SMI Webinar: SMI's Next Lap - Towards a Global Maritime Research, Knowledge and Innovation Hub
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Answers to Questions posted during the Panel Discussion

No	Question	Answer(s)
1	**[Dr Shahrin Osman]** Cheng Peng, I think one of the key things you mentioned as the main focus for the next lap is to attract talent. The key part of the talent is about the need for us to increase the talent pool for the research, scientists, engineers (RSEs). That is a good aspiration and I do anticipate there will be quite a bit of challenges. So, maybe can you share what do you see as the challenges and how do we intend to overcome those challenges to attract talent and also the talent pool of RSEs?	**[Mr Tan Cheng Peng]** Thank you Shahrin for the question. Indeed, the talent pool of research, scientists and engineers is one of the key challenges facing our maritime R&D efforts. We have to take a multipronged approach to tackle this challenge, because we do have a limited pool of local talent. I would propose that there are three approaches that we have to take. Firstly, to attract more local R&D talent. Secondly, go regional, go global. Thirdly, partnerships and collaboration. So let me maybe elaborate my ideas on this. The first is to attract more local R&D talent, we need to raise greater awareness and interest in maritime R&D, and profile the research work, the very good research work our research scientists and engineers, as well as our Centres of Excellence (COEs) are undertaking, and the impact and the contributions they are making to the Maritime sector and our national economy. Right now, many of them came up with very good research technology that are deployed, translated and adopted in industry. So, we need to profile more of these excellent outcomes that they have achieved so as to excite and let more people know that we are making significant contributions, and there are many exciting opportunities in maritime R&D to pursue. In line with that, as I mentioned in my presentation earlier, we're launching two new programmes to support this push to attract more local talent. The first is the SMI scholarship programme, setting aside for a start S$1 million fund, to fund a PhD scholarship to support the CoEs, as well as the new programmes we are starting. In a small way, we're hoping to contribute to attract some of these additional talent pool into the R&D sector. Secondly, also setting aside another million-dollar fund to support continuing education and training, which will

		be spearheaded by Singapore Polytechnic for future maritime skill sets. These are the two small ways that we are doing in seeking to help to build a talent pool. The second prong that I mentioned earlier, is to go regional and to go global. The stark reality is that within Singapore itself, we will still have a limited pool of Singaporeans to tap upon for maritime R&D. So therefore, I think we need to cast our net beyond our shores, and be prepared to take in talent from the region and expand our R&D network globally. That is why I thought the new thrust on international network building is key and important to take us to the next lap. In this way, we can tap on the rest of the world to complement our local R&D talent and efforts. The third prong I would offer is to increase partnership and collaboration. In our next lap R&D push, our approach is to foster greater and closer partnership with maritime industry players, and greater collaboration amongst the researchers in the various centres of excellence, IHLs and RIs. In this way, I think we can rise above the limited pool of our research scientists and engineers and leverage on the industry, as well as each other's resources and expertise to push the R&D agenda.
2	**[Dr Shahrin Osman]** In terms of the maritime AI, Keng Hui, you mentioned quite a lot of significant growth opportunities within maritime AI, but at the same time there are various barriers for companies to adopt. In your view, what would be your advice for companies looking to adopt and benefit from AI?	**[Dr Lim Keng Hui]** Thanks Shahrin for the question. Very often, I would advise companies to adopt 'F.I.R.S.T'. 'F' for 'Familiarity'. For companies that are not adopting yet, get yourself familiar with AI. There are plenty of online literature, or you could engage A*STAR, IHLs or companies that offer AI solutions. Having done that, the second is to 'Identify' and 'Investigate' the problems that you want to solve, or the opportunities that you want to go in, and start small before you scale up. But it's also very important for you to do 'R', which is to 'Review' how digitally ready your organisation is. If you're not that digital, if a lot of processes are still manual, you will require some effort for you to go digital. That includes your

