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RESEARCH ARTICLE

Strengthening technology and knowledge transfer from Sri Lankan universities by the establishment of University Business Linkage Cells

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Abstract: The Accelerating Higher Education Expansion and Development (AHEAD) operation tested the Triple Helix model, which provides the theoretical framework for the development of Technology Transfer Offices (TTO) in 15 state universities in Sri Lanka. These TTOs are referred to as University Business Linkage (UBL) cells. The development followed a scorecard in which the actions were divided into 4 different phases. The allocated funds were released in tranches after successful completion of each phase. The interests of the other international development partners, trade chambers and associations were also integrated into the central planning. Freedom was granted to develop the IP policy of the universities based on the World Intellectual Property Organization's (WIPO) Intellectual Property (IP) policy template. It was noted that all universities allocated 50-80% of the revenue from the commercialisation to the inventors. The number of Invention Disclosure Forms submitted to UBLs varied from 12-79 in 15 different UBLs from 2019-2023. A total of 228 patent applications were submitted to the National Intellectual Property Office (NIPO), a total of 124 other forms of IP were filed and 21 Patent Cooperation Treaty (PCT) applications were filed at WIPO by the 15 UBLs. The total number of university-industry collaborative research agreements and license agreements signed through the UBLs was 95 and 77 respectively, within the first 5 years of development. The total number of products on the market was 42. The overall satisfaction survey was conducted at the baseline, mid-term and final stages for all stakeholders. The percentage UBL directors in the highly satisfied category vary from 20%, 66% and 94% respectively.

Keywords: University-industry linkage, technology transfer, innovation, commercialisation, intellectual property.

INTRODUCTION AND LITERATURE REVIEW

Research is for the public good that generates a wide and varied range of economic and social benefits. These include knowledge creation, new discoveries and inventions, international knowledge exchanges, and the rapid acquisition and transmission of new ideas (Aturupane, 2016).

In the twenty-first century, countries actively seek to promote research and innovation to increase economic growth and development (Altbach, 2015; Gareth *et al*., 2021; Jose *et al*., 2013; OECD, 2019; Ramli *et al*., 2013). Universities engage in research and innovation activities that directly contribute to economic development are increasingly important in advanced and upper-middle-income countries (Elsevier, 2020; Mgonja; 2017; Guimon, 2013).

As described by Carlsson *et al*. (2007), there are two types of research, namely academic and industrial. Most of such research has no direct economic value as depicted as a cloud in the middle of Figure 1. As illustrated in the bottom part of Figure 1, industrial R & D which passes the economic filter will be patented if it is relevant and commercialised via 3 mechanisms. The author illustrates that there are two types of outputs from academic research. First the graduates will take the skills to the educated labour market and the other is illustrated with the purple arrow which begins with

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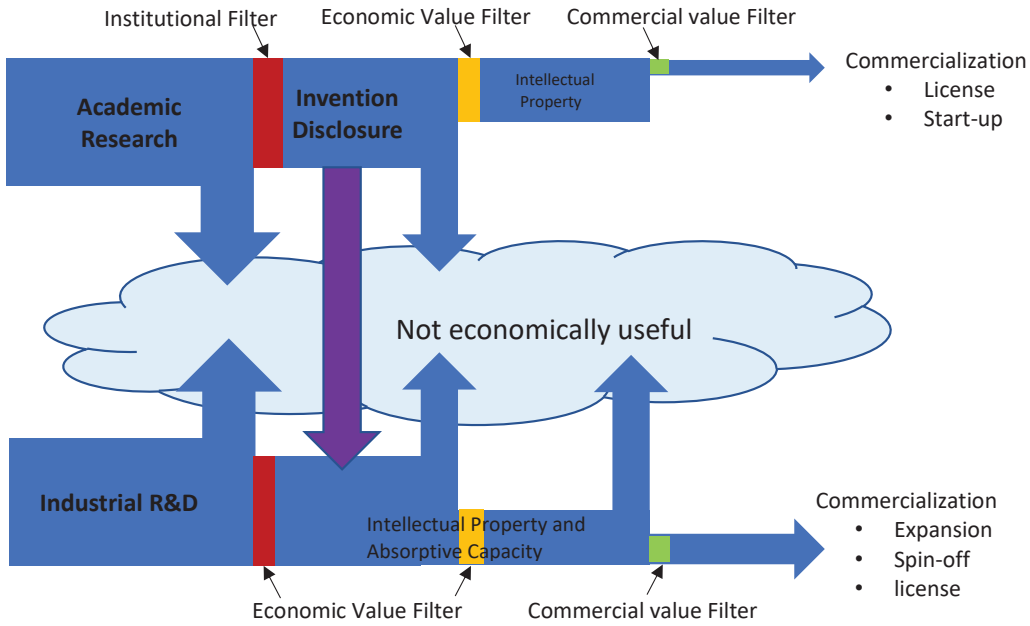

Figure 1: Knowledge filter model of university-industry commercialisation processes
Source: Carlsson *et al.* (2007)

an invention disclosure. The human factor associated with the institutional filter highlighted in red has been discussed in the literature (Tijssen *et al*., 2017). The role of academics with prior industry exposure will have a crucial role to play in the filters identified in Figure 1.

Staff-mobility between University and Industry

Staff mobility between the university and industry at various levels is illustrated in Figure 2. Such engagements enhance collaborative learning leading to the formation of joint human resources (Lam, 2007). The base of the triangle in Figure 2 can be extended to a much broader base by adding the undergraduates in Sri Lankan university setting. A larger number of mobility can be seen as many universities have internship placements for undergraduates in industries.

The practical problems from industry will stimulate the academic mind providing practical insight to a theoretical setting (Christopher, 2017) and expose them to the necessary skills in an industry environment. Further the Industry will have a competitive edge over other industries as they can capitalise on academic research findings.

The conceptual framework: Triple Helix model

The Triple Helix model provides a framework to conceptualize the roles of three agents; government, universities, and industries; in generating innovations and developing them into commercial products. Traditionally universities engaged in fundamental research. Industries produced goods and services for consumers. Governments sought to regulate and supplement markets. In the context of innovation, however, these three types of agencies interact in such a way that each agency takes on some of the characteristics of the other two agencies (Figure 3). These hybrid characteristics are described as the Triple-Helix model (Etzkowitz, 2003). As an example, government can take a leading role in creating innovative ecosystems through developing the National Intellectual Property Office, funding applied research in universities, and facilitating technology and knowledge transfer from universities to industries. Universities can proceed beyond basic research through patenting and licensing innovations. Industries can advance the level of technology in their products by working interactively with universities. The development of Silicon Valley is considered one of the best examples of the Triple Helix model. A recent discussion of the promotion of research and innovation commercialisation in Sri Lanka,_along the lines of the Triple-Helix model, is given in Aturupane *et al.* (2022) Chapter 5.

