# ENHANCING BLOOD ORDERING MANAGEMENT OF MALAYSIAN NATIONAL BLOOD CENTRE

MOHD SHAIFUL BIN ABDUL RAHIM

UNIVERSITI TEKNOLOGI MALAYSIA

# ENHANCING BLOOD ORDERING MANAGEMENT OF MALAYSIAN NATIONAL BLOOD CENTRE

MOHD SHAIFUL BIN ABDUL RAHIM

A thesis submitted in fulfilment of the
requirements for the award of the degree of
Master of Philosophy

Faculty of Science
Universiti Teknologi Malaysia

DECEMBER 2019

**ACKNOWLEDGEMENT**

I would first like to thank my post-graduate supervisor and my boss, Prof. Dr. Mohd Shahir Shamsir Omar whose office was always open whenever I ran into a trouble spot or had a question about my research or writing. He's not only consistently allowed this paper to be my own work, but also steered me in the right the direction whenever he thought I needed it.

I would also like to acknowledge the staffs from Pusat Darah Negara who were involved in the planning and analysis of the system. Without their passionate participation and input, the development process could have not been as successful.

Finally, I must express my very profound gratitude to my parents and to my maternal family members for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. Thank you

## ABSTRACT

As the responsible blood centre of central Malaysia, Pusat Darah Negara (PDN) manages over a thousand requests from both private and government hospitals daily. Every blood request is regarded as urgent and thus, processed immediately. However due to the irregular and unpredictable status of blood stock, combined with limited shelf life of the blood products, some requests were unfulfilled. Currently, all blood requesting operations in Malaysia are managed using manual physical form and unfulfilled requests are informed by telephone and email. But, because of the high load of requests, PDN response might be delayed, therefore risking the life of patients on the receiving end. In this project, an online web-based blood requesting system in an open sourced client-server Drupal 7 Content Management System environment with features such as requesting, replying and monitoring functions is proposed for development. Studies have shown that E-health systems can be benefiting to the healthcare sector. Therefore, an electronic requesting system is hypothesized able to efficiently mediate the communication between blood centre and hospital, provide automated data reporting capability to its users, and ultimately provide a competent blood inventory management system. At the end of the System Development Life Cycle, PDN unanimously agree that the system met their requirements and completion of the project is finalized by the signing of the User Acceptance Test document. Accordingly, on the 23rd November 2016, the online web-based Malaysia's Blood Ordering System (MyBOS) officially replaced the paper-based blood ordering form to mediate blood requesting operations for central Malaysia. In a survey distributed to 27 participating hospitals, all 38 respondents agreed that the system is a definite improvement over the paper-based system and over 76.31% of the users agrees that the system's added functionality improves the overall blood management operation.

# ABSTRAK

Sebagai pusat darah bertanggungjawab di pusat Malaysia, Pusat Darah Negara (PDN) menguruskan lebih seribu permintaan daripada hospital swasta dan kerajaan setiap hari. Setiap permintaan darah dianggap sebagai kecemasan dan dengan itu, diproses dengan serta-merta. Bagaimanapun, disebabkan status stok darah yang tidak dapat diramalkan, digabungkan dengan sahlaku terhad produk darah, sesetengah permintaan tidak dipenuhi. Pada masa ini, semua permintaan darah di Malaysia diuruskan menggunakan borang fizikal secara manual dan permintaan yang tidak dipenuhi dimaklumkan melalui telefon dan e-mel. Bagaimanapun, disebabkan oleh permintaan yang tinggi, respon PDN mungkin akan tertangguh dan membahayakan nyawa pesakit. Dalam projek ini, sistem permintaan darah atas talian berasaskan web menggunakan pelayan pelanggan dalam persekitaran sumber terbuka sistem pengurusan Drupal 7, dengan ciri-ciri seperti permintaan, membalas dan pemantauan fungsi dicadangkan untuk pembangunan. Kajian telah menunjukkan bahawa sistem E-kesihatan dapat memberi manfaat kepada sektor penjagaan kesihatan. Oleh itu, sistem permintaan elektronik dijangka dapat mengantara komunikasi antara pusat darah dan hospital, menyediakan keupayaan laporan data secara automatik kepada penggunanya, dan pada akhirnya memberikan sistem pengurusan inventori darah yang kompeten. Pada penghujung Kitaran Hayat Pembangunan Sistem, PDN sebulat suara bersetuju bahawa sistem yang dibina memenuhi keperluan mereka. Sehubungan itu pada 23 November 2016, Sistem Pesanan Darah Malaysia (MyBOS) berasaskan web secara rasminya telah menggantikan borang pesanan darah berasaskan kertas untuk mengantara operasi permintaan darah di pusat Malaysia. Dalam kaji selidik yang diagihkan kepada 27 hospital yang mengambil bahagian, kesemua 38 responden bersetuju bahawa sistem tersebut adalah penambahbaikan yang ketara terhadap sistem berasaskan kertas dan lebih daripada 76.31% pengguna bersetuju bahawa fungsi tambahan sistem tersebut meningkatkan operasi pengurusan darah secara keseluruhan.

