State of Artificial Intelligence in Sri Lankan Software Industry

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Abstract— **This paper has examined propagations and deliberations of AI in Sri Lankan software industry. A survey has been carried out for gathering the information. Even though software industry is a rapidly growing sector in Sri Lanka, it is lagging behind in terms of using AI technologies with compared to other countries in the world. According to the survey, this is due to the lack of popularity, knowledge, experts, requirements and sponsorship for the AI related software projects. Sri Lankan software industry has the required maturity to adopt with AI technologies and they have already made their foot print on potential markets where they could find advanced AI research and development projects in different domains. However, Sri Lankan software industry has not been able to achieve the required momentum, stability and the confidence on research and development projects in AI. Large-scale companies must increase their attention on AI technologies and the required knowledge and work force should be supplied through the Sri Lankan education system. Professional organizations, research groups, academics and the industry experts got a huge role to be played jointly to overcome the barriers in order to introduce AI technologies to the Sri Lankan software industry.**

Index Terms — **Artificial Intelligence, Software Industry, IT Export, Sri Lanka, Education**

I. INTRODUCTION

Artificial intelligence (AI) has been one of the most controversial domains of inquiry in the computer science field, since its inception in the 1950s at the Dartmouth Conference [1]. Defined as the part of computer science concerned with designing systems that exhibit the characteristics associated with human intelligence, understanding language, learning, reasoning, solving problems, and so on. AI field has attracted researchers because of its striving goals and enormous underlying intellectual challenges. The field has been debatable because of its social, ethical, and philosophical implications [2]. Such argument has affected the funding environment for AI and the objectives of many research programs such as Defense Advanced Research Projects Agency (DARPA) [3].

A range of scientists and technologists with varying perspectives, interests, and motivations conducts AI research. Scientists tend to be interested in understanding the underlying basis of intelligence and cognition, some with an emphasis on unrevealing the mysteries of human thought and others examining intelligence more broadly. Engineering oriented researchers are interested in building systems that behave intelligently. Some attempt to build systems using techniques comparable to those used by humans, whereas others apply a range of techniques adopted from fields such as information theory, electrical engineering, statistics, and pattern recognition [4]. Those in the latter category often do not necessarily consider themselves AI researchers, but rather fall into a broader category of researchers interested in machine intelligence.

Most of the federal support has come from the DARPA, known during certain periods as Advanced Research Projects Agency (ARPA) [5] and other units of the Department of Defense (DOD) in United States. Other funding agencies have included the National Institutes of Health, National Science Foundation, and National Aeronautics and Space Administration (NASA), which have pursued AI applications of particular relevance to their missions, health care, scientific research, and space exploration.

Sri Lanka is becoming a major software outsourcing country in the world close with India in the Asian region [6]. Sri Lankan software industry consists of lots of different scales of companies from the large scale to small scale. Due to the popularity of the IT industry, Sri Lankan education of IT is also becoming strengthening and developing into an advanced level. Majority of the services are offered by IT outsourcing companies are software development and product service [7]. To identify the barriers and the reasons to introduce AI to Sri Lankan software industry, two different surveys were dispatched targeting the software industry and the IT education sectors. By analyzing different factors several conclusions and recommendations were made to overcome barriers and issues in the Artificial Intelligence area.

In this research, key trends were highlighted in the development of the field of AI in the world and the barriers which influential, not to popular AI in Sri Lankan context. The sections of this research paper, presented in roughly cover the launching of the AI field by the US government's initial participation and the pivotal role played by DARPA, AI in the 1990s. Section III describes the status of the software industry in Sri Lanka. Section IV expands our methodology and the Section V shows the results. Final sections describe the issues identified, conclusion and our recommendations.

II. LITERATURE REVIEW

"It is hard to predict, especially the future", which is the famous quote done by Niels Bohr is very much relevant about the future of artificial intelligence [8]. After fifty years

of explorations about the future of artificial intelligence systems currently world has learned enough about the nature of intelligence. The Dynamic Analysis and Re-planning Tool (DART) is an AI based decision support system used throughout the Persian Gulf War. DART could solved the logistical problems such as moving military assets from Europe to Saudi Arabia [9]. Amount of money that DART saved reportedly balanced all funds the Defense Advanced Research Projects Agency (DARPA) had spent into AI research in the previous thirty years [10]. People started to see the power of AI after seen the advantages gained by the DART program.

