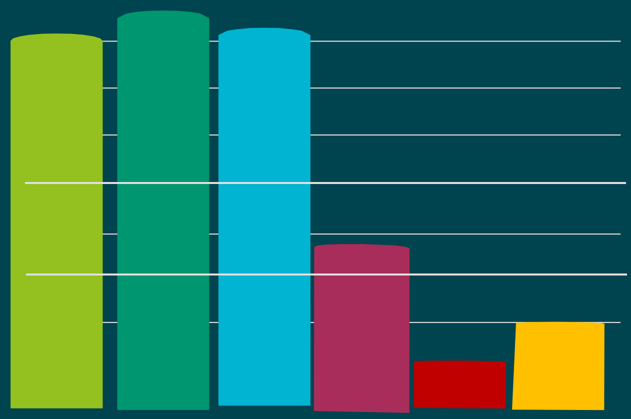
- Increased Learning improves Knowledge Sharing.
- Informal ways of Sharing Knowledge such as unscheduled are considered as the most effective.
- Knowledge Sharing amongst colleagues is considered as a standard
- Your Business expect you to use company time to pursue knowledge.

The results show that the majority of respondents are considering learning as an asset rather than an expense. Also, almost 90% believed that increased learning improved knowledge sharing in the organization (i.e. the more you know the more you share). Almost the half (approximately 52%) agreed that knowledge sharing is considered normal in the company. However, almost 75% disagreed with the view that prefers informal ways of sharing knowledge. Further, the majority of the workforce could not use company time to pursue knowledge (76%) - a critical factor for further research.



- It is Important for you to be able to trust colleagues in order to share your knowledge.
- Rewards and Incentives are important for Knowledge Sharing.
- It is important for you to have regular contact with other colleagues.

What influences the most in Time and Quality terms the insufficient knowledge transfer in your department?