**TABLE OF CONTENTS**

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| CMS | - | Content Management System |
| CSS | - | Cascading Style Sheet |
| FTP | - | File Transfer Protocol |
| GPL | - | General Public License |
| HTML | - | Hypertext Markup Language |
| ICT | - | Information and Communication Technology |
| ISO | - | International Organization for Standardization |
| IT | - | Information Technology |
| MLT | - | Medical Laboratory Technologist |
| MyBOS | - | Malaysia's Blood Ordering System |
| NBA | - | National Blood Authority |
| OBOS | - | Online Blood Ordering System |
| OMG | - | Object Management Group |
| PDN | - | Pusat Darah Negara |
| PHP | - | Hypertext Preprocessor |
| RAD | - | Rapid Application Development |
| RBC | - | Red Blood Cell |
| SDLC | - | System Development Life Cycle |
| SOP | - | Standard Operating Procedure |
| SUS | - | System Usability Scale |
| SQL | - | Structured Query Language |
| UAT | - | User Acceptance Test |
| UML | - | Unified Modeling Language |
| URL | - | Uniform Resource Locator |
| USA | - | United States of America |
| WBC | - | White Blood Cell |
| WBS | - | Work Breakdown Structure |

## LIST OF APPENDICES

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

Blood is a precious but perishable resource of the healthcare service line which is used in blood transfusions that are performed to treat blood loss or to supply blood components that are absent in the recipient's body. Blood components differ in their shelf life, for example red blood cells may live up to 42 days outside of the human body, but in contrast platelets will expire after 5 days of collection. Considering these limitations, proper management of donated blood is vital to the healthcare community, primarily to minimize blood wastage. In 2007, Pusat Darah Negara (PDN) collected a total of 171,169 blood units, but 8986 of these are discarded. The wastage of 2.6% of the total blood unit received could come up to RM269,580 of loss. In order to reduce these wastages, the blood centre, then had to identify their causes and act accordingly through either improving donor selection, training and evaluation of the staff, in addition to implementation of automation (Morish et al., 2012).

Blood centres such as the national blood centre of Malaysia, PDN facilitate blood donations campaigns, collects, process and disseminate donor's blood and components for the use of hospitals in central region of the country. Aside from that, they also accept interns and perform training for government personals to improve the overall blood donation services in Malaysia (PDN, 2017). A blood centre operational workflow starts with the registration of donors until the dissemination of blood to hospital and patients. In the dissemination process, the donor's blood and components are diffused to the respective hospitals for their patients use. Current method of disseminating donor's blood and components in Malaysia are initiated by a physical ordering form which are filled and sent in on site or by fax. Then, the products are collected at the centre. While the paper ordering form is sufficient in managing the hospital requests and responses, it is limited to that particular process. Advancement

in the analytical approaches has proven to be able to utilize statistical data to predict demand trends, monitor stocks and decrease wastage (Osorio et al., 2015). Besides that, the digitization of the ordering form is a step forward towards complete healthcare information system software integration. Furthermore, at present a blood centre such as PDN processes over a thousand requests from more than 20 hospitals every day. An online system could very likely result in an increase in the efficiency of the total operation (Blaya et al., 2010). Online blood ordering system (OBOS) would assist both the blood centre officers and hospital representatives in requesting and approving the blood orders. OBOS emergency blood order or special blood components order is an asset to the blood service (Thomas et al., 2016).