Universities need to create mechanisms, such as Technology Transfer Offices (TTOs), to help academics and researchers contribute directly to commercial development through their inventions.These TTOs do not

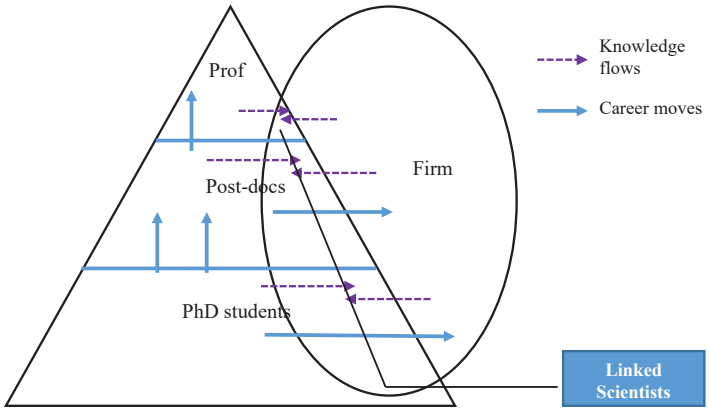

Figure 2: University-industry interactions: collaboration, knowledge flows, human resource mobility, and academic careers
Source: Tijssen, R. *et al.* (2017)

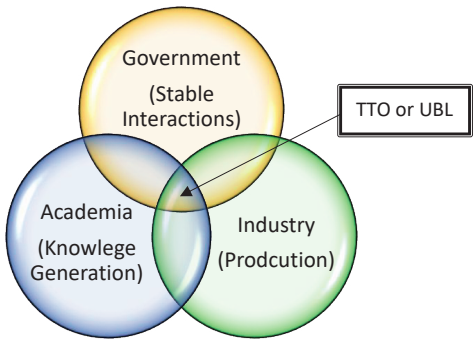

Figure 3: The Triple Helix system; the Technology Transfer Office (TTO) or the University Business Linkage (UBL) Cell connecting the players of the Triple Helix
Source: Modified from Barrie, J. *et al*. (2017)

merely transfer technology, they also support economic development through technology licensing and revenue generation, knowledge transfer for social benefit, foster collaborations with industry, venture creation and support for start-ups. It is evident that most licenses may not generate revenue, however, there will be a social benefit, as the birth of the World Wide Web, which changed the way we live, at CERN, Geneva. Technology transfer from university or any institution capable of generating knowledge to an enterprise that allows it to innovate and expand to get the technology to the marketplace has been reviewed (Mendoza *et al*., 2018). The review identifies 15 models, 15 mechanisms and 3 agents, 30 positive and 21 negative factors involved in the process. In most universities in the US, the TTOs support commercial exploitation of research outcomes while managing the Intellectual Property (IP) created within the University (Holgerssona *et al*., 2019). The basis and the best practices of technology commercialisation mainly from publicly funded research is documented (APEC, 2018). This document includes a large number of URLs which are useful, and a glossary of terms related to technology commercialisation. Hamilton & Philbin (2020) reports that a TTO to secure strongest returns, management and deployment of new knowledge with existing companies and startup businesses play a major role.

A university with a successful knowledge and technology transfer mechanism has more opportunities for new research collaboration and funding (McDevitt *et al*., 2014) which improves university competitiveness to attract top faculty and researchers.

Sri Lankan universities are relatively new to research and innovation activities that are of economic value to firms and industries. The degree of intensity of collaboration between universities and industry varies (Larsen *et al*., 2016) from contract research, consulting, testing and certification to training of industry employees

and internship programs for students. However, this is on a limited scale, and requires considerably greater scale and scope across universities and among industries to make a significant contribution to economic growth. Several initiatives have been undertaken to resolve some of the problems and constraints reported above. Under the World Bank financed HETC project, Quality and Innovation Grants (QIGs) were awarded on a competitive basis in 2013 to boost dissemination and commercialisation of research in Sri Lanka.

A survey of academics and employers (Dundar *et al*., 2017) gives a snapshot of university-industry collaboration in Sri Lanka. One observation from this survey is not having formal university-industry offices but having individual academics or administrators coordinating such interactions.

METHOD

Development of University Business Linkage (UBL) Cells for Technology and Knowledge Transfer

Various efforts have been made by Universities in Sri Lanka to transfer technology and knowledge created within universities for the benefit of society. However, there were no central offices in Sri Lankan universities to manage IP and to give the support required by the academics to make use of their research for public benefit.

The objective of this study is to identify the extent to which the establishment of University Business Linkage (UBL) cell in each university enhances the university-industry interaction and stimulate innovation. These UBLs will help to transfer the knowledge and technology developed by universities to the society/industry. The development followed 4 phases based on the scorecard developed by Accelerating Higher Education Expansion and Development (AHEAD) operation.

- Phase 1: Establishment of Core UBL Cell (appointment of the director, advisory board, faculty coordinators, drafting the constitution, development of an action plan and monitoring and evaluation system for UBL activities, development of the IP policy at the university level, development of the templates required for commercialisation of research)
- Phase 2: Identification of the internal R & D strength and equip the UBL (Develop an overview of R&D and innovation projects at the university, completion of the infrastructure for the UBL and recruitment of the full-time manager)
- Phase 3: Operationalisation of UBL Cells (Building network of entrepreneurs, investors, small and large businesses, inviting the private sector to participate at the university undergraduate/ postgraduate symposia, supporting research teams in their collaborative research agreements, license agreements etc. with external parties)
- Phase 4: Outcome of UBL Cells (Sale of technology transfer and royalty revenue, industry process/ logistics improved through research, company investing to commercialise a technology, foreign direct investment to commercialise a technology, startup company formation and creation of employment, government policy designed or improved based on research)

Each Phase consists of a number of actions and different UBLs were requested to identify the target dates for completion of the actions after evaluation of their internal environment. The targeted dates to complete actions were set by the UBL/university and the actual achievement date was used in the self-assessment, based on the criteria given in the scorecard. As an example, if the target date and actual achievement date are within a month, full marks for that action can be claimed. If the two dates are apart by one year zero marks could be claimed. In between 4 such levels were identified giving different weightages for the self-evaluation. The self-evaluation was reviewed by external reviewers and quality of work was also a dimension in the evaluation process. This model allowed the UBL teams to complete different phases at their convenience, depending on their readiness to develop the UBLs. The work with the two new universities established under the state university system in 2021 was also initiated in 2021 itself.

The key skills required by technology transfer managers are reported as knowledge on Intellectual Property (IP) rights, commercial awareness, networking, domain knowledge, negotiating, communication and business development (Mom *et al*., 2012). Development of the necessary expertise on IP is essential for Sri Lanka to be successful in technology commercialisation. As a first step in skills development, which should be the government's responsibility in the Triple Helix model; AHEAD supported the UBL staff in acquiring knowledge in IP rights and commercialization process.

Merely allocating funds will not improve the research landscape in universities. Access to non-patent and patent literature databases should be at the fingertip of the researchers. AHEAD under the Ministry of Education, has taken the initiative and provided access to commercial patent databases namely, Derwent and InnovationQ Plus,

for the first time in Sri Lanka. This must be continued after the lifetime of AHEAD as government support is essential for the success of the Triple Helix model.

UBL cells were encouraged to allocate AHEAD funds to secure IP and some UBLs are providing this support to the research teams at their university. Further support through AHEAD was arranged to evaluate inventions from universities by providing Invention Evaluation Reports. Patent Corporation Treaty (PCT) applications were filed only if the evaluation report was promising. The national entry of the PCTs in Sri Lanka was also arranged by AHEAD if a filing at the National Intellectual Property Office (NIPO) was absent.

The role of the UBL is to promote the technology and knowledge transfer process by connecting the available interesting technologies with prospective commercial partners. This is new to Sri Lankan universities. Therefore, it requires special training in this process. The UBL staff, academic staff, legal officers in administration, librarians and research assistants must also get this exposure in order to fully develop the UBLs.