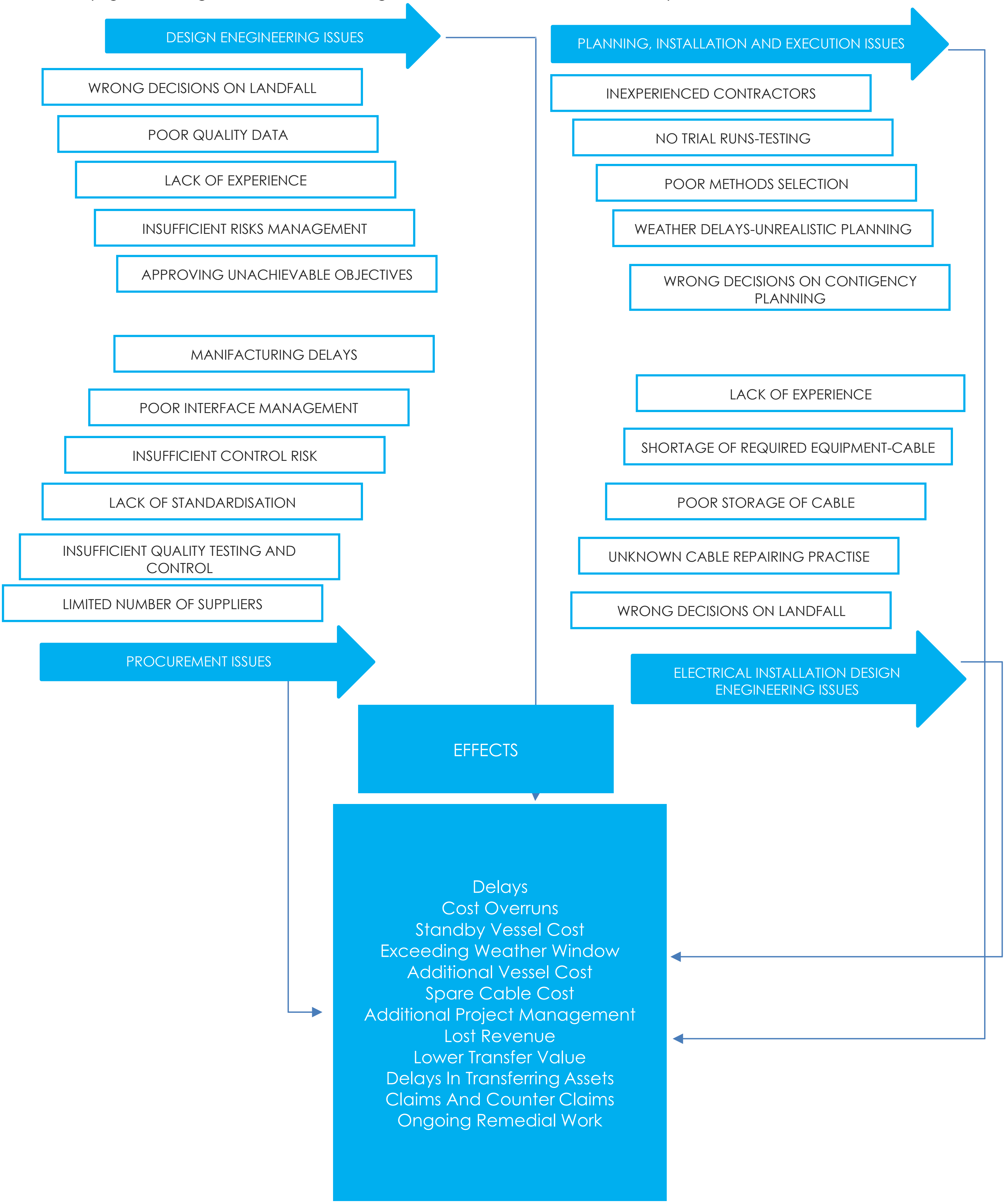


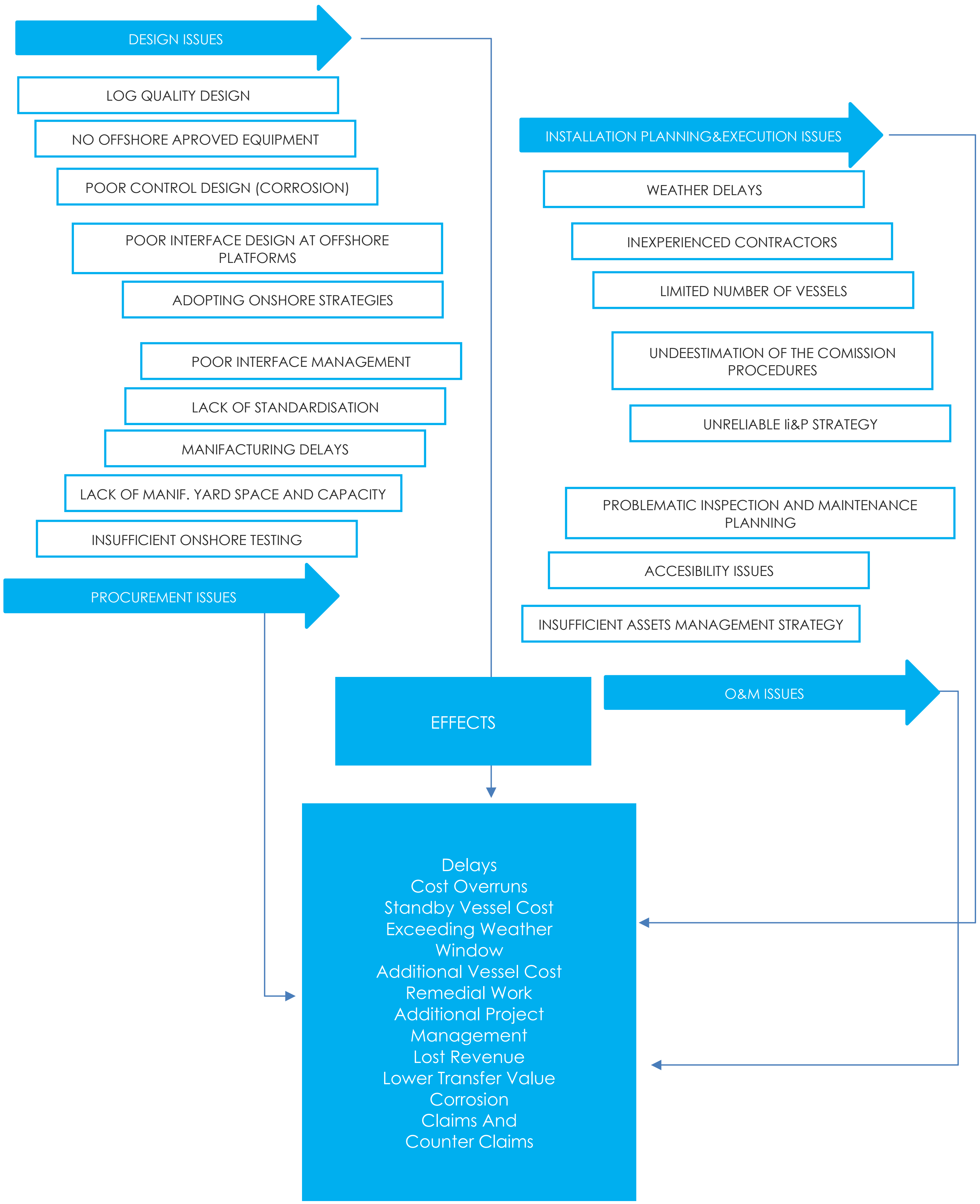
- Productivity
- Consistency
- Turnover
- Lost Expert with critical knowledge
- Innovation
- Other

A majority of respondents (almost 90%) agreed that it is important to be able to trust colleagues to share knowledge. Additionally, most respondents (over 60%) did not agree that rewards and incentives are important for knowledge sharing. Most respondents (80%) did believe it is important for employees to be to have regular contact with colleagues in the same position in other departments. So, in short, the majority of employees accept that they should admit mistakes and learn from them, suggesting a high level of confidence and interaction in the organization.

Root Cause Analysis

The fishbone diagrams below summarize the main causes that influence offshore wind projects life-cycle and technical viability. On the left hand side of each diagram, the various sources of problems are illustrated. These individual problem-origins are grouped together into an "integrated" theme which finally lead to the corresponding effects noted at the btom of the page. The integrated theme has been generated from the answers of the respondents.




DESIGN ISSUES
LOG QUALITY DESIGN
NO OFFSHORE APROVED EQUIPMENT
POOR CONTROL DESIGN (CORROSION)
POOR INTERFACE DESIGN AT OFFSHORE PLATFORMS
ADOPTING ONSHORE STRATEGIES
POOR INTERFACE MANAGEMENT
LACK OF STANDARDISATION
MANIFACTURING DELAYS
LACK OF MANIF. YARD SPACE AND CAPACITY
INSUFFICIENT ONSHORE TESTING
PROCUREMENT ISSUES
INSTALLATION PLANNING&EXECUTION ISSUES
WEATHER DELAYS
INEXPERIENCED CONTRACTORS
LIMITED NUMBER OF VESSELS
UNDEESTIMATION OF THE COMISSION PROCEDURES
UNRELIABLE Ii&P STRATEGY
PROBLEMATIC INSPECTION AND MAINTENANCE PLANNING
ACCESIBILITY ISSUES
INSUFFICIENT ASSETS MANAGEMENT STRATEGY
O&M ISSUES
EFFECTS
Delays
Cost Overruns
Standby Vessel Cost
Exceeding Weather Window
Additional Vessel Cost
Remedial Work
Additional Project Management
Lost Revenue
Lower Transfer Value
Corrosion
Claims And Counter Claims

Offshore Wind Key Innovation Proposals

The responses about the key innovations that may lead to much more economical viable and technical feasible offshore wind projects led to various comments. Broadly, interviewees referred to the need for applicable and novel methods and techniques to derive LCOE reductions. However, it is worth mentioning that there has been much discussion on low cost manufacturing alternatives. The exodus of factories moving out of Europe in search of lower-cost options is accelerating, as manufacturers face increased pressure to reduce costs. After China, India and Vietnam could well become the go-to destination for offshore wind manufacturing companies looking to uproot their facilities and relocate to cheaper destinations (see Figure 14).

