

DEVELOPMENT OF SMART ACCESS AND TRACKING OF INFORMATION
RESOURCES (SMART LIBRARY) SYSTEM USING RADIO FREQUENCY
IDENTIFICATION (RFID) TECHNOLOGY

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DEDICATION

To my beloved parents for being the best gurus in my life

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ABSTRACT

In recent years, Radio Frequency IDentification (RFID) technology has become widespread automatic identification and data capture technology with huge potential in broad range of industry sectors including libraries. The main goal of this thesis is to give more visibility concerning the use of the RFID technology applied to the library environment in SIRIM Berhad. For almost a decade, SIRIM Berhad library has never failed in disseminating technical information and wealth of knowledge to its customers through the Library Management System. Limitations imposed by the system include complexity in system integration and enhancement, slower circulation rate and inefficiency in inventory identification and tracking due to the barcode system. Therefore, this thesis presents the development of an integrated Smart Library System which utilises the RFID technology with the aim of replacing current system and speeding the patron identification, material circulation and inventory tracking process, besides providing broad accessibility and efficient traceability of information. In adherence to the software engineering discipline, the Smart Library System is developed according to the Software Development Process defined in the organisation Quality Management System (ISO 9001:2000). This thesis focuses on the Object-Oriented method aided with Unified Modelling Language (UML). Substantial findings on salient characteristics of RFID are presented to incorporate the technology in the system development. The results of this thesis not only demonstrate a successful integration of RFID technology in library environment to promote improvement in service within the libraries, it also delivers required documentations according to DOD-STD-2167A standard. In conclusion, the thesis achieves its objectives to consistently apply software engineering practice in delivering the system that complies with the organisation's needs besides producing documentations that meet the selected standard.

ABSTRAK

Teknologi Identifikasi berasaskan Frekuensi Radio (atau RFID) telah berkembang sebagai teknologi identifikasi dan pengambilan data yang berpotensi besar di dalam pelbagai ruang sektor industri termasuk perpustakaan. Matlamat utama tesis ini adalah untuk memberi gambaran luas tentang penggunaan teknologi RFID yang diaplikasikan ke atas perkhidmatan perpustakaan di SIRIM Berhad. Lebih daripada satu dekad, perpustakaan di SIRIM Berhad tidak pernah gagal di dalam menawarkan maklumat teknikal dan ilmu pengetahuan kepada pelanggan melalui Sistem Pengurusan Perpustakaan. Masalah yang dihadapi oleh sistem tersebut meliputi kerumitan dalam integrasi sistem, kelambatan kadar pengedaran dan masalah penjejakan inventori menggunakan sistem barkod. Justeru itu, tesis ini membentangkan pembangunan Sistem Perpustakaan Pintar yang bersepadu dengan teknologi RFID untuk menggantikan sistem sedia ada bagi mempercepatkan pengenalan pengguna perpustakaan, pengedaran dan pencarian inventori, serta meluaskan akses dan penjejakan maklumat secara efisien. Berasaskan disiplin kejuruteraan perisian, sistem dibangunkan mengikut Proses Pembangunan Perisian yang ditetapkan oleh organisasi berdasarkan Sistem Pengurusan Kualiti (ISO 9001:2000). Tesis ini memfokuskan kepada pendekatan *Object-Oriented* serta dibantu oleh penggunaan *Unified Modelling Language* (UML). Pelbagai ciri-ciri teknologi RFID dibentangkan bagi melaksanakan teknologi ini di dalam pembangunan system. Hasil tesis ini bukan hanya mempamer kejayaan melaksanakan integrasi teknologi RFID dengan persekitaraan perpustakaan bagi meningkatkan mutu perkhidmatan, ia juga menghasilkan dokumen projek berteraskan standard DOD-STD-2167A. Kesimpulannya, tesis ini menepati objektif untuk mematuhi kejuruteraan perisian secara konsisten di dalam pembangunan sistem yang menepati keperluan organisasi, di samping menghasilkan dokumen sejajar dengan standard yang dikenalpasti.