AI has been well supported by the US government research and development for decades now, and people are beginning raise concerns. There are key attributes needed to commence AI projects [11]. Those key attributes are shown in the following Table 1.

Narrow Scope	Makes knowledge engineering difficult, hence expensive
Focused objective	Assures importance of accomplishment
Stability of environment	Allows us to put on blinders and limit concerns
High degree of automation & reputation Small Project	Gives maximum return for fixed development cost
Lots of custom work by talented professionals	Not cookie-cutter applications

Table 1: Critical Ingredients in the Typical AI success

The suggested list of new focus problems for AI research as shown in the table 2 [11].

Table 2: Suggested List of New Focus problem for AI Research

Multifaceted Intelligence	• Comprises many components • Exhibits many functions • Supports many tasks • Understands and knows a lot
Cooperation	• Multiple and heterogeneous agents • Comparative advantages • Bandwidth limited • Time stressed
Affordability	• Knowledge and component reuse • Knowledge-based • Knowledge acquisition and update
Manageability	• Estimate, predictable, testable development processes

Table 2: Suggested List of New Focus problem for AI Research

Following table categorized and identified AI techniques, which can be successfully implemented as a software program [12] [13] [14].

Representation	Languages, Domain Modeling and knowledge engineering Rules, frames, classes, hierarchies, propositions, constraints, demons, certainty factors, fuzzy variables.
Inference	Theorem-proving, heuristic Reasoning and Matching Techniques Forward and backward chaining, unification, resolution, inheritance, hypothetical reasoning, constraint propagation, case based reasoning.
Control	Goal and data directed, messaging demons, focus, agenda, triggers, meta plans, scheduling, and search algorithm.
Problem-solving architectures	Rule based, object oriented, frame based, constraint based, blackboard, heuristic classification, task-specific shells.

Table 3: Proven AI Techniques

One could observe the excess of Moore's laws across the spectrum of computing. But the transistor changed the situation. AI also is in the same category, and hence argues that AI development must follow a similarly exponential curve [15]. Some people believe AI is to never be achieved, it will require a long-term, collective effort of a lot of scientists over many generations [16]. Recently Stephen Hawking warns artificial intelligence could end mankind [17]. Machine learning experts from the British company Swiftkey [18] were also involved in its creation. Their technology, already employed as a smartphone keyboard app, learns how the professor Hawking thinks and suggests the words he might want to use next.

Concerning the current status of software industry and economic status of Sri Lanka, and ICT export value, ICT export has dominate massive percentage rather than tea and rubber like exports [19] [20]. Even though, there is no research done on the capacity of AI in Sri Lankan context, a research was carried out in the area of software implementation in the Sri Lankan organizations [21]. Lack of proper software engineering knowledge is the major reason among rest of them. This reason also valid for the Artificial Intelligence.

III. SOFTWARE INDUSTRY IN SRI LANKA

Software industry is a growing industry in Sri Lanka and IT exports itself is a vast growing sector in Sri Lanka [21]. In 2010, there were 147 export companies operating in the industry and their distribution is shown below.
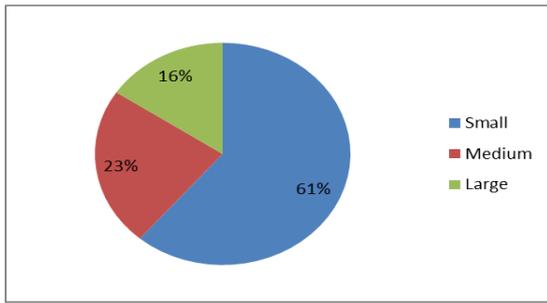
Figure 1: IT Export Company in Sri Lanka – Scale Wise

