Abstract - The modern world has seen Information Technology being used in most of the business areas. The Enterprise Resource Planning (ERP) systems are typically the largest, most complex, and most challenging information systems implemented by firms, representing a significant departure from the individual and departmental information systems prevalent in the past by integrating the key functions and assisting better and timely decision making. While many private organizations have successfully taken advantage of these new technologies to develop enterprise-wide information systems that reduce costs and improve performance, public sectors in most of the developing countries still lag far behind when compared with developed countries. Defence organizations of Sri Lanka, which is one of the largest components of government of Sri Lanka with an annual budget around 200 billion Sri Lankan Rupees, still relies on manual procedures and methods that are error prone and redundant and do not provide the enterprise visibility necessary to make sound management decisions.

Selecting the most suitable ERP product is crucial for the success of ERP implementation. In this study, Open Source ERP systems and proprietary ERP systems are critically evaluated in order to determine the best applicability for the defence sector in developing countries. Transformation of defence organisations into business entities is the way forward considering the Sri Lankan post war scenario, while achieving to be digital organizations from paper based with emphasis on appropriate product, technology, affordability, flexibility, and long term sustainability with the importance multi-disciplinary approach and it will give the necessary efficiency and effectiveness in overall aspects.

Keywords - Defence Sector, ERP Systems, Information Systems, Open Source and Proprietary Systems, Defence Business

1. INTRODUCTION

ERP systems and the defence sector of a country may seem topics so unrelated. Nevertheless, taken together they can become a force which could save millions of public money and could take the defence sector to the next level. This statement may seem unrealistic and impractical. The interdisciplinary research such as this study requires broad understanding on areas of defence sector, ERP, IT, MIS, Business processes, economics and sociology thus these researches has a big potential of being beneficial to the industries at large.

Most of the manufacturing oriented organizations in the globe have moved on with implementing ERP systems, and some of them are reaping benefits. The ERP systems are typically the largest, most complex, and most challenging information systems (IS) implemented by firms, representing a significant departure from the individual and departmental ISs prevalent in the past. Other than manufacturing organizations several other organizations also have moved on however service organizations yet to understand the full potential and the main reason behind this is the lack of knowledge and understanding about
the benefits of an ERP system to such organizations [1].

Defence Sector is one of the most recent areas to move in to ERP systems. The potential of ERP systems in defence industries was not thought of till around 2005. The main reason for this delay was that ERP benefits were not derived for the defence sector, which has severe deviations in operations when compared with regular manufacturing and service organizations. However some leading ERP vendors have come up with customized ERP systems to best suite the defence sectors [2-5]. In some countries defence organisations have opted to implement ERP systems to assist the military operations, especially the control and management of logistics.

The ERP systems which are especially geared to serve the defence sector support the wide-ranging requirements of current military operations and they assist with all aspects of defence transformation projects including strategy, operations, organization, change management and information technology. The defence sector focused ERP systems cover three specialty areas which are transformation of military business, military business ICT and defence outsourcing [6]. The 21st century defence organisations have strong bonds with suppliers, service agencies, government agencies and clients. So the defence ERP solutions help defence organizations and supporting defence agencies connect with each other for real time information.

The systems provide centralized information, planning and resourcing capabilities across the different services to support effective joint operations and effective management of projects involving large-scale change transformation [7]. The similarities have given way for a new thinking and finally have resulted in several attempts to implement an ERP system in defence sector. The US Department of Defence has launched the largest ERP implementation project linking all the services and several other countries have followed [8].

2. ERP SYSTEMS

Enterprise resource planning systems integrate internal and external management information across an entire organization, embracing finance, accounting, manufacturing, sales and service, customer relationship management, etc. ERP systems automate this activity with an integrated software application. The purpose is to facilitate the flow of information between all business functions inside the boundaries of the organization and manage the connections to outside stakeholders [9].

An ERP system is a business management system that comprises integrated sets of comprehensive software, which can be used to manage and integrate all the business functions within an organization with rationalized data architecture characterized by core process integration and shared product and/or customer databases [10]. Among the most important attributes of ERP are its abilities to automate and integrate business processes, enable the implementation of best business practices, share common data and practices across the entire enterprise and produce and access information in real time [11].

The term ERP originally referred to the way a large organization plans to use its organizational wide resources. Formerly, ERP systems were used in larger and more industrial types of companies [12]. However, the use of ERP has changed radically over a period of few years. Today it is used by any type of company, operating in any kind of field and of any magnitude and in any kind of industry [13].

