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Practices of Blood Donation in Khartoum, Sudan: Opportunities and Challenges for ICT Support

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ABSTRACT

This article investigates practices of blood donation in Khartoum, Sudan, to examine and discuss how such practices may be supported with new information technology. Based on data collected through fieldwork, the article shows that although blood donors consider blood donation an act of humanitarian goodwill, there is a lack of voluntary blood donors, and those that give blood rarely do so repeatedly. This situation is due to several factors, including misconceptions regarding blood donation especially among people from rural areas, suboptimal settings for the act of donating blood, and a lack of organization surrounding the act. Due to this lack of voluntary blood donate in the Khartoum area, providing blood to a patient in need often fall on the family members of the patient whom are asked to donate the blood needed in situ. To mitigate the limitations of the current practices of blood donation the article examines design implications with an aim to support and improve these practices with new ICT. The paper explicitly discusses how one may motivate donors to give blood more frequently through new ICT initiatives.

Keywords: -Blood donation, Sudan, ICT support, Development, Fieldwork.

I. INTRODUCTION

Blood is invaluable to human life. Every day, blood is required in hospitals and emergency treatment facilities, particularly during major surgeries. Many patients frequently require blood, such as those undergoing chemotherapy, those who have been in accidents, and those dealing with anemia.

This tremendous demand poses a challenge to hospitals and emergency treatment facilities, which must provide enough blood to perform transfusions. Moreover, despite technological advancements in the field of healthcare, blood remains a scarce commodity that cannot be manufactured like other products [1], [2].

Donations are the only means of obtaining blood and keeping blood banks sufficiently supplied. According to the World Health Organization (WHO), in order to meet global requirements for life-saving transfusions, 1% of the population must donate blood [1]. While giving blood is one of the most valuable contributions that an individual can make to society, more than half of the global population is eligible to donate blood, and most people are aware of the need for blood, donation rates remain low, and few donors become regulars [3].

A report by the WHO indicates that, out of the 112.5 million blood donations made globally each year, approximately half of those donations are collected in high-income countries, although those countries only house 19% of the world's population. In addition, there is a significant difference in access to blood between countries. Blood

donation in developing countries relies heavily on replacement donors (family and friends that must replace blood used in transfusions). This practice may be seen in contrast to the current practices of voluntary blood donation used in more developed countries [4]. This article is a case study of blood donation in Khartoum, Sudan, which aim to not only analyses and describe blood donation practices but also to discuss how future ICT initiatives may improve practice. Sudan is one of the countries in Africa most afflicted with diseases that may cause blood loss, these afflictions include malaria, cancer, hemophilia, and renal failure. Moreover, the country is greatly in need of blood to meet the demand for complex surgeries, due to childbirth, traffic accidents, and other casualties.

In Sudan, blood transfusion services are authorized by the National Center for Blood Transfusion under the management of the Deputy Minister of National Health. Every state in Sudan has one or more blood banks, which are responsible for providing blood transfusion services. In Khartoum, the central blood bank (STAC) is responsible for such services. Since 2006, the needs of private hospitals have been covered by STAC's laboratory. This came to be after the government issued an order preventing blood from being sold to private hospitals out of fear that allowing such sales could negatively affect blood donations by volunteers. While every public hospital has a blood bank that is responsible for providing transfusion services, as well as collecting and storing blood, they are all under the management and control of STAC.

In Khartoum, both replacement and voluntary donation are used to meet the high demand for blood. However, family replacement tends to be used more frequently than voluntary donations. According to STAC, only 40% of the blood collected in Khartoum is from voluntary donors. Increased efforts are needed to bring this percentage up to 100%.

Voluntary blood donations are fundamental to maintaining a safe and adequate supply of blood to meet high demands. Additional efforts are required to motivate donors to give more frequently, in order to move away from family replacement donation and towards a voluntary program. This study aims to assist in that shift by investigating the current blood donation practices within Sudan and subsequently exploring opportunities to use information technology to support those practices.

II. RELATED RESEARCH

Many studies have been conducted regarding blood donation, in relation to different topics and from various perspectives, in order to highlight the most important factors for developing and implementing effective programs that motivate donors and improve overall donation rates.

While it is crucial to recruit new donors to replace ineligible repeat donors and deferred donors to achieve a safe and adequate blood supply, blood donation organizations must also focus on donor retention [5]. Increasing the proportion of first-time donors that become regular donors can provide numerous benefits, such as minimizing infections transmitted during transfusions and motivating others to donate. In addition, it costs less to use returning donors than first-time donors and makes it easier to schedule future donations [6], [7].

Studies have shown that medical concerns, fear of needles, negligence, lifestyle barriers, perceived inconvenience, lack of marketing communication, lack of knowledge, and negative experiences are cited as the main barriers and obstacles for increased blood donation [8]–[13].

Eliminating these barriers is essential, particularly for firsttime donors, as previous donation experiences play a large role in shaping one's attitude towards donation [14].

To assess and improve recruitment and retention programs, many studies have investigated the different knowledge levels, attitudes, and practices (KAP) of blood donors and nondonors [8]–[13]. Altruism, repositioning, social pressure, rewards, and advertising were cited as major reasons that people donate blood, while medical concerns, fear of needles, negative reactions to the idea of donation, apathy, busy schedules, lack of adequate publicity, and convenience were cited as major reasons for an unwillingness to donate.