Interestingly, most respondents expect the impact of innovation to allow commercial offshore wind to compete with cheaper forms of energy and make a substantial reduction in the LCOE (see Figure 16a and 16b). It is important to note that a bar does not indicate cost reductions of an element. Instead, it indicates the impact of innovations in a particular element, which may drive changes in the cost of that and additional elements.

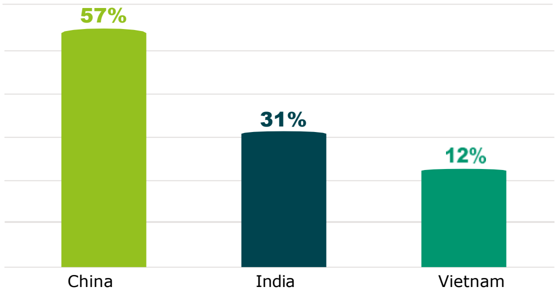


Figure 14: Which country is an alternative manufacturing destination option for your business?

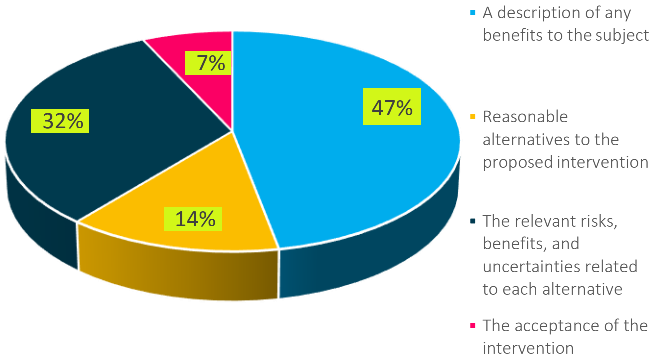


Figure 15: What Are The Elements Of A Complete Research and Innovation Consent?

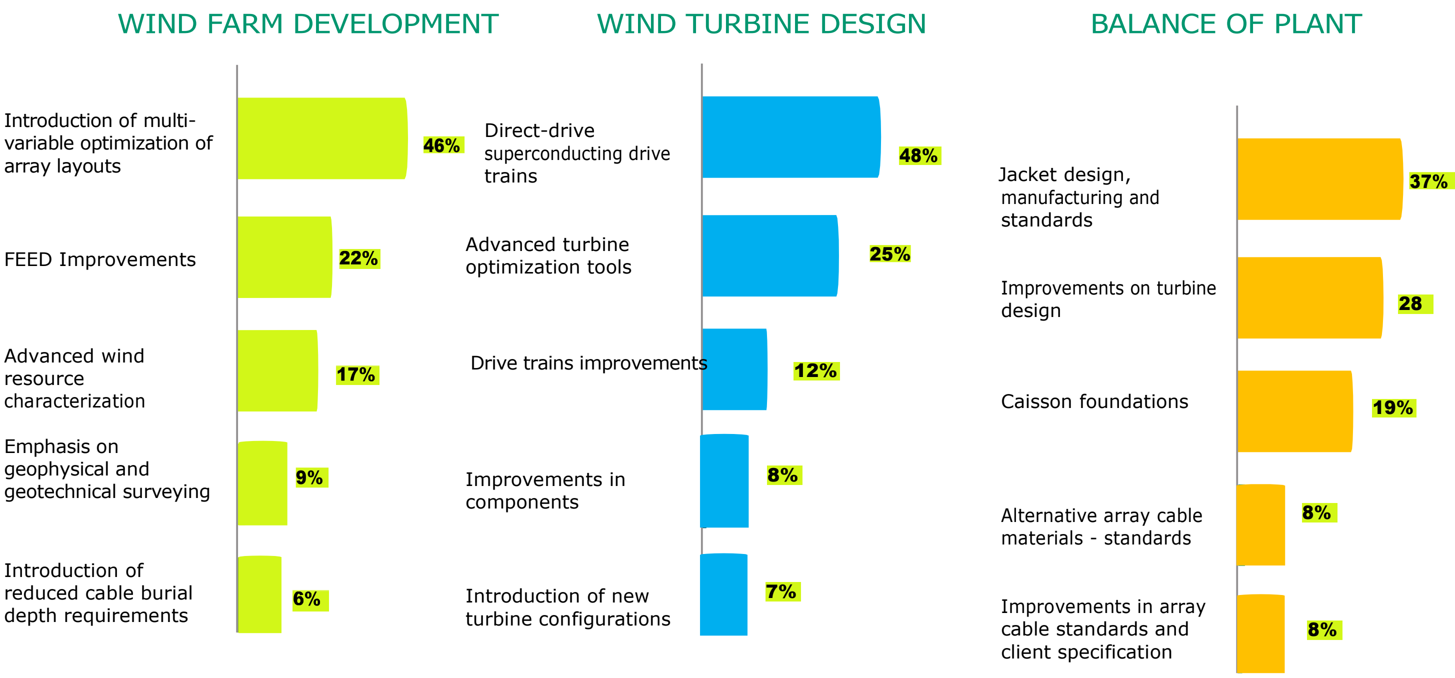


Figure 16a: Which innovations will have the most impact on within offshore wind over the next five years?

