Analysis and Design of an Information System for Blood Component Donations

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Abstract. In the UK, NHS Blood and Transplant (NHSBT) administers the blood and transplantation service to National Health Service (NHS), overseeing blood collection in England and transplant facilities in the United Kingdom. This research focuses on improving blood component donations by using an information system. This paper presents system analysis and user interface design of an information system for blood component donations to improve the current process. The software system requirements were gathered via a focus group consisting of employees from a Blood Donation Centre in the UK. The problem space in the component donation process was analysed and human factors has been explored for potential users of the component donation information system. Both low-fidelity and high-fidelity designs have been designed where interactive user interfaces have been made on Adobe XD tool. Usability evaluation has been performed with potential users from the focus group using a cognitive walk through to examine usability concerns and user experience of the design prototype. Conclusions and future work have been presented for potential further research opportunities.

Keywords: user experience · usability · component donation · information system design · blood component donations information system · system analysis

1 Introduction

The demand for blood and its components is increasing in many countries due to several reasons such as the rising number of trauma patients, including those involved in road traffic accidents, cancer chemotherapy, patients requiring long-term blood therapy, such as sickle cell anaemia, etc. [1]. In the UK, NHS Blood and Transplant (NHSBT) administers the blood and transplantation service to National Health Service (NHS), overseeing blood collection in England and transplant facilities in the United Kingdom.

Our research focuses on improving blood component donations in the UK by introducing a new information system to the existing process. Although, there are studies in the literature regarding the blood donation process and its improvement [2–7], component donation is slightly different and not covered much

in the existing studies so there are limited research about it in the context of information systems. We focus on the component donation process in the UK, but the terms are similar in other developed countries [8, 9]. However, it is difficult to say that there is a common standard for all countries. WHO recommends that all blood donation activities should be coordinated at the national level through effective organization and integrated supply networks, but only 73% of the reporting countries, or 125 out of 171, had a national blood policy according to 2018 data [10].

As it is known, human blood is a complex mixture of various components such as plasma, red blood cells, white blood cells and platelets [11]. When centrifugal force is applied, distinct blood components with different relative density, sediment rate, and scale can be differentiated [12]. Since each blood component has an individual purpose, the component isolation has increased the utility of a single whole blood unit. For therapeutic effectiveness, different blood components need different storage conditions and temperatures. Alternatively, to collect specific blood components from the donors, apheresis blood donations can be performed. Apheresis is the process of separating blood components from whole blood by using special equipment [13], hence the process is also known as component donation.

NHSBT involves managing blood, organ, skin, bone marrow, and stem cell donation, storage, and transplantation, as well as exploring alternative therapies and processes. According to the NHSBT Statistical Reports [14], there are 416,381 new registrations and 131,825 new donations in 2019-2020. The numbers show that NHSBT should cope with a large amount of data and information without compromising blood safety and donor safety. Due to high volume of data, there are issues and challenges during the donation process such as the potential inconsistent or wrong data if donor data and records were manually recorded [15]. Besides, when donor information is not stored properly or data is not well-structured, then it becomes difficult to use the data in the future as well as it affects the document's legibility.

Using information technologies in the management of component donations can support effective organization and tracking with streamlining the donation process. However, information of the donors should be confidential and blood safety is a crucial factor [15]. Using technologies such as barcodes in the component donation operations can enhance patient safety and ensure quality control. A reliable and secure information system is highly beneficial to users in data management and decision making by helping with effective management of the activities and digitally recording them. Furthermore, NHSBT Board Meeting in 2019 [14] has highlighted the need for future innovations to perform the component donation operations like electronic component day sheet, electronic donor health check, and electronic component donor procedure notes. The report also stated that there are various financial and non-financial benefits such as increasing the blood donation safety by reducing the number of errors, facilitating the management of data, improving the donation process, reducing the donor journey time, improving donor satisfaction, increasing front line staff morale, and

enabling the future innovations [14]. In conclusion, there is a need for an information system to perform the component donations safely and securely to enhance donor safety and satisfaction.

This paper presents system analysis and user interface design of an information system for blood component donations to improve the current process. This research aims to digitally transform all operational activities for the component donation process and digitise the paper-based component donation records. The data collected from the participants were obtained from an online questionnaire. Personas and user empathy mapping facilitated understanding the user needs and behaviours, which allowed the creation of low fidelity wire frames. High fidelity designs and user interactions are created using Adobe XD tool. The design prototype has been evaluated by usability testing and collecting feedback from potential users.

The remaining of the paper is structured as follows: Next section presents the literature review and related work. Research methods are explained in Section 3. Problem space contextualisation and requirements analysis are given in Section 4. Design process and evaluation of the study are presented in Section 5 and 6 respectively. Finally, conclusions and potential future work are provided.

2 Literature Review

National Health Service Blood and Transplant (NHSBT) is responsible for various blood and transplantation services, including promoting tissue donation, delivering life-saving therapeutic apheresis, and managing patient blood. NHSBT is a special health authority, and it is responsible for saving and enhancing lives by supplying blood and supporting the supply of organs and tissues to the NHS, as well as overseeing blood donation services in England and transplant services throughout the UK [16].

