An Alternative of Secured Online Shopping System via Point-Based Contactless Smart Card

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ABSTRACT

This exploratory study focuses on the analysis, design, development and testing of an online shopping system by using contactless smart card as security mechanism and point values for making purchase. The rationale is to provide alternative ways for secured online shopping without worrying about real cash being transacted in real time, thus encourage more people to shop online. All online purchases could be made via a centralized web-based system, in which the transaction is permitted by using point values stored in the contactless smart card integrated to the system. Short messaging service (SMS) and email were chosen as the medium to notify the confirmed purchase. The testing results have demonstrated that the system performs its intended functionalities and fit for use should it is deployed in the real environment.

KEYWORDS

Online shopping, contactless smart card, point, security, short messaging service, electronic payment.

1 INTRODUCTION

Online shopping has become alternative way to purchase desired items since it is more comfortable than conventional shopping, which is usually attributed with anxious, crowded, traffic jam, limited time, and difficulty in locating parking space. E-commerce has expanded due to the advancement in broadband and other networking technologies, thus it has contributed to the comfort in performing online shopping [1].

However, to some extent, there are still people who refuse to perform online shopping due to perception that it is not secured, exposed to fraud and not trusted in actual delivery of the purchased item. Although various security mechanisms have been put in place when items are purchased online such as via credit card and PayPal assured with VeriSign authentication, the cautious still exists and becomes hindrance to actively shop over the Internet. Besides being so doubtful about the quality of purchased item or delivery of the purchased item, Internet users are also very concerned whether the money paid really goes to the retailer or not.

Realizing these concerns, significant alternatives should be explored and introduced in encouraging more people to shop online and boost the business transactions done over the Internet. One of the possible alternatives is to purchase items online by using contactless smart card that is stored with point values. The purchase is done via a specific online portal that could read the point values stored in the card to allow the purchase. In more detailed explanation, this study on development the online shopping system using point-based contactless smart card is derived from following concerns:

- Changing the perception on security of online shopping in the sense that the use of credit card or debit card for purchase will be cheated by the merchant
- The increasing need for offering product and services online via secured transaction to compete and survive in business
- The increasing demand by current customers to shop more via Internet instead of conventional shopping
The importance of providing positive online shopping experience

By embarking on this effort, the current scenario, practices and process of online shopping can be analyzed so that an improved process can be proposed in relation the proposed online shopping. Thus, this leads to realization of online shopping system using contactless smart card that contains point values with real time notification of the transactions made via SMS and email.

2 RELATED WORKS

With the advancement of Internet, it has brought the payments and transactions in electronic form the next level, in particular at exponential growth [2]. This leads to the introduction of digital money that offers flexible electronic payment with added security features that is required for transaction, such as replicating the individual activity [3].

Among the common elements involved when discussing about electronic payment methods are credit card, debit instruments, prepaid payment services, cumulative collection services, payment portal services and mobile phone payments [4]. This mode of electronic payment (e-payment) offers several benefits. This can be seen by the need to only enter account information for making online payment [5]. Besides that, it is apparent that e-payment is convenient, helps in cost reduction and secured, which translates into reliable online transactions for purchasing goods or services over the Internet [6]. Automation of payment made electronically can even contribute to the reduction of the overall cost for payment system [7].

In recent years, many approaches and technologies have been introduced and adopted in ensuring the security of electronic payment via the Internet. Cryptography is the most common security measures for online payment but slow in speed and less efficient [8]. Other alternative is by using credit cards with RFID technology as part of mobile phone architecture for secure e-payments [9]. [10] proposed the use of fingerprint verification technique and steganography for the customers to have more confidence in online shopping. Apart from that, speech recognition and encrypted USB device are another mechanisms for secured online transaction that could be adopted [11][12]. At the framework level, [13] introduced a new framework that omits hardware deployment at customer’s site for online shopping by taking into account the mutual authentication between merchant and customers as the key feature in the framework.