As shown in Figure 1, majority of the companies are small-scale companies, which accounted for more than 50%. In 2010, IT export value was USD 250.3 million which is 46% of growth when it is compared to 2009. This is 107% growth when it is compared with 2006. If the same growth rate continued, in 2012 IT export value would have been USD 533.5 million. When total IT export value is considered in 2012 IT export value is behind only for Textile & Garments ($ 3991 millions), Tea ($ 1,411.9 mn), rubber products ($ 859.4 mn) and gem, diamonds & jewelry ($ 558.9). Figure 2 indicates that the IT exports with regards to other popular exports in Sri Lanka [3] which is shown in figure 2.
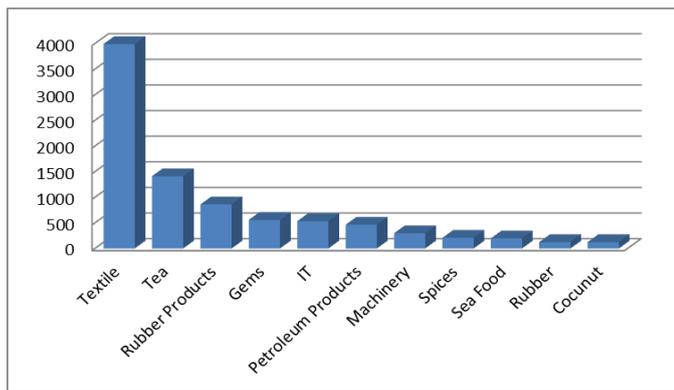
Figure 2: Composition of Export in Sri Lanka in 2012 (in USD $ millions)

When the number of employments are considered, total of 10,967 employees were employed in the IT export companies in 2010.
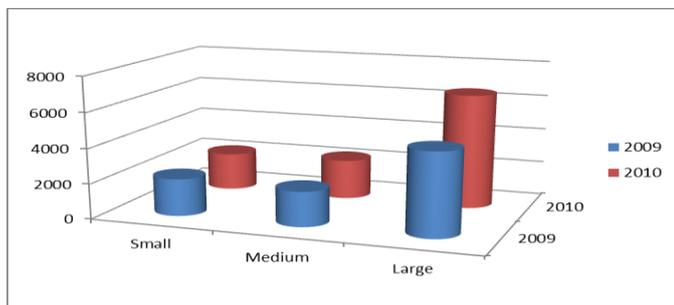

Figure 3: Composition of Employment in IT Export industry 2009 and 2010

As shown in figure 3, large-scale companies have shown rapid growth of number of employees from 2009 to 2010.

Currently, different services are offered by the IT export companies in Sri Lanka as shown in figure 4. They are

- Software development/services
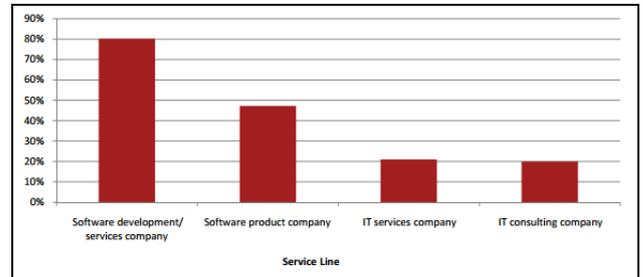- Software Product
- IT Services
- IT Consulting

Figure 4: Services offered by IT export Companies in Sri Lanka in 2010

Majority of the services are offered by IT export companies are development and product service as majority of the companies are developing software for the foreign countries. Foreign countries are looking forward to hire software development services from the third world countries for lesser cost however they keep the advanced research kind of ideas with them. They outsource the standard not proprietary work which helps to run with the intelligent final product from third world countries like Sri Lanka rather than giving the advanced idea for us. So, the majority of software companies in Sri Lankan software industry work on standard software development. However, Sri Lanka Association for Software and Service Companies (SLASSCOM) indicates that in recent years, IT export has started monitoring, help desk and live operational tasks.

Most of the IT exports in Sri Lanka are to countries like US and European countries.
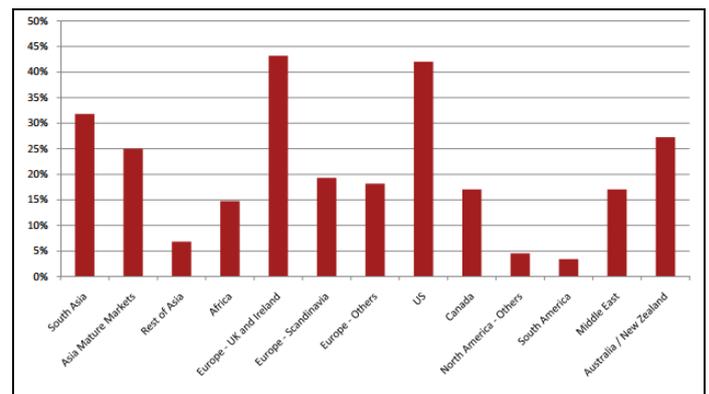

Figure 5: IT exports countries

The top three markets for IT Exports were Europe, US and South Asia. Moreover, the industry also maintains a

significant market presence in Australia/New Zealand, Asian mature markets and Middle East [2].

