

A Framework for Business Process Re-engineering to reduce The Number of Processes:A Case Study of National Blood Transfusion Services

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Abstract— Blood Donation and Blood Transfusion Services play a vital role in saving people’s lives. The blood donation process usually consumes a lot of time and effort from both donors and medical staff since there is no concrete and precise information system that allows donors and blood donation centers to communicate efficiently and coordinate with each other to minimize the time and effort required for the blood donation process. Besides, most blood banks work in isolation and are not integrated with other blood donation centers, which affect and degrade the quality of overall blood donation and blood transfusion services. This work aims at developing a standard framework named as “One Blood” based on business process re-engineering concepts, cloud storage services, and web application development technologies. This paper comprehensively describes the conceptual framework based on a case study of National Blood Transfusion Services in Sri Lanka. As a result, several pitfalls, highly critical processes, and points of failure were identified, which needs to be redefined. Improving the workflows and organizing the processes was conducted by the application of BPR concepts followed by the proposed framework. To further amplify the application of BPR two additional verticals namely Process Re-Organization and Radical Redesign was aligned with the Process Re-engineering phase. Process Re-Organization performs the comparing and contrasting of manual and systematic approaches while Radical Redesign enables the chance to leverage IT related technologies to achieve integration and automation of processes. The outcome of this research was presented as a cloud-based centralized web solution for the NBTS using the One Blood System by the integration of all of these concepts and technologies.

Keywords—component; Blood Transfusion Services, BPR, Cloud Storage, Framework, Web Application.

I. INTRODUCTION

National Blood Bank of Sri Lanka is the head authorized party who is handling the entire centralized blood transfusion system. Apart from that as a convenient solution the administrative power is distributed amongst the different Cluster heads. The cluster is a collection of hospitals within a

selected region, and the categorization is performed based on a provincial level. Therefore, the Cluster head is acting as the responsible party which handles, manages and administers the blood transfusions bound to a single cluster. Additionally, the Cluster head would be communicating with other Cluster heads and also with the National Blood Bank of Sri Lanka in order to maintain a seamless and quality blood transfusion service[1]. Even though Sri Lanka has developed a well descriptive, centralized blood transfusion system from scratch still, it consists of several clearly identifiable breaches. The main issue is that the entire system is still managed individually by the different parties who are involved. Because of this prevailing manual system, it has led to situations where the quality of the transfusion system is degraded.

Based on the case study and by analyzing the workflows it was identified that the ideal and an inevitable solution to overcome this issue can be derived by the application of concepts and methodologies related to BPR. According to the [2] Business process re-engineering is defined as “A management approach that rethinks present practices and processes in business and its interactions. It attempts to improve underlying process efficiency by applying fundamental and radical approaches by either modifying or eliminating non-value adding activities and redeveloping the process, structure, culture”.In [3] BPR is an integrated and systematic approach, enhances analysis and re-design of the functions, workflows and structure of the organization to improve service quality and cause cost and time reduction.

Since this research suggests a whole new approach towards conducting the nation-wide blood transfusion service, a unique framework was defined to adopt and apply the techniques behind BPR. Upon the successful completion of the framework the One Blood system (Cloud Based Centralized Web Application) was implemented as the outcome.

II. RELATED WORK

Before concluding the proposed idea of a cloud-based centralized blood transfusion system, a literature survey was performed to analyze the existing systems related to the same field. The designed framework is inspired by two main sources namely the retrospective analysis of the prevailing working environment in NBTS and related BPR literature [4]. Since the absence of any local solution towards addressing the problems faced by the NBTS, the required ideas to design a descriptive framework was inspired by other existing design approaches. Following systems can be described as one of the leading bloodstock management systems available globally.

Safe Trace Transfusion Management Software System [5] which was present in the United States provides comprehensive blood stock management and delivers a complete testing and transfusion history in one consolidated record. Other than that it provides Arm –to – Arm tracking ranging from donor recruitment and collection to final transfusion and billing.

Aegis Healthcare’s Blood Bank Management System [6] which was present in INDIA is a web-based solution designed to perform various critical functionalities pertaining to the blood management. It facilitates the complete cycle from gaining blood to processing, preserving and supplying it to the hospitals. It also retrieves and analyzes data about the inventory management, administrative and clinical aspects of offering services within a blood bank.