NHSBT was founded in 2005 to combine the functions of two different NHS organisations: UK Transplant and the National Blood Service [16]. Since then, there are now more than 25 million people on the NHS Organ Donor Register, representing 38% of the population. Currently, NHSBT have five operational responsibilities including: (1) Blood donation and supply, (2) Patient blood management, (3) Organ donation and transplantation, (4) Tissue and eye donation and (5) Therapeutic apheresis.

Therapeutic apheresis services of NHSBT use specialised equipment to exchange, remove, or collect particular components within the blood to give life-saving and life-enhancing therapies. Harris and McKeown [16] stated that NHSBT had treated over 1,200 adults and children each year from designated treatment units located around the UK.

In this study, our main focus is on the component donations. Blood donations are most commonly classified into two types which are whole blood donations and apheresis donations [17]. During the whole blood donation, one unit of blood is extracted from a donor; it will be separated into its constituent components in the lab later. However, apheresis donations, a.k.a component donations, allow

the donor to maximise their contribution and donate specific blood components based on their blood type. The unique aspect of these donations is that only required blood components can be donated, with the rest can be given back to the donor.

Healthcare providers may face multiple operational challenges to get the blood and blood components according to their therapeutic requirement. Knight et al. [18] highlighted some challenges in the blood donation process.

- *High demand*: To meet the needs of hospitals, NHSBT must collect the proper combination of blood types and blood components daily. NHSBT has to recruit over 100K new donors each year to replace those who cannot donate for various reasons.
- *Donor satisfaction*: Donors are healthy volunteers and good donor experience is crucial to keep the existing donors and recruit new ones. Staff should be professional and ensure that the donor is comfortable during the process. At the same time, they must guarantee that the blood donation process is easy.
- *Component availability*: Hospitals should assist in preserving blood donations for those who genuinely require it, ensuring that the appropriate blood component is accessible for the appropriate patient at the appropriate time. Platelets are especially sensitive because of their limited shelf life.
- *Communication*: Information flow and communication plays an important role in the daily operations of the blood donation process because NHSBT is a nationwide organisation with geographically distributed donation centres.

2.1 Component Donation Process

Component donation is more flexible to donate various blood components than a whole blood donation, but it needs more time which may be up to two hours. Component separation is performed by special equipment that separates the blood components obtained from the donor by centrifuging, stacking them by weight and separating them from the liquid [17]. The device may then take out the necessary blood components and store them in a sterile bag. For employees performing component donation operations, a complete training program is offered in the donor management, donation process and procedures, and the apheresis equipment. It allows to maximise component donations based on particular component and blood type needs. In the literature, it is suggested that component donations are to be performed in the static blood donation centres but not in the mobile blood donation units [19]. NHS Give Blood had created a short video to provide an overview of the component donation process, and the outline of the process is illustrated in Figure 1. Component donation process starts with welcoming the donor, and then donor completes the health questionnaire. The donor should be in good health. A qualified clinical professional must do the health screening of the donors. Donors who undergo component donation procedures may be subject to additional or separate criteria compared to whole blood donors. If the eligibility criteria is satisfied, then component donation is done, and next appointment may be booked.

Fig. 1. Component donation process overview.

Various organisations regulate the blood donation centers to offer the best quality of blood products and service. For example, NHSBT is required to comply with the Blood Safety and Quality Regulations as well as follow the donor selection guidelines of the Joint UK Blood Transfusion and Tissue Transplantation Services Professional Advisory Committee. Those guidelines specify the criteria for determining whether or not a person is qualified to donate blood. In addition, Medicines and Healthcare Products Regulatory Agency (MHRA) conducts inspections to check the process, procedures and protocols [19].

2.2 Related Work

In the literature, there are studies regarding the blood donation process and its improvement [2–7]. HL7 (Health Level Seven) specification includes fields for blood component specification and a few blood banks utilize software including component management features [20]. However, these studies do not fully cover the blood component donations, e.g. platelets donation. There is limited research in the field of information system support for component donations.

All NHSBT staff are responsible and accountable for entering data and ensure that data entry is complete and legible. NHSBT uses the PULSE software system that empowers the blood donation life cycle. All elements of blood donation and processing are handled by this management system and it is in use for many years [21]. PULSE system helps to enrol donors and manage the laboratory activities such as testing, labelling, stock tracking, supply and delivery of blood to hospitals and medical research facilities.

A new system called as 'Session Solutions' has been introduced to have a more efficient donation procedure [18], especially focusing on mobile blood donation centres which require portable handheld devices to track a donor's progress during the session. These devices offer real-time data exchange among the NHSBT and streamline the donation process. The new system is expected to enhance donor safety and donor experience by improving ineffective working practices [14]. Existing system offers some partial operational and database support for the component donations, but this is limited. Currently, staff perform the component donor recruitment, donation documentation, and future donation appointments manually. Digital transformation of the component donations strives to improve donor experience as pleasant as possible. However, there are many challenges to the change. The component donation process should enhance aspects of donor experience like scheduling, processing time, and apparent effects, as well as reduce the cost and effort.

