

System of digitizing and paying of civil status documents via an RFID card

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Abstract

Nowadays, with the remarkable advancement of technology in almost all fields of activity, we notice a considerable decrease in data search time. Thus we are witnessing the birth of new technologies and applications that continue to make our lives easier and in the most beautiful ways.

However, the computerization of systems remains a valuable aid, particularly in the field of administrations such as civil status. At the time, before the idea of computerizing civil status in Senegal, all citizens' files were managed on paper. Which continued to create problems within these services (loss of transcription, loss of time for research), queues and jostling. We had to make an observation that all civil status documents, in any case a good number in the world are computerized so that obtaining papers has become simpler than usual while in Senegal obtaining civil status documents is generally done on paper, but there are areas where the process is digitalized.

First of all, the user presents the badge or RFID card which is scanned by the RFID module and the system checks the existence of the card at the database level. Then, if the card is registered, it connects to the network in order to access the web page to enter its password. And finally the person obtains his request if the password is correct.

The account is recharged manually by the platform administrator or automatically by the user via mobile money operators such as Orange money, Wave and others.

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Keywords: RFID card, civil status documents, paying, IoT (Internet of Things)

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1. Introduction

Civil status is the designation of the administrative services of a municipality that collect all declarations allowing individuals to be identified in a territory. It is a set of rules that are both legal for recording births, marriages and deaths in the registers in a continuous and mandatory manner, for keeping, and for issuing copies of information relating to events related to civil status. More precisely, civil status records the status of a person, it is the situation of the person in the family and society, the result of a written administrative identification procedure. Civil status

documents therefore have the role of recording all important events that mark the life of a natural person such as birth, filiation, marriage, divorce or death for example. Civil status, particularly in Senegal, is often faced with certain difficulties that are closely linked to its mode of operation.

Indeed, most civil status services use the manual method for recording data, which can lead to several problems, including errors or inaccuracies in the data and cases of loss or destruction of data due to poor archiving. This manual method also affects the recovery and payment of documents and directly affects citizens, especially since they are forced to travel to obtain their papers. This can lead to long and tedious administrative processes and cases of corruption that can lead to

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unjustified delays or refusals in the processing of requests.

To put an end to this scourge, we propose a system for digitizing and paying for civil status documents throughout the Senegalese territory via an RFID card to manage the obtaining of said documents simply and efficiently.

2. State of the art

Civil status is both a fundamental element in the lives of citizens and an essential source of demographic data. Consequently, the modernization, computerization of centers, securing data and civil status facts must occupy a prominent place in public policies and economic and social development strategies of the country. Indeed, with the evolution of new technology, IoT (Internet of Things) offers many advantages for businesses, governments and consumers, particularly in the collection, transmission of data in real time, optimization of processes and remote monitoring. Combined with RFID (Radio Frequency Identification) technology, they can create unique identification solutions to secure and easily access data but also to actively monitor data. Thanks to these new technologies, civil status will be seen in a new light, a new era of IT thus solving certain problems related to services. [1]

Despite the efforts made by the State and its partners, the problem of civil status and its reliability is acute in Senegal. Every year, thousands of citizens struggle to recover their papers due to the loss of their documents at the civil status office, painful and endless administrative procedures, dishonest embezzlement or due to false numbers. Between negligence or ignorance of the importance of the civil status document which is a right and the remoteness (rural area) of registration centers and recurrence of forgery, the evil is deep and Senegal has continued to get bogged down in it since independence [2] and [5]. This problem is all the more important since examples of voluntary degradation (acts of vandalism) or not (poor archiving conditions combined with wear and tear over time) of civil status documents exist with all the harmful consequences for the citizens who are victims and who thus find themselves unable to obtain, for example, a birth certificate. This situation could have been avoided if the civil status system was modernized, computerized and more secure in Senegal. This is where the idea came from to design a system for paying for and retrieving civil status documents via an RFID card.

