The reality of research and commercialization; a Sri Lankan story

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1. You have a lot of expertise in the field of nanotechnology. Do you remember when you first found yourself interested in this field and what got you into this field in the first place?

I think it was during my PhD because when I was at the University of Peradeniya, I was involved in a research project focused on coordination chemistry and I was clueless about nanotechnology back then. However, after I went to the US to do my PhD we were given a period of 6 months to select a PhD supervisor. It was at that time I was introduced to the field of nanoscience by the director of material science at the University of Connecticut and when I learned about all the possible applications and the impact that it could have on the future, I realized that this should be my area of focus. So that's how I got involved with nanomaterial synthesis and the design and fabrication of nanomaterials and their applications.

2. That's quite an interesting story. Since then, you have come a long way and now find yourself being the Head of business development at SLINTEC. What helped you gain this position?

I got to know about SLINTEC while I was studying for my PhD at the University of Connecticut. I knew that I should follow a profession that could create change because with my personality I didn't want to be restricted to a laboratory for the rest of my life. After returning to Sri Lanka, I joined SLINTEC in late 2015 and in 2018 I worked as a postdoctoral fellow there and also gained some experience in dealing with the demands of the industry.

Ever since I started working on my PhD, I knew what the industry expects from research. When you compare the two types of industries we have in the States and SL, the expectations are somewhat different. In the US the target is for long-term research and high-value intellectual properties (IPs) that could be converted into a commercialized process someday. But in Sri Lanka, companies look for short-term benefits. They expect short-term outcomes through research to improve their current product without targeting any disruptive products or processes. Fortunately, I got the chance to experience both these two different types of industrial approaches to R & D.

In 2018, SLINTEC was looking to fill the position of head of Business Development and I was asked by our CEO and the head of HR whether I would like to take over the position owing to the prior experience I had gained in dealing with the industry. I had mixed feelings about it at that time. Because in one way I didn't want to end my scientific career and on the other hand I had an opportunity to make an impact in the commercialization and innovation process.

So, what I requested was one day to conduct research and to work on business development for the remainder of the week The CEO agreed and but when I got the job description, I realized that it was going to be full-time work and amidst it, I wouldn't be able to conduct hardcore research. In the end, I took up the position full-time.

3. As the head of business development what challenges did you have to face and how did you approach them?

One of the main problems we face is finding the money to run an organization such as this. Although we are a public-private partnership, we don't get a recurrent budget from the government. We have a lot of very high-end equipment like the only TEM in SL, NMR, HPLC and XPS as well. So there's a huge overhead for the maintenance of this equipment.

The business model of SLINTEC is to do contractual research funded by the private sector or strategic research funded by the government. For these

projects however we can only charge for the cost of the research and we can't charge huge amounts either for R & D because what we are selling are untested ideas and the industry is not capable of forecasting the end product. Even though the investment needed during the research phase is low compared to manufacturing and scaling up, companies are reluctant to invest because of the high risk. Finally, they don't get any incentives from the government such as tax concessions so there's no real appetite to do R & D for them. Most companies don't have a person dedicated to R & D in the company, who understands its value. Usually, our team deals with the CEO or the factory manager about the project but most of the time, they have other things to deal with making RnD a low priority to them.

So doing research and development in a country like ours is in itself a challenge. When you compare and consider other countries their industries are driven by innovation so there is a lot of competition between companies in the same kind of industry. They are always trying to acquire more patents and come up with more innovations or at least stop their competitors from getting ahead so there is a very high focus on R & D. But here in Sri Lanka, there is no necessity in the industry to conduct research because most of the time they just want to solve a typical issue in their factory or else they just want to improve their current product. Only a handful of companies are interested in coming up with new IPs, acquiring patents, and coming up with innovative, disruptive products.

Basically, our business model is to conduct R & D, cover the research cost by charging a research fee, and come up with a good IP (intellectual property) that can be commercialized, This is where we must innovate and come up with commercializable IPs which we can license to another party either exclusively or non-exclusively, transfer or use to form a joint venture. Attracting people to invest in research is a challenge. Doing research from the beginning to completion is a challenge because you can get an unexpected outcome. And once the research has ended the hardest part is to convert the outcome of the research phase into a refined product or a process. Then you have to think of everything from raw materials, government rules, shipping charges, to even electricity charges.