While increasing the number of donations and donors is essential, finding an effective means to manage donor visits is also fundamental and will greatly improve the performance of the overall blood donation system and maintain a reliable supply of blood [14].

In regard to practices, studies found that developing countries depend on replacement blood donors far more than voluntary donors. In addition, fewer women donate than men. Since voluntary blood donations are a fundamental resource for maintaining safe and adequate blood supplies, organizations should make more of an effort to improve the donation experience, reinforce positive KAP, develop health science campaigns to improve general knowledge and attitudes towards donation, and encourage voluntary blood donation through motivational packages and incentives (such as a leave of absence from work, t-shirts, and donation certificates), [8]–[13].

In regard to knowledge about blood donation, most studies found that inadequate knowledge and misconceptions about blood donation and the donation process (such as ideas that giving blood causes impotence or loss of appetite) are common between donors population. In addition, most individuals get the majority of their information about blood donation from their friends and relatives [8]–[13].

Moreover, exploring donor satisfaction regarding the blood donation process is necessary to identify and improve the weak links in the chain of the overall process, maximize donor satisfaction, and determine which donors become regulars (this is particularly important when it comes to young and first-time donors) [15].

In regard to donor satisfaction, reducing wait times and delivering better services are cited as key factors that may help increase the number of donors and frequency of donations. Most blood collection organizations utilize an appointment-based schedule in order to reduce wait times, increase staff efficiency, and improve equipment utilization, thus guaranteeing better service to donors, which is essential to ensure frequent donations and recruit new donors [16], [17].

On the other hand, many communication campaigns use slogans and arguments, such as "save lives", to encourage people to give blood. However, studies have shown that the effectiveness of donation campaigns is heightened when they rely on experimental evidence, instead of generalized arguments, as these slogans do not lead to increased donor returns [18]. Moreover, blood donation rates improve when donations are described as a means of preventing death rather than saving lives [19].

In the past, various forms of media were used to disseminate appeals for blood donors, including cinema slides before films, book covers, postal flyers, magazine advertisements, and posters [20].

Today, social media has completely changed the concept of communication and sharing. In regard to blood donation, social media can reach a broad audience in a very short time and can play a vital role in eliminating misconceptions about the process by disseminating accurate knowledge about donation [21].

Many studies [22], [23], have sought to take advantage of the heavy use of social media to engage communities and raise awareness regarding blood donation by sharing stories about donors and the blood donation process. Doing so creates connections between donors and transfusion services while supporting and developing relationships focused on recruiting and maintaining volunteers by encouraging donors to help tackle shortages.

Although social media has the advantage of being able to reach numerous volunteers, it is limited in its ability to optimize the blood donation process, as most social media platforms provide only one-way communication. Thus, these platforms do not allow for a conversation between donors and blood banks that need donations. Social media is also inefficient if the need for blood is broadcasted to irrelevant potential donors [24].

Advertising alone cannot increase blood donation. Wait times, queues, the location of fixed clinics, and the promotion of mobile blood clinic visits were all cited as pivotal factors that could increase donations [25].

Furthermore, in the age of information technology, smartphones, and other communication technologies represent the advent of tremendous growth. During the last decade, the number of smartphones per person has increased dramatically. In regard to blood donation, this growth can play an important role in information dissemination and supporting the donation process. The WHO announced that the mobile health sector has the ability to transform the face of health service delivery around the world [26].

Globally, various smartphone applications have been released to support blood donation practices and motivate donors to become regulars [24], [27]–[32]. These apps can help blood donation organizations manage and track donor records, find new donors, check donor eligibility, schedule donations, visualize the available bloodstock, and inform users of donation needs in nearby locations using geo-location services.

In addition to the features mentioned above, apps are considered valuable resources for blood donation organizations, as they can assist in planning for future demands and easily remind existing donors to donate more frequently thanks to the fact that most young people have smartphones. This is especially useful since studies indicate that most blood donors are young (more likely to have smartphones) and would like to track their donations [33].

Apps can even help users find blood centers, allow donation centers to advertise their needs, monitor blood bank levels, and map the exact path to reach a donation center using GPS (Global Positioning System).

Although mobile applications provide many advantages, better incentives are still required to retain existing donors and recruit new, less-willing ones. Moreover, most apps do not support multiple languages and use traditional authentication methods, such as social media logins. Because of this, most apps are connected to social networks rather than IT resources, such as laboratory websites or medical devices [34], [35].

While many efforts have been made to improve overall donation rates, blood banks are still struggling to provide adequate bloodstock. In this study, we aim to investigate the current blood donation practices in Sudan and subsequently explore opportunities and challenges for information technology to support these practices.

III. METHODS

In this study, semi-structured qualitative interviews, observations, and the collection of documents were used to gather empirical data on the current blood donation practices in Khartoum, Sudan.

A total of 19 interviewers were conducted with 12 men and 7 women. Each interview lasted for an average length of 45 minutes. Interviews with first-time donors and regulars were conducted at the STAC building. While other interviews were conducted in August 2017 in Khartoum, as part of a collaborative campaign between the STAC and a non-profit organization that donates blood to the children of cancer patients. The table below shows information about the interviewed individuals.