Blood Hound Blood Tracking System[7] which was present in the United Kingdom Provides facilities to track Blood transfusions and the clinical management of Blood products. At its core is an entirely secure access and computerized audit, reporting, and stock management solution allowing for the cross-matched issue, remote issue, tailored reporting and auditing through to Transfusion bedside management, patient observations monitoring and reporting with real-time alerting and communication.

E-AIMA Blood Transfusion Management System [8] which was present in Greece manages the clinical and personal records of recipients and donors. Automates the blood, collection procedure, the blood transfusion, ordering, blood transportation, and the cover requests of other centers. It manages the workflow of the immunology department and the blood sample cross match department. Moreover, it sets aside the need to maintain books of daily performed tasks such as blood circulation, daily bloodstock, and daily transfusion requests.

Electronic Clinical Transfusion Management System [9] which was present in the United Kingdom support the automated tracking of blood products from the initial ordering of a blood transfusion for a patient, through to the taking of a

blood sample for cross matching, to the administration of a blood transfusion and subsequent updates to care records.

III. RESEARCH METHODOLOGY

This section discussed the proposed methodologies, techniques, and concepts behind the Business Process Re-Engineering, which is more specific to One Blood system. As shown in fig 1, proposed framework include four sequential phases namely Initialize phase, Analyze phase, Re-engineer phase and Implementation & Evaluation phase [10].

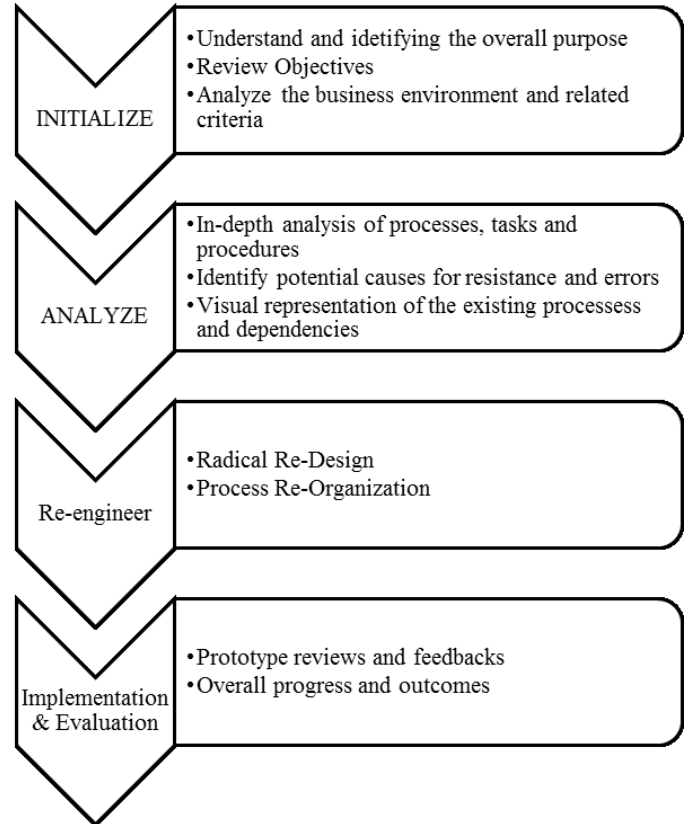


Fig. 1 BPR Framework for One Blood

A. Initiation Phase

This stage is aimed at identifying and understanding the purpose, the rationale, and the objectives of the process review (PR). This stage requires active participation from all stakeholders to document and to understand the environmental dynamics and the risks associated with the proposed reengineering process.

Initiation phase from the point of One Blood System’s perspective was carried out through several reviews and analysis of related sources including original paper reports, manuals, and forms and by interviewing several staff members and administrators at both the National Blood Bank and Local Blood Banks. Based on the studies conducted it was revealed that even though there are many possibilities to switch to a

well implemented semi-automated approach related to the workload performed associated with the National Blood Transfusion Services, still the entire processes are carried out through traditional paperwork related methods.