There are different parameters that drive or discourage people from donating blood [22]. To advertise, encourage, attract, and retain blood donors, several approaches have been investigated using ICT and smart devices. Donor motivation for blood donation can be effected by altruism, self-interest, and responsiveness to direct or societal influence. In this regard, the introduction and expanding usage of digital collaboration platforms may be an effective tool for increasing blood donation, particularly among the younger generation [22].

NHSBT is looking to secure the systems by bringing in the latest and cutting-edge technologies like cloud services to provide resilience, scalability, and flexible solutions to integrate standard operating procedures of blood donation. For example, 'DonorPath' app is launched to transform risk assessment operations in organ donation to make it easier for nurses to fill in the risk profile.

The digital transformation of the component donations process should involve a multidisciplinary team to gather the requirements and design a system to enhance the donor experience and support new donor recruitment. The success of the digital transformation depends on the system compliance with the regulatory procedures. The ongoing registration of new donors and concurrently preserving previous donor records, i.e. launching a new system while maintaining the legacy one, is a challenge due to the critical nature of the process.

To the best of our knowledge, while there are systems in use for whole blood donations, research about IT support for blood component donations is limited. Our research focuses on improving blood component donations by introducing a new information system to the existing process and aim to fill in the gap in information system support for component donation process and operations.

3 Research Methods

In this study, we used Checkland's Soft Systems Methodology (SSM) as applying SSM in health domain is a proven approach and used in the literature commonly [23, 24]. Checkland points out that it is useful to consider potential users' aspirations and include them at various stages of the analysis and design.

We did a qualitative study and used various methods including focus group, interviews, usability testing, etc. The software system requirements were gathered via a focus group consisting of employees from a Blood Donation Centre in the UK. The problem space in the component donation process was analysed and human factors has been explored for potential users of the component donation system. Both low-fidelity and high-fidelity designs has been designed where interactive user interfaces have been made on Adobe XD tool. Usability evaluation has been performed with potential users from the focus group using a cognitive walk through to examine usability concerns and user experience (UX) of the design prototype.

Interviews are one of the most effective ways to acquire system requirements from the potential users and domain experts. However, due to the Covid19 pandemic and social distancing measures during the research, the researcher has chosen online questionnaires to collect data from the participants. The ques-

tionnaires aim to collect targeted data of functional, non-functional and user requirements about the application early in the designing process. The user insights may support the design thinking process and drive the research to achieve the rationale. Component donors are not included in the study's target participants due to the time constraints but included as a future work. Participants are chosen from the staff members in donation centres, specifically employees from Poole Donor Centre in the UK have joined this study.

The online questionnaire was created using the Microsoft forms tool, with the sections of the participant information sheet, participant consent form and over 25 questions regarding the functional, non-functional and user requirements. Participants were contacted through social media and the online questionnaire was open from 20/04/2021 to 30/04/2021. The participants were selected and invited from those with working experience and knowledge of the component donation process. Eleven participants have participated in the online questionnaire from Poole Donor Centre who have various roles.

The data was analysed with Microsoft forms tool. The critical findings based on the participants' responses are summarised below:

- 91% of the participants required a barcode scanning feature in the system.
- 82% of the participants recommended the system should generate reconciliation reports.
- 82% of the participants suggested that signature fields should be embedded in the forms.
- 91% of the participants agreed that the system must comply with GRPD and data protection guidelines.
- 64% of the participants agreed that the system should not navigate the next screen without fulfilling mandatory fields and must display required fields.
- 64% of the participants required the blood group management feature.

while only,

- 55% of the participants required the detection of donor signatures mismatch in the donor consent form and donor health check questionnaire.
- 55% of the participants required an electronic donor health check form.
- 55% of the participants agreed that the system should be interoperable.
- 45% of the participants required a validation alert feature.
- 36% of the participants agreed to restrict the number of concurrent users.
- 36% of the participants wanted to have an aesthetic look.

The primary purpose of the online questionnaire is to gather some of the system requirements from the potential users to design an information system that can digitally transform component donations. The results from the online questionnaire have shown the significant importance of an information system that supports the component donation process because major features scored high 80% percentage or higher. According to the results, we identified that the staff prioritises facilitation of core functionality and easy to use system over advanced features or decision support because desirable features scored average 55% percentage or lower.

4 Problem Space Contextualisation and Analysis

4.1 Problem Analysis

The digital transformation of component donations and designing a new information system to support component donations is a challenging task and require a thorough analysis of the problem space. When dealing with complicated issues and enhancing project activities, driver diagrams can help to find a solution to the problem [25]. Driver diagrams, a.k.a tree diagrams, can provide what modifications are most likely to result in the desired outcomes and attainment of the aim. This problem analysis technique is suitable to get insights for designing an information system. Creating driver diagrams is beneficial during the initial phases of the study, but they should also be used throughout the study. Three stages are depicted in basic driver diagrams (aim, primary drivers and actions). Driver diagrams for more complicated goals include more layers, so each principal driver has its own set of supporting elements. Table 1 presents the analysis of the problem space.

Table 1. Driver diagram for problem analysis.