		infrastructure, designing your internal workflow, and also to have a digital culture for effective adoption. ‘S’ is to bring in ‘Specialists’ if you don't have. Specialists with implementation expertise, or to recruit. Lastly, which is ‘T’, which is aligned to what Cheng Peng just mentioned, is to look at ‘Training’ and educating your workforce. Nowadays, there are a lot of emphasis on continuing education and also retraining. We also find that there are a lot of online courses which people can subscribe to, in order to train and equip themselves with skills. So, I would recommend ‘F.I.R.S.T’.
3	**[Dr Shahrin Osman]** Kenneth, you have shared about the IMO targets which are ambitious, but yet it's challenging to achieve because of the significant uncertainties which you have also shared. From your view, what would you think should be the key consideration for ship owners to design their vessels to be future ready?	**[Assoc Prof Kenneth Low]** Thanks Dr Shahrin. In fact, as I delved into this subject of future ship and system design, I realised that there are so many unknowns. I think this is exactly the same feeling for many ship owners. If we take note of the prevailing trends, access to capital is going to be an issue if companies do not continuously work on the topic of sustainability. So, I think this is something that is driving a lot of ship owner to look at how they can decarbonize, and I think that is an important lever. As ship owners, traditionally, they will be using a proven building spec, and then they will go to the shipyard and say to build according to these specs, with the list of makers appointed by the ship owner. I think the trend moving forward will have to take a very collaborative approach if we want to optimise the design. Meaning to say that the ship owner and the charterer will first have to come together, because the incentive for many ship owners is to make sure that the assets are as low as possible, because the operating cost is passed on to the charterer. The charterer will then say, I want to make sure that I burn as little fuel as possible, so they want to pass the cost back to the ship owner. I think a consensus has to be met at the very top level between ship owners and charterer, and they have to really work with the classification society to basically map out a plan that is commercially viable. I'm talking about really the top level.

		In terms of the technology wise, I feel that a lot of design houses also have to work with the classification society and the regulatory authority closely, because a lot of the regulations have to be put in place in order to ensure that the move towards alternative fuel will be viable. In recent case, we have talked about Singapore increasing our carbon tax. Just to share with you, a lot of people mentioned what could be the announced carbon tax. Some said it could be maybe $40, $50 per tonne of CO_2 equivalent. From the various studies that I've done, they said that the right pricing is USD230. So, it's really very different. I think that both the ship owner, the regulatory authority, have to come together to meet somewhere in the middle in order for this policy to fly. Finally, I think shipyards will have to take a proactive role. In fact, in Singapore, a lot of our shipyards have design capability, I think, rather than in the past, waiting for the customer to give us the building specs, I think it is important for shipyards to work with IHL, RIs and ship designer to really work on a future ready ship. So even though the customer may not want to actually adopt the future fuel at the moment, but the ship should be designed with the right provision to make sure that they are future ready. Finally, I think conversation with the Port Authority is very important because ultimately, the fuel will have to be bunkered at the relevant port and the port will have to invest in the infrastructure. I probably will say that the way forward is actually going to be very, very complicated. Not like in the past where we just look at the ship design in isolation, but now we have to look at the entire value chain and also the ecosystem. In short, I think we have to really work collaboratively, as what I highlighted in my presentation earlier. Thank you.

