regard to formation and validity of contract, the Ethiopian Civil Code, Article 1719 (1) reads, "Unless otherwise provided, no special form shall be required and a contract shall be valid where the parties agree." This sub -article stipulates that except for some instances where a special form is prescribed by law, the Ethiopian law addresses the issue of freedom of form. This has the role of addressing the problem that would arise for e-commerce and e-payment if contracts required the form be hand written and signed.

This is in line with the possibility of forming contracts by means of data message and rendering validity for the same stipulated in Article 11 of the UNCITRAL e-commerce model law

Regarding the requirement for signature, Article 1727 and 1728 of the Ethiopian Civil Code stipulates that contracts required to be in writing shall be supported by a special document signed by the parties bound by the contract and be attested by two witnesses. Affixing the party's handwritten signature or a thumb mark shall carry out the signature. No provision is given as to the acceptability of electronic signatures. Hence the provision in the UNCITRAL model law to accept e-signatures is not addressed in the Ethiopian Civil Code.

Other crucial elements for the success and wide use of e-payment include explicitly stated privacy and data protection laws. Such are missing in Ethiopia currently. The government, however, has given such security issues due regard in its ICT policy. The Ethiopian Civil Code is being revised and provisions pertaining to payment reform have been suggested to be incorporated in the upcoming revised Commercial Code [55].

4.5 Socio-Cultural Aspects

In their attempts to introduce and adopt new technologies such as electronic payment systems, the Dashen Bank, Total Ethiopia, and the Ethiopian Commercial bank, have faced some problems related to social and cultural attitude. The result of the interviews we conducted with these companies indicate that there is resistance to changes among customers, and to some extent staff members. This is attributed to lack of awareness on the benefits of new technologies, fear of risk, lack of training, and tendency to be content with the existing structure instead of looking for better opportunities (conservatism). All the three companies underline, however, that the trend is promising.

Ethiopians today, in spite of the widespread poverty in their country, are making use of some of the recent developments in ICT. An astounding example is their use of mobile text messages for their 2005 election campaign.

Lately private and public colleges offering courses in information and communication technology are mushrooming. This above and beyond arming the trainees with the necessary skills and capacity to operate in ICT environment will play a crucial role in creating an ICT aware and user society.

Genuine Leather

Genuine Leather craft is an Ethiopian seller of fashionable leather clothing targeting Ethiopians in the Diaspora. They classify orders they receive in terms of the volume involved. They can entertain both individual order and bulk order for delivery to anywhere in the world. However the terms of payment, delivery and other conditions of trade are different.

Bulk Purchases are orders for commercial purposes the minimum quantity of which is 25 pieces per style. Payment is conducted by irrevocable confirmed letter of credit in their favor through the Commercial Bank of Ethiopia, Addis Ababa Meskel Square Branch payable at sight upon presentation of the shipping documents.

As far as Private purchases are concerned, individual buyers are welcome to shop online. Genuine Leather can accept an order even for one jacket and send it to the buyer by courier service any where in the world. Prices include worldwide shipping! Clicking the Order icon and completing the forms that follow make credit card purchases. Moreover, other means of payment such as wire transfer via Fax to their account in Commercial Bank of Ethiopia is also possible [53].

4.6 Challenges of E-payment in Ethiopia

E-payment in Ethiopia is has some major challenges. Some of these challenges are the following.

- Poor telecommunication infrastructure
- Frequent power disruption
- People are resistant to new payment mechanisms
- Lack of skilled manpower
- Unavailability of payment laws and regulations particularly for e-payment

5 Conclusion and Recommendation

5.1 Conclusion

In the paper an attempt has been made to study mainly the opportunities and challenges of e-payment in Ethiopia. To this end, a review of the related literature, interview with open-ended questions, observation, and development of prototype for bill payment and e-commerce suitable to Ethiopia have been carried out.