TABLE I INDIVIDUALS INTERVIEWED INFORMATION

Interviewees	Age	Gender	Occupation
P1	30	Male	Civil engineer
P2	22	Male	Student
P3	25	Female	Lab Technician
P4	32	Male	Teacher at Secondary
			Schools
P5	23	Male	Student
P6	29	Male	Architect
P7	35	Male	Web developer
P8	30	Female	lecturer
P9	25	Female	Trainee(banker)
P10	33	Female	Doctor at STAC
			laboratory
P11	40	Male	Employee at STAC
			laboratory
P12	31	Male	Farmer
P13	28	Female	Nurse
P14	29	Male	Sales Representative
P15	26	Female	Graphics designer
P16	30	Male	Doctor at public
			hospital
P17	27	Male	Electrical Technician
P18	29	Female	Human development
			coach
P19	36	Male	Lab Technician at
			STAC laboratory

All interviews were conducted by the first author in Arabic and later fully transcribed into first Arabic and then translated into English. The interviews started by asking the interviewee about his or her perception of the significance of blood donation, and his or her experiences with the process of donating blood. Next, the interviewees were asked about the methods used to notify them about the needs for donations to for example family members or as voluntaries. Then the interviewee and are asked to discuss the advantages and disadvantages of the current blood donation process.

In addition, the interview typically ended on the topic of motivations and barriers that lead to or prevent a donor from becoming a regular.

Furthermore, observations of the blood donation setting and process were also carried out. The first author examined the physical settings for the blood donations in Khartoum and

observed the process by which blood is donated. Specific attention was paid to looks for the limitations of current practices that has negatively effect on donors decision as well as elements that may motivate them.

Finally, data generation included collecting documents used in the process such as forms and lists pertaining to the organization and administration of the process. Both blank and filled out forms where collected and analyzed.

IV. PRACTICES OF BLOOD DONATION IN KHARTOUM, SUDAN

In this section, we will present the findings of the study. First, we will introduce the blood donation setting and process, then we will account for the remainder of the findings under six analytical headings.

A. The blood donation setting and process

In Khartoum-Sudan, blood banks deal with both family replacement and voluntary donation in meeting high demands for blood. In family replacement type, required blood is collected from patient's family, friends or relatives donors while in voluntary donation required blood is collected from volunteers donors. Donation place depends on hospital type (public or private) in which the patient admitted.

In case of patient admitted in public hospitals, donation is conducted at blood bank of the hospital in which the patient admitted while in case of patient admitted in private hospitals, donation is conducted at STAC laboratory building. Beside the responsibility of meeting the needs of private hospitals, STAC laboratory also responsible from collecting blood as voluntary donation from all society members.

In terms of donation process, donors are asked to fill out forms of detailed information such as name, age ,gender ,date of last donation , type of donation , qualification , chronic diseases ,phone number , blood pressure and the desire of being regular donor . After that donors who filled the forms stay to see doctors in order to get approval for donation(doctor's signature or stamp) after passing routine tests such as blood pressure and heart rate etc. Approved donors are checked by laboratory technician to determine their blood type group and ability to donate, and eligible approved donors are getting blood bags labeled with group type and directed to donation room for the process blood drawing or extract specific blood components such as RBC or plasma .

After the process of blood drew, sometimes donors get juice before they leave donation room . Finally, blood banks keep records contains information about the donors who will to be regular donor or donors with rare blood group.

B. Blood donation - public understanding and behavior

From the viewpoint of all the donors interviewed, blood donation is considered a humanitarian act that contributes to saving lives. Since donating also renews a donor's blood cells, some donors view blood donations as a charity and believe they must be done regularly. For instance, a civil engineer said, "I'm donating blood to help and save lives of others. Besides that, donation renews blood cells and makes me active."(P1);

While another donor, a lab technician said, "I think blood donation is a charity for our bodies and must be done regularly for as long as we can." (P3);

Furthermore, reciprocal feelings were noted between most of the interviewees, for some, blood donation is considered a debt that must be repaid.

On one hand, a lecturer as one of the interviewee said, "I think if we reverse the positions, I'm sure those who need blood now would donate to us if we were in need." (P8);

Whilst, a teacher said, "Thanks to the donation of a stranger, I am alive now. I promised myself that I would give blood for as long as I could." (P4);

Moreover, although most of the donors interviewed at the campaign site were happy with their decision to donate, they expressed less satisfaction with some elements of the event, such as the late start and the location change from one hall to another.

"At least tell us when the place is changed." (P1);

On the other hand, a student as one of the interviewee said, "I think they failed to start at the time they announced in the campaign poster." (P5);

In sum, we may say that although reasons for individuals to be blood donors are differ but most of interviewed are understanding the importance of blood donation to help in saving human life. In addition although donating made them feeling good but few of them are frustrated regarding campaign coordinator due to they are unannounced when location changed.

C. Sources of Information and Blood Donation Awareness

According to most interviewees, the primary sources of information regarding blood donation is family, friends, and social media. This situation is probably partly due to the fact that in Sudan family replacement makes up the highest portion of blood donations. In addition, many people had not received any information regarding blood donation from e.g. government agencies or NGOs, especially in rural areas where much of the population is illiterate.

"Today, social media is considered a valid environment to disseminate information regarding blood donation." (p1);

Voluntary blood donation in Sudan is mostly dependent on educated people, such as students, employees, and those advised by their doctors to donate frequently in order to refine their cells or fix problems in their blood. While family replacement donations are considered a moral responsibility, individuals must be given more knowledge about blood donation.