For this paper, the focus is on avoiding real cash being transacted when doing online shopping by replacing it with using a point-based contactless smart card integrated into an online shopping portal. This means, a card reader needs to be plugged into the computer for reading the contactless smart card and use the points stored inside the card for making online payment.

3 END-TO-END PROCESS OF PROPOSED ONLINE SHOPPING SYSTEM WITH POINT-BASED CONTACTLESS SMART CARD

Before executing the development of the proposed system, it is important to have clear picture on the end-to-end business process of the proposed solution. The process should not totally change the common practice of online shopping. Thus, the common online shopping process was revisited and tailored to match with the proposed online shopping system. The activities involved in the process are:

1. The user need to purchase the contactless smart card stored with point values at the authorized retailer and register the purchase.
2. User need to register his/her profile into the online shopping system and tie the card purchased with the profile.
3. Once user is registered, online shopping activity start: search for items, confirm items to purchase and their quantity, agrees with terms and perform checkout.
4. User then make payment after confirming the total amount of points required. (Payment here means purchase the items using the points instead of typical actual cash and subjects to availability of point values in the contactless smart card)
5. The process ends and user waits for delivery of item according to specified time stated in the system.

The above explanation is simplified in Figure 1 below:

![Figure 1. End-to-end business process for online shopping system using point-based contactless smart card.](image)

### 3 DEVELOPMENT OF THE PROPOSED SYSTEM

This section explains the process in developing the proposed online shopping system using point-based contactless smart card.

#### 3.1 Requirements of the Proposed System

The system is intended to cater for two types of users: administrator and normal users. The potential requirements from users would include the following functionalities:

1. User can register into the system
2. User can login
3. User can view card points balance
4. User can change password
5. User can manage product to purchase
6. User can manage own profile
7. User can access to the shopping page
8. User can make purchase product and make payment using contactless smart card
9. User can view product on page and straightly purchase the item
10. User can purchase the product by using point values
11. User can purchase the product based on point values, which is cash value of RM 1.00 is equivalent to 100 points or P100
12. User can top up the point values in the contactless smart card using credit card
13. User can view the transaction history

14. User can receive confirmation about the transaction made for purchase or point values top up by email and SMS notification.

The use case diagram in Figure 2 translates the user requirements into system requirements.

![Figure 2. Use case diagram for online shopping system using point-based contactless smart card.](image)

From the Figure 2 above, it is clear that the functional requirements of the system consist of the following items:

- Login
- Update administrator information
- Update user information
- Manage product
- Manage user
- Manage log
- Manage system setting
- View history
- View items
- Make purchase
- Checkout
- Perform payment
- Perform top up
- Manage card

As for the non-functional requirement, the following items are identified:

- Compatibility - the system should be able to be viewed in different browsers, namely Firefox, Internet Explorer, Chrome and Safari
• Performance – the system should be able to handle at least 100 transactions at a particular time
• Usability – the system should be easy to use for all functionalities defined

3.2 Design of the Proposed System

System architecture for the end-to-end process in the proposed system is depicted below in Figure 3:

![System architecture for online shopping system using point-based contactless smart card](image)

Figure 3. System architecture for online shopping system using point-based contactless smart card

Based on Figure 3, the contactless smart card is attached to the client’s computer. User will use the browser to access the online shopping portal via Internet. At the server side, the system is deployed separately to web server and database. No application or component server involved in the architecture.

This is further depicted in Figure 4 below on how the system works in detail.

![Detailed server side and client side processes in online shopping system with contactless smart card](image)

Figure 4. Detailed server side and client side processes in online shopping system with contactless smart card