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LIST OF ABBREVIATIONS

AMTC	-	Advanced Manufacturing Technology Centre
DoD	-	Department of Defense of the United States
DOD-STD-2167A	-	Defense System Software Development, 1988
EPC	-	Electronic Product Code
Gen2	-	Generation Class 2
HF	-	High Frequency
ISO	-	International Standards Organisation
OOAD	-	Object-Oriented Analysis and Design
RFID	-	Radio Frequency Identification
SDD	-	Software Design Document
SRS	-	Software Requirements Specification
STD	-	Software Test Description
STR	-	Software Test Report
UHF	-	UltraHigh Frequency
UML	-	Unified Modelling Language

LIST OF SYMBOLS

<i>cm</i>	-	Centimetre
<i>ft</i>	-	Feet
<i>GHz</i>	-	Gigahertz
<i>KHz</i>	-	Kilohertz
<i>m</i>	-	Metre
<i>mm</i>	-	Millimetre
<i>MHz</i>	-	Megahertz

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CHAPTER 1

INTRODUCTION

1.1 Overview

As a large organisation with multi-disciplinary units, SIRIM Berhad plays a vital role in ensuring its services offered with the best quality and exceeds the customers' satisfaction. In responding to these diverse customers' and business clients' requests, the organisation constantly look forward in improving its services especially when there is inefficient process identified within the operating departments. Efficient mechanisms need to be introduced as part of cutting cost of operations and bringing added value to the organisation in the long term.

One of the services requires an attention in terms of exploitation of advances in Information and Communication Technology (ICT) is pertaining to the Intellectual Property Services, Knowledge Management and Information Resources Department. This Department involves in disseminating the latest technical information and resources to the internal organisation as well as providing services to the public and industry partners for them to compete better in the global markets. In essence, the Department's main services are related to the technical library management, intellectual property and knowledge management.

Mechanism in identifying and tracking of Department's materials and patrons currently uses older Automated Identification and Data Capturing (AIDC) technology namely barcodes. The advent of AIDC technology specifically the Radio Frequency Identification, also known as RFID, promotes better mechanism of tracking and security not only in services sector, but also in manufacturing, logistics, access control, document management and many other sectors. Being a technology frontier, the organisation intends to take a new leap and exploit this breakthrough technology to be applied to its business activities and thereafter, commercialise the local solution to the public. As a consequence, introducing the RFID technology in the SIRIM Berhad technical library environment not only promotes innovation, but also enhancing the Department's business to be more flexible and secured in the administration process. It also improves employee productivity through better utilisation of their time.

In summary, this thesis outlines the development of Smart Access and Tracking of Information Resources System (also known as Smart Library) using RFID Technology to improve the access of information resources and tracking process with the aim of broadening sharing of knowledge. In this project, Smart Library System consists of basic operations namely cataloguing, circulation, acquisition and reporting are developed with improved tracking capability via RFID technology to identify and monitor movement of library patrons and circulated materials to the rightful access.

The thesis is organised into six chapters with the first chapter introduces the overview of the thesis, company background, project background and importance of project to the targeted organisation.

The second chapter describes project objectives, scopes, deliverables and plan. This chapter ends with the project summary.

The third chapter addresses the literature review focusing on the study of the existing system and a brief overview of the proposed system. The background of RFID technology and its characteristics are also reviewed and comparisons between this technology and barcodes are listed. On top of that, similar applications offered in the market are surveyed for comparison. Software methodology and its constituents are elaborated in comprehensive manner to ensure a sound selection of the project methodology being made. By the end of the chapter, a summary of all findings are presented.

The fourth chapter emphasises on project methodology covering discussion on software development methodology, software techniques, methods, software and hardware requirements and problem solving issues.

The fifth chapter contains most of the software development work performed to achieve the outcomes. As a result, technical documentations are produced as project artefacts. The chapter ends with summarised development efforts and outputs.

The last chapter finally concludes the thesis and presents the project outcomes, challenges and future works of improvement.