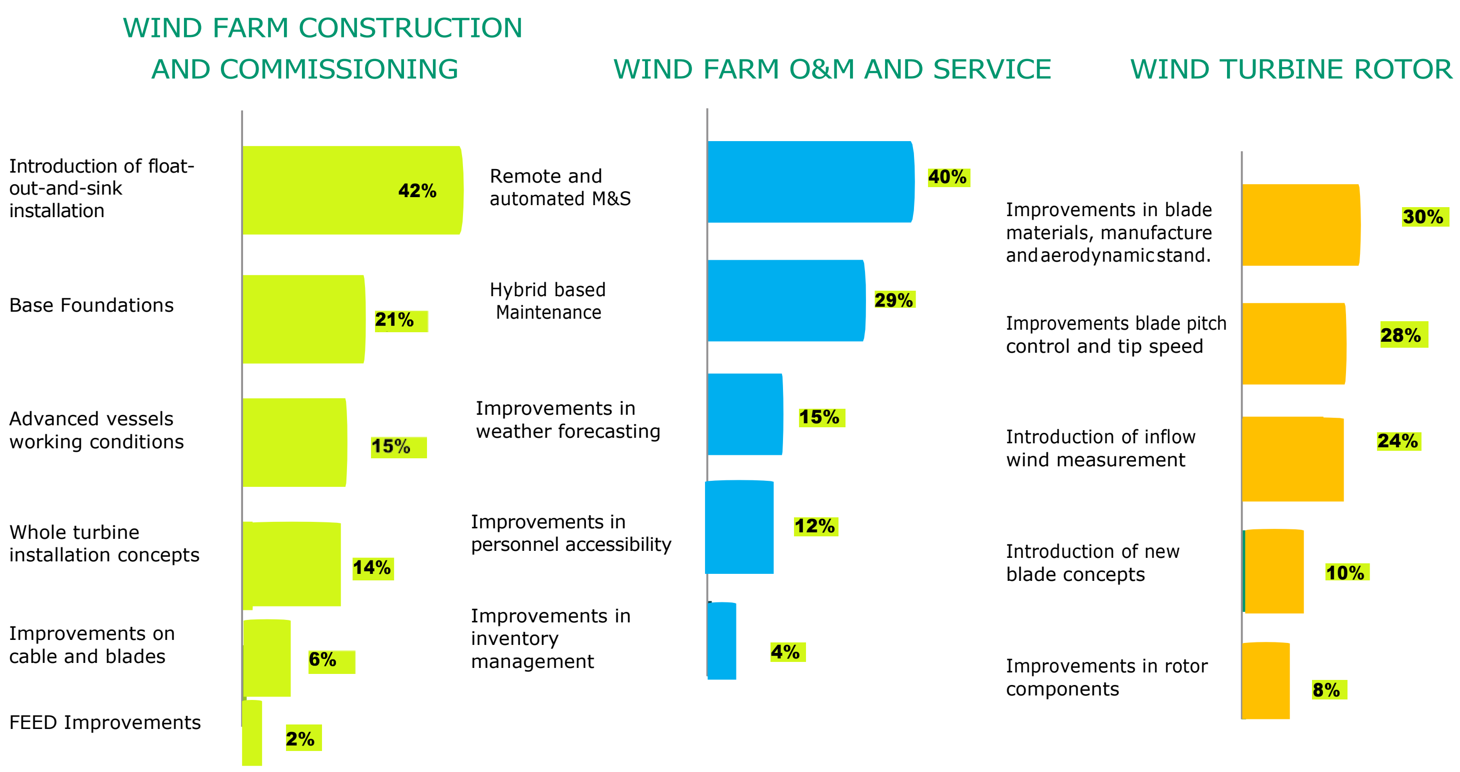


Figure 16b: Which innovations will have the most impact on the offshore wind industry over the next five years?

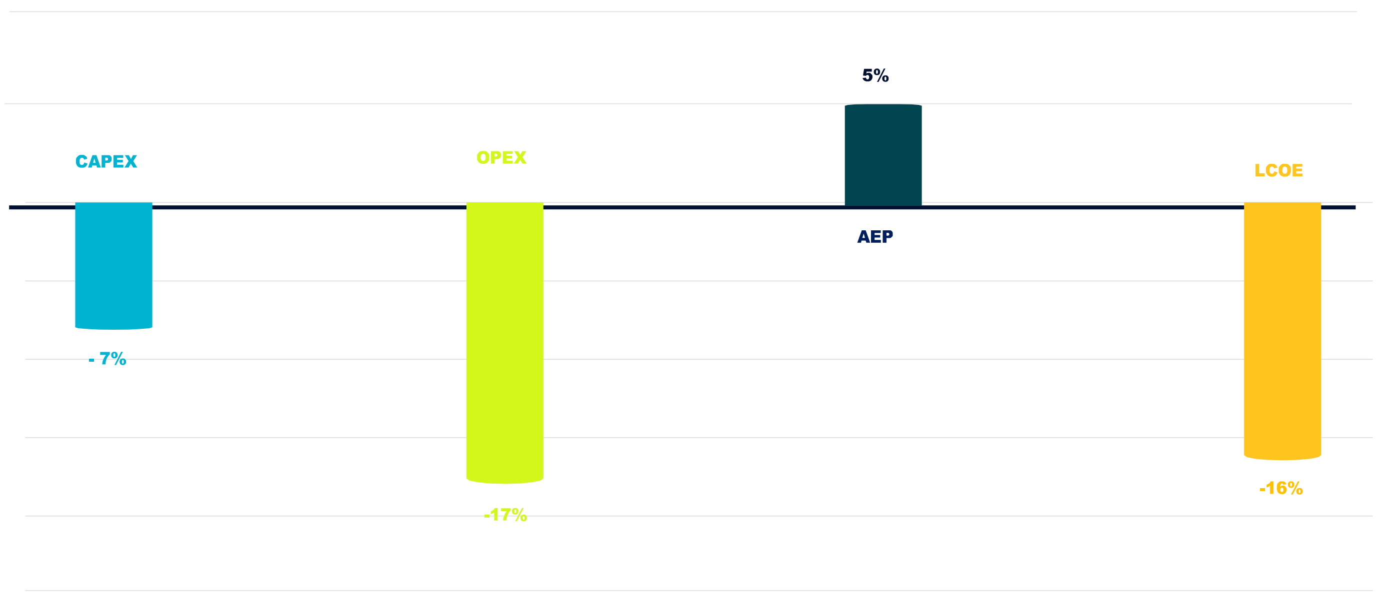


Figure 16c: What is the anticipated impact of the innovations proposed over the next ten years?