After observing the processes and workflows associated with the National Blood Transfusion Services, a clear understanding of the overall organizational structure and related process workflows was identified and documented. Based on these findings the complete workflow was broken down into sub-processes, and the main critical workflows was filtered out and carried towards the next phase for analyzing purposes.

B. Analyze Phase

This second stage involves an in-depth analysis of the process tasks and procedures by analyzing the function, so reviewing risks and assumptions. By identifying the potential causes of resistance and inertia and the documentation obtained from phase one, the outcome of this analysis phase is used to flowchart the process. A pictorial presentation of the current process dependencies and interdependencies is not only critical to mapping the core tasks and procedures of the process but is also foundational for the re-engineering process itself. In this phase in-depth and comprehensive analysis of the tasks and procedures involved in the prevalent National, Blood Transfusion Process was conducted. The outcome of the previous Initiation phase was considered as the Input for this phase.

As a result, the workflow structure related to the main core functionalities namely Donor Registration Process, Donations Management Process, Mobile Campaign Handling Process and Blood Inventory Management Process was illustrated regarding process diagrams. Then the issues, problems, and blunders related to the prevailing manual system were identified. Then the solutions, new features, ideas and recommendations to overcome those issues were noted down, and the results were directed towards the next phase which is the Re-Engineering phase.

C. Re-Engineering Phase

This third phase is intended to design the features and functionalities of the re-engineered process, so includes a lively participation and feedback from all appropriate personnel and its users. As the process is reformed, the flowchart outlined in phase two is updated to include a clarification of the key measurement variables. In this phase, information technology is used as an enabling and facilitating tool. Re-Engineering phase related to the One Blood system was carried out mainly focusing on two verticals namely Process Re-Organization and Radical Re-Design. Descriptive information associated with the both these verticals can be stated as follows.

1) *Process Re-Organization*: In this vertical the main objective was to introduce an updated version of the process workflow related to the prevailing methods. This phase involves comparing and contrasting the manual prevailing process against the newly introduced semi-automated approach considering both the human aspects and the system aspects [11]. This includes the outcome of the workload carried out related to the comparing and contrasting of below stated core process work flow namely Donor Registration Process, Donations Management Process, Mobile Campaign Handling and Blood Inventory Management Process

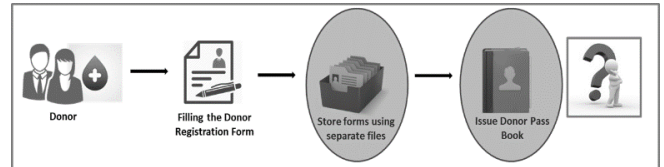


Fig. 2 Manual Work Flow - Donor Registration Process

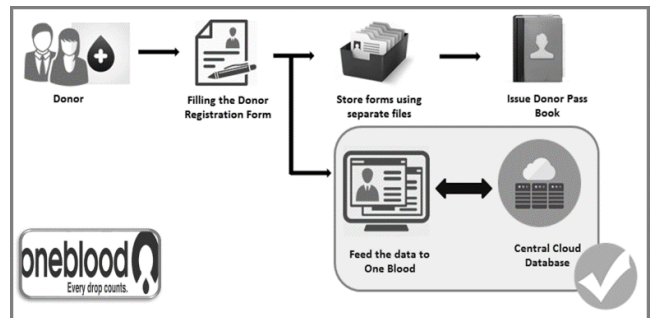


Fig. 3 One Blood Work Flow - Donor Registration Process

TABLE I. DONOR REGISTRATION – MANUAL VS. ONE BLOOD

Donor Registration Process	
Manual Work Flow	One Blood Work Flow
Only manages the donor registrations using paper work and forms.	Provides functionality to manage donor identity in an organized manner.
Chances of misplacing the donor information are high.	Information is managed in a centralized manner.
Information is not managed as a centralized source of information.	High availability and ease of access to Donor-related information.