So, when I first started these were all the responsibilities I undertook. However, my CEO was kind enough to limit the pressure I faced since I also had to gain some initial experience in business development. Eventually, I had to come up with new processes, streamline everything, think of new marketing strategies, create and manage new social media accounts, and promote the message that we, SLINTEC, are ready to conduct R&D and that we are ready to do commercialization.

I also had to change the mindset of most of the scientists. As scientists, we always get fascinated by various research topics which sometimes aren't valuable from the perspective of a business. Sometimes a very simple process might be a better business idea than a complicated research project. So, it was a huge challenge to deal with scientists but with time the mindset changed and now everyone knows what the institute needs.

Simply put It all starts with ideas. These ideas have to be converted into proof of concepts, researched, and developed further to a point where they can be commercialized, a prototype made, the feasibility of scaling up is explored, and then finally the refined product is made. The ideas that have a very high feasibility of being converted to a product or process were picked and we started funding them internally. I created an internal program similar to shark tank called Innovation Pitching Session where scientists would get a few minutes to pitch their idea to all the scientists, and personnel from the business, finance, and technology transfer teams at SLINTEC. Their ideas were evaluated and if they were judged favorably, we would start funding them. In that way, we were able to change the mindset of the scientists towards commercialization and at the same time, we have a good set of ideas that even if we don't fund, we could pitch to a potential client who has the ability to invest in them. These are the challenges and some of the actions we have taken together as a team.

4. Some of your most recent publications were on nanomedicine, which is somewhat of a novel field in the world and especially in Sri Lanka. What are some of the major obstacles you had to face with regard to implementing solutions and processes related to nanomedicine here?

Personally, my first obstacle was that I didn't have any idea, even during my PhD time, on nanomedicine or on biomedical sciences since I was a materials scientist who was fabricating nanomaterials for catalytic applications. Sometime after I joined SLINTEC, they decided to come up with another entity called SLINTEC Academy which offers MPhils and PhDs. Through this program, I came across a student who had done his bachelor's in biomedical sciences. Eventually, I collaborated with him to conduct research as his experience in biomedical science completed my knowledge of material sciences. I began to learn about biomedicine from him and he learned about chemistry and materials science from me. And we began reading and also collaborated with some other people as well.

When it comes to biomedical science applications the main obstacle is the in-vitro studies and clinical studies and then the approval process. The approval process in biomedical science is very stringent and lengthy, which is good in one way as the country should have a safety process like that. However even at the research level, you have to do a lot of in vitro studies, so you need to have a good biological lab to perform these tests and, in some cases, you have to collaborate with others because SLINTEC mainly focuses on material science applications. This gave us a good opportunity to collaborate with other people and that was the main challenge that we had. I would say that there's still a long way to go because we just publish papers and compared to the other work that I have done the biomedical-related work that I am doing still has a long way to go with all the tests and approvals before we can get them commercialized.

I can relate one such experience I had at SLINTEC back in March 2020 when the country didn't have enough swabs to do COVID-19 tests. There was no way to get down the swabs from other countries because globally there was a huge demand for swabs and comparatively the Sri Lankan market is very small so nobody was interested in supplying swabs to us. The country also didn't have any equipment that could produce swabs although we were capable of producing the other liquids and chemicals we needed. So SLINTEC got to know about this through the task force and then within three days, our scientists had found a method to convert a machine that is being used in the textile industry into a swab-making machine and then we supplied more than 300,000 swabs saving about Rs.150 million to the country. Thanks to the scientists, at that emergency point we were able to supply swabs to the market. But even then, we had to go through all the approvals like in vitro studies and clinical trials even though this is a tool that was being used externally. Despite the emergency situation we had to go through the full process and obtain approval from the NMRA.