Many e-payment systems have emerged since the 1980s. However, major security, infrastructure, legal, regulatory and socio-cultural challenges have characterized the systems. Some regions and counties have made some commendable efforts to address the problems. For instance, the European Commission has developed a legal framework consisting Directives to ensure free movement of online services, Directives for the issuance of e-money and Directives for e-signatures. The UNCITRAL formulated a model law on e-commerce in 1996.The SADC member countries developed the SADC Model Law on Electronic Transactions and Data Protection.

In Africa, e-payment is characterized by widespread challenges. Poor telecommunication infrastructure, limited readiness by banks, behavioral constraints, inadequate legal and regulatory framework, low level of credit card access are among the constraints that have hindered the progress of e-payment in Africa. However, it is to be underlined that there are some promising efforts in some African countries such as Egypt, Tunisia, and Morocco to lay a strong foundation for e-payment. These countries have committed huge resources towards ICT infrastructure, legal and regulatory framework for e-payment.

In Ethiopia, the study has found that e-commerce as well as its essential aspect e-payment is a recent phenomenon. However, the undergoing endeavor by some banks, and business enterprises to introduce and use e-payment is not to be undermined. As far as e-payment for bill payment is concerned except the success achieved by the Ethiopian Telecommunication Corporation by the introduction and wide use of prepaid cards for mobile bill payment, there is little progress by other companies despite a large potential demand in the country.

The major challenges of e-payment in Ethiopia include

- Poor telecommunication infrastructure
- Frequent power disruption
- People are resistant to new payment mechanisms
- Lack of skilled manpower
- Unavailability of payment laws, and regulations particularly for e-payment.

The Ethiopian government has given a considerable attention to ICT as expressed in its ICT Draft Policy. Moreover, the State owned Ethiopian Telecommunication Corporation has invested huge fund to implement state-of-the-art telecommunication infrastructure that provides national information link. This has an essential role in laying the foundation for e-payment.

The introduction of ATM with a plan to expand in the near future by the Commercial Bank of Ethiopia, the continuing effort by the Dashen Bank to introduce and issue its own international payment cards beyond the present mere encashment services of Visa and Master Cards, the success expressed by Total Ethiopia by the development and use of Abyssinia Card are witnesses of e-payment potential in Ethiopia.

In this paper we have proposed a model for e-payment that is applicable for the Ethiopian context. Two models one for e-commerce and another for bill payment have been proposed. We have also developed prototypes to demonstrate each model. Details about the models and prototypes can be referred from the annex.

5.2 Recommendation

In Ethiopia ICT infrastructure like other African countries is not well developed. This is one reason why e-payment is not expanded in the country. But the current effort

by ETC to expand the country ICT infrastructure is encouraging. The national ICT draft policy has also given great emphasis on the expansion of ICT infrastructure. Current effort done by the government to establish nation wide networks such as *WerdaNet* and *RevenueNet* need also to be encouraged and expanded.

In Ethiopia, the cost of ICT services is quite high. For instance the cost of dialup Internet is expensive. For e-payment to expand and used by considerable proportion of population, the cost of ICT has to be decreased. A way has to be created that enables citizens to get ICT services in cost effective way.

Automating banks is another important factor that fosters growth of e-payment. In Ethiopia and most other African countries banks are not automated. For instance in Ethiopia there is no financial network that links different banks. Due to this the check and clearing office run by NBE is totally manual. When it comes to ICT banks are more conservative. Banks are expected to do more in the area of ICT. It is important to introduce a financial network used for settlement and clearing purpose

Another important factor related to the e-payment infrastructure is the reliable supply of electric power. The frequent interruption of electric power is a challenge by itself. Electric power providers are expected to deliver uninterrupted power.

It is known that e-payment system need a good network infrastructure. But network infrastructure is not a must for e-payment systems that are based on smart card. This, however, entails stringent security requirement on the smart card. Abyssinia Card, a smart card payment system used for fuel purchases is an instance of e-payment system that does not involve the use of network for its operation. The only challenge in the use of smart card is the ubiquity of smart card readers. Smart card reader must be available in cost effective way.