As it can be seen clear in some of the interviews opinions such as an architect who said, "My first donation happened because the doctor said: 'to be healthy you need to donate blood every three months." (P6);

Another interviewee, a doctor at STAC laboratory said, "Many family members of patients are told to donate to their relatives, although they have medical issues that prevent them from doing so." (P10);

Furthermore, there was a consensus among all interviewed donors that misconceptions regarding blood donation pervade the population particularly, especially within the illiterate community. Some tribes in parts of rural Sudan see blood donation as a difficult ordeal and will only do it for their family.

"(....) In east Sudan, the El-Bega tribes consider blood donation to be an act that is rarely done." (P10);

In regard to awareness of the constant need for blood, most interviewees revealed that blood banks typically only advertise their continuous need for blood by asking family members of patients to bring additional donors. Sometimes, blood banks will broadcast their needs on social media to catch the attention of some volunteers.

To spread awareness about the massive need for blood, organizations seem to rely on social media, television, and posters alone. In the case of blood donation campaigns, they largely depend on reposting or retweeting through social media (Healy and Murphy, 2017).

Furthermore, although social media have advantages of reaching and raising the awareness or disseminate the right information about blood donation but community with illiteracy and digital divide may challenged the roles and opportunities offered by social media. In regard to digital divide, find specific methods to reduce these challenges or bridge this gap are feasible and require participation and efforts not only from governments but from all organization in Khartoum particularity those who are concerned with ICT such as telecommunication companies through expanded their networks or facilitate through broadcasting and free messages about the importance of blood donation and high demands for blood .In addition, health convoy or free treatments that are implemented periodically by medical colleges can used to target areas of illiteracy and digital divide in Khartoum.

D. Current Approaches to Promote and Stimulate Blood Donation

There are many strategies used to stimulate and promote first-time donors and regulars, but these techniques differ from one blood bank to the other.

In STAC, complete blood count (CBC^1) analysis is the approach used to motivate volunteer donors. In addition, sometimes donors are given mango juice after completing their donation.

To some of the interviewees, CBC analysis and mango juice are inadequate incentives to become regular donors. This is because, in the case of regular donors, some of their family members may need a blood transfusion in the future. If these individuals commit to donate or bring volunteers, blood banks should ensure there is blood for their family members. Therefore, most interviewees believe that the process of obtaining blood needs to be better than the current methods used by the STAC blood bank. For instance, as one interviewee, a web developer said, "When I need blood for some relative, STAC employees must remember that I am a regular donor." (P7);

Furthermore, only a few volunteer donors prefer CBC analysis, due to fears of discovering undesired problems in their blood, such as AIDS. In addition, the results of CBC analysis require a full day to be determined and these results may only be received by hand. Most donors can't return the next day, due to the high cost in both time and money, especially for those who live far from the blood bank.

While another interviewee, a doctor at public hospital said, "Most donors are afraid of conducting CBC analysis or have no time to return and receive the results of the analysis." (P16);

One way used to further motivate donors and grab the attention of a large numbers of potential volunteers is campaign events, which frequently feature entertainment programs featuring famous singers, poets, musicians, and other celebrities. While many donor candidates attend such events, some have noted that the donation locations are not as comfortable as the locations where people are celebrating and having fun. Donor queues are frequently situated in hot, uncomfortable locations, while other parts of the event have air conditioning and luxurious seating.

Furthermore, a student as one of the interviewed at campaign said, "As you see, we sat in the heat, while others enjoyed comfort." (P2);

Some blood banks and hospitals provide full meals to volunteer donors to ease their anxiety. In the case of family donation, blood banks do not use any kind of stimulus to elicit donations. Family donations are also based solely on the moral responsibility of donors towards their relatives.

E. Assessment of the Current Services Provided to Donors at STAC Blood Bank

For most interviewees, the design of the STAC building was one of the most significant factors that held them back from wanting to become regular donors. Some donors had decided against giving blood because of the building's age and poor design. Many of the rooms and halls allocated to blood donation are inadequate and cannot accommodate a large number of donors.

This idea is supported by one of the interviewee, Sales Representative when he said, "I think the government should replace this old building because it has been there since colonial times and is always overcrowded." (P14);

In addition, P10 as one of the interviewed said, "(.....) always, I see people standing."

Furthermore, the waiting rooms and hallways are narrow, hot, and furnished with uncomfortable chairs. The blood drawing room only has six beds and the room for donating specific components only has two Trima devices. The interviewed donors believed that the waiting rooms should be comfortable and contain some sort of entertainment, such as games or free Internet access, to ease their anxiety and boredom, especially for first-time donors. And that is represented by a farmer when he said, "They should

¹ Complete Blood Count (CBC): is a blood test that gives a complete information about blood cells such as the numbers and shape of cells.

appreciate our visit, and at least offer simple things like drinking water and a comfortable environment." (P12);

While a STAC employee said, "I have visited many countries that provided more than the basic elements, such as comfortable rooms, games, and free Internet to reduce boredom as the result of waiting." (P11);

Some interviewees believe the current methods for recording donor information need to be improved, in order to maintain better blood donation historical records and deliver the best services to donors. Allocating adequate staff members and preparing materials for donors who are expected to arrive can achieve higher efficiency in the donation process. Many donors request specific times for their donations, but many leave without donating as a result of waiting too long.

The majority of the interviewed agreed with this point, for example a trainee said, "Twice, I left without donating due to waiting too long. I have work to do." (P9);

Moreover, some interviewees were frustrated by noncompliance on the part of other donors when it came to maintaining the correct order to see the doctors, participating in routine tests, and entering the blood drawing room.