Upon completion of Phase 1 of the UBL Cell, all UBL directors were exposed to US consultations in June 2019 which was financially supported by the US Department of Commerce, Commercial Law Development Program (CLDP). The second CLDP training program was held in December 2020. It was a two-day virtual training program that covered the role of UBLs as tech transfer offices and protecting and exploiting IP generated within the university. The third CLDP program in 2021 was based on the fundamentals of university-industry collaboration. This was a live, interactive virtual group discussion that was held in September 2021. A total of 80 attendees participated in this session. Further, all UBLs were given the opportunity to attend the annual meeting of Association of University Technology Mangers (AUTM) conference in 2021. The 2022 CLDP program focused on preparing for the negotiation of license agreements. This was a multi-series hybrid program consisting of two 2-hour live virtual sessions and one 3-day in-person workshop in Kathmandu, Nepal. United States Patent and Trademarks Office (USPTO) collaborated with CLDP in most of these programs. AHEAD funds were not used in conducting all these programs with CLDP.

To take policy initiatives, a central committee consisting of all UBL Cell directors was established under the apex body of all state universities which is the University Grants Commission (UGC). This UGC/UBL standing committee gathers every 2 months and as of December 2023, 22 meetings have been conducted since its inception in May 2020. The representatives from trade chambers and associations representing different commercial sectors are also invited for these discussions. Five virtual exhibitions were arranged for different commercial sectors with the help of Ceylon Chamber of Commerce where inventions from different universities were showcased to find commercial partners. The participation and networking through these exhibitions indicate the commitment from the 3rd arm of the Triple Helix model.

To check whether the establishment of the UBL has contributed to improve technology and knowledge transfer activities at universities the number of research agreements, license agreements and products commercialized through UBLs from 2019-2023 were collected from UBLs in Q2 2023.

If commercial partners have an interest in taking the products to international markets, a consultancy was arranged to generate freedom to operate search reports to check the possibility of commercialisation in foreign jurisdictions. Additionally, AHEAD arranged license partner scouting assistance for eight cutting-edge inventions to find foreign licensees.

The sustainability of University-Business Linkages (UBLs) will largely depend on the income they generate. It is too early to draw conclusions about this income. The percentage revenue distribution in the IP policy was collected from all UBLs as this is useful for future policy decisions.

Policy initiatives such as Start-up AHEAD, guidelines in the identification of commercial partners, and incentives for academics to engage in commercialisation of research were done through the UGC UBL standing committee meetings.

A baseline survey and stakeholder satisfaction survey were conducted to measure the effectiveness of the intervention.

Analysis methodology

A questionnaire was designed and circulated among stakeholders of 17 UBLs (VCs, UBL advisory board members, UBL directors and faculty coordinators). Data from completed surveys were analysed as follows. Satisfaction scores were calculated by adding the given ranks (1-5) for relevant statements in the questionnaire.

Satisfaction level	Normalised satisfaction score range
Low	0-44
Medium	45-66
High	Above 66

Table 1: Normalized satisfaction scores

Min-max normalisation method was applied to transform satisfaction scores to a common scale of 0-100.

$$Xnormalized = \left(\frac{X - Xmin}{Xmax - Xmin}\right) \times 100$$

Three levels of satisfaction; Low, Medium, and High, were identified based on the normalised satisfaction scores as in Table 1. Overall satisfaction was determined based on the responses to the below questions.

1. The implementation of the UGC circular 10/2016 on the establishment of UBLs and the policy environment at the university is supportive and encouraging,

2. The Government of Sri Lanka (GOSL) funding for equipment, consumables, research assistant salaries, protection of IP, travel for conferences, and the dissemination of research outcomes are adequate, and the cash flow is steady,

3. The opportunities to participate in UBL advisory committee meetings or UBL management meetings at the university are useful and the decisions are taken to utilize research outcomes to benefit society/ industry are satisfactory,

4. There are specific reference standards to assess if the UBL is functioning to specified practice standards and to assess progress (phases in the scorecard),

5. There is an intellectual property policy for technology transfer and the commercialisation of IP with adequate intellectual & legal considerations and the implementation is at a satisfactory level (e.g. IP strategy and royalty distribution etc.),

6. The central guidance for protecting IP (patent, industrial design, etc.), management of IPs and renewal of IP is well-resourced and efficient,

7. The enabling environment in terms of the templates and legal guidance required for commercialisation of research (Non-Disclosure Agreement, Material Transfer Agreement, and license agreement, etc.) are known and the necessary legal support is available,

8. The interest from the academics towards the commercialisation of research/knowledge transfer to external agencies through the UBL is at a satisfactory level,

9. The progress and performance in research (product/ process/ideas) with potential for commercialisation/ knowledge transfer at the university are monitored consistently (e.g. progress in Technology Readiness Level of a new technology),

10. The university has a strategic approach in the process of establishing academic-industry linkages (e.g.: market assessments and sourcing of respective partners, regular programs to disseminate research outcomes to industry, etc.),

11. The interest from the private sector/external parties towards the technology and knowledge transfer through the UBL is at a satisfactory level,

12. The sustainability plans are in place to continue the UBL after the lifetime of AHEAD (e.g.: enhance the research interest of academics, efficient procedures to use monetary benefits from industry and external partners with accountability, arranging internships for undergraduates at UBLs, incentives and training for UBL managers),

RESULTS

The extent of the impact of the Triple Helix model could be verified by closely observing the collaboration among the government, academia, and industry to facilitate the transfer of technology through the UBL and by examining the outcomes produced by these cells over a five-year period.

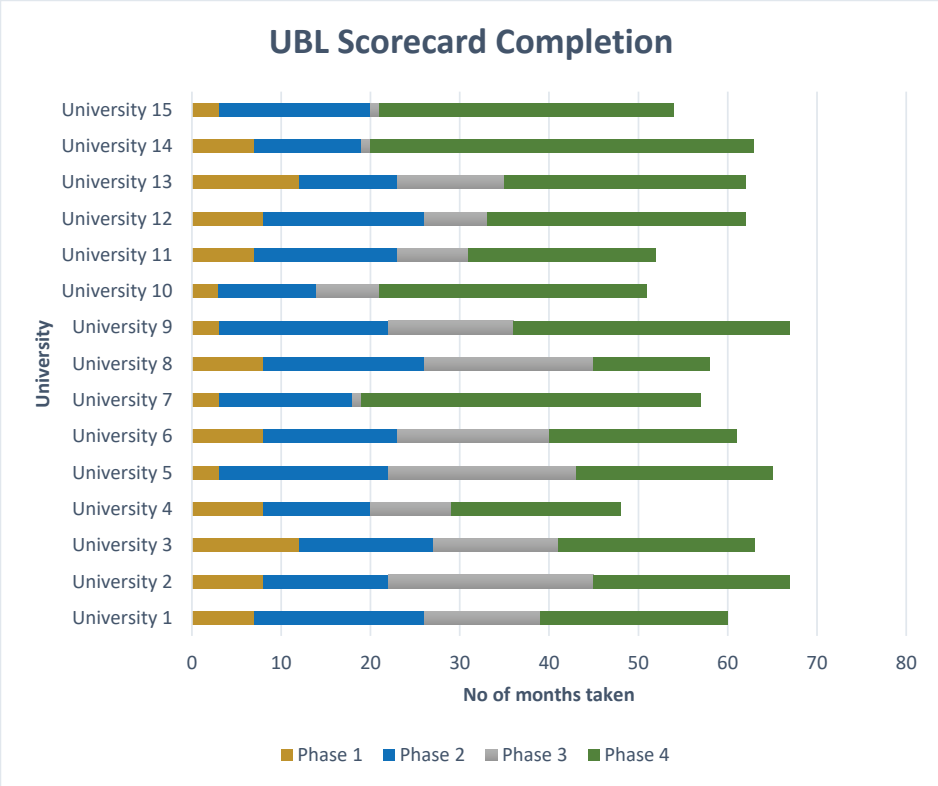

Figure 4: Number of months taken by different UBL to complete the different phases of UBL

Essential attributes in successful university - industry linkage

The establishment of a well-informed University Technology Transfer Office is an essential attribute in the successful University-Industry interaction as it provides support to mediate relationships between academia and industry. Having an IP policy and the template documentation in place are top priorities when developing UBLs.

