



USER FRIENDLINESS OF NEAR-FIELD COMMUNICATION

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ABSTRACT

Near-Field Communication or NFC is a new technology that was introduced in recent years. However, even with the simplicity and security that the technology provide, the adoption of this technology is not widespread. In this paper, we describe the user-friendliness criteria essential for NFC technology through a proposed library system. To determine the criteria of user-friendliness for the technology, we conducted a survey on the understanding and usage of different users that would be exposed to a library system. The survey included questions about the existing library system (OPAC) and their perception of the NFC technology. Based on the results, we managed to identify that the OPAC system is not a user-friendly library system. Further, we have also identified that there are three main user-friendliness criteria deemed necessary by users for an NFC-enabled library system to be more effective than the OPAC system: usability, security and efficiency.

Keywords: near-field communication, OPAC system, radio frequency identification (RFID).

INTRODUCTION

Over the last few years, one of the emerging communication technology introduced within mobile devices is the Near Field Communication (NFC) technology. Most of the devices in the current market such as smart phones, tablets, and even cameras have been embedded with the NFC functionality. NFC is a newly introduced wireless technology that evolved from the Radio Frequency Identification (RFID) technology. Both NFC and RFID are bidirectional short-range communication tools. The contactless interaction between two NFC-enabled devices is approximately 5-10 cm [1]. The technology uses radio waves to identify, track devices and send data in a near-field approach. The technology is widely used as a contactless payment in some grocery shops, food outlets and as a ticketing method for public transportation [1]. The NFC technology is also implemented in library systems in Japan. The Saitama Prefecture in Hanno, Japan has utilized the NFC technology [2] within their local library. Around 100 tags, or known as "Tatchitagu" is placed on the shelves where the tags contain the necessary information about the specific books. The users are able to review the books or recommend it to another user via the tags.

The term, user-friendly alludes to ease of use even by new users. As such, the learning curve for each new application or technology should be reduced as much as possible [2]. In order to achieve this aim, a user-friendly application would have to take into consideration the effective development of the Graphical User Interface (GUI) to suit the needs of users. As an example, the existing library system utilized widely is the Online Public Access Catalog (OPAC). However, as most existing research have found that although the system has a number of functionalities, it does not achieve an acceptable level of user-friendliness required by users. This is due to the complex multi-leveled options built into the GUI coupled with the low legibility, as the font is small and sometimes incomprehensible for the average user [3]. In order to

overcome the system weakness, we have proposed an NFC-enabled application. This is due to the high number of users, especially students that possess a number of NFC-enabled electronic devices such as smart phones. The proposed system could mitigate or even achieve an acceptable level of user-friendliness in terms of borrowing books in an effective manner. As such, this paper will focus on the user friendliness of the NFC technology.

The rest of this paper is as follows: Section 2 examines the existing research related to the user friendliness of NFC followed by Section 3, which highlights the user-friendliness criteria that the NFC technology could provide. The next section then provides an overview of the proposed application that includes a comparison between the proposed application and the existing OPAC system. The comparison is based on the criteria of user friendliness identified in section III. The results of our survey along with the discussion concerning to the user-friendliness of NFC technology is described in section 5. Finally, we outline the conclusions gathered through our research on the user-friendliness of NFC.

RELATED WORK

The role of design in developing an NFC-enabled application is essential as developers need to understand the required design guidelines in order to attract users while achieving a favorable level of usability. Köbler *et al.* [3] have highlighted their initial findings from a number of design guideline case studies related to NFC-enabled application. Their case studies provided results from four main areas: 1) NFC technology and application, 2) tag infrastructure, 3) human factors and lastly 4) device. The guidelines were developed as an initial step to designing a better application and at the same time to satisfy the user's demands. Based on their findings, simplicity is considered an essential criterion within the design context. The simplicity of an application would increase the user friendliness of the system as it is easy to use which will continue to attract users to utilize the application [3].