As one of the interviewed (P7) said, "It is shameful to see some donors when it comes to the correct queuing order."

In fact, the majority of interviewees revealed that they held negative opinions of waiting time and the methods used for queuing donors. Many donors believe that the method by which most organizations document donor information (manually on paper) is severely limited and causes problems, such as increased wait times, difficulty when searching for information, and errors mistakes in the queue order.

Which can be seen in what is said by (P12) that "We filled out the same paper again, which took time, especially since they did not offer pens."

"(....) Identifying which donors must donate soon is timeconsuming and requires them to stop everything to figure out." (P3)";

Most interviewees were unsatisfied by the lack of signboards that could be used to guide first-time visitors. The STAC building consists of many departments, such as the blood laboratory and blood distribution center, which makes it easy to get lost.

Some of the interviewees strongly support this opinion such as (P7) when he said, "A lot of time is wasted trying to reach the donation room. Putting up some signboards is an inexpensive way to guide new donors."

In regard to the blood drawing room, besides being narrow and only able to accommodate six donors, most interviewees and doctors consider the rooms uncomfortable and inadequate to accommodate both doctors and donors at the same time. Moreover, the rooms suffer from a lack of the most basic facilities, such as clean water and sufficient chairs. In addition, it is located on the top floor of the building and there are no elevators.

This is been reflected in many interviewees comments such (P16) when he clearly said, "As you can see, the bed and chairs are old and uncomfortable.

While anther interviewee (a nurse) said, "I think putting all the donation rooms in one place is more feasible." (P13);

In addition, none of the rooms can be customized postdonation to avoid unforeseen consequences or deal with complications during or after donation.

Regarding this point, a lab technician at STAC laboratory as one of the interviewed, said, "Due to insufficient beds and chairs, donors must leave immediately after their donation is complete, which is dangerous when there are complications." (P19);

The STAC laboratory and other blood banks record blood distribution and delivery on paper forms which provides challenges in terms of remote access to information, and in terms of anticipating future demands and exploring the current bloodstock at the STAC laboratory. This method has been criticise by most of the interviewed, as of the interviewed, a lab technician at STAC laboratory said, "We've only used manual recording for all processes up to now." (P11);

As a result of information being recorded manually, the STAC laboratory and other blood banks have trouble preparing lists of donors whom they should stay in contact with and remind about future donations. Also, the current methods of recording make the process of identifying donors, searching for donors, and determining which donors belong to rare groups difficult and time-consuming, as all existing donors are listing in paper notebooks.

In relation to this point, P11 said, "I think donors with rare blood types should be able to donate based on the needs of specific locations, which can be achieved by sharing donor information between blood banks."

In sum, most of interviewed donors are believed current service provided to donors needs improvement including provide adequate staff members and preparation of adequate and comfortable rooms and halls that accommodate a large number of donors. In addition, the current methods used for both recording information and queuing donors are main reasons for them to bee unsatisfied regarding blood donation process due to time waste or non-compliance with ordering queue specially for those connected with other work.

F. Professional-User Relationship and the Recruitment of Regular Donors

Most interviewees stated that receiving professional treatment during and after the donation is one of the essential factors that greatly influenced them to give blood more frequently. In addition, this factor also motivates and stimulates first-time donors to become regulars by positively affecting their decision to return to the service center and voluntarily donate again.

In terms of positive motivations, P4 as one of the interviewed said, "I believe professional treatment from all STAC staff will encourage donors to donate frequently and help recruit new donors."

Although most of the donors positively assessed their relationship with the staff, improvements are still necessary. This includes being attentive and caring towards donors during the blood drawing process, encouraging donors to give

blood more frequently, and motivating donors by providing them with more information about the process.

Furthermore, in regard to improve relationship with staff, a graphics designer as one of the interviewed said, "Although most staff members are professional in their work, some of them are busy with their phones while drawing blood." (P15);

The interviewees considered the current methods of communication between donors and blood banks to be in need of improvement. The practice of recording phone numbers on paper documents is inadequate because a specific donor's phone might have no service when the blood bank calls to request a donation. Furthermore, some donors live far away from their blood bank and may be unable to attend at the desired time. Most donors prefer to make donations at the nearest blood bank to their current location, has been said by an electrical technician that "Sometimes, it is difficult for me to attend, because STAC employee contacts me for donations at inconvenient times." (P17);

As Sudan is suffering from a lack of Rh-negative blood, some interviewees suggested making donor information available to all blood banks. This would allow donors to give to any blood banks in need of blood for transfusion services, which would be especially beneficial for banks in need of rare blood, which is always in demand around different parts of Sudanese cities.

Blood banks not only need a minimum number of regular donors but also must translate existing donors into active donors that can be used to recruited new donors and disseminate information about blood donation throughout the population.

In regard to donor motivation, interviewees mentioned that, with the exception of CBC analysis, blood banks do not use any form of motivation to inspire regular or first-time donors. Furthermore, donors suggested positive motivators that should be increased and negative stimuli that should be eliminated or reduced.

In terms of positive motivation, most interviewees believe that giving donors an award letter, one day off work, a t-shirt, being listed on a social media honor board, and/or free Internet access can provide incentives to donate more frequently.

For instance, P15 said, "I think blood donation organizations should use different motivation methods other than CBC analysis."

Furthermore, some donors believed that building a donor database and creating an appointment system could be used to sort donors based on location and direct blood donation vehicles to those places. Doing so will likely stimulate additional donations, especially from those who are unable to visit the STAC building directly due to a lack of money and time.