During Phase 1 of the scorecard, all UBLs were requested to work on an Intellectual Property policy and other templates required for the commercialisation of research. Those templates were Invention Disclosure form (IDF), Non-Disclosure Agreement (NDA), Material Transfer Agreement (MTA) and license agreement. At the time of implementation of UBLs under AHEAD in March 2018, only one university had a finalized IP policy document. However, by 2019 April all universities (Maximum 13 months, based on Figure 4) finalised their IP policy and had developed templates required for commercialisation of research. The contents in all aforementioned documents were entirely decided by the UBLs at the university level.

The role of universities in generating growth through research, innovation and development of linkages with industry is of major importance to any country. The funding available for the university invention, technological sophistication of industries, the capital available to firms, and the governance framework for innovation are the challenges for Sri Lanka. One significant achievement that will accelerate the decision-making process with regard to IP commercialisation is the existence of an IP policy at the university level. The templates available for commercialisation of research will also be helpful to expedite the process, although the licensing terms and some conditions in these agreements will have to be modified for different inventions. Once a university completes Phase 1, the first tranche of funds was released for the UBL to plan the actions in Phase 2.

All universities completed Phase 2 within 27 months which was by June 2020. As soon as a university successfully completed the Phase 2 evaluation, the second tranche of funds was released enabling them to invest the funds in Phase 3 actions. All 15 universities completed phase 3 within 45 months (Figure 4) which was by December 2021. The third tranche of funds was released to the UBLs as soon as Phase 3 was completed to

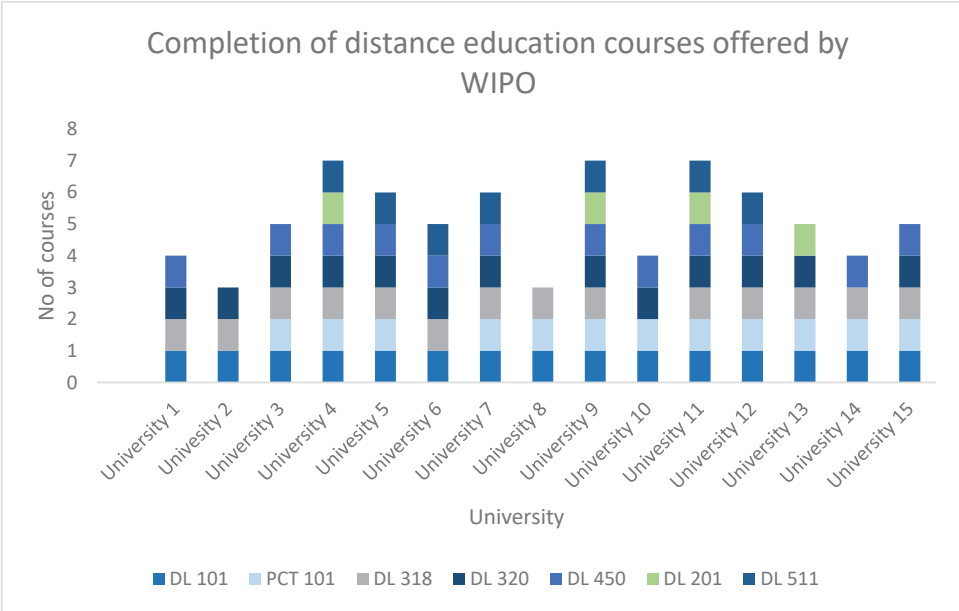

Figure 5: Completion of WIPO e-learning courses by UBL director/managers as at December 31, 2022. (DL 101: General course on intellectual property, PCT 101: PCT Distance learning course: Introduction to the Patent Corporation Treaty, DL 318: Patent Information Search, DL 320: Basics of patent drafting, DL 450: Intellectual property management, DL 201: Copyright and related rights and DL 511: Software licensing including open source.

work on Phase 4. Within 5 1/2 years after implementation of UBLs (by October 2023), all UBLs completed the selected actions in the Phase 4.

Technology transfer knowledge acquisition, management and deployment

AHEAD under the Ministry of Education, encouraged all UBL managers to follow the WIPO Distrance Learning programs. In the last quarter of 2019, managers were requested to follow the course on "Patent information search". In Quarter 1 of 2020, the managers were requested to follow the distance learning program on "Basics of patent drafting". Thereafter the managers were given the freedom to choose courses which would help them to perform well at the UBL. AHEAD recommended the applications and WIPO provided scholarships for the UBL managers to follow these courses (Figure 5). Some UBL directors also followed these courses, which will undoubtedly help to strengthen the AHEAD/UBL program.

During the initial stages the manager was empowered with the necessary skills. Thereafter each UBL can consider providing short term internships to the fresh graduates at UBLs under the guidance of the Director. These interns can help UBL to provide the services related to patent prior art searches etc. for a wider academic community if the interns are identified from various disciplines. Interns could be financially supported from the earned income.

Commercialisation journey begins with an Invention Disclosure

GoSL has invested funds through various ministries for researchers at universities to engage in research. However, to begin the commercialisation journey the researchers require some support. At the university level this formal support was absent prior to AHEAD/UBL. The method described by Norman & Eisenkot (2017) which is an accepted norm in the world was adopted by all UBLs and the journey starts with the submission of an Invention Disclosure Form (IDF). It is the responsibility of the UBL to evaluate the technology with the help of the UBL advisory board and/or the UBL faculty coordinators. Having a strong advisory board with industry participants and committed UBL faculty coordinators are essential elements for UBL growth and sustainability. At the end of 5 years of development, the number of IDFs submitted to different UBLs are presented in Figure 6 which gives an idea about the university readiness towards this initiative.