Aim	**Primary Drivers**	**Actions**
Improve Donor Experience	Decrease in waiting time	Appointment management
	Smooth journey of donors	Pre-booked appointments
	Efficient blood collection planning	Robust IT system
	Best use of resources	
Reduce the errors	Training for staff	Using IT
	Collaboration between the staff	Signature validation
	Mitigation of preventable errors	Barcode technology
Improve the process	Paper-based donor records	Digital donor library
	Storage	
System usage by donors and staff	Donor Health Check	Electronic donation records
	Consent forms	Accessible to all parties
	Procedure notes	
Reduce the workload	Manual documentation process	Donor management
	Data Protection	Blood group management

As mentioned before, currently, staff perform the component donor recruitment, donation documentation, and future donation appointments manually. The proposed system can help to overcome the challenges of accountability in the component donations within blood donation centres. It can also help to reduce the financial burden for printing weekly Donor Health Check Forms and the storage and retrieval charges for the forms [14]. Especially, such an information system can overcome the inconsistency issues and dependencies of the paper-based donor records.

4.2 System Requirements

During the early iteration process, system requirements are gathered from the users using online questionnaires. The potential users of the system can be Donor Carers, Donor Centre Supervisors, Donor Carer Administrators, Session Nurses, Component Donors and Blood Donation Centre Managers. The system should mainly provide a digital library or repository for component donors' records and donations as well as help to manage appointments. The MoSCoW model prioritises system needs to determine needs for system design. Table 2 presents the major system requirements according to the MoSCoW model.

Table 2. System Requirements.

Must	The system must perform appointment management
	The system must have a barcode scanning feature
	The system must perform session reconciliation
	The system must generate an Electronic Donor Health Check record
	The system must validate the donor's signatures
	The system must provide a signature field where required
	The system must generate an electronic donor number record
	The system must generate an electronic donation day sheet
	The system must have a blood group management feature
	The system must comply with GDPR and Data Protection Act
	The system must provide user login authentication
	The system must back up the data automatically
	The system must be available all the time
	The system must not proceed without fulfilling mandatory fields
	The system must perform all the operation without fail
Should	The system should generate electronic donor procedure notes
	The system should not restrict the number of users
	The system should be interoperable
	The system should give a response in three seconds
	The system should have an aesthetic look
	The system should provide a validation alert to the user
	The system should show the status of the process

Use case modelling is used to capture and understand the behaviour of the system. Use case modelling is helpful to know what a system needs to achieve, considering who will use it. Figure 2 illustrates a high level use case of the system where actors are the interface users like donation centre staff and donors who interact with the system for a specified use case.

5 Design Process

Designing a usable and human-centred interface can be challenging. Because the design process frequently involves many groups of individuals from many departments, creating and organising ideas to find a solution. Design plays a vital part

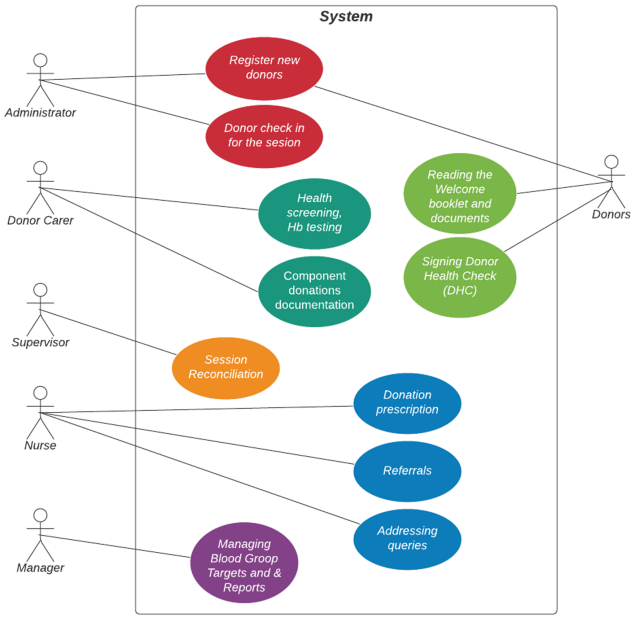

Fig. 2. Use cases of the system.

in the invention and development of meaningful processes, as well as contributing to product functionality, aesthetics, and usability [26]. A design thinking approach extends beyond goods and services to combine an understanding of technical challenges with respect for the socio-cultural environment [26].

Design thinking is an iterative approach that allows teams to understand people, question assumptions better, re-frame challenges and develop and test novel solutions [27]. Design thinking offers a problem-solving strategy centred on solutions and a set of practical techniques. It enables us to observe and empathise with the target user. By addressing the problem in human-centric ways, developing ideas in brainstorming sessions, and using a hands-on approach with design prototyping and design testing, design thinking is highly beneficial in resolving ill-defined or unknown challenges [27]. Empathy is essential in a human-centred design approach like design thinking because it helps you acquire meaningful user insights and their needs.

According to the design thinking process, a design process map has been created in this study to support the design process. A process map may assist a design team in scaling, designing quickly and maintaining brand harmony as well as aid other groups, such as project managers or developers [28]. In the design process map, there are four phases: ideation, definition, iteration, and implementation [28]. In the ideation phase, understanding the users and product strategy have foremost importance. The system's primary goal is to improve the donor experience by digitally transforming the component donation

process. In the next phase, definition of the subsystems and implementation of human-centred design principles are done. In the third phase, prototyping the design solution and testing with potential users are performed. Finally, according to the user's feedback, redesigning the prototype and delivering the improved version are aimed. The steps of the design approach are depicted in Figure 3.