Because of the different WTG's size the potential changes cannot be compared directly. Thus, assume the proposed innovations on offshore wind projects using 6MW turbines.

The Culture to Cultivate

CULTURE TYPE	EMPHASIS	GOALS	LEADERSHIP STYLE	DECISION-MAKING
GROUP	Flexibility, trust, belonging, participation	Development of human potential	Participative and supportive	Seek out diverse opinions, integrate viewpoints
DEVELOPMENTAL	Flexibility, growth, resource acquisition	Growth, develop new markets	Entrepreneurial, idealist, risk-taking	Intuition; made quickly, adjusted as needed
RATIONAL	Productivity, performance, achieving goals	Planning, efficiency, productivity	Directive, goal-oriented	Focus on general principles; data-oriented, rarely changed
HIERARCHICAL	Efficiency, following rules, uniformity, coordination, stability	Control, stability, and efficiency	Conservative, cautious, detail-oriented	Data used to determine and justify single-best solution

Table 1: Continual Improvements and Culture Type Characteristics

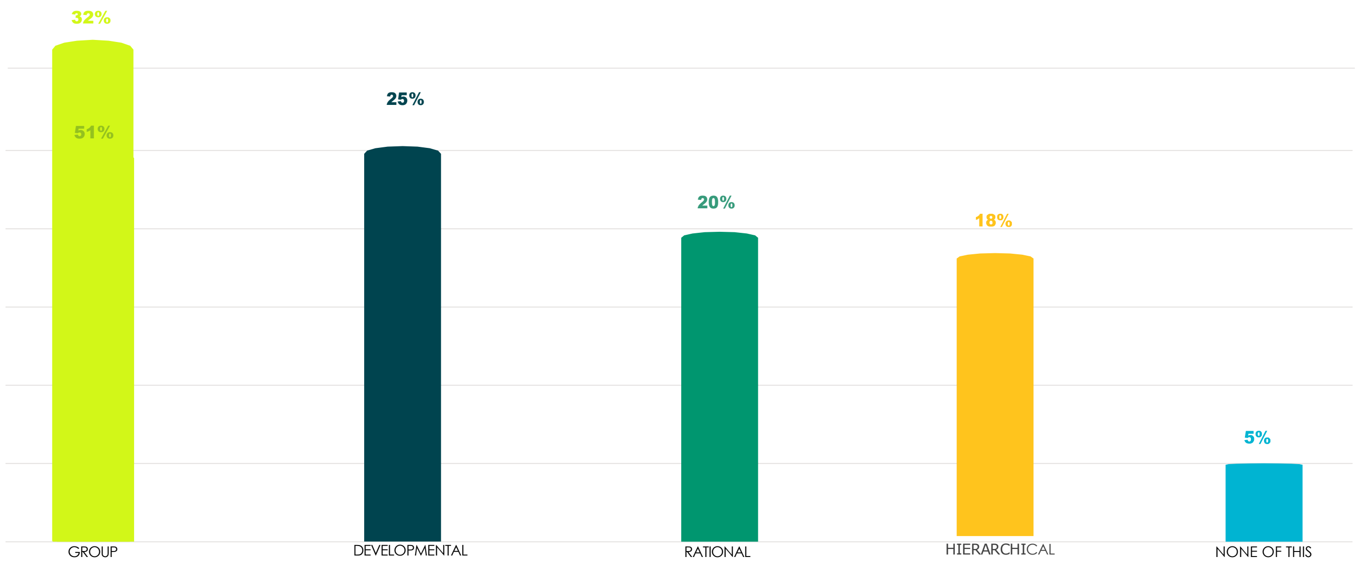


Figure 17a: In which CI type do you belong?

Continuous improvement is recognized as a key factor in the offshore wind energy industry. The collective pursuit of CI is powerful not only because of the performance gains it produces, but also, because it's the only cultural value that could unify an industry as large and diverse as offshore wind. Of those who say CI is an important factor, 32 percent recommend that a group culture is the most important culture type for an organization. In addition, 25 percent of respondents believe that the developmental characteristics can successfully foster a CI culture. 20 percent of the respondents favor the rational characteristics while 17 percent indicate a hierarchical culture as the ideal one to instill a culture of continuous improvement (see Figure 17a).

A culture of CI is built upon three critical foundations: engaged leadership, a reliable improvement strategy and enabling technology. Although engaged leadership is arguably (see Figure 17b) the most significant determinant of success when it comes to establishing a philosophy of CI, it is striking that the fewest respondents picked out the engaged leadership as less favorite.

One of the respondents discussed his experience with the author of this survey to explain his decision on engaged leadership low ranking. When his organization attempted to develop a Lean culture, employees "felt like we had the motivation, and the passion, but we had it from a grassroots level; we didn't have the support from the management. If we didn't have the support from the Head - if he didn't think it was important - we weren't going to be able to drive it."