As the majority of current users have their own views and interests; any system, application or devices that have a usable interface are important. This is because an interface initiates the initial interaction with the users [3]. Based on this understanding, Riekkilä *et al.* [4] proposed utilizing NFC-based user interfaces as part of an interactive space, which provides a variety of services depending on the space needs. They had tested more than twenty prototypes, which utilized NFC-based user interfaces and found that most applications tested used NFC to achieve a simplistic method of interaction. This method of interaction provides users with an ease of use and additional functionality as the users have the ability to control the services that they need at a specific time. There have been numerous experiments and applications based on the NFC technology in achieving an intelligent and pervasive environment depicted in many future planned environments [4]. Nasution *et al.* have built a prototype train ticketing application by utilizing the NFC technology available on Android devices [5]. The application utilized the NFC as a means of performing virtual transactions instead of utilizing money. The ability to initiate quick transactions is helpful in minimizing queues at the ticket counters, as daily ticket transactions at a train station are considerably large. The prototype application depicts the user friendliness of using the NFC technology because users are able to save more time in purchasing tickets instead of wasting time queuing. This usability-based research is also supported by a similar research conducted by Juntunen *et al.* [6]. They conducted interviews with development experts to analyze the deployment of mobile ticketing services, which utilized the NFC technology. In the interviews, they found that the ticketing service is made easier and quicker to use for users. The ticketing service is also convenient for the user as the user could purchase their travel tickets any time and at any place [6]. Additionally, there are researchers that have proposed the development of NFC-enabled applications to perform university-related activities in a pervasive manner [7, 8]. Bueno-Delgado *et al.* [8] also carried out similar relevant research where the impact of the NFC technology within a university environment is examined via a survey. Their research aim is to create a technological environment for the university's activities to interact in a natural way in a pervasive computing environment based on the NFC technology. The results that they have managed to gather through their survey shows that most university students and employees are confident with the implementation of the NFC technology in the university environment after a brief explanation was provided. The brief explanation on NFC was provided due to the low visibility of NFC-enabled technology among many users. However, 79% of the respondents are still apprehensive about the security aspect of NFC related payments.

Another research conducted by Monteiro *et al.* [9] has proven that the NFC technology is safe to be utilized use in a payment transaction. They had experimented with a simple application, which enables the transfer of mobile credits between two mobile phone sim

cards using two different communication tools, which are NFC and Bluetooth. Their research highlighted that the transaction between NFC-enabled devices are much safer, reliable, and trusted for credit exchange rather than relying solely on Bluetooth. This is because NFC requires the user to be physically touching the intended mobile device for the transaction to be a success. The low range of the NFC technology also eliminates the possibility of an unintended user or hacker to receive the credit. A study by Majors [10] on the end-users successful rate to complete common library tasks without any help using the existing library system, the Web OPAC interfaces. He discovered that end users were having problems with typing errors, high searching failures with truncation as well as early session termination. Based on this result, Borrego-Jaraba *et al.* [7] proposed an NFC solution for accessing required learning bibliography by using the ontology specification of the IMS Learning Design. The application provides effective bibliography accessibility to the students in locating the physical sources recommended by their lecturers. Students are able to access relevant book information by utilizing their NFC-enabled devices to read the NFC tags on the relevant resources such as books. The information is then displayed on their NFC enabled devices for their usage. The user will be able to perform specific actions such as obtaining advice or guidance for a subject, retrieve information about the recommended reading source and, acquire reviews for the intended books. These actions are beneficial in providing additional learning support to students in their studies.

The User-Friendliness of the NFC Technology

There are a number of criteria in order to evaluate the user-friendliness of an NFC technology such as usability, security, and efficiency. The usability of NFC can be measured by the simplicity of use achievable with the technology. This simplicity criterion examines the ease of use and the learning curve required by end-users to successfully utilize NFC. In order for any technology to be deemed as usable, the technology is required to meet a certain condition. If the end-user has a negative perspective on NFC due to the high learning curve, it defeats the required usability criteria. This supports the simplicity of NFC, where the user only needs to activate the NFC feature or application and tap on the device or tag intended for a specific activity. It is a simple and most direct way of conducting specific activities without the need of the user requesting or approving the activities. Users are only required to activate the NFC feature on their device and tap their device to another device or tag to execute an activity.