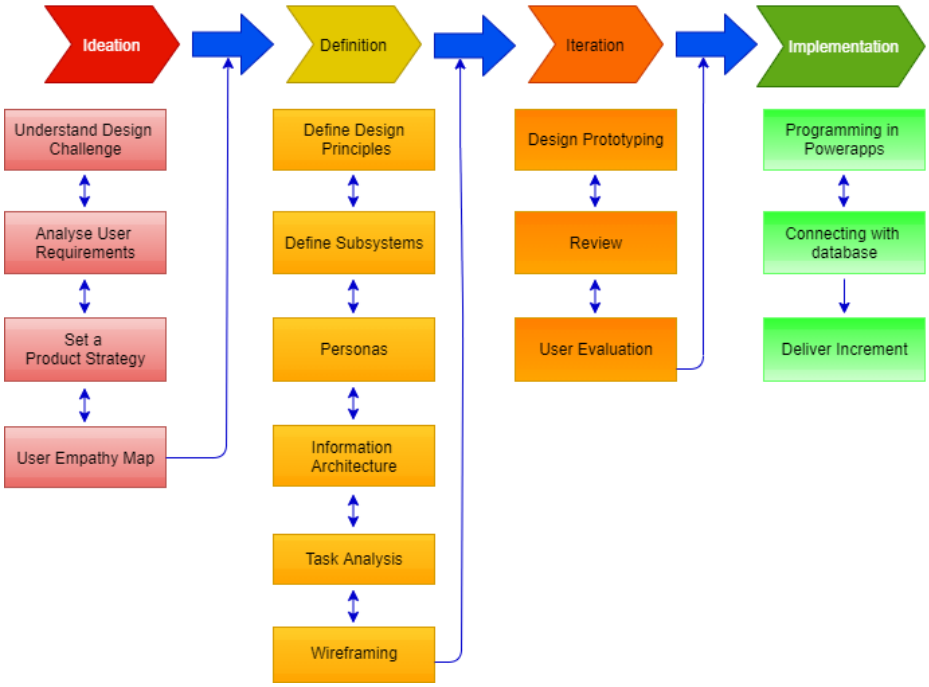

Fig. 3. Design process map.

5.1 User Empathy Mapping

Empathy mapping is used in this study to construct user personas and to identify and prioritise user requirements. It is used to find knowledge gaps and classify qualitative data obtained from the online questionnaires. User empathy maps assist the project team in comprehending the user's perspective and help to visualise user attitudes and actions. Mapping procedure identifies any gaps in current user data [29]. Five maps are developed for Donor Carer, Donor Carer Supervisor, Donor Centre Administrator, Session Nurse and Donor Centre Manager. As an example, Figure 4 illustrates the empathy map of a Donor Carer. Empathy mapping is a collaborative visual tool that illustrates what we know about a specific user group. It externalises user knowledge to facilitate decision-making and build a shared understanding of user demands [29].