The optimal implementation of such a project requires a good prior understanding of the situation of the civil status registration and statistics system

in quantitative and qualitative terms. Indeed, the availability of such information will make it possible to have a dashboard and to carry out reliable comparative analyses during the different stages of the project in order to measure successes, failures, to understand the success factors and constraints in order to propose appropriate corrective measures. Consequently, carrying out a diagnostic study of civil status centers in Senegal becomes a priority before any intervention with a view to modernizing the system. In order to achieve this solution for modernizing the system, we must ensure the following objectives [3] and [4]:

- Each citizen must have an RFID card.
- Each card must be linked to an account that can be filled in terms of money at the level of each civil status.
- Each account is located at the level of a web server. It is the web server that manages the accounts and transactions of citizens. -Each citizen must have an Arduino device that is connected to the web server.
- To retrieve his documents, the citizen must present himself with his card at the system level and this will display the card identifier and an IP address that he can then type at the web server level to access the platform.
- The server will verify this account and from there it can cross-check the price according to the type of document chosen, if of course all the conditions are met.
- A return without failure will display a payment confirmation notification and print the chosen document, the citizen will therefore be able to retrieve his papers and check the changes to his account.

3. Presentation of the RFID Card and some programming languages

3.1. Connecting the RFID card

The RC522 RFID module uses the SPI protocol to communicate with the ESP8266. SPI communication uses specific pins on this type of microcontroller. In order for the RFID module to read a card, we will connect the RFID [6] and [7] and the ESP8266 using this pinout method (figure 1):

3.2. The PHP Language

PHP (HyperText Preprocessor) which is a scripting language works on the server side. It is mainly used to

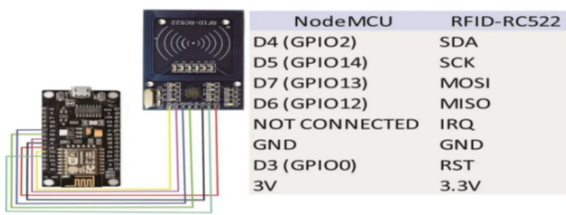


Figure 1. NodeMCU-RFID pinout

produce dynamic web pages via an HTTP server, but can also work like any language interpreted locally. PHP is an imperative Object-oriented language.

The first pages of the Web were static and based on simple HTML code. PHP has made it possible to create a large number of famous websites such as Facebook and Wikipedia. This is why it is considered a basis for creating so-called dynamic websites but also web applications. On a technical level, PHP is most often used on the server side. It generates HTML, CSS or XHTML code, data or PDF files. It has been the subject of specific development for many years and now enjoys a good reputation for reliability and performance. It is multiplatform: as much on Linux as with Windows. It easily allows the same code to be repeated on a roughly similar environment. It is free, easy to use and install. This language requires, like any programming language, a good understanding of the main common functions as well as an acute knowledge of the security problems linked to this language [9].

3.3. FPDF

FPDF is a PHP library that allows you to generate PDF files from PHP data. It is an open source and free solution to generate PDFs dynamically on a web server without going through the PDFlib library or external libraries. F in FPDF means Free: you can use it for any type of use and modify it according to your needs. FPDF has other advantages, high-level functions, here is a list of its main features: Choice of measurement unit, page format and margins, Management of headers and footers, Automatic page break, Automatic line break and text justification, Image support, Colors, Links and Page compression. FPDF is therefore a free PHP class that allows you to easily create PDF files directly from PHP [9].

3.4. HTML

HTML is a computer language used on the Internet. This language is used to create web pages. The acronym stands for HyperText Markup Language. This meaning is apt since this language allows you to create hypertext based on a markup structure. It is not strictly speaking a programming language, but rather a language that allows you to format content. Tags allow you to format

text and place interactive elements, such as links, images or animations. These elements are not in the source code of a page coded in HTML but "next to" it and the HTML page only uses these elements. To view an HTML page, you need to use a web browser. Some computer languages are associated with an HTML-coded page. For example, CSS allows you to format the content of an HTML-coded page. There are also computer languages that depend entirely on HTML such as JavaScript [9], [6] and [7].