Presently, online web-based blood ordering system has been utilized by most countries around the world including Thailand, Singapore, Australia, India, China, United States of America and United Kingdom. In the development process of a software system such as the OBOS, stakeholders' participation has been reported to have a vital role in the success of the project. Aside from development models, there are also several approaches in designing a web system such as OBOS which includes complete scripting using web or text editor or using a standalone desktop web compiler and online compiler, however open sourced Content Management System (CMS) concept is the best cost-effective approach because of its expendability and wide range of free libraries (Borisov et al., 2018). In brief, by utilizing CMS as the framework, a cost-effective web system such as OBOS can be developed to improve the blood stock management in blood centres.

## 1.2 Aim

The aim of this research project is to improve the overall method of blood ordering in blood centres using a cost-effective open sourced web-based blood ordering system by studying and understanding the functionality and user requirement of the system development. From the study of blood ordering operation requirements, a complete blueprint and an online web blood ordering system would be developed

and recorded to satisfy the objective of enhancing the blood ordering management of PDN cost effectively.

## 1.3 Problem Statement

The existing process of requesting donor's blood from the National Blood Centre in central Malaysia is a 'paper and ink'-form based operation which is inefficient and insufficient in terms of productivity and function. Specifically, the manual process of blood request lacks the ability to respond to client and inefficient in terms of statistical data collection method. The inability to communicate wirelessly with hospitals causes problems such as delayed request replies, delayed product acquisition, time wastage and confusion related with the request modification. Currently, telephony communications are used to avoid these complications, however with the rapidly increasing requests every year, it is becoming increasingly difficult for the blood centre's officers to manage. Automated and digital technology could be used to manage the orders, but unfortunately, these methods involve large funds which are scarce in institutions that manages voluntary non-remunerated blood donor. Recent statistical data shows that there is a significant increase in the demand for IT in the market (Omelyanenko *et al.*, 2018). The annual spending for IT globally increased from $2.65 trillion in 2005 to $3.83 trillion in 2013, in which $922 billion going to IT services and some $300 billion on corporate software (Babenko *et al.*, 2019). Most importantly, unless these issues are circumvented they may even endanger the life of the receiving patient that requires the blood for transfusion. Apart from that, the use physical ordering form means that the collection of raw statistical data is performed manually by a direct form inspection which is both time consuming and susceptible to clerical errors. Additionally, the paper forms require large physical storage space considering the number of requests the blood centre receives on daily basis.

## 1.4 Research Goal

The goal of the research is to enhance the blood ordering management using a cost-effective online web-based framework system.

### 1.4.1 Research Objectives

The objectives of the research are:

1. To identify and understand functional and non-functional requirements
2. To analyse and design diagrams based on the identified system requirements
3. To implement the designs and create an online web-based blood ordering system

## 1.5 Research Scope

The scope of the research can be classified into two different categories which is the complete System Development Life Cycle (SDLC) and the developed system. The SDLC will be based on Rapid Application Development Prototyping methodology which will be described in Chapter Three. In the technical architectural aspect, a comprehensive blood ordering system will be developed in a web client-server architecture; a two-way communication between an end-user device with a database server. Functionally, the system's function is limited to the three user roles determined in the requirements based on the physical request form's normal procedures and within the limits of the available materials and software.

## 1.6 Research Significance

The proposed system will be useful for the improvement of the donor's blood ordering operation which would

1. Increase the communication quality from blood centre to hospital and subsequently reduce the need to use telephony communication for requesting and replying purpose.
2. Hospitals can reduce the cost on transportation of the orders.
3. Eases the requirement of large space for the physical form storage.

## 1.7 Thesis Structure and Organization

The contents of the thesis are organized into five chapters that mainly consist of literature reviews related to the project and the processes executed throughout the development of the system. The five chapters mentioned are, the introduction, literature review, research methodology, results and discussion and lastly, conclusion and future work. Thesis is structured in a way, which first introduces the reader of the project outlines and followed by literature evidence to outline the purpose the research and provide evidence of its importance. Next, methodology chapter lists out and describes processes that were conducted to produce the data and the accepted system.