The main aspects covered by an ERP system include Manufacturing, Financials, Human Resource, Supply chain management, Projects, Customer Relationship Management, and Data Warehouse for decision making. The ERP market is dominated by several key players such as
SAP, Oracle and Microsoft dynamics and the ERP market shows a steady growth and the current trend is that it is slowly moving towards the small and medium enterprises. There are few emerging open source ERP systems that can match the capabilities of market leading ERP systems. The most radical trend of ERP systems is that the big ERP vendors have come up with sector specific ERP systems such as health, defence, government, service, banking, higher education, and engineering/construction.

3. ECONOMIC AND SOCIAL BENEFITS OF ERP SYSTEMS

There have been so many researchers conducted about the benefits or the savings an organization can achieve with an ERP implementation. Table 1 contains a summary of several research outcomes on these benefits [14-19].

<table>
<thead>
<tr>
<th>Benefit/Savings of ERP Implementation</th>
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<tbody>
<tr>
<td>Inventory Reduction</td>
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<td>Reduction of cost of annually</td>
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<td>importing information twice</td>
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<td>IT Cost Reduction</td>
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<td>Order Management Improvement</td>
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<td>Revenue / profit increases</td>
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<td>Procurement Cost reductions</td>
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<td>Shorten the procurement cycle</td>
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<td>Productivity Improvement</td>
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<td>Financial Close Cycle Reduction</td>
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<td>Cash Management Improvement</td>
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<td>Strategic Competitive Advantage</td>
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<td>Benefit/ Saving (%)</td>
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different place with contrast of war times. The United State of American War College has done studies and has identified the role of military in post war scenario. The main tasks include deterrent of potential threats to safeguard the country, use military force and defeat internal aggression in support of civil authorities, protecting humanitarian relief workers as those representing international agencies, directly engage in humanitarian actions such as delivering humanitarian relief supplies maintaining essential services and reconstruction of damaged structures, the military must routinely work and plan in concert with civilian organizations [22].

Sri Lankan defence forces have successfully performed the above tasks and in a very short time frame they bring normalcy in war tone provinces of North and East. The government took a policy decision to deploy the defence forces for the development and reconstruction of the country. There are several large construction projects undertaken by the Army, Navy and the Air force. Even the civil defence force has contributing to the economy by producing agricultural products. In other words, Sri Lankan defence forces are slowly converting in to a production entity inside the Sri Lankan economy. Several examples would be “Ranaviru Apparels” and several major construction projects undertaken by the military including the “Defence Services College”, “Diyagama International Sports Complex”, and “Defence Headquarters Complex”.

In many countries, militaries do engaged in businesses and contribute the economy. As some case studies in 1994, the People’s Liberation Army (PLA) operated over 10,000 enterprises. The main logistics and constriction considerations were tasked to the General Logistics Department (GLD), a chief organ of the Central Military Commission. In these enterprises, profit-making is considered to be the most important internal goal. The expectation was that the PLA’s own military economy would be able to generate sufficient revenue to make up for the inability of the defence budget to fund its operations [23].

In fact, according to the ‘Guide to Complete Practical Guide to Chinese Military Finance’, hotels and guest houses operated by the PLA were to transfer 20 per cent of their profits to the GLD, while the distribution of the remaining sum is decided by the PLA that controls the businesses. The PLA also established Polytechnologies and Sanju Enterprise Group which deals primarily in pharmaceutical goods. Sanju owns approximately 34 military-affiliated enterprises and other foreign subsidiaries across the world. In 1992, the PLA also began to involve itself extensively in joint ventures which resulted in foreign capital rising to approximately 230 per cent. Military units in the Xinjiang Province were also alleged to be heavily engaged in foreign trade with various former Soviet republics. In 1994, it was estimated that the PLA’s business enterprises owned approximately 30 per cent of the service sector [24].

A similar structure can be noted in Turkey where its military businesses are wholly-controlled by the armed forces’ two foundations. OYAK (Armed Forces Pension Fund) and TSKGV (Turkish Armed Forces Foundation) are the two holding companies which effectively run the commercial enterprises of the armed forces. The foundations also own various properties which help to provide income for the armed forces. Together, they operate several companies and like the PLA, contribute a sizable amount towards the national economy [25].