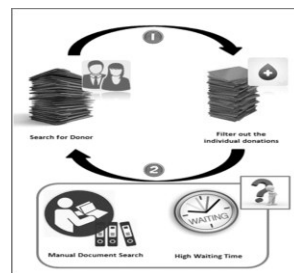


Fig. 4 Manual Work Flow – Donations Management Process

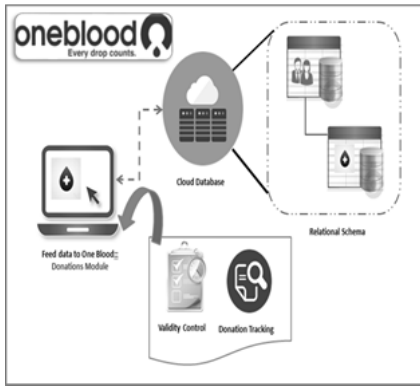


Fig. 5 One Blood Work Flow - Donations Management Process

TABLE II. DONATIONS MANAGEMENT – MANUAL VS. ONE BLOOD

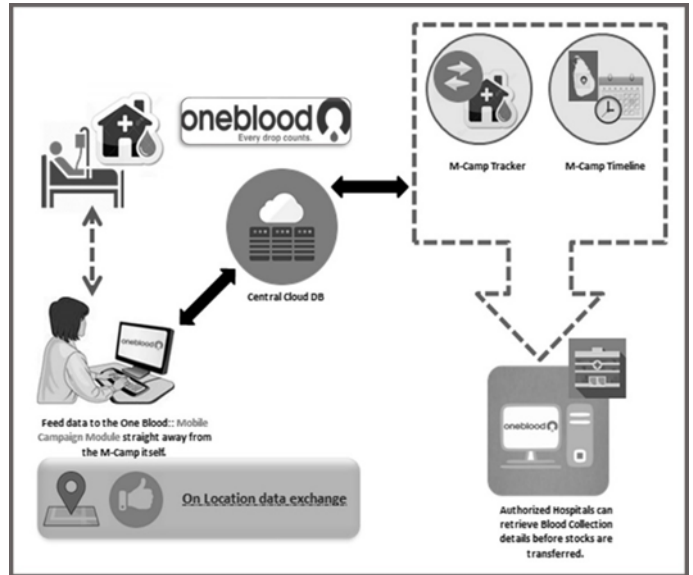


Fig. 7 One Blood Work Flow – Mobile Campaign Handling Process

TABLE III. MOBILE CAMPAIGN HANDLING – MANUAL VS. ONE BLOOD

Donations Management Process	
Manual Work Flow	One Blood Work Flow
Donor-Donation details are managed in the traditional paper related methods.	Maintain proper centralized donation tracking and validity controls.
High time consumption when accessing donation related details.	High accessibility and high availability achieved through centralized information management. Simple and easy way of managing donation history related to each donor.

Mobile Campaign Handling Process	
Manual Work Flow	One Blood Work Flow
Each hospital individually manage the registered mobile campaign under their authority using traditional paperwork.	Provides a centralized, well-organized approach towards managing mobile campaigns which are conducted throughout the island.
	Includes an M-Camp tracker to track down the information related to each and every mobile campaign which is conducted.
	M-Camp Timeline facility view details related to mobile campaigns which are already conducted or to be held.
	Introduces On-Location information exchange where the authorities can feed data on the M-Camp location itself.