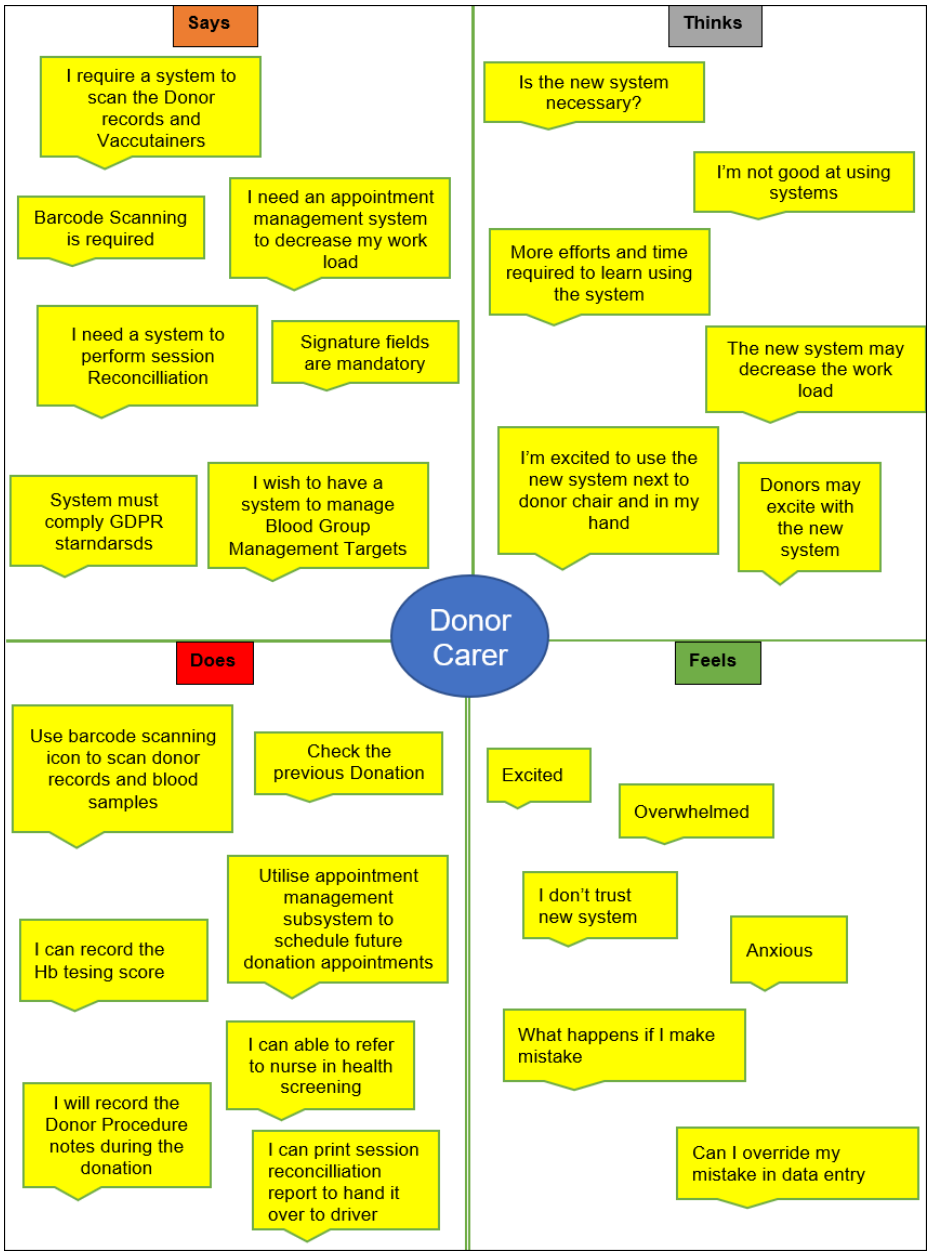

Fig. 4. Empathy mapping for Donor Carer.

The user or persona is in the centre of traditional empathy maps, which are divided into four quadrants (Says, Thinks, Does, and Feels). Empathy maps are not chronological or sequential but rather present a snapshot of who a person is as a whole [29]. In Figure 4, the first quadrant depicts the system requirements gathered from participants during the online survey. The user's behaviours are illustrated in the other quadrants.

5.2 User Personas

Personas give user research a face, transforming data into information that improves user experience. A persona is a realistic character sketch that represents a user or a focus group. Personas condense user research results and bring them to life in a way that allows anybody to make judgments based on these personas rather than on themselves [30]. Creating fictional characters of users according to the user research should represent the users and can be utilised by the project team as a decision-making tool. Personas help people to focus, build empathy, encourage consensus, increase efficiency, and help people make better decisions. Personas also assist in developing information architecture, interaction design, visual design, content development and user evaluation in the designing process [30]. In this study, five distinct personas are being created to represent each user segment. As an example, Donor Carer persona is illustrated in Figure 5.

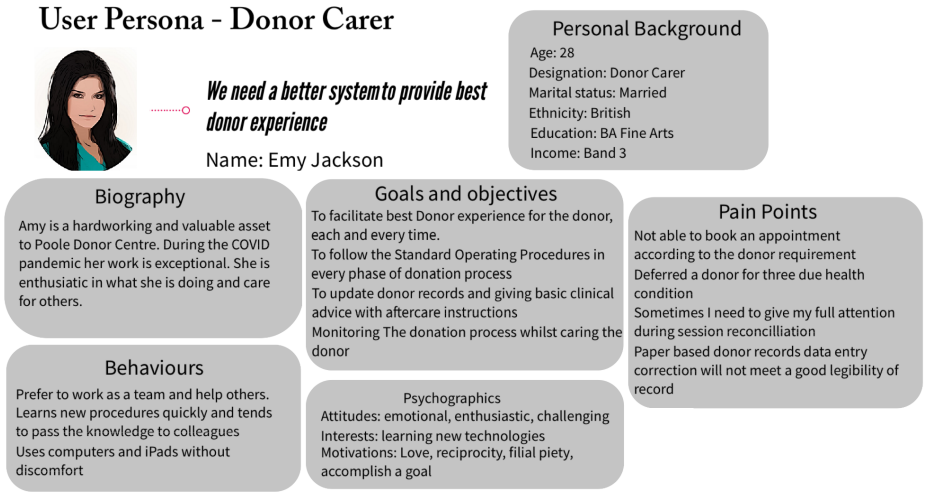

Fig. 5. Donor carer user persona.

Mulder and Yaar [30] proposed three phases in developing personas; conduct research, segment users based on research, and create a persona for each segment. In this study, the preliminary information for developing personas is obtained from online questionnaires, a design process map, and user empathy mapping.

Users have been separated into two main segments, blood donation centre staff and donors. A good persona is intended to be detailed representations of users that go beyond demographic or personal information and include such as goals, motivations, behavioural and cognitive details [31].