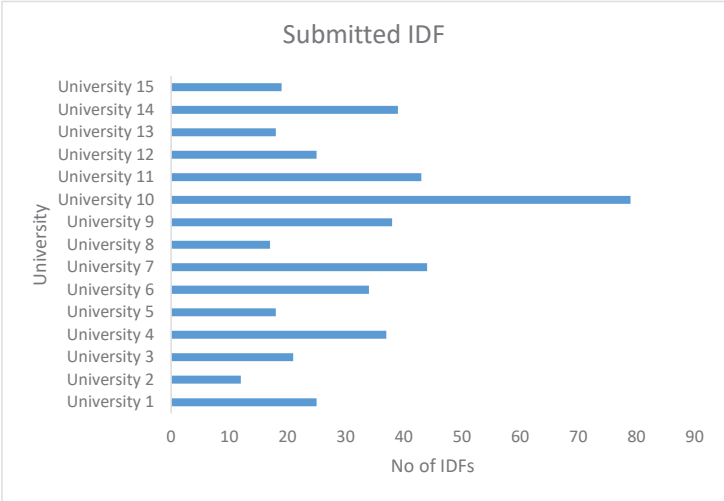

Figure 6: Number of Invention Disclosure Forms (IDFs) submitted to UBLs

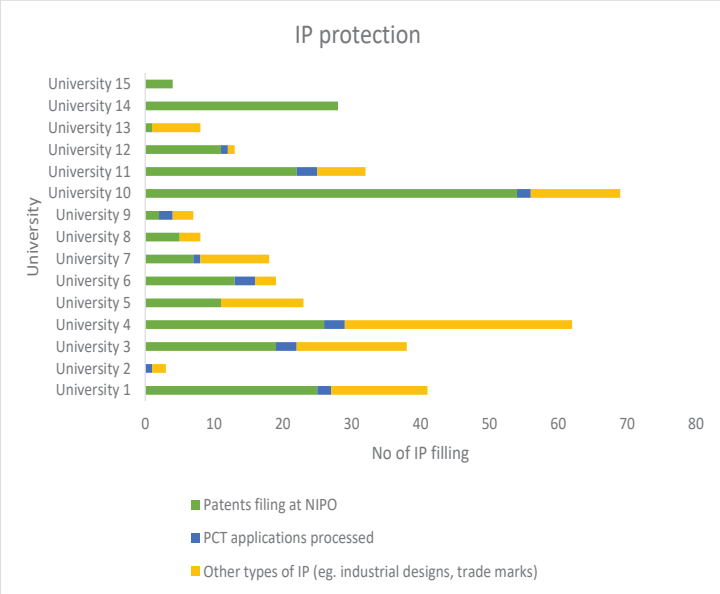

Figure 7: Protection of Intellectual Property through UBLs

The interest from the university in the Triple Helix model is evident from the number of IDFs received by the UBL. All UBLs have received more than 10 IDFs within 5 years of implementation.

Access to commercial patent databases and support for IP-filing

Singh *et al*. (2016) reviewed the use of various free and commercial patent databases, highlighting their unique features, strengths, and weaknesses. The review concludes that scanning freely accessible patent databases is appropriate for determining if a technology is novel and inventive which contains millions of inventions that have already been patented. However, to conduct value added searches efficiently, the use of commercial patent databases is important.

Before the establishment of UBLs, most universities did not have a support system for researchers to analyze the outcome of their research and to identify commercially exploitable work. Proper analysis of the value of the IP and the suitability for formal filing of IP can be evaluated to a certain extent using the commercial patent databases subscribed by AHEAD. Further, support is essential for the researchers to file their IP in

different jurisdictions depending on the technology and the potential commercial partners. This should be a joint effort by the inventor and the university and efforts taken by different UBLs in filing of IP from 2019-2023 is given in Figure 7. AHEAD financially supported this activity.

The total number of patents filed at NIPO during 5 years of implementation is 228 based on Figure 7. This shows that there is an interest from the university in IP protection. The commercial exploitation of the patents will provide the interest and the capacity of the private sectors which will assess the industry input in the Triple Helix model. The total number of products in the market is 42 based on Figure 8, however some products are available only through on-line platforms.

The access to already existing patents will stop the researchers spending the public funds on reinventing of technologies already known to the world. The above aspects should be taken into consideration when evaluating the return on investment on these commercial databases. Patent development in partnership with industries is still low (Alves & Daniel, 2022), access to the databases will also strengthen the co-development of patents with a focus on possible markets.

Patent protection is just the start of the commercialisation journey. In order to take maximum benefit from filing, the patent renewal needs to be done. The incentive for the renewal comes only if the patent gets commercialised (Marcus & Aaboen, 2019; Svensson, 2012). An important factor which affects the possibility of commercialisation is the quality of the patent which in turn will determine the survival of the patent.

The number of patents may not have a strong link towards the success in commercialisation as many non-patent products and processes also get commercialised. A study carried out on 3736 Australian inventions indicates that patents play a modest role in successful commercialisation (Webster & Jensen, 2011). It is important to note that patents are neither a necessary nor sufficient condition for successful commercialisation.

Figure 7 also shows that 21 Patent Cooperation Treaty (PCT) filings were done at WIPO. AHEAD supported some of the filing and the Ministry of Education procurement committee approved such a consultancy for the first time in Sri Lanka indicating the commitment from GoSL. PCT filing was encouraged for the inventions with a good Invention Evaluation Report in order to take inventions to the international market. The International Search Report (ISR) obtained from PCT filing will indicate the strength of the invention. ISR can be used to take the university inventions to the global market with suitable commercial partners. Of the above 21 PCTs, 7 PCT applications received "A" grade for all claims.

The other forms of IP amount to 124, which includes industrial designs, trademarks and copyrights will also help the commercialisation of research outcomes through different licensing options.

Table 2: Outcome of the sector wise virtual exhibitions organised by AHEAD with the support of The Ceylon Chamber of Commerce

University	Sector wise virtual exhibitions (Number of exhibited inventions/number of companies interested)				
	Food	Electric, electronic & IT	Agriculture	Medical	Creative Arts
University 1	3/2	1/1	4/0	3/0	-
University 2	1/1	1/0	4/2	-	-
University 3	1/1	2/2	-	2/0	1/0
University 4	-	4/2	3/5	1/0	-
University 5	4/2	4/1	3/1	2/0	-
University 6	3/3	1/1	2/1	4/0	1/0
University 7	3/3	3/0	4/3	-	-
University 8	3/3	3/1	4/3	2/0	2/0
University 9	2/1	6/1	1/1	-	-
University 10	4/4	-	3/2	5/0	-
University 11	3/3	3/1	6/1	-	-
University 12	1/1	2/0	-	2/0	1/0
University 13	-	4/1	-	-	4/0
University 14	3/2	3/0	3/3	1/0	-
University 15	4/3	3/1	3/3	4/0	-

Collaborative efforts and international support

By partnering with the US Department of Commerce/ CLDP, AHEAD managed to provide several training programs to all UBLs. During these training sessions important aspects of technology transfer were addressed. The first exposure was given to all 15 UBL directors in 2019 in USA about the essential elements in the documents developed during Phase 1 UBL scorecard. The CLDP training programs in 2020, 2021 and 2022 covered essential elements of technology transfer, key terms and conditions for licensing agreements, technology valuation, negotiation basics, and case studies exercises and discussions culminating with mock negotiations and team critiques. The number of participants in these programs varied from 40-80. The final Tech Transfer consultation was given to 17 participants from universities and 3 from UGC, Ministries of Education and Finance with CLDP support in December 2023 in USA.

Technology Innovation Support Centers (TISC) is a program developed by the World Intellectual Property Organisation (WIPO) to support innovators in developing countries. It is implemented through the NIPO in Sri Lanka. AHEAD recognised that not having an allocation of funds to establish TISCs at universities can hamper the functioning of TISCs in universities. As the funds for the establishment of UBLs are from AHEAD, allocating an office space within the UBL for the TISC was an ideal way for the implementation of this activity. "Establishment of a TISC" was added as one action in the Phase 2 of the UBL score card creating an enabling environment to establish TISCs in all state universities in Sri Lanka.

All the above international support mediated through AHEAD could be considered as the government support given to the UBLs in the Triple Helix model.

UBL & commercial partners

Collaboration with industry is identified as a solution to reduce several barriers in the university-industry technology transfer process (Daniel & Alves 2020). In order to support the UBLs to identify commercial partners, AHEAD organised 5 virtual exhibitions with the support of the Ceylon Chamber of Commerce to showcase the inventions by universities to the private sector (Table 2).

The total number of registrants from different fields for the above exhibitions was 132 (from 99 food companies), 233 (from 162 agriculture companies), 61 (from 40 electric, electronic & IT companies), 58 (from 51 medical companies) and 10 (from 4 creative arts). "The number of exhibited inventions/number of companies interested" in Table 2 and "number registered" shows that the private sector in food, IT, electrical, agriculture are keen to work with universities.

The results from Table 2 indicate that more work should be done to win the interest and trust from the private sector to engage with universities in innovation activities.