1.2 Company Background

SIRIM Berhad is a wholly-owned company of the Malaysian Government under the Minister of Finance Incorporated. Registered on 15 November 1995 and in full operation as a corporate entity on 1 September 1996, and since then, it has successfully delivered its role as the national agency for industrial development. SIRIM Berhad continues to enhance its role by becoming a strategic partner to the industry through Research, Technology Transfer, Technology Incubation and Skill Development. Besides aiming to promote the development of new sources for Small Medium Enterprises (SMEs) in the quest for growth in the manufacturing, technology and services sectors, SIRIM Berhad continues to set the foundations for the second phase towards Vision 2020 and to become a key player in the broadening of Malaysia's knowledge-based economy.

SIRIM Berhad is organised into four Divisions namely; Group Corporate Division, Support Services Division, Standards and Quality Division and Research and Technology Division. Activities undertaken by the Standards and Quality Division and Research and Technology Division are supported by the Support Services Division and also the Group Corporate Division.

Advanced Manufacturing Technology Centre (AMTC) which is grouped under the Research and Technology Division of SIRIM Berhad offers a wide range of services to the industries through its three programmes comprising of Electronics and Intelligent System Development Programme (EISDP), Industrial Automation and Robotics Programme (IARP) and National CAD/CAM Programme (NCCP). Focusing on the fields of electronics and ICT, industrial automation and robotics together with CAD/CAM/CAE technologies and manufacturing systems, AMTC provides various services to the industries through contract/strategic/joint research and development, product development, system integration, technical trainings and consultancy services.

1.3 Company Structure

The company structure is illustrated in Figure 1.1, each division is broken down into departments or centres which focus on specific functions and core businesses.