This first criterion, simplicity of use is achieved with the NFC technology through the peer-to-peer mode. The peer-to-peer mode works when any NFC device is being tapped to another NFC-enabled device or tag. This mode only requires the NFC feature or also known as Android Beam on the device to be turned on. The usage instruction is intuitive even for a first-time user. The short range of the NFC communication of approximately 10cm



simplifies the connection between devices and also increases the level of security as well for any specific activity. Communication among NFC-enabled devices occurs when the magnetic inductive coupling transfers the energy and data from one device to another NFC device. This makes the NFC function to be simple as only a tap is required to connect two NFC devices or a device with an NFC tag or active NFC reader.

The second criteria, security is derived from the feature that NFC is not vulnerable to eavesdropping, data corruption or manipulation, interception attacks, and even theft. The short-range communication overcomes the probability of eavesdropping from occurring, as the range is too short for intended attackers to intercept the signal [11]. The privacy of a user is also well protected as the data has been encrypted before the transfer and only the authorized device can decrypt the data. Further, NFC is considered secure, as it requires fewer actions from a user. The enabled devices will automatically connect to each other when they are within the effective range of each other. This promotes a sense of safety for the user as performing excessive actions may corrupt the transaction. The low actions required for a specific activity may attract users in using the NFC-enabled application repeatedly. This is coupled with the easy navigability of NFC could allow the technology to become one of the favorable features of any NFC-enabled device. The third criteria, efficiency completes the required criteria to assess the user-friendliness value of an NFC technology. As highlighted in the previous section, the NFC technology can be embedded in various types of applications or systems such as library systems, ticketing systems and even payment systems. The NFC feature also varies according to the functionality required by an application. There are three modes available in NFC as shown in Figure 1. From the perspective of a developer or an advanced user, the read/write mode is more suited as the mode allows an administrative related activity to occur. For example, a library system that requires the librarian to write the ISBN in the NFC tag to allow the borrowing transaction to occur. The second mode, peer-to-peer mode is the standard mode that occurs between two NFC-enabled devices as highlighted earlier, while the third mode, card emulation could be utilized when the application requires the device to act as an NFC card. This would allow the device to be read by an external NFC reader as an emulated NFC card [12]. The card emulation mode and peer-to-peer mode is the standard mode that most users would be used to.

As highlighted in the previous section, there was recent research conducted on NFC within the context of a university environment. By taking into consideration that most of the possible NFC users consist of the more technology-inclined generation [5, 14], we decided to focus on the university students in order to highlight the user-friendliness of the NFC technology. A survey was conducted among the university students where we utilized a library system as an initial comparison case between a proposed NFC-based library system with the

existing Online Public Access Catalogues (OPAC) library system. The system was selected due to the higher chance that most students would utilize the systems and the NFC technology during their studies at university



Figure-1. Three modes of NFC transaction.

Overview of Application

The study of user friendliness or user-friendliness in this paper is more focused on the usage of NFC within a library environment. The OPAC system is the existing system that is widely utilized by most libraries while the NFC Library application is a prototype developed based on related research on the NFC technology [7].

The OPAC System

OPAC is a stand-alone online catalogue of a library's collection that is made available to the public. The system works as an online database where details of a library's book collection, such as the book's title, author's name and location of the book are stored. Based on a study by Zainal *et al.* [13], the users of an OPAC system frequently faced issues such as typing errors, ineffective advanced search results and minor confusion with the truncation based searches. Additionally, users are found to have problems with the library terminology implemented in the OPAC interface when using the system [10]. The common jargon utilized in the OPAC system is confusing to the average user and this leads to a decrease of the system's user friendliness. A similar research conducted by Thanuskodi [14] found that the OPAC system does not provide crucial features such as online book reservation and an effective online help guide. The findings from the research recommended that the OPAC system should be more user-friendly by implementing an online help that guides users to start a search in a more effective manner. In order to borrow a book, a user searches for the location of the book through the OPAC system and note the call number for the books required. After the user has successfully found the required book, the user heads to the counter to have their books scanned so that a record of the books can be tracked by the library. This process requires a librarian to operate the borrowing book system, which may consume time, especially if there is a long queue of students.