## 1.8 Thesis Structure and Organization

This chapter introduces the research collaborator and research background as well as the aim and purpose for an online blood ordering system. One main objective with three minor objectives were set to solve the problem statement of the study. The scope of the study is confounded to documenting the system development and final resulted system product. The next chapter will elaborate on findings in literature review conducted throughout the study.

## REFERENCES


Abdelmaboud, A., Elsafi, A., Ismal, A. O. A., Eisa, T. A. E., and Ibrahim, A. O. (2019, 3-4 April 2019). Identification of stakeholder's roles in cloud environment: A Survey. Paper presented at the *2019 International Conference on Computer and Information Sciences (ICCIS)*, 1-5.

Abomhara, M., and Lazrag, M. B. (2016, 14-16 Sept. 2016). UML/OCL-based modeling of work-based access control policies for collaborative healthcare systems. Paper presented at the *2016 IEEE 18th International Conference on e-Health Networking*, Applications and Services (Healthcom), 1-6.

Alperowitz, L., Weintraud, A. M., Kofler, S. C., and Bruegge, B. (2017, 22-22 May 2017). Continuous Prototyping. Paper presented at the *2017 IEEE/ACM 3rd International Workshop on Rapid Continuous Software Engineering (RCoSE)*, 36-42.

Alshamrani, A., and Bahattab, A. (2015). A comparison between three SDLC models waterfall model, spiral model, and Incremental/Iterative model. *International Journal of Computer Science Issues (IJCSI)*, 12(1), 106.

Altamony, H., Al-Salti, Z., Gharaibeh, A., and Elyas, T. (2016). The relationship between change management strategy and successful enterprise resource planning (ERP) implementations: A theoretical perspective. *International Journal of Business Management and Economic Research*, 7(4), 690-703.

Amrein, K., Valentin, A., Lanzer, G., and Drexler, C. (2012). Adverse events and safety issues in blood donation—A comprehensive review. *Blood reviews*, 26(1), 33-42.

Andreasen, M. S., Nielsen, H. V., Schrøder, S. O., and Stage, J. (2015). Usability in open source software development: Opinions and practice. *Information technology and control*, 35(3).

Anjum, R., Azam, F., Anwar, M. W., and Amjad, A. (2019). A Meta-Model to Automatically Generate Evolutionary Prototypes from Software Requirements. Paper presented at the *Proceedings of the 2019 7th International Conference on Computer and Communications Management*.

Anwar, F., and Razali, R. (2015). A practical guideline of selecting stakeholders for requirements elicitation - An empirical study. *International Journal of Software Engineering and its Applications*, 9, 95-106.

Atinuke, F. F., Adebola, S. W., and Rachael, K. T. (2015). Blood Wastage Rate in a Sub-Saharan African Hospital Based Blood Bank.

Babenko, V., Lomovskykh, L., Oriekhova, A., Korchynska, L., Krutko, M., and Koniaieva, Y. (2019). Features of methods and models in risk management of IT projects. *Periodicals of Engineering and Natural Sciences*, 7(2), 629-636.

Balaji, S., and Murugaiyan, M. S. (2012). Waterfall vs. V-Model vs. Agile: A comparative study on SDLC. *International Journal of Information Technology and Business Management*, 2(1), 26-30.

Borisov, A., #252, Sieck, r., Ashikoto, L., Kamenye, G., Mwenyo, J., et al. (2018). Development of an efficient, cost-reducing content management system for augmented reality applications. Paper presented at the *Proceedings of the Second African Conference for Human Computer Interaction: Thriving Communities*.

Briones, R. L., Kuch, B., Liu, B. F., and Jin, Y. (2011). Keeping up with the digital age: How the American Red Cross uses social media to build relationships. *Public Relations Review*, 37(1), 37-43.

Brooke, J. (1996). SUS-A quick and dirty usability scale. Usability evaluation in industry, 189(194), 4-7.

BuiltWith. (2017). CMS Usage Distribution in the Top 1 Million Sites.

Caro, J. L., Guevara, A., and Aguayo, A. (2003). Workflow: a solution for cooperative information system development. *Business Process Management Journal*, 9(2), 208-220.