While working on that we did some real science and we came up with another technology called lamp PCR which can be used as a substitute for the current PCR method. At that time there was a huge queue for PCR tests and it took about six hours to get the PCR results and the cost was also high. So, in this case we collaborated with some European parties and we came up with this technology to do the test within about 3 hours and at a lower cost too. We then formed a joint venture with the private sector after convincing them about the business potential behind it. We were targeting a profit of Rs. 36 million per month because the demand was huge. But in order to get all the approvals through NMRA it took more than 1 1/2 years. I don't say that we should not have any approval process but we should have an efficient approval process. By the time we got approval even the third wave was gone so there was no business at all and the private party was also not interested in doing this business as a joint venture because at that point, there wasn't any demand.

In summary, the main obstacles would be the time it takes for clinical studies as well as our need for good labs and an efficient approval process. Despite the research we do and the papers we publish,

commercialization is still a very lengthy process with a lot of obstacles.

5. With regard to collaborating with international organizations and dealing with foreign clients, what is the process like and are they receptive to joint ventures?

In some cases, we establish contact with a client through a middleman. This middleman will pitch a certain idea or a project proposal to a client such as an institute or a business entity. They undertake the project and then they hand it over to us. In other cases, we tried to form joint ventures with external parties or we directly wrote to them, and then after an evaluation and background check, they started collaborating with us.

The technical capabilities that we have as a country wasn't a problem but building the network and reaching out to them is the hardest part. I think a national strategy is needed. I'm very worried about this and it's not all about SLINTEC but it's about the research community in the country as a whole. We spend a lot of energy, time, and money on research but sometimes we don't get the right problem statements, which is a huge issue. When it comes to fundamental research it's fine since you can read and understand by going through literature but when it comes to industrial applications and commercialization, we lack good problem statements because when we talk to the people in the local industry, they only what the pain points are. And those aren't real problems that scientists should get involved in. An engineer should be able to solve these problems.

But if we can get connected with corporations like Toyota, Panasonic, Tesla or Pfizer for example, we might get the right problem statement. As a country, we don't have a proper idea of what the world needs so we do something that we think the world would buy but once we do the research, nobody buys it and we all get disappointed.

I think we as a country should come up with a good national program to reach out to international entities, to get good problem statements to the country as a whole so that we have a set of problems that our scientists can focus on. Generating IP and transferring them or licensing them to other countries is also an export of a high value. At one point we came up with a slow-release fertilizer about 10 years ago and after we got the US patent, we had a discussion with an Indian party to transfer the IP which was valued at $3 million. So, what I suggest is we should come up with a mechanism to reach out to these big giant companies and get the right problem statements because otherwise, it's a waste of all the resources and capability we have here.

Finally, when we market ourselves, we must be very specific. We can't simply list our published papers and PhDs and equipment and expect to gain their business. For example, when we market ourselves to Toyota, we should say how they can come up with a good composite material with high strength that can be used in their cars. Or if you are pitching to Panasonic as an example, we have to be specific and say that we can use graphene to increase their battery performance by a specific amount. Basically, the issue now is that we don't know what their problem is, that needs fixing.

6. Not many professionals who do their doctoral studies and research abroad return back to Sri Lanka. What made you come back to Sri Lanka after your graduate studies?

I can't give a very direct answer for that but both my wife and I knew that we would come back after our studies. Even though many people said that we would change our minds after several years of study in the US, we didn't and after our graduation, we came back because we had already made up our minds, and also because I had gotten an offer from SLINTEC. But during our time there, we published papers, did our PhD work, and during weekends we always tried to travel and get the maximum experience that we could get within those five years.

Deciding to return back to Sri Lanka is a personal choice. The people who do come back have the ability to join universities and generate graduates in the country and make a big impact. On the other

hand, Scientists who stay back in those countries join companies like NASA and make a huge impact on the entire mankind. You can't really say which is right and which one is wrong because it's ultimately up to the individual. Even by staying in another country, you can still help your country and also serve the entire world. I believe that both kinds of people should be there; some people should come back here and some should stay there.

For me and my wife, we didn't have any regrets when leaving the states except the fact that we were very much attached to the people over there who were very nice and treated us like family. But then we still believe that we took the decision that is correct with respect to our measures. That's a very important thing because people have different measures of things to evaluate when making such a decision.

7. Do you have any words of advice or any words of wisdom for students who are interested in pursuing a career in nanotechnology as you have done?