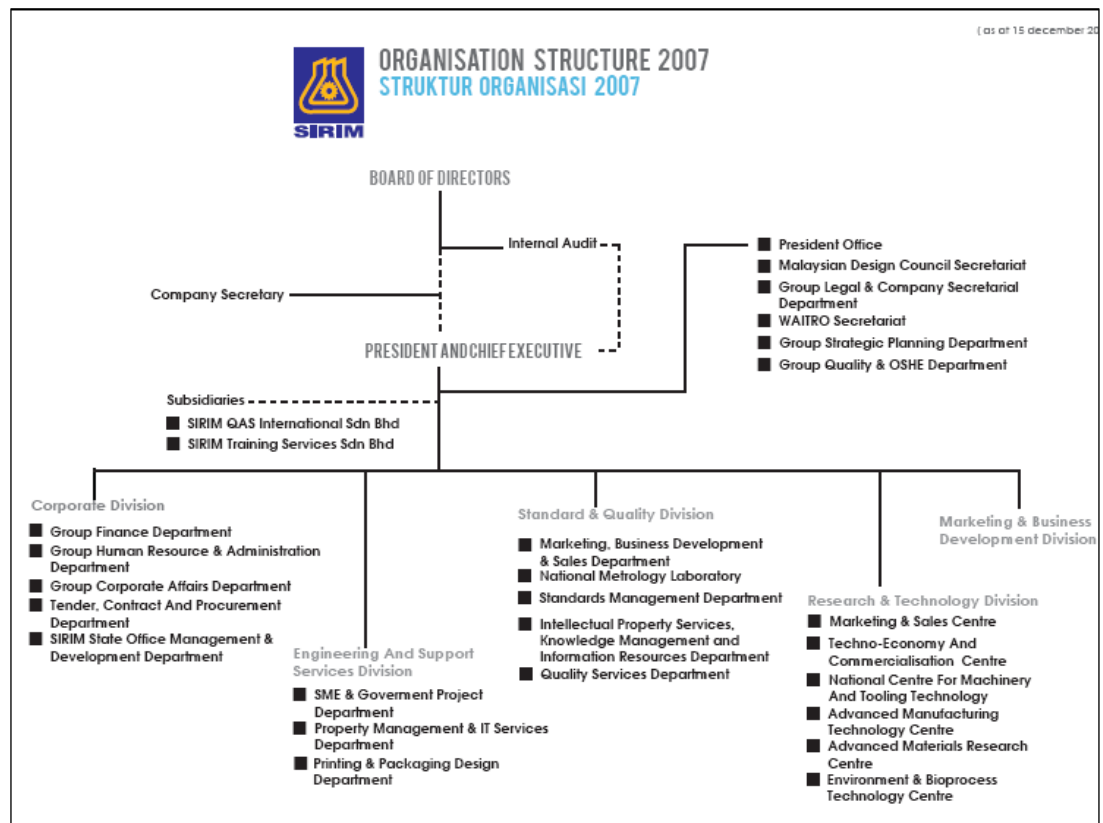


Figure 1.1: SIRIM Berhad Organisation Structure

1.4 Core Functions and Businesses

AMTC's core functions cover research and technology development activities in the aim of developing national capability in industrial and manufacturing

technology focus area specifically related to Research and Development (R&D), product development, design and prototyping, consultancy and advisory, technical support, technology transfer and dissemination through technical trainings. Its office is located in Bukit Jalil, Kuala Lumpur and it offers a variety of services to the industries through its three programmes:

1.4.1 Electronics and Intelligent System Development Programme (EISDP)

Electronics and Intelligent System Development Programme (EISDP) specialises in the design and development of hardware and software for electronics and ICT application systems. The programme assists local industries in enhancing their competitiveness through the application of the latest electronics and information technology. EISDP also promotes R&D activities on electronics and ICT-based products, processes and system design for the industries. The core expertise lies in the areas of RFID and signal processing, control and instrumentation, electronics identifications, communications and intelligent systems development.

1.4.2 Industrial Automation and Robotics Programme (IARP)

Industrial Automation and Robotics Programme (IARP) provides services in applied R&D to assist local manufacturing industries in the applications of industrial automation and its related technologies in aim of upgrading their competitiveness. The programme involves in design and development of customised automated machines, manufacturing equipments and system. IARP also provides design and development in robotics technology.

1.4.3 National CAD/CAM Programme (NCCP)

National CAD/CAM Programme (NCCP) established in 1995 by the Malaysian Government with the aim to assist industries and organisations improve their quality, productivity and competitiveness through the application of CAD/CAM/CAE and related technologies. NCCP offers R&D, consultancy and trainings in CAD/CAM modelling, rapid prototyping, reverse engineering and manufacturing systems.

1.5 Background of the Problem

SIRIM Berhad remains focused on its core business of Quality and Technology through its own main portfolios, Research and Technology and Standards and Quality. Enhancing the competitiveness of industries and protection of the consumers as well as the environment has been the mainstay of SIRIM Berhad's endeavours in the implementation of its standardisation and quality programmes.

With wide ranges of products and services in Standards and Quality business, the Intellectual Property Services, Knowledge Management and Information Resources Department (hereafter will be referred as *User Department*) provides technical information and intellectual property (IP) services for researchers, inventors, industries, IP practitioners and other professionals and business circles through various means. Among the User Department's services are as follows:

- a) Library Membership Schemes
- b) Electronic Information Retrieval
- c) Online search and download system for Malaysian Standards (MS Online)

- d) Comprehensive and updated collection of Malaysian and foreign Standards
- e) Trade-related information
- f) Patents and technical journals

As a large organisation with multi-disciplinary units, being responsive to the internal employees' and business clients' requests necessitates the User Department to manage the technical information resources in efficient manner so as to maintain wealth of knowledge for the company researchers and personnel, yet create lasting relationships with the customers and industry partners. The strategy of separating people from repetitive manual tasks is common in almost all industries to promote productivity. This same trend has been seen within libraries as the organisation seeks to find ways to shift the focus of their staff away from manual labour and towards value-adding self-circulation and inventory monitoring.

The business of running a library in SIRIM Berhad includes boosting staff effectiveness, minimizing recurrent maintenance costs as well as maximizing technology benefits. These present desires to improve customer service and add real value to the customer's visits by maximising the use of professional skills and experience. Inability to locate information leads to poor customer service levels. Delay in tracking information resources, other than causing operation delay, also result in unproductive work, which can cost the organisation. This project thus recommends using Radio Frequency Identification (RFID) technology in tracking of library technical resources and inventory in SIRIM Berhad, simultaneously replacing the existing Library Management System to be more scalable and integrated.