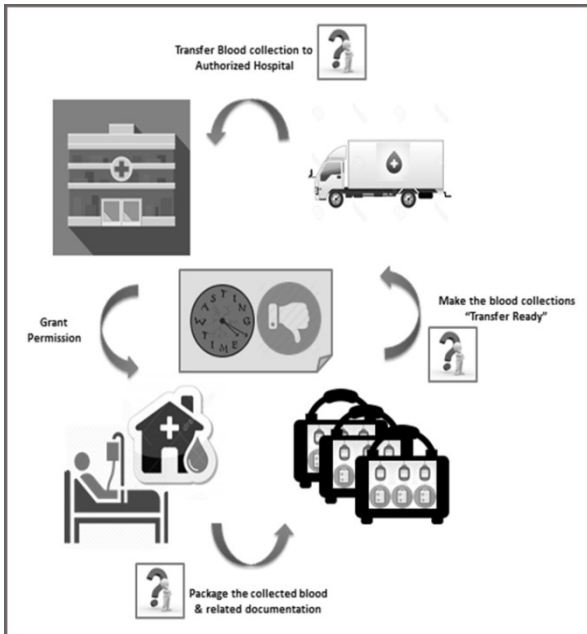


Fig. 6 Manual Work Flow – Mobile Campaign Handling Process

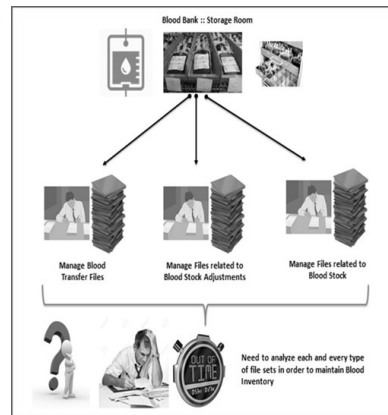


Fig. 8 Manual Work Flow – Blood Inventory Management Process

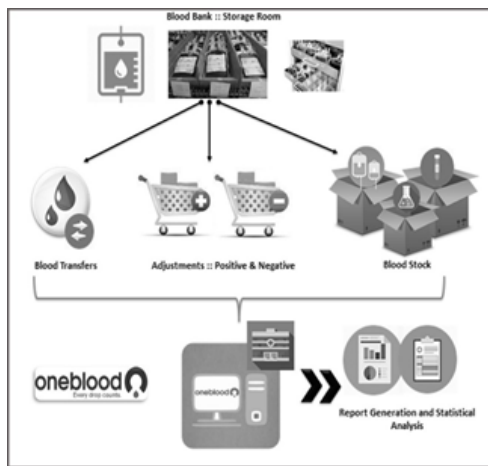


Fig. 9 One Blood Work Flow – Blood Inventory Management Process

TABLE IV. TABLE IV. BLOOD INVENTORY MANAGEMENT – MANUAL VS. ONE BLOOD

Blood Inventory Management Process	
Manual Work Flow	One Blood Work Flow
Traditional paper work based approach is followed in order to manage all types of blood inventory related transactions.	Separate modules are available to seamlessly manage each type of transaction.
	Easy approach towards generating reports related to blood inventory.
	Quick access to blood inventory related statistics.

- 2) **Radical Re-Design:** Radical re-design is the second vertical of the Business Process Re-Engineering [12]. The aim of this radical improvement approach is quick and substantial gains in performance by redesigning the core process. It is mainly involved in merging the information technology and related techniques. To leverage with information technology, One Blood System has built up as cloud-based web based application with a centralized database that can access from any computer or device, anywhere, at any time. It focuses three main technologies namely WAMP, Laravel and cloud technology.

WAMP is a powerful back end web development and hosting environment which is integrated with Windows as the operating system, Apache as the web server, MySQL as the database server and PHP as the primary scripting language. WAMP controls all these components using an intuitive interface [13]. In order to link with PHP, the best possible framework is Laravel. Therefore, Laravel framework has been used to implement the One Blood system. It is a “full stack” framework because it handles everything from web serving to database management. The MVC (Model – View - Controller) architectural pattern which is present in Laravel provides the great benefit of involving UI logic business logic

and request or reply data together into the web application [14].

As the most suitable storage solution, One Blood system was deployed in the cloud environment based on Infrastructure as a service (IaaS). IaaS allows customers to avoid the large capital expenditures associated with infrastructure and data centers [15]. Other than that IaaS enables the user to use the equipment of a service provider to support operations[16], including the provision of processing, storage, hardware, servers, and networking components. The service provider owns the equipment and is responsible for hosting and maintaining it. The client does not manage or control the underlying cloud infrastructure, but has control over operating systems, storage, and deployed applications [16]. Users usually pay on a per-use basis. Customers often use an IT operations management console via a Web-based graphical user interface (GUI) to manage the environment. Customers can self-provision this virtual infrastructure using the GUI.

D. Implementation and Evaluation Phase

This phase is inspired by the successful completion of all the three phases conducted above. This phase generates the final outcomes regarding implementing the real system along with measuring the actual effectiveness of the whole process regarding proper evaluation criteria. In detail description related to this phase is described in the following section.