3.5. CSS

CSS (Cascading Style Sheets) is a computer language used on the Internet for formatting HTML files and pages. Translated into French as cascading style sheets, CSS is presented as an alternative to formatting via tags, particularly HTML. CSS allows in particular to make web pages responsive design, but also to create an interface design perfectly adapted for users. A little more complex to master, it allows a considerable saving of time in the formatting of a web page compared to these tags. Thanks to CSS, you can indeed apply formatting rules to several documents simultaneously. In terms of the design of a web page, CSS also allows to separate the presentation of an HTML page and its structure. HTML will therefore create the structure of the pages while CSS will allow us to modify the appearance of the contents of the page [9], [7] and [6].

3.6. JS

JavaScript is a scripting programming language mainly used in interactive web pages and as such is an essential part of web applications. Along with HTML and CSS, JavaScript is at the heart of the languages used by web developers. A large majority of websites use it, and the majority of web browsers have a JavaScript engine to interpret it. The JavaScript language is mainly used to improve the ergonomics of a website and/or a user application interface. It is also used to integrate aesthetic effects, however rarely essential. Its main interest lies in its mode of operation: the JavaScript language offers the possibility of executing a code without being forced to reload a web page. In this way, it plays a role in improving the speed of loading pages, an increasingly important criterion of ergonomics and referencing. As a client-side scripting language, it is one of the main technologies of the web.

3.7. Sublime Text

Sublime Text is a text editor and more specifically a code editor that stands out for its clean, modern and simple interface. It has essential features for this type of software and can be quickly installed on computers equipped with the Windows 7/8/10

operating system, Mac OS X 10.9 or later, or Linux in 64-bit architecture. Among the interesting features for developers, we can mention syntax highlighting tools, function auto-completion, the search module and the multiple variable selection module. The file and folder tree in the left side panel makes it easier to access the different files that make up your software or website and the thumbnail preview of the document on the right makes it easier to find your way around your document. Although the Sublime Text interface is in English, it remains perfectly understandable for most of its users. The editor also supports opening multiple files with a tabbed management system and even allows you to split the workspace to view lines of code from 2 files simultaneously. Sublime Text supports a large number of programming languages including JavaScript, C, C++, C#, LaTeX, Perl, PHP, Ruby, CSS, SQL, and XML.

3.8. WampServer

WampServer is a local development environment for web applications. It stands for Windows, Apache, MySQL, and PHP and includes all the software needed to run PHP web applications on a local machine. WampServer is not software itself, but an environment comprising three servers (Apache, MySQL, and MariaDB), a script interpreter (PHP), and phpMyAdmin for web administration of MySQL databases. It has an administration interface to manage and administer its servers through a tray icon. WampServer allows developers to test their code and make changes without having to upload it to a live server. It also includes a database management system (MySQL) and a web server (Apache). WampServer is popular among developers because it is easy to install and use and allows for quick testing and debugging of code.

4. Civil status documents payment system

The implementation of an electronic payment system for civil status documents has become a necessity in many developing countries to improve the efficiency and transparency of administrative processes. In this part, we will describe the different steps we followed to set up such a system as part of our study. First, we will talk about the general design of our system based on the general architecture of the project and the modeling for data collection and storage. Then we will move on to the realization of the project by explaining the different connections of the components and the codes used to manipulate it. And finally, we will make a presentation of the platform set up to manage the payment and recovery of civil status documents.

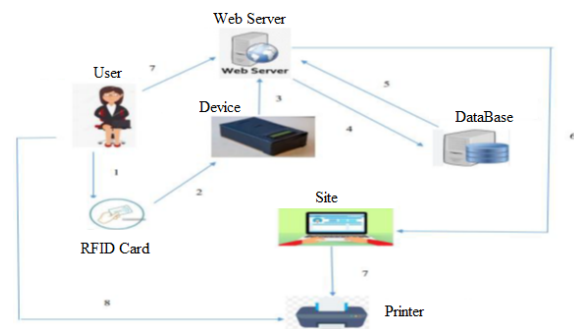


Figure 2. General architecture

4.1. General architecture

Figure 2 shows the general architecture of our work.