The proposed NFC Library System

The NFC Library application is developed with the NFC technology embedded in the system to enhance the users' experience in the library. The application



simplifies the borrowing process with the assistance of the technology. In order to borrow a book, the user is only required to tap on the NFC tag as shown in Figure-2. These tags would contain the International Standard Book Number (ISBN), which acts as a unique identifier. Once, the tags have been updated with the related information, the tags are pasted on the book covers for the user's easy access. The borrowing process does not require any involvement from the librarian. The user is able to perform the borrowing transaction by themselves through their NFC-enabled device. Figure-2 also shows the page that will appear when the user's NFC device is tapped on the NFC tag. Besides enhancing the process of borrowing a book, the NFC technology could also be utilized to search for the details of a book. For example, Borrego-Jaraba *et al.* [7] provides a solution to access bibliographic sources through the implementation of the NFC technology. The tag stores relevant information such as the author name, synopsis of a book and opinions or recommendation by the user if it was available.

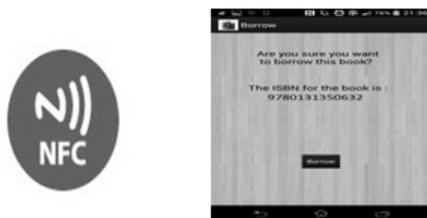


Figure-2. NFC tags; The borrowing book interface on the NFC library system application.

Once a user has initiated the borrowing transaction, the details of the borrowed book would be stored on their mobile device and transferred to the library system through a wireless connection. Every user who is leaving the library are required to tap their mobile device onto an NFC reader device, which would be installed at the exit of the library. This allows the library system to verify whether a book is being borrowed by the user. When the library system has successfully captured the information, the security doors at the exit would open to allow the user through. If a book that was not captured on the system is passed through the reader device, it would trigger the door alarm which would then alert the librarian.

User-Friendliness comparison between the OPAC and NFC Library System

In terms of usability, the NFC Library system application is easy to use and provides an effortless interface for the users. With the implementation of NFC in a library system, the borrowing transaction requires fewer processes from both the user and librarian. Unlike the OPAC system, the user is not required to go to the counter and queue in order to borrow their intended books. At the same time, the task of a librarian can be reduced, which would allow them to focus on other tasks such as shelving and late returns. The borrowing process is more efficient and consumes less time with the implementation of the NFC technology. The NFC Library is more feasible than

the existing OPAC system. The user can navigate through the application easily as the application is simple. The menus and icons used in the application are easier for the user to understand as it is consistent with the terms utilized. The use of graphical icons to replace plain buttons makes the application more attractive and legible. With a simple tap on the tags, the user would be able to continue with their related library activities such as borrowing books without much stress. The prototype for the NFC Library system is a mobile-based application while the OPAC system is a web based application. Most users are more inclined to mobile applications rather than web applications [15]. This is due to the accessibility that users are able to achieve as long as there is an available mobile internet connection. Incidentally, users can easily execute the NFC-enabled application through their smart phones without the need for a larger electronic device. Hence, the NFC Library application is more user-friendly than the OPAC system, as it require fewer actions from the user while striving for an efficient library process for users.

RESULTS & DISCUSSIONS

Due to a limited time constraint, this research has utilized a quantitative method in order to collect the results for the initial comparison case. The survey was conducted in order to find out the level of knowledge among the respondents about NFC technology and the existing OPAC library system. Additionally, we aim to identify the respondents' concerns about the potential of NFC technology in terms of user friendliness while becoming an essential system in the near future. The survey also focused on the user acceptance of an embedded NFC technology within a library environment. The survey was open to all university related respondents for about 3 weeks. This have led to around 50 respondents, with a majority of them being university students, taking part in the survey. The study was carried out with nine close-ended questions and one open-ended question. Question 1 and 2 revolves around the existing OPAC system where the respondents was enquired about their knowledge of what OPAC is and its function. Figure-3 highlights that 68% of the respondents are aware of the OPAC system and its functionality.

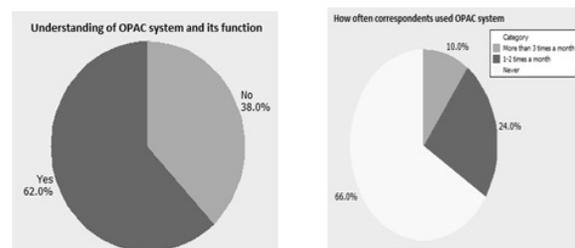


Figure-3. Understanding of the OPAC system and its functions; Frequency of OPAC system usage.