In the 1950s, Richard Feynman said "there is plenty of room at the bottom," indicating that there was an area that was intact and undiscovered in this field. Then in 1974, the term nanotechnology was introduced. Then there was the discovery of electron microscopes, allowing the effective manipulation of stuff at this scale, even though nanotechnology has existed for several thousand years before. And then in 2010, they discovered graphene, another important point or milestone of the journey of nanotechnology.

When you start talking about all these discoveries, it gets people thinking about the commercial side, or the business aspects. And when new discoveries are made, people are amazed by what is theoretically possible, but more often than not there are several practical difficulties when it comes to that. After the discovery of graphene, people were amazed by its theoretical properties. Theoretically, graphene can be used to desalinate water. If you can desalinate with graphene, several problems in this world are solved. Even in Sri Lanka, there are villages that don't have access to clean drinking water. But now we know that it's very hard to achieve that, and the same applies to several of its theoretical properties too.

There is a very high potential in this field, but when it comes to real-world applications, there are several challenges. We already have several nanomaterials whose properties we know, but applying them in a real-world application and solving difficult problems for the entire world, is what the focus should be for students.

8. At SLINTEC do you get client-oriented industrial problems?

Yes, that's a major type of project that we undertake and its termed contract research. What happens is that the client either comes to us with their problem or sometimes, we go to them with solutions that we think could help them to increase their productivity. We do a lot of factory visits to understand the issues from the ground level itself by talking to the people who work in the factories. Even though we might not get good problem statements this way, it enables us to provide solutions within a short period of time. Another strategy we have is to try and identify viable areas. Currently, at SLINTEC we have six different research areas. Technical textiles, agriculture technologies, energy, printed electronics and sensors, natural medicine-related research, *etc*., are some of these areas. We mostly come up with ideas that can lead business schemes applicable in these areas. These can then be pitched to local clients who are scouting for novel technologies.

For example, we are currently working on anti-corrosive paints. After we internally complete the project up to a certain extent, we would convert that technology into a product with the support of an industrial partner. After coming to a certain level of technology readiness, we then start pitching it to potential clients and have discussions with them to get their feedback.

9. Is the income obtained from such contract research projects sufficient to run the institute?

The income that we get is not sufficient. We can't be self-sufficient with such projects and we are currently pitching to the government, because our original mandate states that after a certain period of time we have to be self-sufficient. One strategy that we practice is to link up with other countries but that requires proper marketing and exposure, and you need to get a proper problem statement from the client too. Further, if the company doesn't generate a good high-value IP we cannot generate revenue through licensing. Say, licensing for five million, or 10 million rupees is not enough. The target should be around 100 million.

So our strategy is to collaborate with the industry, give them some incentives from SLINTEC and then get them involved in long-term research. The IP created could be shared because usually we focus on fully owned IP which we can't charge large amounts. Sharing an IP is better and the industry finds it more attractive if they have a real appetite for creating an IP. Joint IPs do come with their own set of unique problems and you must be ready for them but in the beginning, you can attract the industry for long-term research and generate high-value IPs. Having a 40 to 50% stake in an IP valued at Rs 100 million is much better than entirely owning an IP valued at only Rs. 5 million.

10. It is widely known that we have two major resources in Sri Lanka, Eppawala phosphate and vein graphite. As an example, we simply crush down the mined phosphate and export it without any value addition. However, if we had an H_2SO_4 factory we could make triple superphosphate. Even vein graphite is a valuable resource that can be used for several applications. If the government is unable, can SLINTEC collaborate with international parties to create processes that add value to these resources?

Let me start with vein graphite because that's something that we are currently working on. It was initiated as a government-funded project and then we got the US patent to convert it into graphene oxide and then reduced graphene oxide. Then in 2018 we started a joint venture and invested in the intellectual property/patent and we were able to get an investment on the plant from an external private sector entity. Right now, it's the only large-scale plant capable of producing graphene oxide in Sri Lanka. So, through this joint venture, we now have a plant that is capable of producing 10 metric tons of graphene oxide per annum. Right now, this joint venture is trying to attract markets by convincing buyers and showing that there are possible applications for this material. Currently, there aren't many applications in the world right now even though theoretically it has a lot of potential.