Detailed explanation:

1. The user presents himself to the device with his card
2. The device scans the card and displays the card identifier
3. The device sends the card data to the web server
4. The web server queries the database
5. Response from the database, it selects the data to send
6. If the data sent is in the database, the user accesses the site, logs in, then proceeds to pay for these documents on his account
7. The site sends a printout
8. The user will then be able to retrieve the printout

4.2. Conceptual Data Model

The conceptual data model aims to formally write the data that will be used by the information system. It is therefore an easily understandable representation of the data, allowing the information system to be described using entities. After collecting information on users and administrators managing civil status documents, we arrived at this conceptual data model (CDM) described in Figure 3.

4.3. Database

The conceptual data model established previously allowed us to generate the database at the WampServer software level. We created a database named Civil_status with the following tables: administrator, user, birth, marriage, death, divorce, child, payment, rfid_account. The table 1 shows a representation of the different tables in our database.

Table 1. Database

Table	Action					
administrator	Display	Structure	Search	Insert	Validate	Delete
rfid_account	Display	Structure	Search	Insert	Validate	Delete
divorce	Display	Structure	Search	Insert	Validate	Delete
death	Display	Structure	Search	Insert	Validate	Delete
child	Display	Structure	Search	Insert	Validate	Delete
marriage	Display	Structure	Search	Insert	Validate	Delete
birth	Display	Structure	Search	Insert	Validate	Delete
payment	Display	Structure	Search	Insert	Validate	Delete
user	Display	Structure	Search	Insert	Validate	Delete
9 Table (s)	Sum					

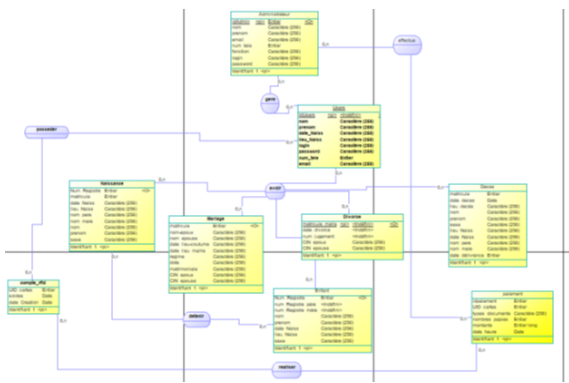


Figure 3. Conceptual data model

The administrator and user tables are tables that store the personal information of users and administrators, which will allow us to identify them. Among this stored information, we have the name, first name, address, user name, password (...) as illustrated in tables 2 and 3.

The birth, marriage, divorce and death tables are used to store the user's birth, marriage, divorce and death information. Thus all the information on the important events in the user's life as mentioned above will be stored in the database. Here is an example with tables 4 and 5:

Table 6 represents the rfid_account table which is used to store information on user payment accounts, including card UIDs, balances and creation dates in the database.

Table 7 which shows the payment table allows you to record the history of payments made in the database.

5. Result and interpretation

5.1. Connections of all components

Connecting all the components used made it possible to create the device shown in figures 4.