Another important factor about IT Export, how IT export companies obtain projects which shows in figure 6.
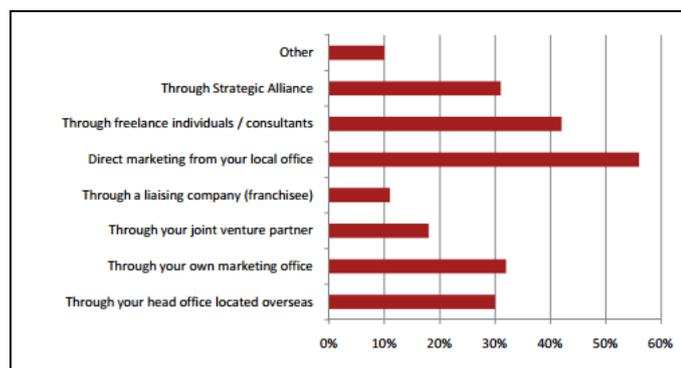

Figure 6: Mode of Canvasing for Export Business

Overall, 56% of companies have used direct marketing as their mode of canvassing for export business. Further, freelance consultants have been used by 42% of the companies to canvass business. 32% of the companies have canvassed for export business via its marketing offices located in overseas [2].

When the technical qualifications of IT experts are considered most of the technical IT exports are graduate or IT degree holders. This means that, the Sri Lankan software industry has well educated people work on behalf of the other countries.
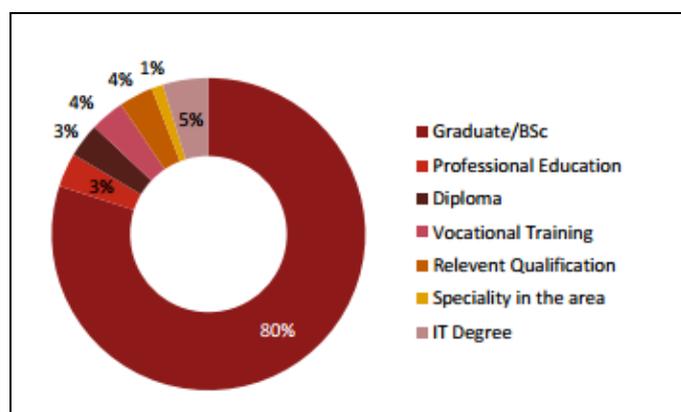

Figure 7: Qualifications of IT Technical Specialists

Apart from IT exports, there is another major sector which develops software for Sri Lankan organizations. However, no proper research done on these areas to identify the capacity of those sectors.

Organizations like ICTA develop standard software systems, web systems and the mobile apps as well.
Ex:
- Train Schedule App Sri Lanka.
- Web sites, online web systems for the government, ministries and departments.

Nevertheless, ICTA is lagging behind by their research work to apply AI techniques for their software products.

However, government is targeting Transport, Tourism and Textile & Garment industry in coming years [3]. Out of these sectors Textile & Garment industry will have a capacity to gain AI technologies as example,

- Cloth cutting sections to check the quantity of each bins to be saw by the sawing department - Monitoring systems
- Automated scheduling systems
- Intelligent ERP Systems using Expert Systems
- Choosing proper material to saw a selected garment by analyzing the paper design

IV. METHODOLOGY

The research is to identify current state of the artificial intelligence in the Sri Lankan industry. Two major contributors to the AI sector were identified as industry and education. Two separate surveys has been sent targeting industry and education, as parameters are different in two areas. However, responses for the education survey was poor but for the industry sector, there were large number of responses.

From the surveys, two types of questions were inquired.

1. Attributes of the responder.
   - Designation
   - Name of the Company
   - Number of Employees
   - Nature of Software Development
   - Nature of Clients
   - Kind of software systems they are developing
   - Programming languages / Intelligent Frameworks they are using

2. Questions about AI techniques and their perceptions.
   - AI techniques they use
   - Industries that they are developing AI related software
   - AI technology related knowledge they have
   - Whether they are member of SLAAI
   - Sponsorship for AI
   - Comparison of AI with MIS
   - Future of the development of intelligent software

Survey results were compared with the attributes of responder and find out whether the behavior is different for different attributes of the responder.