Chang, S. H., Chiang, R. D., Wu, S. J., and Chang, W. T. (2016). A Context-Aware, Interactive M-Health System for Diabetics. *IT Professional*, 18(3), 14-22.

Chowdhury, F. S., Siddiqui, M. A. E., Islam, K., Nasreen, Z., Begum, H. A., and Begum, H. A. (2015). Use of Blood and Blood Components In Dhaka Medical College Hospital. 2015, 26(1), 7.

Coleman, A., and Akinsola, O. S. (2012). Effective Blood Distribution in Rural Hospitals through ICT Service Oriented Architecture (SOA) Framework: A Case Study in Rural Hospitals in South Africa. *Studies On Ethno-Medicine*, 6(3), 141-147.

Davey, R. J. (2006). The blood centre as a community health resource. *Vox sanguinis*, 91(3), 206-213.

Deeba, F., Kun, S., Shaikh, M., Dharejo, F. A., Hayat, S., and Suwansrikham, P. (2018, 20-22 April 2018). Data transformation of UML diagram by using model driven architecture. Paper presented at the *2018 IEEE 3rd International Conference on Cloud Computing and Big Data Analysis (ICCCBDA)*, 300-303.

Delen, D., Erraguntla, M., Mayer, R., and Wu, C.-N. (2011). Better management of blood supply-chain with GIS-based analytics (Vol. 185).

Dennis, A. (2012). Systems Analysis and Design: *Wiley Publishing*.

DesRoches, C. M., Charles, D., Furukawa, M. F., and et al. (2013). Adoption of electronic health records grows rapidly, but fewer than half of US hospitals had at least a basic system in 2012. *Health Aff (Millwood)*, 32, 1478-1485.

Devine, D. V., and Serrano, K. (2012). Preparation of blood products for transfusion: Is there a best method? *Biologicals*, 40(3), 187-190.

Dogether, M. A., Muallem, Y. A., Househ, M., Saddik, B., and Khalifa, M. (2016). The impact of automating laboratory request forms on the quality of healthcare services. *Journal of Infection and Public Health*, 9(6), 749-756.

Duan, Q., and Liao, T. W. (2013). A new age-based replenishment policy for supply chain inventory optimization of highly perishable products. *International Journal of Production Economics*, 145(2), 658-671.

Elijido-Ten, E., Kloot, L., and Clarkson, P. (2010). Extending the application of stakeholder influence strategies to environmental disclosures: An exploratory study from a developing country. *Accounting, Auditing & Accountability Journal*, 23(8), 1032-1059.

Fahimnia, B., Jabbarzadeh, A., Ghavamifar, A., and Bell, M. (2017). Supply chain design for efficient and effective blood supply in disasters. *International Journal of Production Economics*, 183, 700-709.

Farcas, E., Farcas, C., and Krüger, I. (2014). Chapter 12 - Successful CyberInfrastructures for E-Health. In Economics-Driven Software Architecture (pp. 259-295). *Boston: Morgan Kaufmann*.

Federal Drug Agency. (2003).

Fennell, C. M. (2007). Content Management and Web 2.0 with Drupal. *Medical Reference Services Quarterly*, 26(sup1), 143-167.

George, P. E., Vidal, J., and Garcia, P. J. (2016). An Analysis of and Recommendations for the Peruvian Blood Collection and Transfusion System. *J Epidemiol Public Health Rev*, 1(3).

Ghapanchi, A. H., Wohlin, C., and Aurum, A. (2014). Resources contributing to gaining competitive advantage for open source software projects: An application of resource-based theory. *International Journal of Project Management*, 32(1), 139-152.

Gordon, V. S., and Bieman, J. M. (1995). Rapid Prototyping: Lessons Learned. *IEEE Softw*., 12(1), 85-95.

Gunpinar, S., and Centeno, G. (2015). Stochastic integer programming models for reducing wastages and shortages of blood products at hospitals. *Computers & Operations Research*, 54, 129-141.

Guo, N., Wang, J., Ness, P., Yao, F., Bi, X., Li, J., et al. (2012). First-time donors responding to a national disaster may be an untapped resource for the blood centre. *Vox sanguinis*, 102(4), 338-344.