As suggestion to support this idea and motivate donors P7 said, "I think transferring services based on donor locations will greatly motivate donors." P12 also tackled this point by saying, "My desire to donate is challenged by the cost to reach blood bank because I live in a rural area of Khartoum."

In terms of negative stimuli that make donors unlikely to return for frequent or second donations, staff members must eliminate the following issues to attract more donors: impoliteness, carelessness, moodiness, and a lack of sympathy. Which been expressed by many interviewees such as P16 said in his critical point of view "I think all staff members are good at treatment and communication, but the employees at reception must be trained."

In sum, professional and good relationship between staffs and donors are essential factors that greatly influenced them to give blood more frequently. Furthermore, using appointment service or allow donors to make donation based to location are positively stimulate them while staff impoliteness, carelessness, moodiness, and a lack of sympathy are negatively reduce their desire to return.

G. Barriers and Obstacles to Blood Donation

Based on observations and interview data, blood donation in Sudan is limited by many factors and faces many challenges. These factors can be divided into two sections: (1) blood donation organizations and staff members and (2) donors.

The interviewees suggested that blood donation organizations should provide services to donors both at the moment donors arrive and during/after donation. Some donors believe the design of the STAC building is a major barrier to increasing the number of donations. Many believe the building should be replaced or altered, as the blood donation department is often congested the waiting rooms are extremely uncomfortable.

For instance, as one of the interviewed, P5 said, "The government must take care of this old building, replace it, or at least customize more rooms to be functional for the donation department."

In addition, blood donation organizations often do not know how many donors will make appointments, which makes it difficult to provide sufficient staff members and may lead to increased wait times. Some donors have an exact time at which they would prefer to donate, which cannot always be respected by donation organizations.

As one of blood donors, P7 explained this difficulty when he said, "I think that the low number of doctors per donors will lead to many donors being late to work or leaving donation centers without making a donation."

While in terms of raising the willing to donate regularly, P6 said, "If I know that there is an exact time reserved for me, I will donate regularly."

When it comes to issues with donors themselves, all the interviewed donors believed that a fear of needles, medical issues, and misconceptions about donation are the main barriers, while bad treatment and a shortage of time to donate were noted obstacles as well.

As an ideas to reduce these problems, P9 as one of the interviewed said, "I think a lot of work is required from blood banks to make people aware of the importance of donation and to eliminate misconceptions."

On one hand, P10 said, "Blood banks should directly contact individuals that have temporal problems preventing them from donating."

On the other hand , as one interviewee, a human development coach said, "To remove obstacles hindering increased blood donations, donors must be treated better and the number of staff members must be increased to reflect the number of donors (instead of using a fixed number of staff members)." (P18);

In sum, blood donation challenged with many barriers and obstacles that limit both donors decision to return and blood donation rates, and a huge work required to eliminate or reduce them .In terms of obstacles, bad treatment, long waiting time to donate and poor design of the STAC building along with lack of adequate and comfortable waiting rooms are cited as the main obstacles whilst fear of needles, medical issues, and misconceptions about donation are the main barriers.

V. IMPLICATIONS FOR DESIGN

Although blood donation is considered altruistic in Khartoum, as the practice contributes to saving the lives of others, this study shows that the current blood donation practices in that region have many limitations. In addition, this study shows that family replacement donations are antiquated and an adequate amount of blood can be saved in blood banks through voluntary donations. Therefore, it is important to consider feasible ways to mitigate the limitations of current practices and improve these practices, while improving voluntary donation rates.

The advent of information and communication technologies has encouraged new and innovative approaches that can be used to improve these practices. The sections below describe potential ICT supported initiatives that attempt to improve the practices discussed above.

Moreover, the tremendous growth of communication technologies presents many opportunities that can be invests in many different purposes within healthcare scoters. For instance social networks and mobile technologies have been widely used to direct efforts towards patient-centric healthcare by involving the patients in the healthcare process [1].

Having indicated the nature of the challenges for blood donation in Khartoum, Sudan, we will now in a preliminary manner point to some potential ways in which these challenges may be addressed, including a reward programs, an appointment system, and mobile apps. These suggestions are as mentioned preliminary and therefore tentative in nature. Having said that, we believe that the ideas stated have potential and may service as a point of departure moving towards an improvement of the current situation.

A. Reward Programs

As described above, the current approaches used by STAC (central blood bank) to promote blood donation are inadequate

and do not raise donor motivation or persuade donors to donate more frequently. Potentially reward programs may provide incentives that can be designed to create loyalty among donors and motivate them to donate more frequently by providing the best rewards to both regulars and first-time donors.

For example, a reward program may contain three modules. First, build and develop a database that aims to record the donation history of each donor and convert that record to a specific number of points. Second, use this database to issue rewards to donors or provide a report to private-sector organizations that can reward them directly for their social responsibility. Third, use SMS to send "thank you" messages to a donor, remind them of their next donation date, and notifying them of any rewards they have earned.

Through this updated system, donors can attend any blood banks in their area, which will now be able to retrieve the past information of existing donors and record new donor information. Once all routine tests have been conducted and saved in the database, donors can make donations and their donation history will be updated automatically. Through SMS modules, "thank you" messages will be delivered to specific donors along with medical advice. When it is time for their next donation, donors will automatically receive reminder messages.

SMS modules can also send donors information about what type of reward they have earned, as well as the date and place they can receive their reward (if it is being offered by an outside organization and not provided at the blood bank).