Apart from the data gathered from the surveys, ICT Export Value Survey, 2010 – IT/ITES Export Sector, Sri Lanka Export Development Board and August 2011 is used to identify the current status of the IT export of the Sri Lanka.

However, this report was not a latest report. 2012 Central Bank report is also used to gather some other information.

V. ATTRIBUTES OF RESPONDERS

First of all, responders were analyzed depending on the company scale of their working.
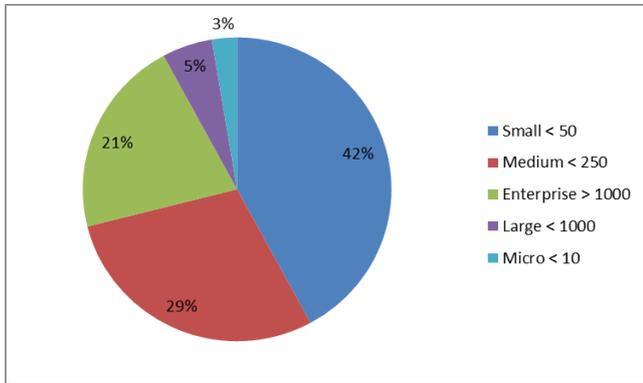
Figure 8: Company Scale of the Responders

Most of the responders were employed at small and medium scale software companies as shown in the figure 8.

Figure 9 shows the type of development done in Sri Lankan software companies.
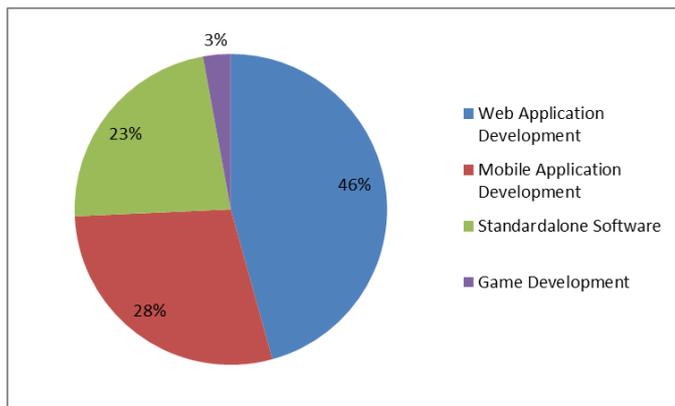
Figure 9: Software System Development

Figure 9 shows that major developments are on web and mobile application. There is a trend that can be easily apply AI Techniques on mobile apps and web apps.

Figure 10 shows the development platform of the responders and it shows that the most number of developers are with Java and C#.
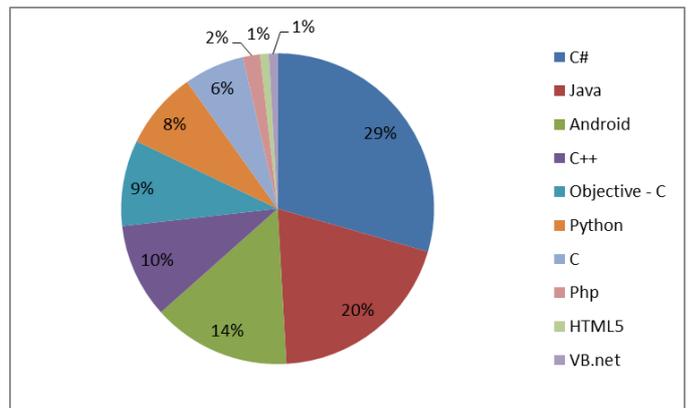
Figure 10: Development Platforms

Java and Python are the most common languages used in AI field. Figure 10 shows, Sri Lanka got development resources for AI developments in Sri Lanka. It is easy to introduce AI frameworks such as JADE, Jena, MadKit to the existing software development industry because majority of them use java, python like languages to program software.

In the sector of education, responders from University of Moratuwa, University of Ruhuna, Open University and Sri Lanka Institute of Information Technology (SLIIT) were participated.