IV. RESEARCH FINDINGS/RESULTS AND EVIDENCE

The overall result of this research is produced in two distinguished forms. One Blood web application represents the final outcome of the BPR Framework in terms of a prototype application while the ESIA rules evaluate the effectiveness of the BPR framework. There for following the proposed BPR framework has ensures that it could implement a successful prototype application while evaluating the effectiveness of it at the same time.

A. One Blood System Overview

Fig.10 illustrates the overall architecture of the one Blood system. It consists of three main composite models which can be listed as a user interface, application, and the backend. In addition, Fig.10 clearly depicts the focal point which the techniques and concepts behind BPR is applied, and it directly showcase how the overall system is influenced by the proposed BPR framework.

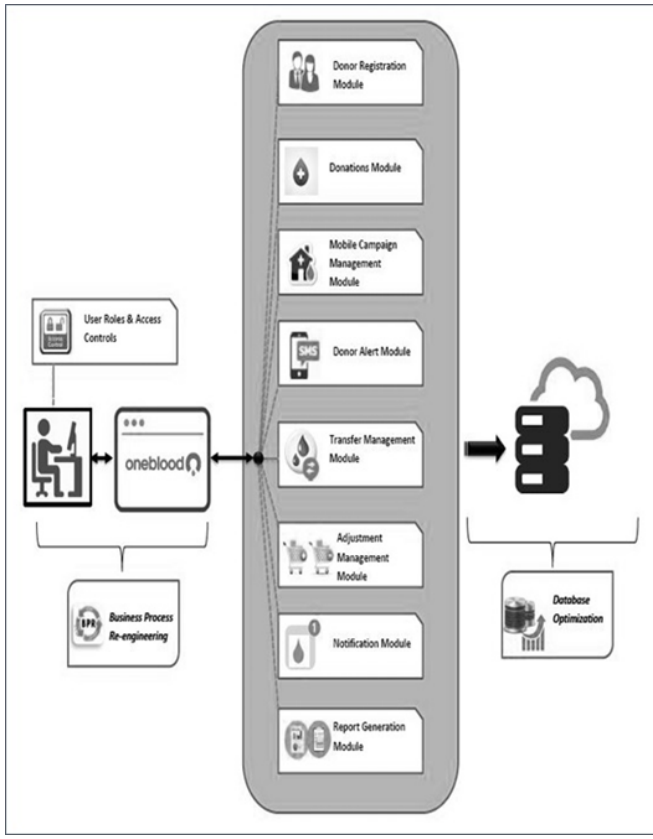


Fig. 10 One Blood Overall System Diagram

TABLE V. SUMMARY OF MODULE WISE FUNCTIONALITY

Module Name	Functionality
User Roles and Access Control Module	<ul style="list-style-type: none"> ✓ Provide the functionality to Create, Edit, Update and Delete user roles. ✓ Assign privilege levels to the created users. ✓ Maintain proper user level access controls.
Donor Registration Module	<ul style="list-style-type: none"> ✓ Provide the functionality to register new donors. ✓ Update relevant information of existing donors. ✓ View Donor Information.
Donations Module	<ul style="list-style-type: none"> ✓ Provide the functionality to save new donation-related information. ✓ Perform donation related validity checks. ✓ List view of Donations.
Mobile	

Campaign Management Module	<ul style="list-style-type: none"> ✓ Register the details of new Mobile Blood Campaigns. ✓ Update the related details of already registered Mobile Blood Campaigns. ✓ List View of Mobile Campaigns. ✓ View Mobile Blood Campaign Timeline. ✓ Provide on-location information exchange functionality.
Donor Alert Module	<ul style="list-style-type: none"> ✓ Send SMS alerts to selected donors in urgent situations. ✓ Filter out the valid donors based on given period
Transfer Management Module	<ul style="list-style-type: none"> ✓ Provide the functionality to create new Transfers ✓ From –location to To-location transfer management ✓ Perform blood availability inventory checks
Adjustment Management Module	<ul style="list-style-type: none"> ✓ Provide the functionality to create new Adjustments ✓ Manage Positive Adjustments ✓ Manage Negative Adjustments ✓ Perform necessary blood inventory related quantity updates.
Notification Module	<p>Generate Notification related to following scenarios:</p> <ul style="list-style-type: none"> ✓ Items with fewer stock levels ✓ Items near expiration date ✓ Upcoming Mobile Campaigns
Report Generation Module	<p>Generate reports based on following details:</p> <ul style="list-style-type: none"> ✓ Donor Details ✓ Donation Details ✓ Inventory Related reports based on available Item Adjustment Details, and Transfer Details ✓ Mobile Campaign related details ✓ Location related details
Dashboard	<ul style="list-style-type: none"> ✓ Acquire all the critical information from each of the modules mentioned above and present in a summarized abridged version. <p>Includes related details as follows:</p> <ul style="list-style-type: none"> ✓ Stock levels of the main Blood Groups ✓ Mobile Campaign Timeline