Table 1 describes the details on the software and hardware requirement at client side and server side, respectively.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Server Hardware:</strong></td>
<td></td>
</tr>
<tr>
<td>• 1U Rack Server</td>
<td></td>
</tr>
<tr>
<td>• 600W High-efficiency Power Supply</td>
<td></td>
</tr>
<tr>
<td>• x 3.5” SAS/SATA Hot-swap Module</td>
<td></td>
</tr>
<tr>
<td>• Intel C202 PCH Chipset</td>
<td></td>
</tr>
<tr>
<td>• 6 X SATA 2.0 w/Raid 0,1,5,10</td>
<td></td>
</tr>
<tr>
<td>• Intel 82574LM/82574L Dual GBE LAN Ports</td>
<td></td>
</tr>
<tr>
<td>• Integrated IPMI 2.0 with Dedicated LAN Port</td>
<td></td>
</tr>
<tr>
<td>• Intel Quad Core Xeon Processor E3-1230V2 3.30GHz 8MB</td>
<td></td>
</tr>
<tr>
<td>• 8GB DDR3 1333MHz ECC Memory</td>
<td></td>
</tr>
<tr>
<td>• X 1TB 3.5” Enterprise SATA HDD</td>
<td></td>
</tr>
<tr>
<td><strong>Software:</strong></td>
<td></td>
</tr>
<tr>
<td>• Windows 2008 x64 Standard Edition License</td>
<td></td>
</tr>
<tr>
<td>• MSSQL 2008 x64 Standard Edition License with 5 client license</td>
<td></td>
</tr>
<tr>
<td>• Internet Information Service (IIS) 7</td>
<td></td>
</tr>
</tbody>
</table>

| **Client Hardware:** | |
| • 4GB RAM Single Channel DDR3 1600MHz - 1 DIMM | |
| • 500GB 7200 rpm SATA 6Gb/s Hard Drive | |
| • 4th Generation Intel® Pentium® Processor G3220 (3M Cache, 3.0 GHz) | |
| • Mifare contactless smart card | |
| • Mifare card reader | |
**Software:**
- Windows 7 or higher, Linux
  Ubuntu 10 or higher, Linux
  Centos 8
- Internet Explorer 9 or higher;
  Firefox version 25.0 or higher;
  Chrome version 30 or higher.
- Java Runtime 7 (JRE7)

At the database level, following tables are created to cater for the services offered by the proposed system:

- **Users** - store profile of users including username and password
- **CardManagement** – store the details of contactless smart card registered with the system
- **PurchaseHistory** – store the history of purchase
- **ProductManagement** – store the details of product offered in the system
- **Countries** – store list of countries
- **TransactionLog** - store the log of transaction took place in the system
- **TopUpValue** – store the list of allowed top up values
- **EmailOutbox** - store the copies of email sent to users
- **SMSOutbox** - store the copies of SMS sent to users

### 3.3 Implementation of the Proposed System

In terms of actual implementation perspective, this can be represented by the screenshots of the proposed system.

![Figure 5. Page for user login](image1.png)

![Figure 6. Page for user profile dashboard](image2.png)

![Figure 7. Page for left panel menu in dashboard](image3.png)

![Figure 8. Page for transaction list](image4.png)

![Figure 9. Page for contactless smart card utility or management](image5.png)
Figure 10. Page for card transaction history

Figure 11. Page for product display

Figure 12. Page for invoice

Figure 13. Page for purchase confirmation

Figure 14. Page for payment using contactless smart card points

Figure 15. Page for adding new contactless smart card details

Figure 16. Page for contactless smart card points top up

Figure 17. Page for top up confirmation
Note that payment via credit card is required to top up the points in the contactless smart card as shown in Figure 18. The cash values purchase are converted into points and directly updated to the card.

As mentioned earlier, user will receive notification of the successful product purchase and successful top up via email and SMS. Figure 19, 20 and 21 below show the related screenshot of the notifications.

### System Testing

A number of test cases have been designed to ensure all requirements stated earlier can work as expected and no defects found in the system. Summary of the test cases is presented below in Table 2:

<table>
<thead>
<tr>
<th>No</th>
<th>User Profile</th>
<th>Total Test Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Administrator</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>Normal user</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>24</strong></td>
</tr>
</tbody>
</table>

---

**Figure 20.** Screenshot for email notification for successful top up

**Figure 21.** Screenshot for SMS notification of successful purchase and top up

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**Table 2.** Test cases used for testing online shopping system with point-based contactless smart card
4 DISCUSSIONS

Referring to the development of the proposed system from the requirement inception until system testing, there are several areas that can be discussed and explained further.