Following are the areas of AI related research work that those responders are engaged in. Data Mining, Neural network and robotics like AI techniques can be easily use because there are sufficient resources to educate our next generation of software professionals to use this kind of techniques. As a nation, Sri Lanka has sufficient resources to direct the education to improve AI in academic perspective since most of the IT graduates are coming out from the above universities.
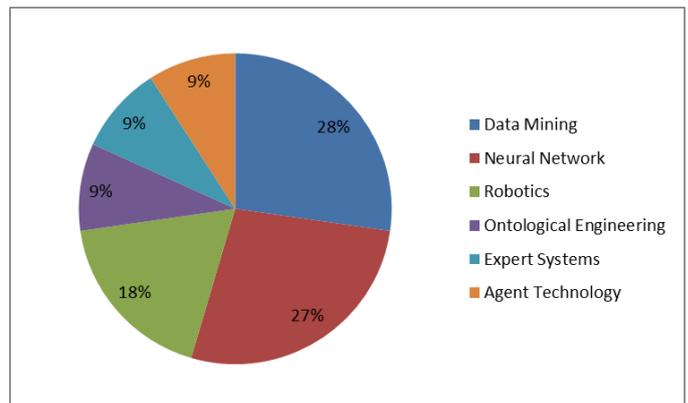
Figure 11: Areas of AI related research work

VI. ISSUES IDENTIFIED

By analyzing the data from the survey, few issues were identified.

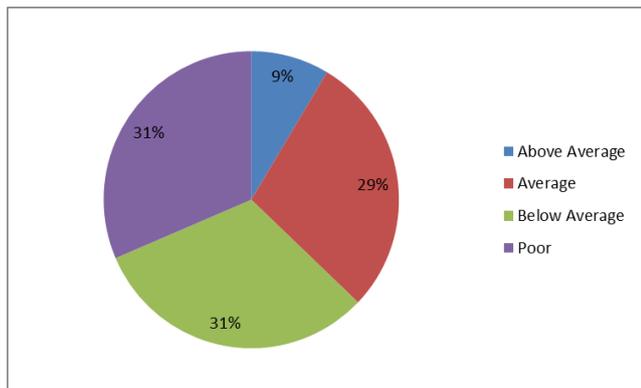According to the responders more than 90% had average or poor knowledge in AI as shown in Figure 11.

Figure 11: AI Knowledge of IT Experts

Figure 13: Company Scale wise Sponsorship

Figure 11 clearly shows the lack of knowledge in AI is a major barrier for AI development in Sri Lanka. When this was further anlyzed in organization scale, it was visible that large and small scale companies have average knowledge on AI.
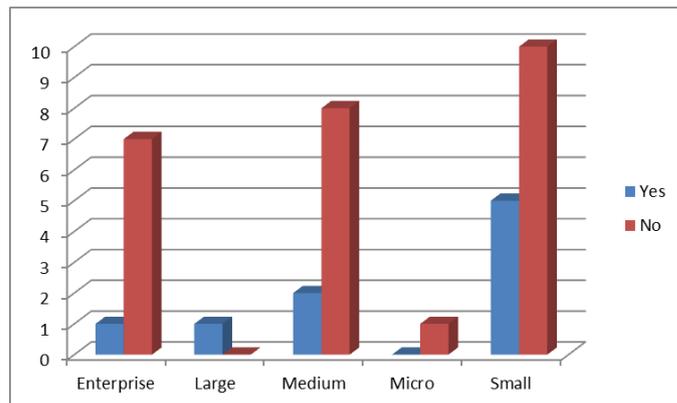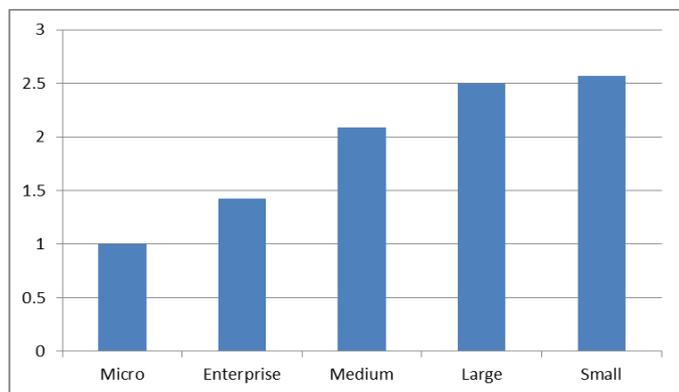

Figure 12: AI Knowledge of IT Experts Company Scale wise

Figure 12 indicates Enterprise organization while has large number of IT employees yet they have very much less than average knowledge in AI. This may be due to the fact that enterprise organization do not have freedom to select AI techniques. They are regulated by the foreign countries according to their requirements. Most of the ideas come from them and not by Sri Lankan experts. Sri Lankan experts are motivated to do the work given by them but no hard work to introduce or implement new research work.