B. BPR Evaluation through ESIA Rules

For the evaluation of BPR Framework, an ESIA rules are applied. According to the ESIA model [17], there are rules and techniques designed to accomplish four core steps namely Estimation, Simplification, Integration and Automation in the systematic re-engineering of an existing process. When redesigning an existing process, non-value adding activities should be eliminated, the remaining process should be simplified, the simplified tasks should be integrated, and the fundamentally entire process should be automated when to implement BPR.

Following diagrams clearly depicts the overall effectiveness of the proposed BPR Framework regarding the ESIA Rules. In order to produce most meaningful outcomes, a total of 14 most

critical activities related to the NBTS were taken into consideration.

ELIMINATION	SIMPLIFICATION	INTEGRATION	AUTOMATION
Waiting Time :: Donor information retrieval process	Procedure :: Centralized Donor Information Management throughout the country	Donor –Donation Integrated workflow	Donor – Donation – Blood Inventory integrated process flow
Waiting Time :: Donation verification and handling	Problem Areas :: Donor to Donation verification	Mobile Campaign – Blood Bank Collaborative workflow	Mobile Campaign tracking and timeline functionality
Inventory related paperwork:: Adjustments/ Transfers & Blood Stock Management	Communication :: Instant SMS notification system to get on touch with donors	Common integrated platform between NBTS, Cluster Heads and Peripheral Hospitals	Module based Report Generation
Duplication :: Redundant donor registrations in multiple locations	Inventory Information management and Statistical Analysis	Total Critical Activities : 14	

Fig. 11 Summary of ESIA Rules Acknowledgment

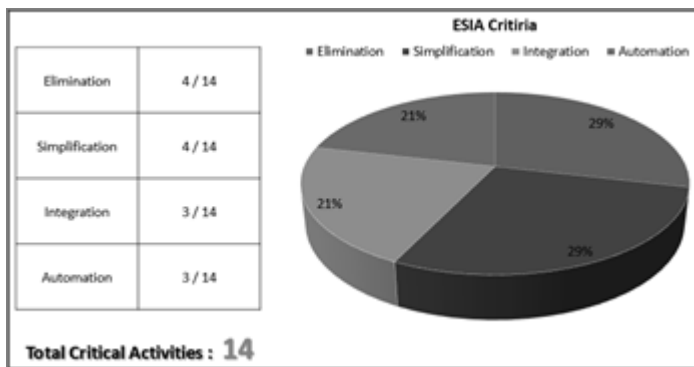


Fig. 12 Percentage-wise Representation of ESIA Rules

V. CONCLUSIONS & FUTURE WORKS

Based on the presented framework which is proposed in this paper, the authors were able to initialize the first step towards implementing a cloud-based centralized web application for the National Blood Transfusion Services in Sri Lanka. Since the concepts behind BPR inspire the framework, several advantages were achieved such as improving and redefining critical processes, re-organizing workflows, automate and integrate processes together and mapping the connection between human-computer interaction. On the other hand, it was beneficial to optimize end to end processes & to leverage IT towards adapting to a rich web application along with proper storage solution.

When the focus is extended towards the future, a performance evaluation model for the framework can be suggested to evaluate the framework by associating several performance matrices, and also, several modifications can be integrated by introducing new functionalities to enrich further the One Blood System.

Since the current framework has been applied by giving the prior focus towards reducing and streamline the process, workflows, the same framework can be extended to adjoin the

time factor as well. By doing so, the impact towards the process flows caused by human user interaction can also be taken into consideration to make it more efficient.

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