This reward program can be funded by various social responsibility organizations and may offer prizes such as: one day off work, award letters, t-shirts, being listed on a social media honor board, free Internet, or a training course.

Using a reward program, blood banks can create loyalty among donors and motivate them to give blood more frequently.

B. Appointment or reservation system

As shown above, the current practices of blood donation in Khartoum are limited and negatively affect both donor satisfaction and donation rates. For individuals involved in the donation process, minimizing wait times and avoiding mistakes in queues are essential to increase satisfaction donation rates.

Most current donors are frustrated due to the long wait times and issues with queue orders that lead to noncompliance. Therefore, setting up a streamlined appointment system may potentially allow donors to select timeslots in which they are willing to donate.

The idea is that by implementing an appointment system that is shared among all blood banks, donors can explore more available timeslots and select their ideal time and location to make a donation. A new system would also make the overall process easier for blood donation organizations, as they will be able to arrange their facilities according to the number of donors arriving and make plans for future improvements. Furthermore, with an exact timeslot, donors are guaranteed

not to be late to work or waste their time waiting around without making a donation.

In addition, blood donation organizations can select specific staff members to serve repeat donors, in order to ensure that the best possible service is delivered to those individuals that come to frequently donate blood.

Many potential donors live far away from STAC (central blood bank) and travelling to reach other blood banks costs both time and money. Therefore, if these individuals fail to make a donation due to long wait times, they will remember this negative experience and it will reduce their willingness to donate in the future. The appointment system will help satisfy donors' willingness to donate and motivate them to give their blood more regularly. By setting up a reservation for a specific timeslot, donors can visit donation centers early to avoid road congestion. Moreover, based on the appointment system, blood banks can group donors based on location and send mobile clinics to specific locations with a high number of valuable donors, thus saving donors time and money.

In addition, appointment tickets can serve as receipts that donors can use as documentation to arrive late to work. Finally, an appointment system can be used to shift staff members between multiple locations based on the number of donors expected to arrive in a given day, while also notifying volunteers doctors and lab technicians about a large number of donors (such as those that come to blood donation campaign events).

C. Mobile Apps for Blood Donation Practices

The use of Mobile phones in supporting health care interventions are significant increased in developing countries such as used in dissemination of health information and raising awareness [36]. Moreover, the WHO announced that the mobile health sector has the ability to transform the face of health service delivery around the world [26].

The increasing popularity of mobile and handheld technology that combines powerful computing and communication into a single device, such as personal digital assistants (PDAs) and smartphones, is a valuable asset that can be used to improve blood donation practices and help eliminate misconceptions regarding the donation process.

Smartphones have the capability to process a massive amount of data, which can be used in mobile applications to help complete important tasks. In addition, there are many open-source Application Programming Interfaces (API) available that can be used to design mobile applications that support and improve blood donation practices.

According to the Sudanese National Telecommunication Corporation, the number of mobile subscriptions and Internet users has increased substantially in recent years and most of the Sudanese population now have smartphones (especially the youth, which makes up a high percentage of blood donors). The massive number of mobile subscriptions and Internet users has the potential to create an important opportunity to support and improve blood donation practices in Khartoum.

Moreover, the Sudanese government's development and implementation of e-government programs and the success of existing mobile applications, such as Mishwar and Terhall (an e-taxi service) also indicate that mobile applications can be used to motivate blood donors and improve donation rates.

In regard to blood donation, globally various smartphone applications have been released and aimed to support blood donation practices and motivate donors to become regulars [27], [28–32].

These apps are helped blood donation organizations manage and track donor records, find new donors, check donor eligibility, schedule donations, visualize the available bloodstock, and inform users of donation needs in nearby locations using geo-location services.

In addition to the features mentioned above, apps are considered valuable resources for blood donation organizations, as they can assist in planning for future demands and easily remind existing donors to donate more frequently thanks to the fact that most young people have smartphones. This is especially useful since studies indicate that most blood donors are young (more likely to have smartphones) and would like to track their donations [33].

Designing a mobile app to support blood donation practices in Khartoum may potentially turn out to be a valuable idea because most blood donors are young people, who are more likely to own smartphones and have accounts on different social media platforms. Through these apps, organizations can disseminate the importance and urgency of blood donation, while dispelling misconceptions by spreading accurate information about the donation process.

Furthermore, apps can be used to visualize the current bloodstock at blood banks and motivate donors to make donations to locations where low levels are noted. GPS systems can be implemented within these apps to help donors find the nearest blood donation centres based on their location, show them the exact path to get there and allow them to explore available donation times.

Mobile apps can potentially enable donation organizations in Khartoum to automate their blood donation process by making it simpler to manage blood donor records, find new donors, check donors' eligibility to donate, schedule donation times, and inform users of donation needs in nearby locations using geo-location services.

In sum, ICT present many opportunities that can used to support and mitigate the limitations of current practices upon blood donation . Using a reward programs donors can be motivated to donate more frequently through many incentives based on the individuals preferred. In addition , in regard to donation process, appointment system and mobile apps are feasible and valuable to improve the weak points throughout blood donation journey because these points are tightly connected with donors satisfaction and wiliness to retune and make second donation.

VI. DISCUSSION AND CONCLUDING REMARKS

A deep understanding of blood donation practices is essential to maintain adequate and safe bloodstocks that can be used to meet the high demands for blood in Sudan and

elsewhere. Furthermore, satisfying these demands may be primarily based on voluntary blood donations.