5.3 Wireframes Design and Information flow

Human factors in the design process focus on how humans interact with technology [32]. There are three types of human demands that a system or device can make are cognitive, visual, and motor loads [33]. Most common human-centred design principles to decrease the user's loads are: physical ergonomics, consistency, familiarity, sense of control, efficiency error management [32]. A wireframe is a low fidelity representation of a proposed design. Wireframes link the information architecture to its user interface design [34]. Balsamiq tool is used to design the wireframes for this project. Over 25 wireframes were designed with a consistent layout. As example, four of the screen designs are shown in Figure 6.

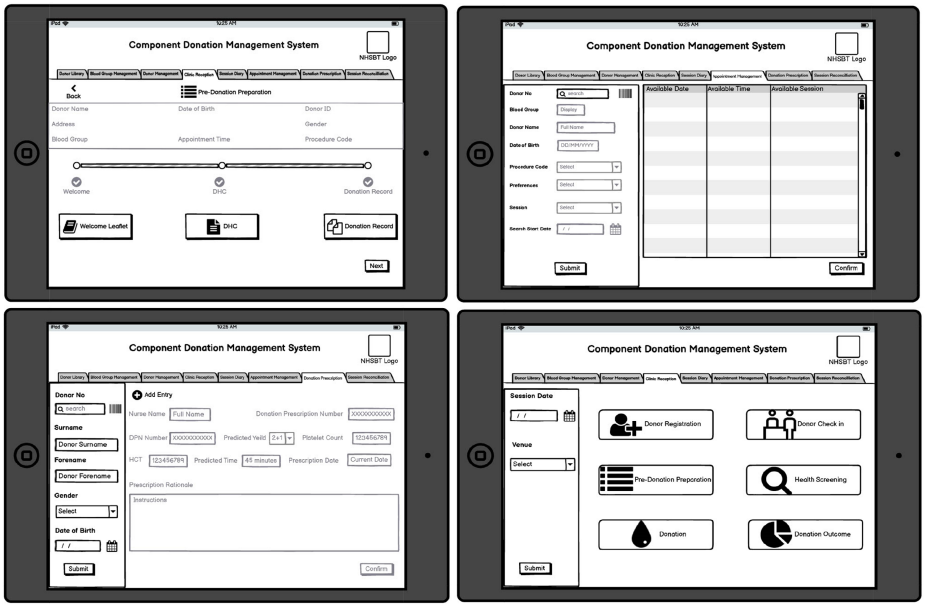

Fig. 6. Sample wireframes of the system.

There are mainly two approaches in designing information architecture for a digital product, the top-down approach and the bottom-up approach. The top-down information architecture entails building the architecture directly from the product goals and user requirements while the bottom-up approach focuses on low level components and their composition to reach the goals. Top-down

method is also categorised into two approaches, narrow and deep hierarchy and broad and shallow hierarchy [34]. The broad and shallow hierarchy is used in this study to decrease cognitive load for users and to decrease the number of taps to reach the desired content. Both global navigation and local navigation are embedded in all of the user screens.

In addition to wireframes, high fidelity designs are created in Adobe XD tool. Over 50 user interface designs were prepared with a consistent layout. Four sample screen designs are illustrated in Figure 7. The designs were made to launch the system on iPad based on user needs and research. Data elements in the design are extracted from the participants and open-source training documents such as standard operating procedures for donor procedure notes, donor health check, component day sheet, and donor centre reconciliation [14].

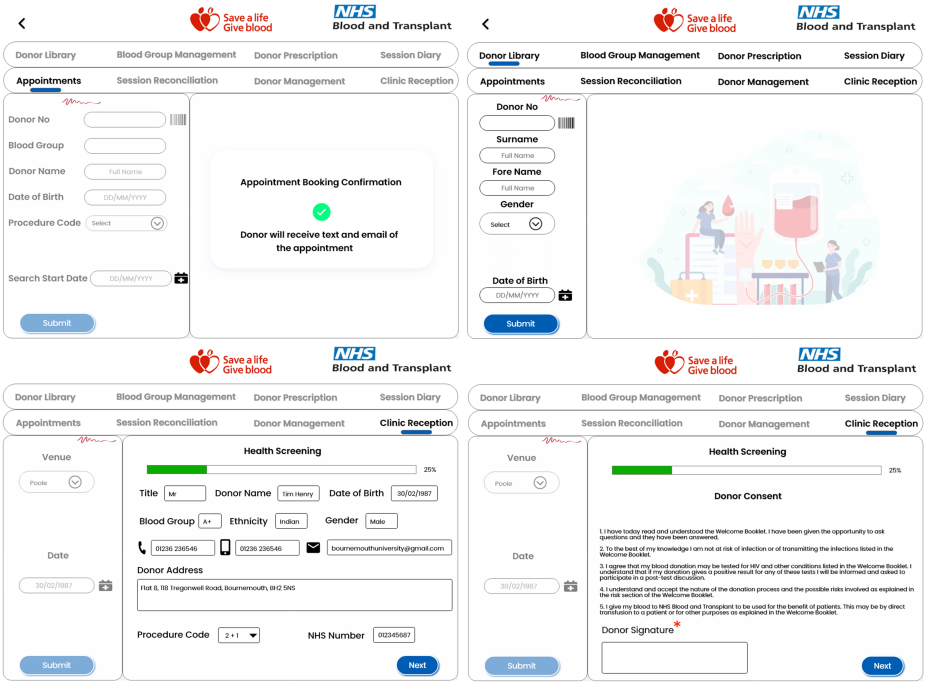

Fig. 7. User interface design with Adobe XD.