RFID in library is introduced to meet long term benefits to libraries in administration process, traceability and security. RFID can enhance existing barcode systems by providing additional features such as automatic check-out and return

whilst adding security against theft. RFID reduces lost books and creates savings in time spent searching for books shelved in incorrect locations.

Using RFID tags in libraries has become common nowadays. The high circulation rates make the math simple: introducing self-service for borrowers increases the efficiency significantly enough to pay back for investment in this emerging technology.

In summary, this thesis outlines the software development project for Smart Access and Tracking of Information Resources System using RFID Technology for the purpose of managing the SIRIM Berhad technical information resources with the common library processes such as administration, cataloguing, circulation and acquisition, which are regarded as valuable business to the User Department. In this project, enhancement includes tagging and tracking process to control library inventory using Radio Frequency Identification (RFID) technology.

Thus, the aim of the project is to develop Smart Access and Tracking of Information Resources System (in short, Smart Library) using RFID Technology to improve the access of library information resources and tracking process because they are known to be important assets to the organisation to bring the values to the SIRIM Berhad as a key player in the broadening of Malaysia's knowledge-based economy and yet, to ensure cost-effective and responsive to clients and customers. It is foreseen that the RFID is the right technology of choice to implement within library environment in SIRIM Berhad. No line of sight required as detection can go through the library materials. This project is not only beneficial for internal departments as a way to facilitate searching of library resources and technical documents, but it is also customised to the unique requirements in the organisation which requires seamless integration with the existing infrastructure and systems.

1.6 Importance of the Project

Although the RFID technology has been in use for the many years in the world, however in recent times, the benefits of RFID has been realised by the organisations throughout the world. The list of benefits and features afforded by an RFID system are quite impressive. They can include applications that remove human intervention completely, allowing for the changing of data in the field, operation where line of sight is not possible, and acquiring of information from multiple items at high speed, and the ability to identify items nested inside of packaging without opening the packaging. Due to this, the project will benefit the User Department by eventually replacing an existing Library Management System in terms of the added functionalities as well as incorporating advanced features such as RFID technology.

Radio Frequency Identification (RFID) provides for 'sightless' or no line of sight identification of items. It includes the ability to facilitate circulation, re-shelving, and theft detection, and it has several other important advantages. It can either replace or supplement existing library barcodes. When the costs of labour is taken into consideration for tasks such as check-out, check-in, inventory holds, lists and mis-shelved items, RFID can prove to be very efficient when compared to traditional barcodes.

It is also important due to fact that the RFID has become technology buzz whereby the essence of it can improve the process of the data capturing and identification. The technology is viewed as an enabler and a major driver of productivity and service improvement. Recent developments in hardware and software for RFID systems in the market have boosted the potential of this technology to be applied in the library automation and security.

Among Research and Development areas and initiatives of the AMTC are focused around researching, developing and implementing RFID technology and solutions in improving security and efficiency in manufacturing, government and service industries. Therefore, the project will bring values to the SIRIM Berhad in general, to hold its reputation as a technology frontier.

RFID is a form of automated data collection and it can offer unique solutions if implemented successfully. Coupled with an application, and at the same time fully utilises its incredible power, a solution can be designed that provides numerous benefits to the company; cost reduction, increased accuracy, improved workforce efficiency, streamlining business process, and improving the company's ability to execute. In the days of running supply chains leaner and at the same time more responsive, RFID in many cases provides the needed functionality to support these elusive goals.

Looking at the capacity building perspective, it is justifiable that the project will benefit the organisation to nurture local expertise in developing RFID solutions and offering seamlessly integrated and innovative local product. In the long-run, this way could alleviate dependency on imported RFID solutions and allow the country to own home-grown product and technology experts.

1.7 Chapter Summary

In summary, this chapter presents an overview of the thesis organisation, company background, project background and significance of project to the targeted organisation.

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