Gupte, S. C. (2015). Automation in Blood Centre: Its impact on Blood Safety. *Asian Journal of Transfusion Science*, 9(Suppl 1), S6-S10.

Health Science Agency. (2017). Apheresis Donation.

Hunt, J., Gibson, R., Whittington, J., Powell, K., Wozney, B., and Knudson, S. (2015). Guide for Developing an Information Technology Investment Road Map for Population Health Management. *Population health management*, 18.

Hurst, J. (2014). Comparing Software Development Life Cycles. *SANNS Software Security*.

Hussain, S. N., Hundewale, N., Aljahdali, S., and Ahmed, K. A. (2012, 22-24 June 2012). A methodology for the abstraction of design components from the software requirement specification to the object oriented system. *Paper presented at the 2012 IEEE International Conference on Computer Science and Automation Engineering*, 311-315.

Islam, A. S., Ahmed, N., Hasan, K., and Jubayer, M. (2013). mHealth: Blood donation service in Bangladesh. Paper presented at the Informatics, Electronics & Vision (ICIEV), *2013 International Conference on Informatics, Electronics & Vision*, 1-6.

Jabbarzadeh, A., Fahimnia, B., and Seuring, S. (2014). Dynamic supply chain network design for the supply of blood in disasters: A robust model with real world

application. *Transportation Research Part E: Logistics and Transportation Review*, 70(0), 225-244.

Leau, Y. B., Loo, W. K., Tham, W. Y., and Tan, S. F. (2012). Software development life cycle AGILE vs traditional approaches. Paper presented at *the International Conference on Information and Network Technology*, 162-167.

Lopez, C. G. (2010). History and Challanges of Blood Transfusion Services in Malaysia.

Mair, F. S., May, C., O'Donnell, C., Finch, T., Sullivan, F., and Murray, E. (2012). Factors that promote or inhibit the implementation of e-health systems: an explanatory systematic review. *Bulletin of the World Health Organization*, 90(5), 357-364.

Mening, R. (2017). WordPress vs Joomla vs Drupal. Pridobljeno 22. 9. 2017 na: *https://websitesetup. org/cms-comparison-wordpress-vs-joomladrupal.*

Mirdha, A., Jain, A., and Shah, K. (2014, 18-20 Dec. 2014). Comparative analysis of open source content management systems. Paper presented at the *2014 IEEE International Conference on Computational Intelligence and Computing Research*, 1-4.

Mohylnytskiy, V. (2016). Content management system. Перспективи розвитку професійно спрямованих мовних компетенцій в сучасній науці: збірник матеріалів Міжнародної науково-практичної конференції для студентів немовних спеціальностей: Житомир, 13 квітня 2016 р./за заг. ред. НМ Андрійчук, 97-99.

Nagurney, A., Masoumi, A. H., and Yu, M. (2012). Supply chain network operations management of a blood banking system with cost and risk minimization. *Computational Management Science*, 9(2), 205-231.

Navarro, P. L. M., Pérez, G. M., and Ruiz, D. S. (2016). A Script-Based Prototyping Framework to Boost Agile-UX Developments. *Journal of Computer Science and Technology*, 31(6), 1246-1261.

Omelyanenko, V., Semenets-Orlova, I., Khomeriki, O., Lyasota, L., and Medviedieva, Y. (2018). Technology transfer management culture (education-based approach). *Problems and Perspectives in Management*, 16, 454-463.

Ouhbi, S., Fernández-Alemán, J. L., Toval, A., Idri, A., and Pozo, J. R. (2015). Free Blood Donation Mobile Applications. *Journal of medical systems*, 39(5), 1-20.

Patil, R., Poi, M., Pawar, P., Patil, T., and Ghuse, N. (2015, 8-10 Oct. 2015). Blood donor's safety using data mining. Paper presented at the *2015 International Conference on Green Computing and Internet of Things (ICGCIoT)*, 500-505.

Pusat Darah Negara. (2017). Pengenalan Pusat Darah Negara (PDN).