4	**[Dr Shahrin Osman]** Wey Lii, Keppel has been successful in terms of putting together a consortium to collaborate. You have been proactive in putting together the partners who were being awarded the two case studies that you shared. So maybe if you can share with the audience, what are the steps that you have put together for Keppel to go about to put together a solid consortium? Do you have some sort of your own criteria that you use in selecting the partners to work together with you?	**[Mr Lee Wey Lii]** Dr Shahrin, thanks for the questions. I think we have a couple of humble sharing in this space. First of all, when we talk about collaborations and working with partners, I think the key thing for us is really to align the aspirations as well as the missions. So, when we have this close aspirations as well as missions, the energy level naturally goes up, and we can take the discussions much deeper and therefore we would also gain much output and outcome through the process. The second one that we also humbly learned through the process is that when working in collaborations, it is good to start in a smaller scale - two or three parties kind of short JIP kind of nature of works, which we have gone through that journey. Through that process, we build the bond, the understanding of our work flow and the processes, as well as the thinking exchange. With that, what happened is that down the road, we just kind of build the collaborations into a bigger team, like what we have in this marine harbour craft project that we have shared earlier on.
5	**[Audience]** A question from the audience that has the highest vote. The question is: we all know that given the LNG is only a transition because LNG only reduce maybe 20 to 25% of Co2, but IMO expect to be at least 50% of greenhouse gas reduction. How long do you think that LNG will last? What would you think would be the next alternative fuel in the next 10 to 20 years? So, Professor Kenneth Low if you can give it a shot?	**[Assoc Prof Kenneth Low]** When I was reading this question, I was really intrigued because I think we are really in the crossroad of deciding what will be the future fuel. Based on the research that I've done, and I think there is a very good report that I will recommend everybody to look at it. It is actually dated October last year, a report published by the Maersk Mc-Kinney Moller Center for Zero Carbon Shipping. I really urge everybody to get a copy of that report. They run various simulations, and to be fair, I think simulation is based on applying the various levers and also the carbon levy. If we are looking at future fuel in general, certainly there are four categories. First is the biofuel, so that is one of the possible replacements. Second is the blue fuel. I think all of us know that it is scalable, but then it is still derived from basically the natural gas as the feedstock. Thirdly is the e-fuel, and then of course back to the low sulphur fuel oil and LNG. I clearly see that the report doesn't rule these two out. What happened now is that in terms of the

		cost, if there is no lever applied, meaning to say regulation and carbon levy, there is actually no way they can compete against the existing fuel. With applying the lever and the carbon levy, the closest is actually bio fuel. I think this is something that they have projected in 2030. In terms of the cost competitiveness, biofuel will actually be closest to both the low sulphur fuel oil and the LNG when the carbon levy has been applied. So, that is one potential. The only problem is, it is not scalable. I think all of us know that biofuel is not scalable. The next on the list is the blue ammonia. For blue ammonia to work, it requires a carbon capture and permanent storage technology. So that is going to be the driver. It is going to be commercially competitive, but we all know very well that eventually, we want to actually move into the e-fuel, which also consists of ammonia, methanol, and methane. You'll notice that I didn't highlight about hydrogen, while hydrogen is actually quite a hot topic, because the pricing for hydrogen is simply quite out of the way based on the current modelling. I will say that, for LNG, if we look at the ships that are being ordered today, taking a practical and pragmatic approach, ships are still being ordered, which is fueled by LNG. We all know that typically the ships' life is going to be 25 to 30 years. If you ask me, a certain number of ships will still stick to LNG with onboard carbon capture technology. I recently read an article that trial is actually ongoing for onboard carbon capture. Obviously, it is still a proof of concept. If that technology is able to work, then we will probably see that LNG will continue to play an important role, but they will not be the most significant role. I just want to share some statistics with you. Assuming that the ammonia is going to work, that means the blue ammonia, we are looking at them really playing a part, maybe contributing up to more than 10%, but the majority will still be low sulphur fuel oil in 2030. This is actually the current mix, and the LNG in this particular simulation play less than 5%. So, I do foresee that it is going to play a minor role, but it will still play a significant role into the future. Thank you.