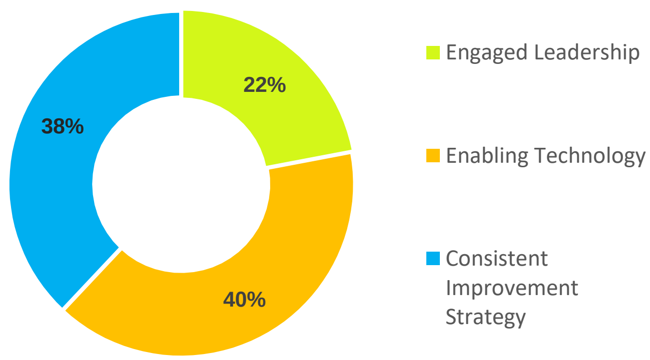


Figure 17b: Which One is The Most Critical Element On A CI Culture?

Lean as a CI Strategy

This research survey also investigated which lean methods respondents have implemented successfully so far, whether lean techniques have different success rates in offshore wind manufacturing versus O&M services, and what factors contribute to the successful implementation of these techniques. (see Figure 18). Overall, the technique that the largest percent (56 percent) of respondents said their organizations successfully implemented was Kaizen. Also, a percentage of 17 indicated their organizations successfully implemented Key Performance Indicators. In addition, approximately 12 percent or more of the respondents reported that Value Stream Mapping (VSM) and 5S were implements successfully within their organizations while Gemba (4%) is an upcoming practice.

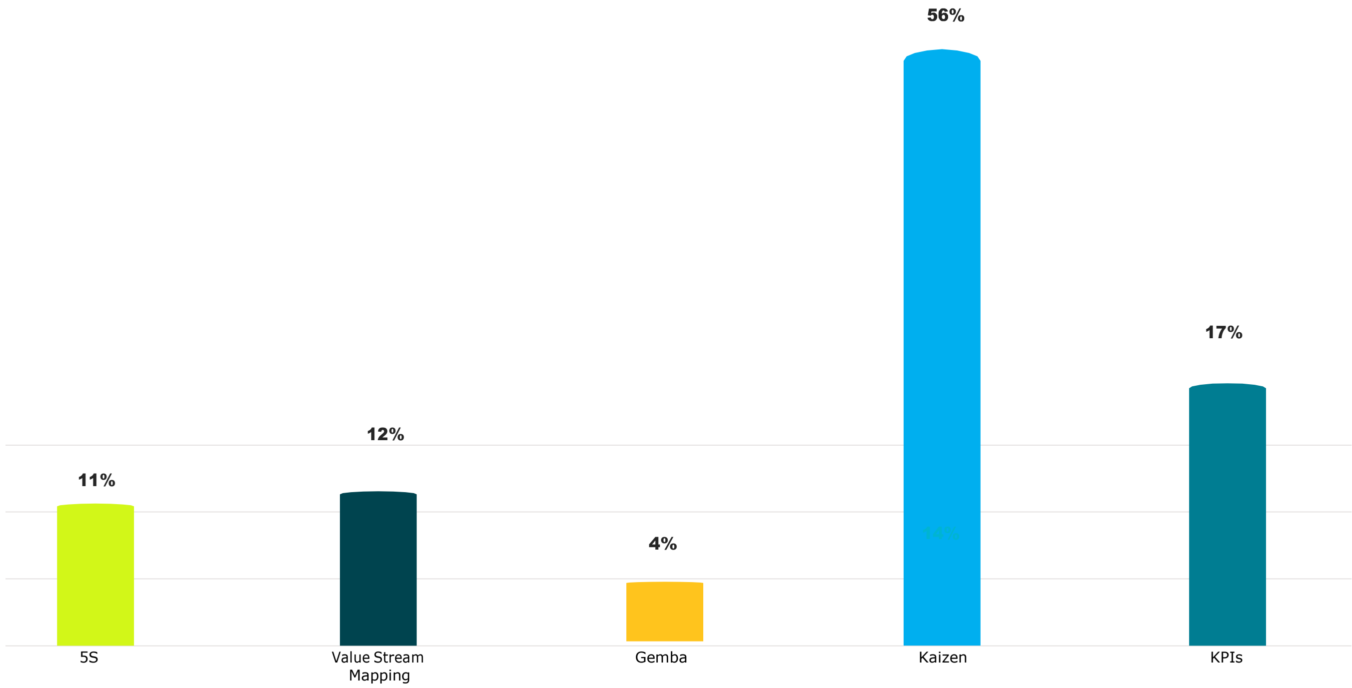


Figure 18: Which Lean technique is the most favorable one in your business?

As shown in Figure 19, more than 80 of the respondents indicated that 1) commitment from leadership, 2) extraversion, 3) good management of gains, and 4) expanding lean into all areas led to the successful implementation of lean techniques. (see Figure 19).

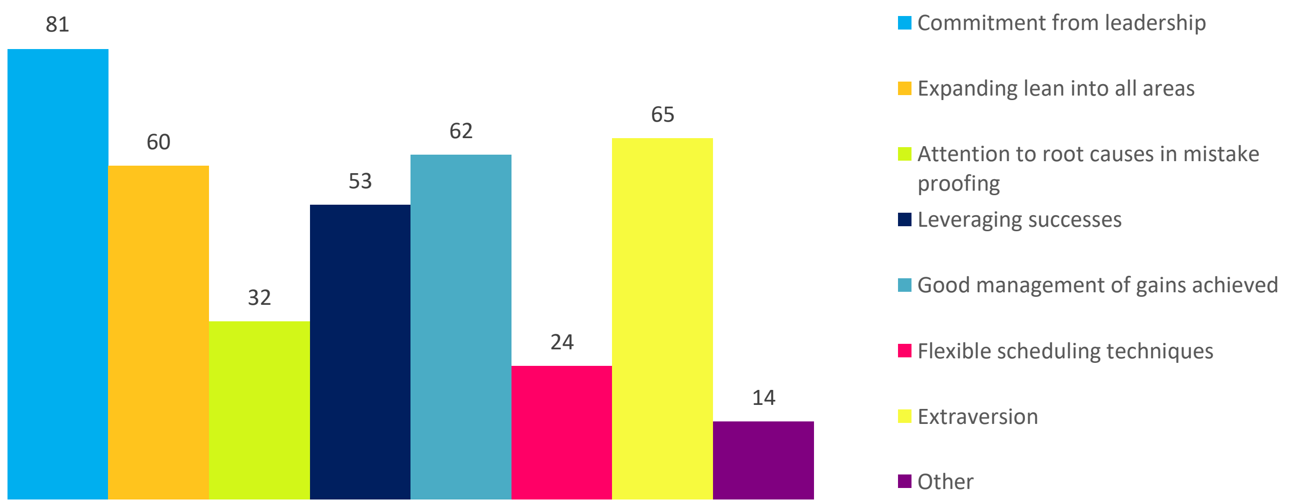


Figure 19: Which are the main reasons for successful implementation of lean techniques in your business?