Figure-3 also highlights how frequent the respondents utilize the existing OPAC system. Around



66% of the respondents have never utilized the system. This result seems to support the initial results from Zainal *et al.* [13] and Thanuskodi [14], which relates the ineffectiveness of the OPAC system to the complicated GUI. Questions 3 to 10 are more focused on identifying the respondents' perspective towards the NFC technology. The survey highlights that the majority of the respondents do own an NFC-enabled device (67.6%). This shows that most of the respondents are utilizing an Android based device as the NFC technology is widely implemented on that platform much earlier before other mobile platforms. As for the respondents who do not own an NFC-enabled device, the likelihood of them upgrading their devices in the next few years is high as the leading mobile phone operating system utilized in Malaysia, as highlighted by the Malaysian Communications and Multimedia Commission (MCMC), is Android at 79.2% in 2012 [16]. When the respondents are enquired about their understanding of the NFC technology, around 28% correspondent is not aware of what the technology is while 72% are aware of the NFC technology. This result supports the initial assumption that there is a higher awareness of NFC among university students. The remaining questions in the survey are geared towards respondents that are aware of the NFC technology. Most of the respondents obtained information about NFC through the news (27%) followed by their friends and through other channels (24.3%). The 'Others' category represents sources that the respondents are able to get from the internet, lecturer and through their own searches either online or offline. The survey also highlights the experience among the respondents in utilizing an NFC system. A majority of them (59.5%) has had some experience in using the technology before the survey was conducted. However, in terms of length of time, most users utilized the technology on a trial basis as it a standard feature embedded in their smart phones. For the next question, we provided them with some usage examples on how the technology is utilized. For example, the NFC devices only require the user to tap to an NFC-enabled device or tag in order to initiate a communication. Thus, fewer actions required by the user's initiation will save time as most of the activities rely on the instructions and activity requested at the specific time. We found that 92% of the respondents agree that the based on that usage example, NFC does save time to the simple interaction. When the respondents was enquired on the implementation of NFC within a library environment, most of the respondents agreed (64%) that the implementation of NFC would positively assist in simplifying the borrowing process. The rest of the respondents were unsure (28%) if the technology would be beneficial while another 8% stated that the technology would not assist in simplifying the borrowing process. Hence, the results depict that the low NFC implementation of daily users' activities, may have hindered the respondents' perspective on the benefits of NFC. The last question examines the feedback from the respondents on what is the potential of the NFC technology in becoming a widely used technology in the future. Some of the

respondents mentioned that NFC could well be the next big technological break as long as improvements in the areas of convenience, faster transaction rates and enhanced security for this technology are made. On the other hand, the remaining respondents were unsure or chose not to respond to the question. Additional in-depth research would be required in order to explore this mixed perspective among the users.

CONCLUSIONS

Nowadays, more technologies are being developed in order to make our lives easier. The user friendliness of utilizing such technology will allow the technology to remain popular among users. At the same time, ensuring that a satisfactory level of efficiency for users utilizing the technology is also essential. From the survey, we have managed to highlight that NFC is a technology that is capable of providing a user-friendly environment for users. By comparing two different systems (the OPAC system and a prototype NFC library system application), we have provided an initial result that shows most of the respondents are inclined to utilize NFC if given an opportunity to do so. In addition, NFC has a much larger compatibility potential with the library system, as it requires fewer technical requirements and provides a direct method for users to conduct their library activities effectively. The implementation of NFC function will definitely improve the capabilities of the library system as it is much easier to use and compared to the OPAC system. This is because the NFC technology requires fewer actions from the users in order to access information about a book and it utilizes an existing technology, which is embedded in most smartphones today.

In conclusion, students are more likely to visit the library as the traditional method of borrowing books is made easier through the implementation of NFC. The library system that is embedded with NFC allows the users to access the library system through a combination of their NFC-enabled devices and tags, instead of a larger device such as a PC. However, as highlighted by the last question in the survey, additional in-depth research is required in order to identify the different perspectives on NFC among users as well as possible methods of implementation that may lead to a successful and wide integration of the technology in our daily activities.

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