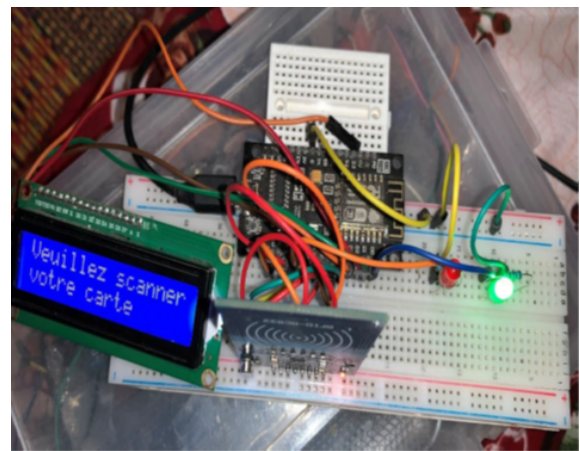


Figure 4. Connecting all Arduino components

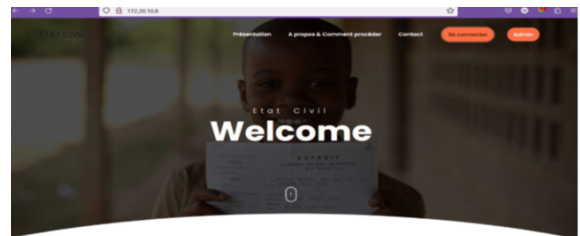


Figure 5. Home Page

5.2. Presentation of the web page

In order for the user to easily access their documents and make contactless payments, we have created a web platform with PHP with several interfaces to simplify the task. In the following, we will present the interfaces of our web application.

5.2.1 Home Page. :

The figure 5 shows the Home Page.

The home page, also called the entry page, is the first page of every site. It therefore requires text content that explains the purpose and content of the site. The home page also contains navigation that allows users to find every other page of the site by three clicks. In the home

Table 2. Administrator table

ID_admin	Name	First name	Email	Phone number	Position	Login	PassWord
1	OUESSE	Houmaame	ouesse@gmail.com	777381217	civil status officer	Admin	1234

Table 3. User table

ID	Name	First name	Date birth	Place birth	Login	PW	Email	N° Phone	N° register	CNI	UID
10	OUESSE	Labibe	31-12-2015	Dakar	Admin	1234	omea82@yahoo.fr	777381217	100	20160069	1001

Table 4. Birth table 1

N register	N register letter	year registration	year registration letter	date birth	Place birth	birth time	sex	First name	Name	father first name
69	Sixty nine	2025	Two thousand twenty five	20-01-1995	Dakar	12:34	F	Aécha	Abdou	Mohamed

Table 5. Birth table 2

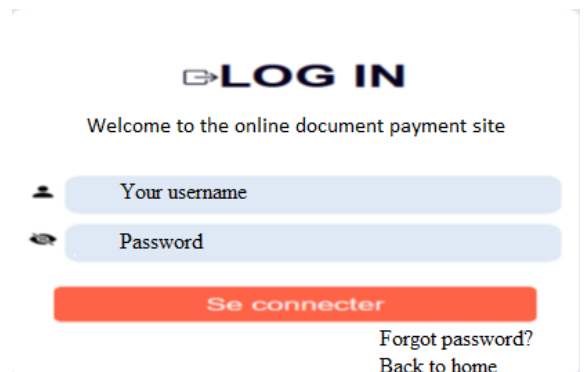
mother first name	mother last name	date issue	matriculation	date entered	declarant name	declarant age	declarant profession	declarant address
Khady	Faye	October 12, 1995	1001	January 13, 2025	Ndeye Diarra	30	agent	Fass

Table 6. Table account_rfid

card number	balance	creation date
1000	16750	2025-01-30
1001	500	2025-02-07

Table 7. Payment table

Payment ID	Card UID	Document Type	Number of Sheets	Price	Date and Time
50	1001	birth certificate	1	200	2025/02/8
51	1001	birth certificate	1	200	2025/02/10

**Figure 6.** Login page

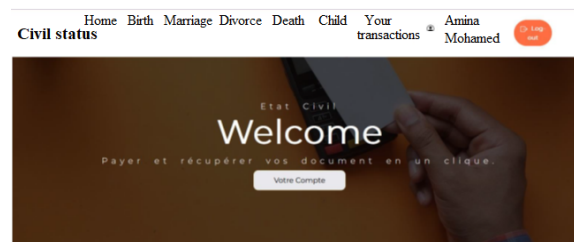
page, we made a brief presentation of our site. Then and finally, we explained how the site works and the procedure to follow to recover your papers.