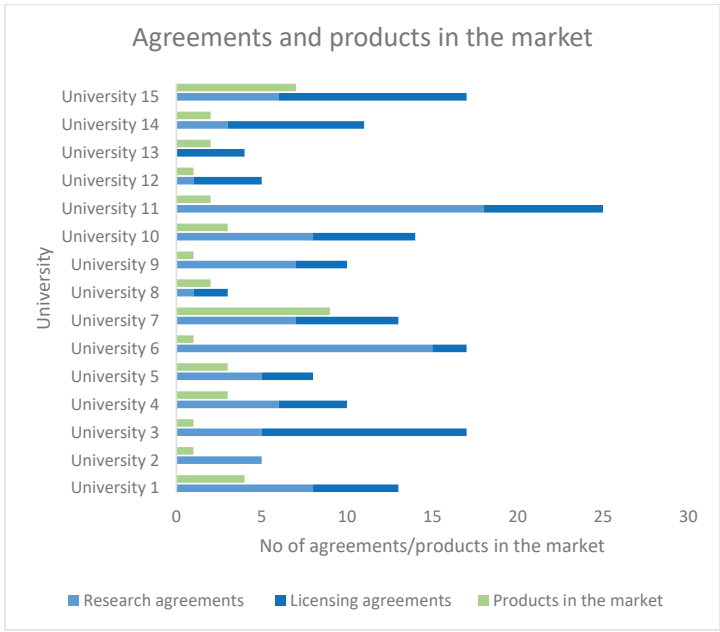

Figure 8: Number of research agreements, license agreements and products facilitated through UBLs from 2019-2023

Technology licensing and products in the market

Collectively all UBLs have signed 77 license agreements with the private sector during 5-year development based on Figure 8. The licensing terms vary from exclusive to non-exclusive, with significant differences in duration, field of use, and territory. The agreement period varies from 1 to 20 years in general. UBLs use 20 years as the upper limit as the lifetime of a patent is 20 years. The analysis of already signed agreements indicates that there are 3 types namely "lump sum upfront payment with or without royalty" and "royalty only" licenses. An upfront payment without a royalty percentage would not be beneficial for the sustainability of the UBL, especially if the product is going to stay on the market for a long time.

The royalty revenue percentages in the license agreements signed by UBL cells range from 0.25% to 10%. In a few licensed agreements, royalty revenue has been calculated based on the profit earned from the product rather than the sales revenue, which is unfavorable from the university's perspective. Since the profit can be manipulated, it is advisable to come to agreements based on the audited net sales of the licensed product.

While encouraging the protection of IP and licensing the technology, UBLs have also facilitated the commercialization of non-IP products and processes. This is a very important aspect in the development of the UBLs in Sri Lanka. Further know-how agreements where patenting is not an option were also encouraged. The 95 research agreements or MOUs shown in Figure 8 will also lead to licensing opportunities in the years to come.

Based on Figure 8, 42 products have come to the market within the last 5 years. It was noted that it is relatively easy to get food, agriculture, cosmetics, and sanitary sector items in the market (AHEAD 2023). This booklet also recognises the efforts taken by UBLs to get IT/Artificial Intelligence and Electric/automation items in the market.

The future GDP growth per capita is positively associated with the increase in the number of universities. It is estimated that 0.4% higher GDP per capita in the region is expected by 10% increase in the number of universities (Valero & Reenen 2019). This increase in per capita is due to the increased supply of human capital as well as innovation. Research and development in universities can enable firms to either develop new products and processes or improve existing products and processes to a higher level which will help the country in the long run (Davies *et al*., 2021).

The Sri Lankan industrial firms acquire new technologies from developed countries via international technology transfers. However, during the transfer of technology, the local firms face many barriers in relation to the complexity of the process, human resources, scarcity of the raw materials, language barriers etc. (Malik & Wickramasinghe 2013). In certain instances, a local agent supports the technology transfer, however in certain instances the local agent does not possess sound technical knowledge in the technology transferred. Certain UBLs may be able to provide this support in the future (Davis & *et al*., 2021).

The importance of connecting academics to the industry utilising modern technology is recognised as

Table 3: Percentage Distribution of revenue based on the IP policy (university percentage include department/faculty/institute)

University	Inventor	University	UBL
University 1	50	20	30
University 2	80	20	00
University 3	60	20	20
University 4	60	40	00
University 5	60	10	30
University 6	70	18	12
University 7	70	05	25
University 8	60	30	10
University 9	75	15	10
University 10	70	15	15
University 11	70	10	20
University 12	60	20	20
University 13*	80	10	10
University 14	60	39	01
University 15	60	40	00

* Proportion is for net income below Rs 500,000.

an important need that will bridge the gap between the academic institutions and the private sector. With this understanding, an app, called CONNECT AHEAD, was developed to connect the two parties.

Sustainability and securing the future of UBL staff

In the long term, the UBL-Cells should have a cadre of permanent directors and managers to manage the work of these Cells. The permanent cadre of UBL-Cell managers was an agreed action with the ministry, and discussions are in the process to obtain the necessary approval. This will enable the universities to retain the especially trained staff for this purpose.

The next step would be to hire technology licensing managers and provide them with necessary skills to negotiate with the private sector and obtain the maximum benefits to universities from their commercialisation activities while paying attention to the requirements and needs of the private partners.

Universities were given the freedom to decide on the revenue distribution from the commercialization of research in their IP policies. According to the revenue distributions in IP policies (Table 3), all universities have allocated at least 50% or more to the research team to motivate the academic staff and researchers involved. However, the percentage allocation to UBL is not at a desirable level in a few universities. This was pointed out during the UBL Cell evaluation, and most universities have discussed this matter to revise the revenue distribution. In certain universities, a percentage of the university allocation is not ear-marked for UBL work. The recommendation from AHEAD is to have this percentage clearly indicated in the IP policy for the sustainability of UBL work after the lifetime of AHEAD.

Challenges for success: ease of knowledge and Technology Transfer

When conducting research, the researchers face numerous obstacles due to the lack of state-of-the-art equipment, insufficient or unavailability of consumables and in general poor infrastructure to conduct research work. Obtaining permits for the purpose of importing certain chemicals and other consumables to the country and the issues related to clearing of such goods from customs are not straight forward, causing impediment to conduct research.

The bureaucracies involved in procurement and financial processes further hamper the research activities conducted at universities, as it is difficult to use the available funds effectively and efficiently. Although interactions with industries have been proposed as a way to move forward in research, the mechanism to achieve this efficiently and efficiently, has not been identified and clear guidelines have not been laid down towards such endeavors. However, with the development of UBLs as detailed in Figure 9, Individual researchers, Departments, Faculties, and Incubators will disclose their inventions to UBL. UBL will transfer the technology to an existing industry, or a start-up by staff & students or start-up by an investor.

The evolution of different technology transfer models has been reviewed (Arenas &González, 2018) and the reported models span from 1982 to 2015.

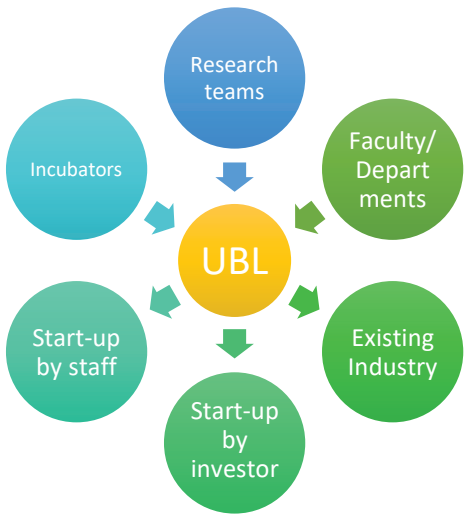

Figure 9: Schematic diagram indicating commercialisation of research through UBL.