Raghavan, N., and Ravikumar, S. (2015). Content Management System: Manhattan, KS: Kansas State University. Retrieved from *http://people. cis. ksu. edu/~ narayana/CIS726. pdf.*

Reay, S., Collier, G., Kennedy-Good, J., Old, A., Douglas, R., and Bill, A. (2016). Designing the future of healthcare together: prototyping a hospital co-design space. CoDesign, 1-18.

Regan, F., and Gabriel, I. (2014). Blood groups, blood components and alternatives to transfusion. *Atlas of Clinical Nuclear Medicine*, 1253.

Ricciardi, L., Mostashari, F., Murphy, J., Daniel, J. G., and Siminerio, E. P. (2013). A national action plan to support consumer engagement via e-health. *Health Affairs*, 32(2), 376-384.

Roberts, J. P., Fisher, T. R., Trowbridge, M. J., and Bent, C. (2016). A design thinking framework for healthcare management and innovation. *Healthcare*, 4(1), 11-14.

Sánchez, A. B., Segura, S., Parejo, J., and Ruiz-Cortés, A. (2015). Variability Testing in the Wild: The Drupal Case Study.

Sharma, N. A., and Kurhekar, P. P. (2013). Content Management System. *International Journal of Innovative Research and Development*|| ISSN 2278–0211, 2(12).

Shi, L., Wang, J.-X., Stevens, L., Ness, P., and Shan, H. (2014). Blood safety and availability: continuing challenges in China's blood banking system. *Transfusion*, 54(2), 471-482.

Tomlinson, T. (2015). Anatomy of a Module. In Beginning Drupal 8 (pp. 141-145). *Berkeley, CA: Apress*.

Tomlinson, T. (2017). Creating Modules for Drupal 8. In Enterprise Drupal 8 Development: For Advanced Projects and Large Development Teams (pp. 45-87). *Berkeley, CA: Apress*.

Usman, M., Soomro, T. R., and Brohi, M. N. (2014). Embedding project management into XP, SCRUM and RUP. *European Scientific Journal*, 10(15).

Wattanagul, N., and Limpiyakorn, Y. (2016, 23-26 May 2016). Automated Documentation for Rapid Prototyping. Paper presented at the *2016 International Conference on Industrial Engineering, Management Science and Application (ICIMSA)*, 1-4.

Williamson, L. M., and Devine, D. V. (2013). Challenges in the management of the blood supply. *The Lancet*, 381(9880), 1866-1875.

Yates, N., Stanger, S., Wilding, R., and Cotton, S. (2017). Approaches to assessing and minimizing blood wastage in the hospital and blood supply chain. *ISBT Science Series*, 12(1), 91-98.

Yu, W. D., and Ong, C. H. (2009, 21-23 Oct. 2009). A SOA Based Software Engineering Design Approach in Service Engineering. Paper presented at the *2009 IEEE International Conference on e-Business Engineering*, 409-416.

Zhang, Y., and Wildemuth, B. M. (2009). Unstructured interviews. Applications of social research methods to questions in information and library science, 222-231.

Zhu M, Hu HY, Wang J, and Zheng ZW. (2014). A Vague Set Based Model for Regional Blood Supply and Demand Balance Adjustment. *Journal of Biomimetics Biomaterials and Tissue Engineering*(19:122).

Zink, L., Hostetter, R., Böhmer, A. I., Lindemann, U., and Knoll, A. (2017, 27-29 June 2017). The use of prototypes within agile product development explorative case study of a Makeathon. Paper presented at the *2017 International Conference on Engineering, Technology and Innovation (ICE/ITMC)*, 68-77.

## LIST OF PUBLICATIONS

Rahim, M. S. (2017). Transferring Knowledge to Enhance Pusat Darah Negara Capabilities Using Online Blood Ordering System. *Paper presented at the 4th National Conference on Knowledge Transfer*.

Rahim, M. S. (2016). Chapter 7: Utilizing Drupal Content Management System for Digitizing Healthcare-related Forms. *Penerbit UTM Press*.

I, Z., N.A, A., M.A.R, S., T, S., Azman, S., and Shamsir, S. (2014). Izoo Mobile: Mobile Application For Mobile Assisted Malaysia Fauna Database Izoo. *Jurnal Teknologi, 71*.