6	**[Dr Shahrin Osman]** Cheng Peng, would you like to add to that?	**[Mr Tan Cheng Peng]** Thanks Shahrin. I think that Prof Kenneth has provided quite a comprehensive update on the state of affairs. There are five horses that are in the running, but there's no clear silver bullet that is identified amongst the five horses, and the jury is still out there. My sense is that I'm not sure whether there will be one winner eventually or it may require a complement of different solutions to be effected across the industry. One thing is for sure is that for short sea sailing, the regional sailing, electric is the way to go. It is the international voyages that is challenging. So, what SMI is doing and supporting in continuing research on these alternative fuels is to continue to investigate all options and potential pathways for each of these potential replacement for clean fuel. MESD, the Maritime Energy and Sustainable Development Centre of Excellence (CoE) at NTU, is the lead CoE with the domain expertise. In their research plan, will continue to investigate these various fuels. In addition, as Kenneth has mentioned, in terms of carbon capture technology, while it is quite well established on the landward side, I think carbon capture for shipboard is indeed the challenge. I think that there's no operational commercial solutions out there yet. It's one of the projects that MESD NTU is also embarking on in the next few years. Thanks.
7	**[Dr Shahrin Osman]** Cheng Peng, you mentioned about the three key missions of SMI, that is the next gen port, smart shipping and the green technologies. Of these three, which area do you think that Singapore can really be a world leader? Recognising that Singapore is well ahead of our peers. Maybe your thoughts on that?	**[Mr Tan Cheng Peng]** Thank you Shahrin for the question. In the interest of time, the short answer is I believe in all three – in next generation port, smart shipping, as well as green technologies. I just take a few moments to share my thoughts on this. First of all, Singapore is already the world's busiest hub port. As released by MPA's 2021 port performance report card, the container throughput is at an all-time high - 37 million TEUs; bunkering also at an all-time high, with more than 50 million tonnes. Looking ahead in the next 10 years, we have a brand new greenfield next generation Tuas mega port in the making of 65 million TEUs. So as far as port is concerned, it will be ours to lose if we

		do not retain our global pole position for the next generation port. The next areas in terms of smart shipping and green technology, as a global hub port and international maritime center. the Menon DNV report has acknowledged Singapore's lead in terms of the technology pillar. We have done very well, and we are very well connected in terms of liner shipping networks. Our government is constantly and consistently investing steadily in our R&D efforts, so that there is a long term sustained effort in future technologies, including smart shipping and green technologies. I do believe with all these concerted efforts, working together with the entire maritime ecosystem, which is one of the unique strengths, because Singapore has been able to garner and muster the entire maritime ecosystem to be on this journey of constantly innovating research and improving ourselves towards those objectives. With these ingredients, I think we have all the key ingredients for Singapore to be a global leader in all three areas.
8	**[Audience]** Should the marine renewable related sector be part of the SMI's master plan? If yes/no, why? How about the subsea aspect of the maritime industry? Should it be part of the SMI's master plan too?	**[Mr Tan Cheng Peng]** SMI's third tranche R&D plans is intended to deliver outcomes contributing to the next Gen port, smart shipping and green tech. As such, maritime R&D topics such as renewables or any other areas which can positively contribute to the three desired outcomes could be considered.
9	**[Audience]** Is the Digital Twin concept already available commercially for the ships or being developed as a part of the research and development project?	**[Assoc Prof Kenneth Low]** Digital Twin has moved from R&D to commercial applications, one example is for structure health monitoring of oil rigs in harsh weather. Digital Twin is currently offered as an additional service from ship or rig builders. Hence, it is still not mainstream.

10	**[Audience]** For future ships and decarbonised goals what are your views especially for the smaller or medium sized ship owners?	**[Assoc Prof Kenneth Low]** Ship owners can consider suitable designs with Total Cost of Ownership in mind. Instead of selecting standard designs which may cost less at the beginning, it would be necessary to customise the design to specific operating profile to obtain overall energy efficiency. Ships should also be designed and ready for bio- and green-fuels. Hence, dual fuel engines capable to running on future fuel within minor modification should be considered.
11	**[Audience]** In terms of future-proofing ships, it is not only owners and charterers who need to come together with the shipbuilding industry to plan the designs. the Fuel industry would need to step up to update the industry on options available for users (ie. owners and charterers). How can we get them to move accordingly?	**[Assoc Prof Kenneth Low]** Totally agreed. More conversations are needed as there is no clear winner for future fuels at the moment. Scaling up on any future fuels is deemed as the biggest challenge at the moment.