Table 4: The responses to the stakeholder satisfaction survey in 2021 and 2022/23 (SD: Strongly Disagree, D: Disagree, A: Agree, AS: Strongly Agree, NO: No opinion, F: Frequency)

		Year 2021						Year 2022/23					
Question		SD	D	A	SA	NO	Total	SD	D	A	SA	NO	Total
1	F	0	0	11	16	1	28	0	1	10	20	1	*32*
	%	0%	0%	39%	57%	4%	100%	*0%*	*3%*	*31%*	*63%*	*3%*	*100%*
2	F	2	13	10	3	0	28	1	10	13	8	0	*32*
	%	7%	46%	36%	11%	0%	100%	*3%*	*31%*	*41%*	*25%*	*0%*	*100%*
3	F	0	0	13	15	0	28	0	0	18	14	0	*32*
	%	0%	0%	46%	54%	0%	100%	*0%*	*0%*	*56%*	*44%*	*0%*	*100%*
4	F	0	0	13	15	0	28	0	2	16	14	0	*32*
	%	0%	0%	46%	54%	0%	100%	*0%*	*6%*	*50%*	*44%*	*0%*	*100%*
5	F	0	1	9	18	0	28	0	1	11	20	0	*32*
	%	0%	4%	32%	64%	0%	100%	*0%*	*3%*	*34%*	*63%*	*0%*	*100%*
6	F	0	3	18	7	0	28	0	3	15	13	1	*32*
	%	0%	11%	64%	25%	0%	100%	*0%*	*9%*	*47%*	*41%*	*3%*	*100%*
7	F	0	1	17	10	0	28	0	0	18	14	0	*32*
	%	0%	4%	61%	35%	0%	100%	*0%*	*0%*	*56%*	*44%*	*0%*	*100%*
8	F	1	7	16	3	1	28	1	9	15	7	0	*32*
	%	4%	25%	57%	10%	4%	100%	*3%*	*28%*	*47%*	*22%*	*0%*	*100%*
9	F	0	4	16	6	2	28	0	6	22	4	0	*32*
	%	0%	14%	57%	22%	7%	100%	*0%*	*19%*	*69%*	*13%*	*0%*	*100%*
10	F	0	2	15	9	2	28	0	2	25	5	0	*32*
	%	0%	7%	54%	32%	7%	100%	*0%*	*6%*	*78%*	*16%*	*0%*	*100%*
11	F	0	8	18	2	0	28	0	8	22	2	0	*32*
	%	0%	29%	64%	7%	0%	100%	0%	25%	69%	6%	0%	*100%*
12	F	1	1	19	4	3	28	0	7	16	7	2	*32*
	%	4%	4%	67%	14%	11%	100%	*0%*	*22%*	*50%*	*22%*	*6%*	*100%*

Oxford University Innovation Limited (OUI) is a technology transfer company owned by the University of Oxford. This company manages the University of Oxford Intellectual Property portfolio and works with the researchers at the university carrying out the functions of a TTO. A similar model is adopted by the Imperial College, London to commercialise the research findings through the Imperial College Innovation Limited. Although these are private universities and their models may not be directly applicable to universities in Sri Lanka, a mechanism must be proposed to enable quick decision-making to facilitate the commercialization of research.

Separate Tech Transfer Entities within a University may be formed as companies limited by guarantee in terms of Section 34 of the Companies Act No. 07 of 2007. Unlike a company limited by shares, a company limited by guarantee does not obtain its initial working funds from its members, but usually these initial working funds are obtained from other sources e.g.: endowments, grants.

The main advantages of forming these entities as companies limited by guarantee are to facilitate the decision-making process when interacting with external parties and to do business easily. In addition, the procurement processes and financial transactions can be expedited. However, those engaged in this technology and knowledge transfer must take caution not to disrupt the university teaching activities. The objects of the company should be for promotion of commerce, art, science, or other useful objects and not for manufacturing or sales of technologies. The company must apply its profit, if any, or other income in promoting its objects and it should prohibit the payment of any dividends to its members. In fact, such companies involved in technology and knowledge transfer would provide useful avenues for students and staff to conduct advanced research in universities as the fixed assets acquired would be in the inventory of the university.

Start-up AHEAD policy

There are situations where it is difficult to find a commercial partner who is interested in investing in the production and distribution of the good/s and service/s which embodies the university invention. In such situations start-ups would be an alternative approach in the commercialisation process. These start-ups may survive or will be bought by technology giants. If a foreign company acquires the start-up and invests in Sri-Lanka, there will be export lead growth.

Start-up AHEAD is a university staff and student start-up policy (UGC Commission Circular No. 12/2022) developed to facilitate the commercialisation of inventions developed at universities in Sri Lanka. This guide will encourage university staff and students in Sri Lanka to form start-ups outside the university's purview, promoting entrepreneurship as a career option.

The developed guidelines are broad, allowing individual universities to develop their own comprehensive guidelines and policies based on this document to facilitate start-up formation. The University will not have to bear any legal or financial obligations towards the start-up or its activities.

Academic entrepreneurship activities should incorporate concepts such as social entrepreneurship to enhance societal benefits (Amry *et al*., 2021) for the universities to contribute to socio-economic development.

Stakeholder satisfaction survey

The results of the overall satisfaction based on the responses to 12 questions in two years are reported in Table 4. Total number of respondents is 28 and 32 in 2021 and 2022/23 respectively.

The satisfaction has been improved in general, however it was noted that the opportunities to participate in UBL advisory committee meetings or UBL management meetings at the university requires attention.

Table 5: Satisfaction of the comprehensiveness of a policy and regulatory guidelines given under the UGC circular 10/2016 for research and commercialisation (the responses from the UBL directors)

	Low	Medium	High
Baseline survey (2018 retrospective)	50%		50%
Stakeholder feedback survey 2021	7%	40%	53%
Stakeholder feedback survey 2022/23	6%		94%

The stakeholder feedback survey in 2021 and 2022/23 indicates (Table 5) that there is an improvement in the satisfactory level shown toward the policy and regulatory guidelines.

Table 6: Satisfaction of reference and practice standards to assess offices (responses from the UBL directors)

	Low	Medium	High
Baseline survey (2018 retrospective)	67%		33%
Stakeholder feedback survey 2021		47%	53%
Stakeholder feedback survey 2022/23			100%

The "satisfaction of reference and practice standards to assess offices" (Table 6) also indicates that in 2021, the low satisfactory level was zero. In 2022/23 all have shown high satisfaction. The AHEAD UBL scorecard developed to guide the establishment of UBL clearly has an impact on the improvement of the satisfactory level. Continuous monitoring and evaluation were conducted based on the UBL scorecard during 2018-2023.

The increase in the satisfactory level as indicated in Table 7 would support the university-industry interaction and prove the impact of the effective use of Triple Helix model.

Table 7: Legal support and guidance for research and commercialisation and availability of guiding documentation and templates required to commercialise research outcomes (responses from the UBL directors)

	Low	Medium	High
Baseline survey (2018 retrospective)	50%		50%
Stakeholder feedback survey 2021		27%	73%
Stakeholder feedback survey 2022/23	6%		94%

Table 8: Overall satisfaction score categories for UBL Directors

	Low	Medium	High
Baseline survey (2018 retrospective)	60%	20%	20%
Stakeholder feedback survey 2021	17%	17%	66%
Stakeholder feedback survey 2022/23		6%	94%

The improvement in the overall satisfactory level of the UBL directors is encouraging based on the data in Table 8.