The designs generated by Adobe XD allows interactive prototyping by defining the flow between the user screens. Interactive prototype allows people to scrutinise design concepts and content [35] and so it enables stakeholders to interact with it and evaluate its usability. A high-fidelity prototype looks and functions more like the final product than a low-fidelity prototype.

6 Usability Evaluation

The need for high-quality software systems is continually growing. However, despite significant investments in software development, a wide range of software solutions cannot fulfil user-specific goals. Ouhbi et al. [36] present as study about the compliance of blood donation applications with the mobile platform usability guidelines. They report that around 35% of the applications had issues with usability. So, it is essential to evaluate a digital product to see how well people can understand and utilise it to achieve their objectives. There are various evaluation methods to find usability and user experience issues in a system. This research used the Cognitive Walk through evaluation approach to detect usability concerns in the design prototype. The cognitive walk through can be applied at every stage of product development, including conceptual design, detailed design, and implementation [37]. Users learn the new product by product exploration process, not through a training. There are several steps for a cognitive walk through evaluation and we used an adapted approach of Wilson's [37] in this study as illustrated in Figure 8.

Fig. 8. Cognitive walk through process in this project.

Define product users: The project cognitive walk through evaluation starts with defining the users for the assessment. Because various personas may follow multiple pathways through the system, it is also a good idea to employ persona-matched users [37]. Considering this, we preferred to have a small group of users who took part in the online questionnaire, to evaluate the design prototype.

Create evaluation guidelines: We created the evaluation instructions sheet, which consists of information on the purpose of the evaluation, an overview description of the design prototype, and participants' role and responsibilities throughout the evaluation.

Develop tasks and action sequences: The tasks and action sequences for each task were created based on the user personas to discover usability concerns for each component of the persona. Table 3 depicts the list of task and action sequences for the tasks used in the project. We asked four questions for each task to analyse the cognitive process and learnability of the user [38].

Summarise the findings: Due to Covid19 pandemic and social distancing measures during the time that this project was done, we could not employ user testing but instead the Microsoft Forms tool has been used to record the responses from the users with associated participants instructions document and a link for the design prototype. Hence, only limited number of user responses were recorded to find the usability concerns of the design prototype. We sum-

marised the findings of the usability evaluation to highlight the issues and list the actions.

Table 3. Tasks and action sequences for each task used in cognitive walk through.

Task	**Action Sequence**
1.Navigate to the home screen	After entering the correct login credentials Click on submit button
2.Print the session diary	Home Screen → Click on session diary button Select the right venue and date Click on submit → Scroll down → Print
3.Edit A+ blood group targets in Blood Group Management	Home Screen → Blood Group Management Select the right blood group and date Click on edit → Update → Save
4.Book a new appointment for future donations	Home Screen → Appointments Enter or scan donor details Click on submit → Select date and time Submit → Confirm
5.Register a new donor in the clinic reception	Home Screen → Clinic reception Select the right venue and date Click on submit → Donor registration Enter donor details → Registration → Confirm
6.Update the Donor contact details	Home Screen → Donor Management Enter or scan donor details Click on submit → Personal information Click on edit → Update → Save
7.Archive the donor record	Home Screen → Donor Management Enter or scan donor details Click on submit → Archive Click on add entry → Enter data → Confirm

7 Conclusion

This research started with exploring the existing knowledge in the component donation domain and collecting the software system requirements. This research produced a design prototype that will be used to implement a proof-of-concept implementation. The data collected from the participants' were obtained from an online questionnaire. Personas and user empathy mapping facilitated understanding the user needs and behaviours, which allowed the creation of low fidelity wire frames. High fidelity designs and user interactions are created using Adobe XD tool. We could only present some of the maps, personas, diagrams, etc. in this paper, but all of the remaining design elements as well as any other information, such as the questions in the online questionnaire, are available upon request by contacting the authors. The design prototype has been evaluated with some limitations in the participation and highlighted specific critical usability

issues. Our study was validated by usability testing and collecting feedback from potential users.

Despite the interesting findings, this study has several limitations. Firstly, the sample group only targets a small number of employees from a blood donation center in the UK. Secondly, the study focused mainly on gathering requirements from the participants using an online questionnaire as a method. If a more comprehensive survey was distributed to all UK blood donation centres as well as internationally, then the research results could provide further insights. We also think that this research would benefit a future proof-of-concept implementation to validate the study more formally.

There are several potential areas for future work. First of all, developing a Microsoft Power app utilising Power Fx language may provide an opportunity to test the system and validate the approach better. Due to the pandemic and time constraints in the project, research methodology and usability evaluation methods have limitations. A more comprehensive survey as well as interviews on larger scale will improve our work. Other well-known evaluation approaches, such as Heuristics Evaluations and Pluralistic Usability Walk through, may also be used to analyse the proposed solution usability problems. The research only concentrated on designing a system to digitally transform component donations in the blood donation centre only. A potential future work to design and develop a larger system that can support other operations such as laboratory testing and blood storage will have more impact.

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