When it comes to sponsring for AI projects by IT companies, it is very much evident that not much sponsorship is avalaible for companies as it indicate around 75% does not have sponsorship for AI. This was further analyzed in company scale wise.

Figure 13 indicates that companies which sponsoring for AI are mainly small scale companies. This means large and enterprise scale companies are not encoraging for AI.

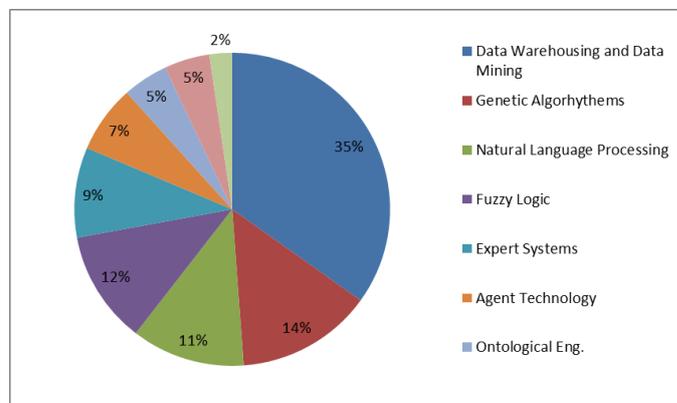Research also looked into the areas of AI technologies of IT companies in Sri Lanka.

Figure 14: AI techniques used by IT companies

Figure 14 shows 35% of AI usage is in data warehousing and data mining. Main reason for this is database technologies are popular in Sri Lanka and for reporting purposes of the organizations they have to extend the databases to data warehouse and data mining. However, it is doubtful whether these organizations are using full-fledged features of data warehousing and data mining. This means that,

a) In Sri Lanka, Software companies do not have the requirements to develop AI techniques.

b) Sri Lanka does not have required knowledge on AI techniques to get more opportunities in AI.

Sri Lanka Association for Artificial Intelligence (SLAAI) is operate as AI research group in Sri Lanka. The primary objectives of SLAAI are to increase public awareness of Artificial Intelligence, improve teaching and research in AI, and also promote industry academia partnership in the use for AI techniques for the real world problem solving. Major SLAAI activities include conduct of AI publicity programs, offering of short courses in areas of AI, promote research in AI, and conduct an annual AI conference and publishing of

proceedings [22]. However, all the responders were not members of SLAAI. This means that many of the IT experts do not aware about what SLAAI is.

As indicated in figure 6, majority of foreign software projects are acquired by direct marketing by the local office and only 30% of projects acquired by strategic alliances. As shown in figure 5, most of the clients are from UK, Europe and US countries to improve AI in software sector, they should move towards strategic alliances rather than direct marketing.

Training plays important factor for success of any technology. However, overwhelming 85% of the responders were in the view that Sri Lanka does not have adequate training for professionals to learn new AI technologies.

Figure 15 shows that industry wise whether they have adequate training.
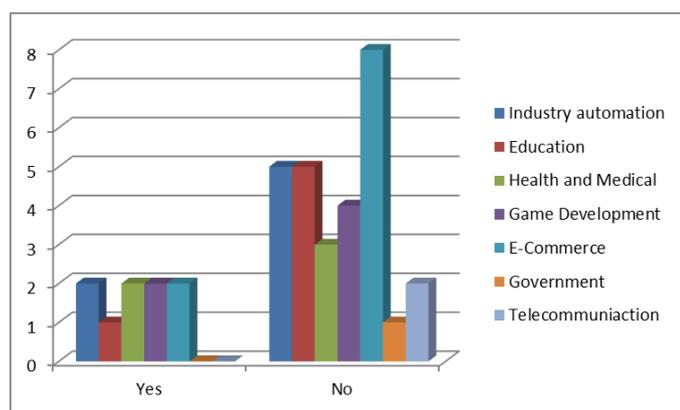

Figure 15: Industry Wise Academic Knowledge

Across all the industries, all the responders were in the view that training is not adequate.

Academic knowledge is an important factor in AI technology. Most of the responders are in the view that AI professionals does not have sufficient academic background. In fact, over 70% says AI professionals do not have academic knowledge in AI.