The analysis of the overall satisfaction during the 2022/23 survey from all stakeholders (16 Vice chancellors, 16 UBL directors, 12 members of the UBL advisory committee and 19 UBL faculty coordinators) shows zero at the low satisfactory level. However, the medium and high satisfactory level are 25% and 75% respectively. The survey was conducted at 2 new universities as the UBL work was initiated in these universities as well.

CONCLUSION

The establishment and the development of the UBLs which act as technology and knowledge transfer entities since 2018 within the state university system in Sri Lanka proves that the enhancement of the roles played by the player clusters of the Triple Helix model has greatly influenced in improving university-industry interaction.

All universities completed the establishment of core UBL cell which required the completion of standard templates required for the commercialisation of research (Phase 1 of UBL) and identification of the internal R & D strength and equip the UBL (Phase 2 of UBL) within 27 months, which indicates that there is a need to have UBLs set up at the universities. All 15 universities completed operationalisation of the UBL cell within 45 months which requires building a network of entrepreneurs, investors, small and large businesses and getting them to work with research groups within the university (Phase 3 of the scorecard). Fifteen universities completed the 4 actions stipulated in Phase 4 of the score card within 5 years and 6 months of the implementation UBL Cells.

The number of Invention Disclosure Forms submitted to UBLs varied from 12-79 in 15 different UBLs. A total of 228 patent applications were submitted to NIPO, a total of 124 other forms of IP were filed through UBLs and 21 PCT applications were filed at WIPO by the 15 UBLs from 2019-2023. This development is significant considering the fact that these outcomes were achieved during the first 5 years of establishment. These figures indicate that all 3 arms of the tripe helix model; government, university and the industry, have been integrated well through the UBL. However, efforts must be made to further develop the UBLs and to strengthen the research and innovation capacity of all universities.

It is encouraging to see that 14 UBLs have already marched towards the commercialization journey having signed licensing agreements. The research agreements signed by all UBLs during the first 5 years of development amount to 95, while a total of 77 licensing agreements have been signed by all UBLs. However, most of these agreements do not cover technology intensive innovations and the number does not necessarily indicate advanced technology readiness. It only indicates that the environment has been created for academics to make

use of their research findings for the public good. On the other hand, it indicates that the private sector in the Triple Helix model is also willing to work with universities and UBLs are facilitating this interaction. Most licensees are SMEs, but well-established companies have also partnered with the UBLs.

Knowledge about the key features in research and licensing agreements and having strong negotiation skills when finalising royalty payments are scarce for the UBL and researchers at Sri Lankan universities. This gap was filled by arranging training sessions with the help of the US Department of Commerce, Commercial Law Development Program. Further, some UBLs used AHEAD funds to obtain necessary support in the identification of legal advisors or a firm.

During commercialization with local industries, the main aim should not be to maximize profits but to establish a solid, long-lasting, and mutually beneficial relationship. In this regard efforts must be made to have a mutual respect for both parties when engaging in negotiations. The negotiation exercises conducted during UBL development will help to improve such skills among UBL staff. As an example, rather than a one-time payment from a license agreement, a percentage royalty would be beneficial for the sustainability of the UBL if the product stays in the market for a long time. Calculating the percentage royalty based on the product sales can be done reliably using audit reports, hence this should be a better option than a percentage royalty based on the profit.

The next step would be to give wider publicity for UBL work and the available technologies for licensing. Television programs arranged by AHEAD with the help of two local channels helped to obtain some visibility. However, the UBLs can use social media platforms more effectively for the same purpose. Development and updating the UBL websites, conducting series of virtual exhibitions with the Ceylon Chamber of Commerce and indicating licensing opportunities at WIPO patent scope database for the PCTs filed were attempted to improve the tech/knowledge transfer initiatives.

PCT filing was encouraged for the inventions with a good Invention Evaluation Report to take inventions to the international market. The International Search Report (ISR) obtained from PCT filing will indicate the strength of the invention. ISR can be used to take the invention to the global market with suitable commercial partners. Of the above 21 PCTs, 7 PCT applications received "A" grade for all claims. The university support for screening inventions to identify the novel inventions with inventive step and providing IP filing support which was initiated by AHEAD should continue beyond AHEAD. Hence allocating funds for such initiatives is extremely important. Thereafter a strategy should be in place to identify local or foreign licensees especially for the products which will become integral part of the global value chain.

AHEAD recognised the value of multiparty engagement in improving the innovation landscape in Sri Lanka and works closely with US Department of commerce/CLDP, USPTO and WIPO. In order to facilitate the IP protection, AHEAD collaborated closely with NIPO.

Managers are acquiring necessary skills to manage the UBLs, however some of the trained managers are leaving the UBLs to pursue other career pathways. AHEAD has made a request to the Ministry of Education to create cadre positions for the managers. Such career prospects will motivate the managers to remain at the UBLs and contribute to the development. A strong team must be built around the UBLs now itself to improve the awareness of tech transfer and IP based licensing. One option for the UBLs is to provide internships to the fresh graduates as the exposure in a UBL will also provide new career pathways to the interns.

Revenue distribution in the IP policies indicates that all universities allocated 50-80% of the revenue from the commercialisation of research for the iinventors. However, the allocation for the UBL varies from 0-30%. A few universities have a low percentage allocated to the UBLs in their IP policy in the distribution of royalties. This must be carefully reviewed considering the importance of sustainability of the UBLs.

The success of UBLs will largely depend on the relationships they build with all internal and external parties. It is recommended to establish very strong, solid, lasting relationships at various levels.

An attractive reward system must be in place for researchers to get involved in research which will bring tangible outcomes to society or industry. This would be an incentive for innovation and commercialisation. In Sri Lanka, the university academics are entitled to a research allowance where the efforts taken in conducting research and development is assessed in awarding the allowance. Based on the efforts through AHEAD, successful commercialisation can also be considered in awarding research allowance to university academics based on the UGC Establishment Circular No. 05/2014(iii) (UGC Establishment Circular 2022).

The freedom in the selection of commercial partners by research teams along with the UBLs play a very important role in commercialisation of research. The selection of a commercial partner should not be considered as a typical procurement as finding a commercial partner from a limited pool of interested companies is extremely challenging, thus, in this instance, GOSL procurement guidelines may not be applicable. Although the Intellectual Property belongs to a particular university, it is important to consider the views of the inventor in the identification of the commercial partner and the inventor should have the right of first refusal. UGC Commission Circular No. 12/2022 will guide universities during selection of the commercial partners or promoting Start-ups.

There are several policy initiatives required to promote research and innovation, especially through university-industry linkages targeted at growth promoting activities. Facilitating the freedom to enter into MOU's and agreements with foreign partners and expediting importation and clearance procedures for equipment and consumables required for research are two key areas where the government attention should be drawn to.

Resources and networking are essential for innovation as this has led to greater research collaboration among academics across universities, countries and even continents. With AHEAD investment, all 15 universities purchased state-of-the-art equipment for research. Over time, it would be encouraging to see rising numbers of Sri Lankan academics collaborate with peers and making use of those state-of-the-art equipment.

For a university to generate inventions that can be transformed to benefit the society, it has to be a research university which has good networks and cooperation with industry, business, and government, with adequate funding sources from government, venture capitalists and/or angel investors. The established UBLs will coordinate such activities and protect IP. Hence the sustainability of the UBL is an essential requirement in the Sri Lankan state university system.

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