In this study, we aimed to explore the current practices of blood donation in Khartoum, Sudan, in order to obtain a clear picture about the current situation and suggest ideas to help improving donation practices in that region.

We found that family replacement donations were used far more than voluntary donations when trying to meet high demands for blood. According to STAC, 60% of blood donations in Khartoum are from family replacement donors. Thus, stronger efforts are needed to increase the percentage of voluntary donations to 100%. These findings were very similar to studies conducted in Egypt [37] and India [38], where family replacement donations make up 87% and 85.2% of the blood supply, respectively. Furthermore, these findings are also consistent with sub-Saharan African countries [38], where family replacement donations make up 80% of the blood supply. However, our findings were dissimilar to studies conducted in Thailand [39] and Kenya [40], where family replacement donations make up only 29% and 36% of the blood supply, respectively.

In this study, we determined that the most powerful incentives to make people become blood donors are altruism and helping save the lives of others. This finding was consistent with other blood donation studies [8–13]. Moreover, these values seem to be found throughout the Sudanese community, particularly within the educated sector, which is almost always engaged in voluntary activities.

Additionally, this study indicated that family, friends, and social media networks are the main sources of information regarding blood donation in Khartoum. This finding was similar to the finding revealed by a study conducted in Pakistan, which showed that 65% of respondents indicated that they primarily received information about blood donation from their friends and family [13]. However, this finding did not match the findings by studies conducted in Uganda [41] and Nigeria [42], where mass media was considered the main source of information regarding blood donation. This finding was also dissimilar to the finding of an Ethiopian study that designated pamphlets as the main source of donation information [43].

Due to family and friends representing the main source of information regarding blood donation in Khartoum, this study found that misconceptions regarding the donation process pervade the population, especially among rural areas and within the illiterate population. These misconceptions ranged from a lack of knowledge about donating to misinformation about donating that decreases the willingness of people to contribute. These findings were supported by studies conducted in Saudi Arabia [44], where a higher rate of infections being transmitted is cited as a common misconception, and Nigeria [45], where donors fears contracting HIV and/or hepatitis as a result of blood donation. Furthermore, the present study found that some Sudanese tribes consider blood donation difficult and will only take part to help their direct family members. Although some studies revealed that many Sudanese women believe the misconception that blood donation will lead to menstruation problems and a loss of fertility [44], in this study, we observed a large number of women donating blood at the campaign event held on 19-8-2017 and were reassured that the majority of them were educated on the donation process.

This study highlighted many incentives that can be used to motivate and encourage new and existing donors to donate blood. We found the current incentives used by the STAC blood bank to be inadequate. The donors we interviewed suggested many ways to motivate them to donate more, such as giving out award letters, allowing donors to take one day off work, giving out t-shirts, listing donors on a social media honor board, providing free Internet access, and honoring frequent donors in some way. The idea of providing incentives to donors is supported by studies conducted in Saudi Arabia, where (the mostly young) donors preferred to receive token gifts as incentives for donation [46], Nigeria, where donors preferred to receive certificates [45], Iran [47], where male donors prefer receiving free blood tests, and the USA, where more than half of donors prefer free health checks [48].

Although incentives can positively boost the attitude of donors, the extent to which incentives can attract and facilitate repeat donation is unclear. In addition, incentives may negatively affect donor motivation when they are removed and could jeopardize overall blood safety by attracting higher-risk donors who conceal information to obtain said incentives [49], [50].

In terms of blood donation barriers, the most common were a fear of needles, medical issues, lifestyle barriers, and misconception about the donation process. These findings were supported by most other blood donation studies [8–13].

The satisfaction of blood donors is an important factor that strongly impacts whether or not donors will become regulars. The satisfaction of existing donors can also attract more firsttime donors. In this study, we found that, although the relationship between donors and blood service organizations are good, the number of donors that come to donate at a single time has a direct negative effect on overall donor satisfaction, due to increased wait times and disorganization. Furthermore, we found that paper notebooks are being used to manually record donor information and queue orders. Such methods are inadequate, as they lead to many problems that decrease satisfaction, such as increasing wait times, exacerbating errors in the queue order, and making it difficult to keep track of donors that have come in and which should be contacted for future donations.

Therefore, to increase the blood donation rate, organizations must use appointments to minimize wait times, connect with donors' places of work to ensure they can take time off for their requested timeslots, and send mobile blood collection units to areas with higher concentrations of donors. These methods will leave donors more satisfied and willing to become regulars.

These findings are supported by similar studies conducted in India, where blood donation practices are seen as an

important factor for determining future donations [51]. Studies conducted in Saudi Arabia indicated that a lack of time to visit donation centers was as the primary reason that many individuals chose not to donate, as men in that country are obligated to fully satisfy their family's needs [46], while, in the United Kingdom, loss of leisure time was cited as the primary reason for not donating [52].

VII. CONCLUSIONS

In conclusion, we may say that in spite of the increasing number of donations, blood banks in Khartoum, Sudan still rely more on family replacement donors than voluntary donors.

The current practices of blood donation in the region suffer from many limitations that represent a challenge for blood banks, which must meet high demands for blood. In addition, blood donors are unlikely to donate repeatedly due to a lack of motivation. We have in this article indicated the nature of these challenges and in a preliminary manner pointed to some potential ways in which these challenges may be addressed, including reward programs, appointment systems, and mobile apps.

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