In several other countries including Pakistan, Indonesia, Angola, Cambodia, Israel, Uganda and Ecuador, military firms are doing business in various dimensions. Military owned businesses are inherently risky ventures for any country because of the potential consequences. Business engagements are detrimental to the professionalism of the armed forces, as it serves as a major distraction from its core duties. One of the most harmful consequences of such practices is the
element of profit-making breeds corruption within the military [26]. The authors do not intend to further study on the question which is whether military businesses are yield the expected results or not. Actually it is a separate study that should be carried out in order to find the effectiveness and outcomes of military owned businesses. However, in post war Sri Lanka where the country is equipped with large military force capable of under taking any kind of a task, production orientated military owned businesses seems the way forward.

5. ERP SYSTEMS CATERED FOR THE DEFENCE SECTOR

Defence and security organizations face new, asymmetric threats that cross international boundaries. Operations are carried out in a multinational environment in which real-time information is crucial. Now more than ever, your entire organization, from foxhole to factory, relies on no-fail data in the right hands.

The leading international ERP vendors have customized their world leading ERP systems to match the requirements of the defence sector. It is worthwhile analyzing defence ERP systems and their features developed by world’s leading ERP vendors such as SAP, Oracle, Microsoft Dynamics and IFS. SAP has released an ERP system called “SAP-Defence and Security” which built upon the SAP core. SAP for Defence & Security solutions, provides meaningful information real time for several layers of the military command. SAP for Defence & Security offers the tools necessary to leverage any technological environment to transform enterprise and operations by providing real-time, visible, accessible information ultimately allowing critical decisions making based on real time information.

SAP came up with a mobile front end for defence in 2004 as a solution package for defense and rescue to manage and control mobile forces during training and operations, which also include all planning and logistic processes. The solution is designed to provide all required and detailed information across borders to make immediate decisions and organise them. The robust information processing and improved decision-making capabilities are the required foundation of today’s defence forces, border patrols, and emergency responders.

It provides some features which allows the soldiers in front line to assist with its key capabilities such as satellite based communication providing fast reaction time, tactical logistic operations, planning and execution for training and operations, organised management & monitoring of units and full control of personnel, equipment and logistic using a single device [27]. SAP for Defence & Security shifts military organisations into a high flexible force even during times of limited resources. Increase mission effectiveness while mitigating operational risk, managed readiness targets, despite unpredictable conditions and required materials.

Greater military supply chain transparency with secure information sharing, Superior deployments due to force planning, improved combat readiness in unpredictable conditions and more accurate measures for sustainable resource utilization are the ultimate achievements for a military organization [28]. The ERP giant Oracle claims that ten of the top ten global aerospace and defence companies depend on Oracle applications to manage their programs, maintenance and compliance initiatives of services, including US Department of Defence, US Air Force, and US.

Department of Homeland Security, and NASA drive innovation and value chain excellence using Oracle applications and technology [29]. Microsoft has come up with a defence solution built upon Microsoft Dynamics. The more familiar Microsoft front end applications will be fully compatible with
Despite several ERP implementations in military organisations around the globe, a specific case study is worth analyzing. The Department of Defence (DoD) and the military branches of USA which can be considered the world's most muscular military machine is still operating on legacy systems after a decade of modernisation by systems integrators and ERP software suppliers whose problematic implementations have gone $8 Billion over-budget. The projects were of immense proportions, seeking to replace at least 500 systems built up to 40 years ago, serving at least 450,000 users in more than 800 locations, and relying on around 400 systems interfaces [31]. The problems were related to systems interfaces, data management, and project management.

The Department of Defence had a several objectives by deploying the ERP system. Better Inventory Management, Better Financial Management and Auditability, Reduced Cycle times and to integrate combat and military systems such as Integrated Personnel and Pay System (IPPS), Global Combat Support System (GCSS), Logistics Modernization Programme (LMP), Naval Air Systems (NAVAIR), Naval Supply Systems (NAVSUP), Space and Naval Warfare Systems (SPAWAR), Naval Sea Systems (NAVSEA), Expeditionary Combat Support System (ECSS) etc. [32]

US Government Accountability Office has obtained status reports under categorization of following systems by 31st of December, 2011.