5.2.2 Authentication interface. :

When the user issues a connection request, Figure 6 is displayed. The user must authenticate. Authentication is a procedure by which a computer system certifies the identity of a person. It is done by a login (username) and a password (password). If the login and password given by the user exist in the database and match, then he will be able to access the site, otherwise an error message will be displayed.

5.2.3 Site interfaces. :

When the user logs into the site, a page is displayed with a menu bar: Birth, Marriage, Divorce, Death, Children,

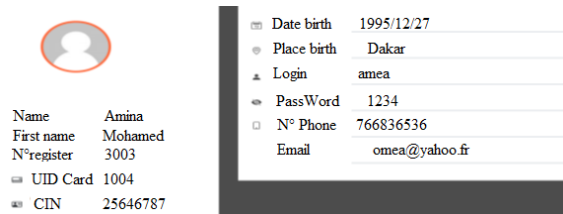
**Figure 7.** User home page

Your transactions and a Profile menu. Figure 7 shows the site interface menu.

In Figure 7, the “your account” button will allow the user to see the information of his account, namely: the balance, the date of creation of the account and the UID

Your account		
Card UID	Balance	Creation date
1004	0	09/02/2025

Figure 8. User account info



Name: Amina
 First name: Mohamed
 N°register: 3003
 UID Card: 1004
 CIN: 25646787

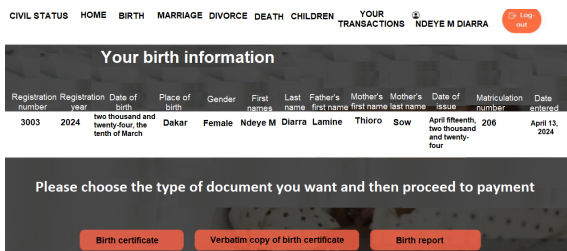
Date birth: 1995/12/27
 Place birth: Dakar
 Login: amea
 PassWord: 1234
 N° Phone: 766836536
 Email: omea@yahoo.fr

Figure 9. Profile page

PAYMENT HISTORY

ID	UID Card	Document type	Number of paper	Amount paid	Payment date and time
149	1004	Birth certificate	1	200	10/02/2025 17:50:10
150	1004	Birth certificate	1	200	10/02/2025 16:35:30
151	1004	Birth certificate	1	200	10/02/2025 14:43:25

Figure 10. Payment History Interface



CIVIL STATUS HOME BIRTH MARRIAGE DIVORCE DEATH CHILDREN YOUR TRANSACTIONS NDEYE M DIARRA

Your birth information

Registration Number	Registration Date	Place of Birth	Gender	First name	Last name	Father's first name	Mother's first name	Mother's last name	Date of birth	Matriculation Number	Date of birth
3003	2024	two thousand and twenty-four, the tenth of March	Dakar	Female	Ndeye M. Diarra	Lamine Thioro	Sow	April fifteenth, two thousand and twenty-four	206	April 13, 2024	

Please choose the type of document you want and then proceed to payment

Birth certificate Verbatim copy of birth certificate Birth report

Figure 11. Birth interface

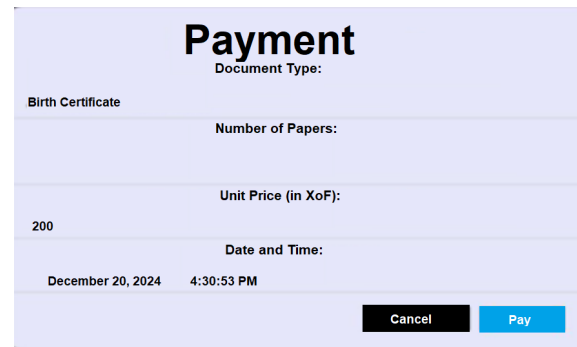
number of his card. Thus the user will be able to check the balance of his account at any time. Figure 8 shows the result after clicking the your account button.

This page revealed by figure 9 represents the profile page which contains all the personal information of the user.

The Your Transactions menu displays an interface representing the user's entire payment history as shown in figure 10.