So, we do research with them and work on specific applications. It could be for water purification, an energy application, or a composite used in the rubber industry. With that, we are trying to produce data sheets and convince buyers to buy graphene from us. Creating the applicability creates the market.

Also, we have to face competitors from China. They have flake graphite which is near the surface so it's easy to mine and even though it has a lower purity, it's not a huge problem for them since it can be purified. The only advantage that we have is the aspect ratio because vein graphite gives very large graphene sheets compared to flake graphite. At the moment lots of countries have expressed interest in Sri Lankan graphite, to mine it or engage in value addition to it, because there is a high potential in using this graphite in lithium-ion batteries.

When it comes to rock phosphate, we just use it as it is and we export some amount. Here the soluble part is only about 2% so different approaches must be tested to solubilize it. One method is the microbial approach, but we are not sure whether we can get a high percentage of phosphorus, because it's very slow and the expected yield is about 20%. Other ways of getting phosphorus from rock phosphate include thermal methods and again you have to think about the energy balance and the amount that you have to spend on heating them. So, the only viable method currently is to use sulphuric acid which is what other countries do, and we have an advantage because we don't have many heavy metals or elements like arsenic present in the ore. At one point there was a discussion about having

a plant for it, but the problem was coordination as the purpose of the plant should not be only for the solubilization of rock phosphate. There should be many other industries that can use the plant and if not, the investment made on this plant won't be sufficient enough to make a good business case.

There are many other opportunities as well, like ilmenite, which can be converted into titanium dioxide. At SLINTEC, we had a titanium dioxide pilot plant funded by a private facility, but it was stopped due to the cost of sulphuric acid. Another opportunity is getting titanium metal out of the produced titanium dioxide and that's the highest value addition that you can get. And once again you need sulphuric acid for that. Also, in the modified Hummer's method you use potassium permanganate and sulfuric acid. But right now, we have to import sulphuric acid as there is no domestic production.

This coordination must be carried out before you start a sulfuric acid plant. In any nation, the capability of production is measured by the number of sulfuric acid plants that they have and we have none right now. We used to have one but it was shut down due to various issues. If proper planning was carried out previously this could've been successful.

Thank you very much for that detailed answer. We certainly learned a lot about the industrial and academic climate in Sri Lanka.

***Dr. Pahalagedera** currently serves as Head of Business Development, Sri Lanka Institute of Nanotechnology (SLINTEC), He obtained his BSc degree in Chemistry (Honours) from University of Peradeniya and PhD from University of University of Connecticut, USA.*

Webinars Organized by the Women Chemists Committee of Institute of Chemistry Ceylon

Theme of the year : Achieving Gender Equality of Women – Challenges and Opportunities

The Women Chemists' Committee (WCC) successfully organized its first two webinar sessions in the council year 2022/23 under their main theme, "Women empowerment in chemical sciences in achieving sustainable development goals" on the 12th of October 2022 at 04.00 p.m. and 1st of November 2022 at 4.30 p.m *via* Zoom. The informative webinar, delivered by **Dr. Nilu Sivapragasam** focused on the topic "Hormonal Imbalances at Various Stages of a Woman's Life: Changes and Remedies" and an interesting webinar, delivered by **Prof. Theshini Perera** focused on the topic "Women in Science; what goes on behind the scenes?".

Dr. Nilu highlighted the physiology and management of stress on women as they strive to find their work-life balance. She also stressed the 'symphony' of hormones, especially estrogen and progesterone, present in women and how they affect behavior, and mental and metabolic health. The facet of the talk emphasized dietary requirements for women when it comes to maintaining a healthy lifestyle, followed by advice regarding a smooth transition into menopause. Dr. Sivapragasam in conclusion drew attention to breast cancer, from its symptoms to diagnosis and prevention. The session successfully wrapped up with a productive question and answer session.

Prof. Theshini was mainly focusing on "How women balance their life by holding heavy responsibilities as a daughter, mother, wife, and worker. She talked about many role model characters in Sri Lanka and overseas in the chemistry field. She shared her past life experiences since her childhood to the professor. It gave a greatly remarkable experience to the audience of how she is managing her busy life schedule smoothly. She inspired all the women by highlighting her life achievements.