In terms of contactless smart card, Mifare card is chosen due to its capabilities to be used for multiple applications, securely encrypted that prevents unauthorized access to information stored on the card thus prevent it from being copied, low maintenance since it is contactless and insertion into card reader is not required [18].

Due to time constraints and limitations to simulate the performance scenario, testing of the system’s performance in handling the 100 transactions could not be done.

The system need to detect the availability of the card to proceed with purchasing of the product. It reads the contactless smart card by using following codes:

```java
private String ReadMiFareSerial() {
    System.out.println("Applet Method: ReadMiFareSerial");

    String tmpstr = "";
    String rtnSNO = "ERROR";

    // show the list of available terminals
    TerminalFactory factory = TerminalFactory.getDefault();
    List<CardTerminal> terminals = null;
    try {  
        terminals = factory.terminals().list();
    } catch (CardException e) {
        e.printStackTrace();
    }
    try {
        byte[] apdu_POLL = new byte[9];
        boolean CardOK = false;
        apdu_POLL = new byte[]{ (byte)0xFF, byte)0x00, (byte)0x00, (byte)0x00, byte)0x04, (byte)0xD4, (byte)0x4A, byte)0x01, (byte)0x00 };
        while (!!(CardOK)) {
            tmpstr = send(apdu_POLL, channel);
            System.out.println("Poll: "+ tmpstr);
            if (!!(tmpstr.contains("D54B009000"))) {
                if (tmpstr.length() > (16+8)) {
                    String sno = tmpstr.substring(16, 16+8);
                    sno_val = GetSNO(sno);
                    System.out.println(sno_val);
                    rtnSNO = sno_val.toString();
                    CardOK = true;
                }
            } else {
                try {
                    Thread.sleep(1000);
                } catch (InterruptedException ex) {
                    Thread.currentThread().interrupt();
                }
            }
        }
        // disconnect
        try {
            card.disconnect(false);
        } catch (CardException e) {
            e.printStackTrace();
        }
        return rtnSNO;
    }
    }
```

As for sending email notification to user, the following codes are required:

```java
Dim Email As New MailMessage()
Try
Dim SMTPServer As New SmtpClient
For Each Attachment As String In Attachments
    Email.Attachments.Add(New Attachment(Attachment))
Next
```
Email.From = New MailAddress(FromAddress)
Email.To.Add(Recipients)
Email.Subject = Subject
Email.Body = Body
Email.IsBodyHtml = True
SMTPServer.Host = Server
SMTPServer.Port = Port
SMTPServer.Credentials = New System.Net.NetworkCredential(UserName, Password)
SMTPServer.EnableSsl = True
SMTPServer.Send(Email)
Email.Dispose()
' Return "Email to " & Recipients(0) & 
" from " & FromAddress & " was sent."
Return 0
Catch ex As SmtpException
Email.Dispose()
" Return "Sending Email Failed. Smtp
Error."
Return -1
Catch ex As ArgumentOutOfRangeException
Email.Dispose()
' Return "Sending Email Failed. Check
Port Number."
Return -2
Catch Ex As InvalidOperationException
Email.Dispose()
' Return "Sending Email Failed. Check
Port Number."
Return -3
End Try

On the other hand, the following codes are
used when sending SMS notification to the user:

For Each ab In smsoutbox
Try
host = "http://www.isms.com.my"
destinationNo = ab.RecipientsHpNo
username = My.Settings.SMSUserName
password = My.Settings.SMSPassword

url = host + "/isms_send.php?" _
& "un=" &
HttpUtility.UrlEncode(username) _
& "pwd=" +
HttpUtility.UrlEncode(password) _
& "msg=" +
HttpUtility.UrlEncode(ab.MessageBody) _
& "dstno=" +
HttpUtility.UrlEncode(destinationNo) _
& "type=1" _
& "sendid=" +
HttpUtility.UrlEncode("eCardShoppingSystem")
Debug.WriteLine(url)
request =
DirectCast(WebRequest.Create(url),
HttpWebRequest)
response =
DirectCast(request.GetResponse(),
HttpWebResponse)
Debug.WriteLine("
Response: " &
response.StatusDescription)
datastream =
response.GetResponseStream
Dim reader As New
StreamReader(datastream)
Dim responseFromServer As String =
reader.ReadToEnd()
Debug.WriteLine(responseFromServer)
If responseFromServer = "" Then
ab.StatusSend = "Send"
ab.SendDate = Now
mydb.SubmitChanges()
Else
End If
reader.Close()
datastream.Close()
response.Close()
Catch ex As Exception
Debug.WriteLine(ex.Message)
End Try
Next
Return 0

There are several real examples of online
shopping platform that can be referred such as
Lazada, MOLPoints, Touch ‘n Go and MEPS
Cash [14][15][16][17]. The comparison between
these platforms and online payment mechanisms
can be summarized below in Table 3:
Table 3. Comparison between existing online shopping platform with the proposed system.

<table>
<thead>
<tr>
<th>System features</th>
<th>MOLPoints</th>
<th>Lazada</th>
<th>Touch 'n Go</th>
<th>MEPS Cash</th>
<th>Proposed System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Webpage system</td>
<td>interactive</td>
<td>interactive</td>
<td>moderate</td>
<td>Low</td>
<td>moderate</td>
</tr>
<tr>
<td>User online registration</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Website have module for online shopping</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>System using any smart card technology</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>System that interact with payment gateway</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Using conversion to point or value to translate the payment transaction</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>System able to support operation via offline environment</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>System marketing promotion</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Easy to use the system</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Flexibility system to the end user</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>System availability in market and user still use until now</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>System able to support multiple sale product</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>System tight on security</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>User system audience</td>
<td>World wide</td>
<td>World wide</td>
<td>Malaysia only</td>
<td>Malaysia only</td>
<td>Malaysia only</td>
</tr>
</tbody>
</table>

Note:  
1 – Do not know  
2 - Do not have  
3 – Partly available  
4 – Fully available

From the perspective of security and protection from hackers, the following is incorporated:

- SSL is enabled in the system to prevent the hackers tap during all transaction and cover the whole website system
- Implement LINQ module which connect .NET web application to the database, thus prevents SQL injection attempt
- Java Applet is used to communicate with the card reader, thus this enables code signing certificate for Java.
- This system is a closed-environment, which means all users should login before there can do the shopping and perform the transaction. So, since the log record exists in the system, user activities within the system are recorded and can be tracked. Any suspicious activities can be detected and the user tied-up with such activities can be blocked.
- Since user need to tap the contactless smart card on multiple check point in purchasing the product, it could prevent hackers from getting extra point from other user or hacking to get illegal point without make the payment. This is because if contactless card is not tapped at the particular check point, user cannot proceed to next stage of purchase.

5 CONCLUSION AND RECOMMENDATION

The project has successfully proved that by using contactless smart card stored with point values, online shopping can be done in secured manner. Besides that, it has also demonstrated that by understanding the clear process on common practice of end-to-end online shopping, it easier to tailor it for better way to shop online, thus leads to the establishment of the right system to fulfill the intended needs. This system itself has been able to demonstrate that online shopping can also be done without having to have credit card as the mechanism of exchange, which in this context of study, the shopping is done using point values.

As for future recommendation, several improvements could be done to the existing system. In the future, this system should able to transfer the amount within cards under same user account. For example, if the same person has multiple contactless smart cards, they can transfer point values from one card balance into other card. It is also beneficial if the system could transfer point values in the card of one person to other account or person’s card. Apart from that, it is good to see if the mode of payment for online shopping via point-based contactless smart card could be extended to other websites that require
online payment. This means besides using credit card, debit card or PayPal, there is another option to purchase product online by using the contactless smart card.

6 REFERENCES