When the user wants to retrieve his birth, marriage, divorce or death documents, he presses the type of document that interests him in the menu bar. An interface will appear containing his information and will ask him the type of paper he wants. Here we take the birth menu as an example, which once selected will display this interface represented by figure 11.

Once the type of paper is chosen, a corresponding payment interface will be displayed. The user will then



Payment

Document Type: Birth Certificate

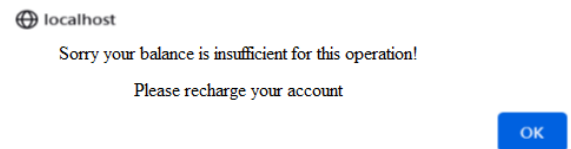
Number of Papers:

Unit Price (in XoF): 200

Date and Time: December 20, 2024 4:30:53 PM

Cancel Pay

Figure 12. Payment interface



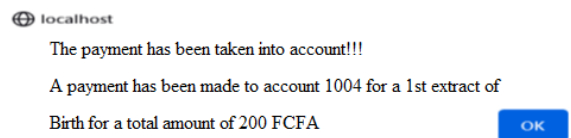
localhost

Sorry your balance is insufficient for this operation!

Please recharge your account

OK

Figure 13. Payment error



localhost

The payment has been taken into account!!!

A payment has been made to account 1004 for a 1st extract of Birth for a total amount of 200 FCFA

OK

Figure 14. Payment confirmation

proceed to the payment. In our example we choose birth certificate which will display this interface illustrated in figure 12.

The payment interface is presented as a form where we will see the type of document chosen, the unit price of this document, the date and time at which the payment is made. The user will therefore have to determine the number of papers he wants and then validate the payment.

However, if the balance of his account is insufficient then an error message will be displayed indicating that he should recharge his account so you will see the figure 13.

Otherwise, if the account balance is sufficient, a payment confirmation message will be displayed and he will have access to his papers which he can print. The figure 14 shows the customer's transaction.

Please note that all user accounts are managed by the administrator. The latter has the right to add, modify and/or delete an account. He records in the database information on births, marriages, divorces, deaths and even children in the case where the user has children. He therefore has access to the documents of all users. Figure 15 shows the administrator interface.

The administrator creates payment accounts and attributes to users, he also manages the recharging of

Home User Birth Marriage Divorce Death Children Account Account Payment Top-up List Logout

Civil Status

Birth Research

First Name	Last Name	Father's First Name	Mother's First Name	Mother's Last Name	Date of Issue	Matriculation Number	Date Entered
Binetou	Diarra	Lamine	Thioro	Sow	12/10/1995	1001	10/10/1995

Figure 15. Administrator interface

Top-up

Card UID:
1004

Amount:
2000

Figure 16. Charging interface

Home User Birth Marriage Divorce Death Children Account Account Payment Top-up List Logout

Civil Status

146	1001	Birth Certificate	1	200	12/18/2024 5:19:30 PM
147	1001	Birth Certificate	1	200	12/18/2024 5:25:32 PM
148	1001	Birth Certificate	1	200	12/19/2024 10:45:12
149	1004	Birth Certificate	1	200	12/19/2024 1:05:14 PM
150	1004	Birth Certificate	1	200	12/19/2024 3:09:05 PM

Figure 17. Payment List Interface

their accounts. He has the list of payments made by users. The figure 16 illustrates how the administrator recharges users' accounts. And finally, the figure 17 shows the display of the list of document payments by users.

6. Conclusion

At the end of our work, we were able to design a system for scanning and paying for civil status documents via an RFID card. First, we designed a prototyping device capable of connecting to a web server, which we had previously created, and reading an RFID card. This device will uniquely identify the user, it offers an authentication system allowing the user to scan their

card and connect to their account. The web server created has a billing and recovery system for civil status documents. So the user connects to the network then scans their card at the device level. Then, being connected to the network, they will be able to access the web server and then move on to the authentication phase to verify that they are in the database. Finally, once connected to their account, they will be able to pay and recover their documents.

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