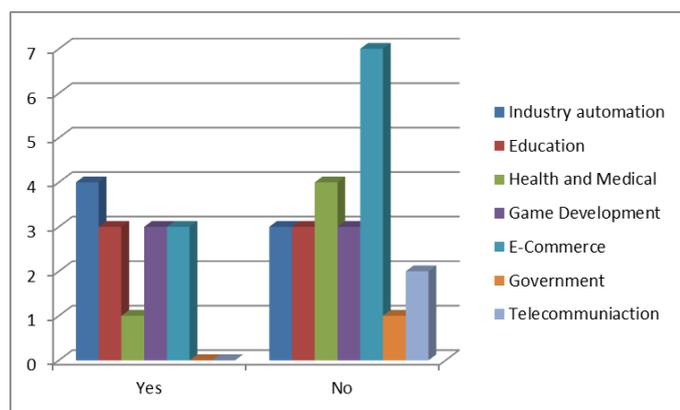Figure 16 shows that industry wise academic requirement.

Figure 16: Industry Wise Academic Knowledge

It is clear that e-commerce sector needs more training with respect to AI techniques. However, in the industry of automation, marginally more responders believe that they have more acedamic knowledge.

It is very important to understand the responders view of the future of the AI technoliges in Sri Lankan software industry.
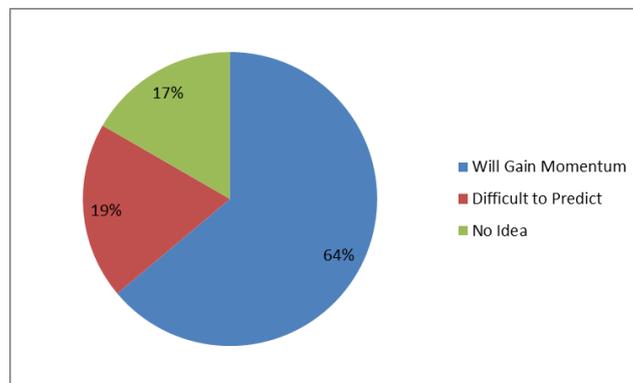

Figure 17: Future of AI Technologies in Sri Lanka

It is important to reveal that more than 60% were in the view that AI will gain momentum in future. This is an influencial factor to improve AI techniques in Sri Lanka.

Perception about AI industry is also a slightly concerned factor to implement AI in software industry in Sri Lanka. However, 60% of responders are in the fear that how people will use the AI technologies. That perception will have a negative impact on improving AI usage in Sri Lankan software industry. Research done on Software Implementation Failures in Sri Lanka in 2006 indicates that 60% of software failures due to transition issues during the software implementations [4]. Since AI is a new technology, AI software implementers may face more difficulties during the transition phase of the projects.

VII. RECOMMENDATIONS

Though the proper research was not done on the recommendations, as a byproduct of this research, it was decided to comeup with few recommendations.

- Organizations like SLAAI can improve the awareness in AI in Software industry. Since 85% percent of IT export workers as shown in figure 7, are graduates, this would not be an impossible task.

- To improve the awareness, acedemic and training , universities and SLAAI should conduct more trainings and workshops. Also, universities should conduct short courses targeting the industry.

VIII. FUTURE WORKS

- More data should be collected from academic sector since the responses for the education survey were not appealing.

In case survey method is not working, interviews should be carried out to collect the data.

- Further analysis should be done for the AI projects which are already implemented. By analyzing them, we can find out what are the problems they encountered during the life cycle of development. Since those projects have gone through the entire process of software development like requirement gathering, design, development, quality assurance, implementation and support.

- More data should be collected so that comprehensive analysis can be done. Since this research has used data for 2010 of IT export industry, it would be much better to analyze the data with the latest data at least in the year 2013.

- Results of this research would be helpful to figure out the areas to be improve AI and how AI can be implemented in Sri Lanka.

IX. CONCLUSION

Small-scale companies have much support/sponsorship to AI than to Large and Enterprise companies. Apart from data warehousing and data mining most of the other AI techniques are not much popular among AI software developing companies. Even in the education sector, data mining is the most popular area of research among academic professionals. AI awareness is a very much needed to improve the AI in the software industry. Though SLAAI has mandate to improve the awareness, SLAAI is not much popular among the IT professionals. As per now, academic and training are not enough for to improve the AI technologies in Sri Lanka.

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