**Army**

- General Fund Enterprise Business System (GFEBS)
- Global Combat Support System Army (GCSS-Army)
- Logistics Modernization Program (LMP)
- Integrated Personnel and Pay System - Army (IPPS-A)

**Navy**

- Navy Enterprise Resource Planning System (Navy ERP)
- Global Combat Support System-Marine Corps (GCSS-MC)
- Integrated Pay and Personnel System-Navy (IPPS-Navy)

**Air Force**

- Defence Enterprise Accounting and Management System (DEAMS)
- Expeditionary Combat Support System (ECSS)
- Air Force-Integrated Personnel and Pay System (AF-IPPS)

**Defence Logistics Agency (DLA)**

- Defence Agencies Initiative (DAI)
- Enterprise Business System (EBS) The reports clearly state that complexity of the implementations has caused the schedule and budget over flows as well as lack of project management. [33] The status of the DoD ERP implementation is 12.5 years in delay and $8 Billion over budget as the Managing Director, Forensic Audits and Special Investigations, United States Government Accountability Office. [34] The reports and the technical audits report the following issues as causes for the ERP implementation debacle.

- Flexibility: Adapting private sector processes to the public sector, especially military processes that have required more code customization than anticipated. The DoD did not focus enough on the regular business functions that can be incorporated after a Business Process Reengineering.
• Integration: Integrating with existing software which an ironic problem is given that ERP vendors failed to integrate and the biggest challenge was trying to integrate military and defence systems into the ERP system.

• Complexity: Dealing with complex ERP software for configuration and customization to match complex defence and military requirements.

• Legacy: Dealing with proprietary development languages and infrastructure, this was based on legacy client/server technology. Even though most of the legacy systems were planned to be replaced, some special military applications had be integrated resulting a mismatch of technologies [35].

An example of the following diagram shows the amount of legacy military systems in US Navy alone that were to be integrated with the ERP and the DoD.

![Diagram of Legacy Systems Integration](image)

Fig 1.

The DoD had ambitious goals with their ERP system resulting the implementation to be complex that it could not properly managed [34]. Despite the mammoth ERP failure at US Department of Defence, several other military organisations have achieved completed and partial successes. Several examples will be German Defence Forces, Danish Defence Forces, Israel Defence Forces, New Zealand Defence Forces and Norwegian Defence Forces [36].

6. CONCLUSION

There are few aspects which should be looked in to when selecting the best ERP solution for the defence sector in Sri Lanka. Being a developing country, the sustainability of the ERP becomes very crucial for a successful ERP implementation and the technological aspect should match the Sri Lankan technological infrastructure. This technology and selection will be the base stone for successful ERP implementation [37].

When considering the selection between proprietary and Open Source ERP systems, the open source systems score more on sustainability for a developing country such as Sri Lanka with the omission of heavy license costs of commercial ERP vendors. Not only the financial sustainability but the technical sustainability is there is Open Source Systems since they embodies local knowledge and is adapted to local conditions [38]. There is another unseen advantage of Open Source systems, which is the ability to audit system even from the source code level. This is possible because Open Source systems allow the Source Code to be revealed providing the visibility about core of the product hence for sensitive applications of IT such as in defence organisations core auditability is crucial.

A web based ERP system would be the ideal solution for Sri Lankan defence sector with its scattered formations. The internet coverage of the island by various vendors is sufficient enough to operate a web based system [39], however the technology used should be light and simple enough to match the current bandwidth limitations. The lessons learnt from US Department of Defence illustrates the complexity of implementing an ERP for a diverse sector such as defence. The ERP implementation project may run in to huge cost and schedule overruns if not properly managed.

However, the main reason for that failure was that trying to match the processes of an ERP system which is designed and developed
to cater regular business requirements with complex military and combat processes. It is critical to identify and categorize the business functions that should be automated by the ERP, otherwise trying to automate all the functions of defence organisation including complex battle and combat functions may lead to a failure as seen in the US DoD. On the other hand the Sri Lankan military branches have become more of production and service organizations rather than combat organizations. As authors have presented military organisations can be converted to revenue generating businesses and their business operations can be optimized with an ERP system. A regular ERP system after some modifications and customizations can be opted for business oriented military with a business process reengineering.

Several implementations of systems in Sri Lankan Government sector has failed because of the “people factor”, in other words because of the resistance of the employees [40]. However, the discipline and the hierarchy of military organizations will eliminate the resistance and it will make more feasible to implement ERP systems in military organisations when compared with other government organisations.

With a successful ERP implementation Sri Lankan military branches may be able save its operational costs especially with better management and monitoring and will be able to achieve cost savings and benefits that the authors have presented in this study. So when considering the status of current operations of Sri Lankan military branches it can be said that a sustainable and suitable ERP solution is possible and the background is such that all the aspects for a successful ERP implementation are favourable and it is crucial that these kind of approaches should be multi-disciplinary.

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