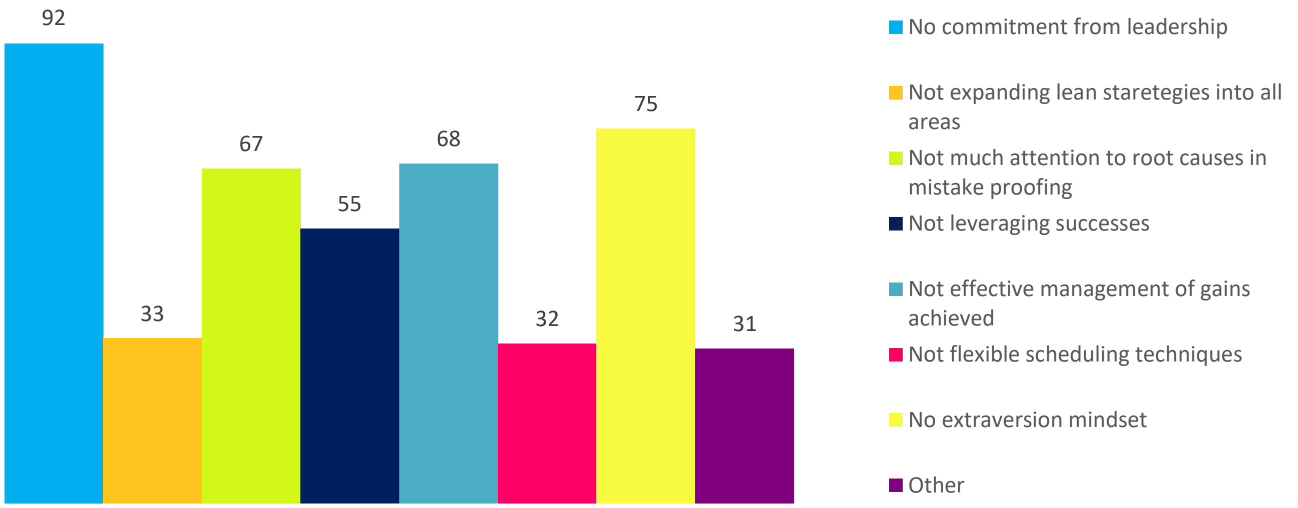


Figure 20: List one or more reasons for the failed implementation of lean techniques in your business

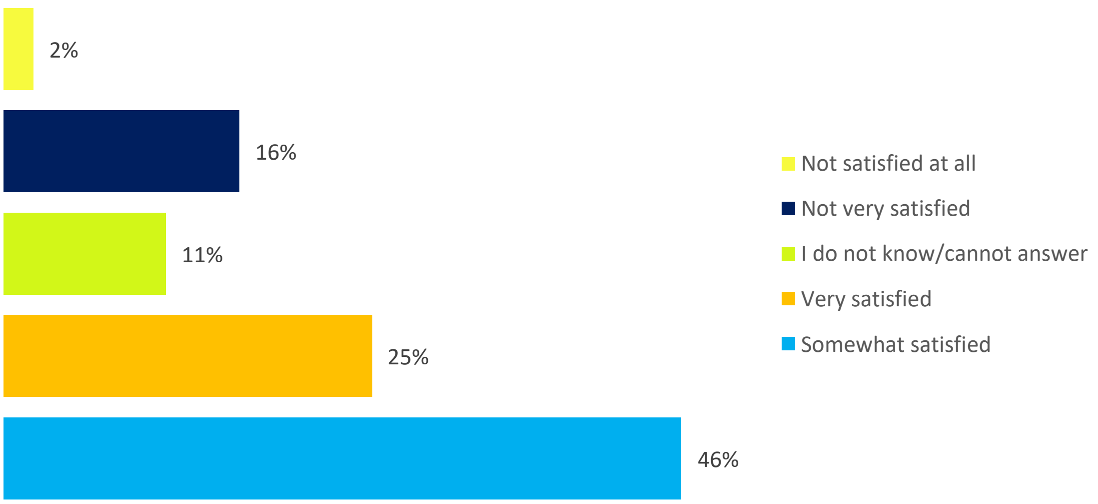


Figure 21: How satisfied is your senior management with the progress your company has made to date through a Lean initiative?

CONCLUSIONS

This survey research examined the implementation and effectiveness of continuous improvement and knowledge sharing methods for the offshore wind power industry to mitigate the LCOE, optimize performance and establish business excellence.

The three main elements: knowledge sharing, organizational learning and continuous improvement are all related and seem to be mutually reinforcing. For instance knowledge sharing, especially through lessons learned form the past, leads to effectively and efficiently create, sustain, and transfer knowledge - and when people learn they tend to share more. An effective and transparent knowledge sharing culture seems to help employee engagement, improves systems implementation time and reduces project schedule. Acquiring and sharing knowledge are linked to offshore wind organizations competitiveness but this survey suggests that other factors (e.g. data secrecy, organizational culture, ease of use of IT tools, leadership, regulatory compliance) are also significant to how competitive and successful the organization is.

Underlying the issues and barriers behind CI and Knowledge Sharing the fundamental question is, ''What kind of relationship exists between knowledge sharing and performance optimization and what factors influence this relationship for the offshore wind industry?'

One of the most surprising observations is the number and scale of disconnects between what respondents say are important factors on a Continuous Improvement and Knowledge Sharing culture and where the offshore wind power industry invest money and effort.

For example, 79 percent, expect regulatory changes-reformations to severely impact their business over the next 36 months, and 82 percent of our respondents expect regulations to significantly change their revenue model (see Figures 1 and 2a, 2b). Also, the most critical concerns include data secrecy, policy irregularities and taxation systems problematic procedures. This indicates that offshore wind power firms face the hazard of not effectively preparing for forthcoming new regulatory framework changes and not successfully adopting a knowledge sharing culture, despite their responses indicating that they consider regulatory changes and information withholding a significant concern and a threat to ROI.

Another conflict occurs between technology and continuous improvement. The impressive 89 percent of the respondents consider offshore wind as being a technology- driven industry (see Figure 22).

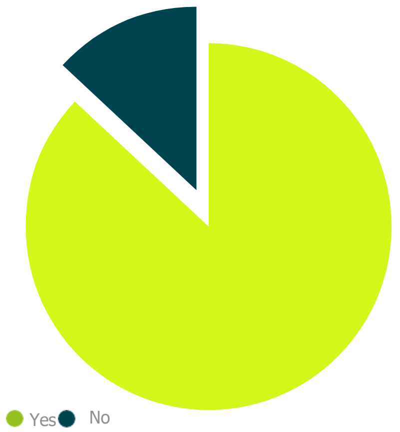
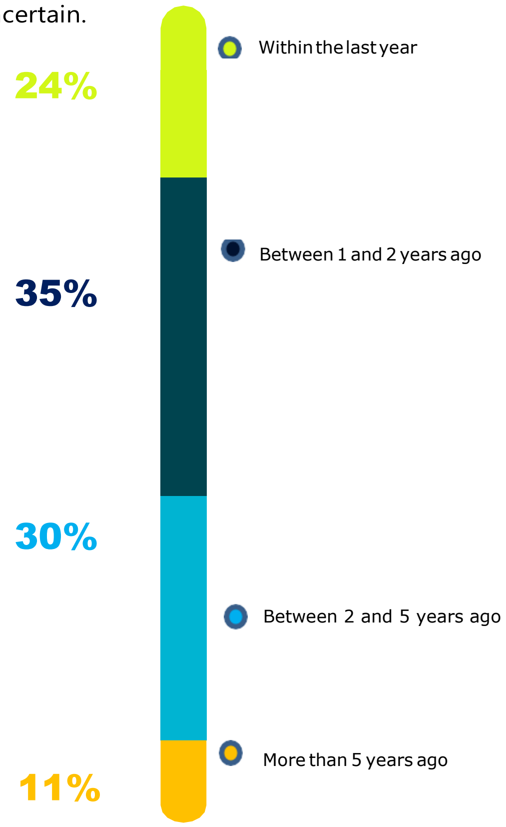


Figure 22: Do you feel your company is becoming aCI-driven business?

However, only 11 percent of the respondents have applied technology improvements for the long term period of more than five years-thus, reliable assumptions on the relation to CI appear to be uncertain.



The findings support the idea that knowledge sharing is related to offshore wind LCOE mitigation and performance improvement. However, different dimensions of knowledge sharing result in diverse ways of performance improvements. The survey noted that whilst there is evidence of continuous improvement culture and knowledge being shared across the sector to date, more effective knowledge management and sharing could be achieved if it were more coordinated. This was supported by the respondents, who believed that improved knowledge sharing would benefit offshore industry as a whole.

Furthermore, the findings also indicate that some synergistic factors influence the relationship between knowledge sharing and offshore wind projects performance. Primary, project life-cycle integration is a fundamental factor, which facilitates the knowledge sharing-performance relationship. Moreover, organizational structure is another important parameter, which moderates the link between a cooperative climate and knowledge sharing. Last but not least, charisma and contingent reward are among the most effective leadership characteristics for establishing a culture of knowledge sharing.

The results of this survey also indicate that some continuous improvement and knowledge sharing methods are more often successfully implemented and perceived to be effective than others. The conclusions that emerged from the research survey on the reasons of the success or failure of knowledge sharing and continuous improvement techniques provide evidence for further investigation.

Appendix: Survey details

Methodology

This study has been conducted by Wind Energy Science Research Group, an independent wind power research firm.

Predefined professional demographics and industry geographies were set prior to conducting the survey. Technologies with the potential to impact the offshore wind power industry were assessed and developed into a 45-question survey. The questions were designed to draw out respondents' opinions on offshore wind industry trends, impacts and opportunities.

An online and telephone questionnaire was completed by a total of 190 respondents. The full survey responses have been tabulated and charted by question and the data further sifted to identify trends across the overall sample. The survey was supplemented by qualitative interviews. Small extracts from these interviews are quoted in the report.

The sample of respondents who participated in the survey included specialists and experts from offshore wind manufacturing, installation, management and O&M and operations. The number of responses obtained from those working in manufacturing organizations compared with offshore wind service firms was relatively equal (i.e., 64 percent manufacturing operations and 46 percent service operations). The majority of respondents had job titles of Head, director, manager, engineer, specialist, analyst or consultant. Their job functions were concerned mainly with offshore wind and lean strategies or CI practices and the majority of respondents had more than five years of experience working in these specific areas.

By geography, the highest share of respondents, 88 percent, was concentrated in Europe, followed by the USA (4 percent) and China (2 percent). The remainder were from a range of countries: Canada, India and Australia.

For any inquiries or suggestion please email the author of this report at stavros@windenergyscience.com

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