Security is one of the important factors for e-payment system. Security is one factor that builds confidence of users. Proper security means has to be applied in the system to gain users trust. In this paper we have focused on transaction security of e-payment system, as this is the most important and the one, which can be easily

broken. But system security that takes into account the technical and organizational IT infrastructure security must also be given the necessary attention.

Users of e-payment system need to be aware of the security risk of e-payment system. For instance users should not provide their private payment information such as credit card numbers to a website that they do not know or to a website that does not have a certificate from well-known certificate issuers.

Concentrating too much on the security may reduce the efficiency of the system. Care has to be taken in this respect. Early payment systems concentrate too much on the security without giving proper attention to users' requirements. As the result most of them did not get acceptance [56].

Clearly stated regulatory and legal framework for ICT is essential for creating a certain and reliable environment for economic agents. E-payment laws and regulations, aiming at enhancing instead of strictly regulating the same, play a crucial role in development of e-commerce. Although the 1960 Ethiopian Civil Code is open to incorporate technological changes, by no means can it be claimed adequate for the development of a full-fledged e-payment system. In fact there is a growing and urgent need to establish a comprehensive legal and regulatory structure for the growth and protection of e-commerce in general and e-payment in particular.

Moreover, growing globalization has necessitated cross border e-commerce. Its success, however, has been limited by differences in legal systems, cultural values, religious beliefs, political ideologies and so on. This blunt fact incites the need for creating legal and regulatory framework compatible with that of other countries. Adopting Model laws such as the 1996 UNCITRAL Model on E-commerce, and SADC Model LAW on Electronic Transactions and Data Protection could serve the purpose.

Still equally important to consider is the fact that Ethiopia lags behind in establishing clearly set laws related to e-transaction. These include consumer and data protection laws, privacy laws, Internet laws, and so on. These are so important that their absence could put a barricade on the growth of e-commerce and e-payment.

It is indispensable for the improvement of society's social and economic life to raise public awareness of the benefits of new technologies such as computer enabled net-

works e-commerce, and e-payment. Schools, higher institutions and the media should give due attention as an important part of their task. Managers of financial institutions such as banks should be bold enough to invest on ICT equipment and manpower training in the field to ensure competitiveness in modern world of information. An essential aspect of this task is to invest on efficient and secure e-payment and e-banking systems.

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Annex

E-payment System Model

Both for e-commerce and bill payment web-based client/server architecture is proposed. Users of e-payment system called clients access the e-payment system through their web browsers. The server side will hold the business logic and the database. This architecture often called three-tire architecture provides flexibility, scalability and modularity. Clients need only browser in order to interact with the rest of the system. The middle-tier holds the business logic. It communicates both with the client and the database. The database, another tier, provides storage structure for persistent information. The database and the business logic may reside on the same server or in different server linked through network. The company that runs the e-payment system is responsible to implement and administer these components. The company in the case of e-commerce can be a trusted third party or owner of an e-commerce. In the case of bill payment it can be a utility company that was previously involved in issuing bills manually. Internet is the primary medium of communication between clients and the server.

In order to pay, clients must have money in their e-payment account. Clients deposit money in their e-payment account using internet cash card. Internet cash card is debit card, which is very similar to prepaid mobile phone card. Like prepaid mobile phone card, it represents a fixed value of money. It can be purchased at physical stores, supermarket, etc. Clients have to provide the secret code found on the card in order to fill their account. The cards are issued and controlled by the company that runs the e-payment system.

The next sections discuss about tools and technology used in the prototypes. For security purpose SSL has been used. Java is the programming language used to implement the business logic of the system. The web server, DBMS and related tools and technology used in the prototype have also been discussed.

Secure Socket Layer

In order to provide the desired transactional security, SSL (Secure Socket Layer) is used.

SSL is security service that is used for securing the Internet mostly HTTP. SSL secures Internet communication between network applications, by providing privacy, authenticity and integrity.

SSL provides privacy by encrypting every message transferred between clients and servers thus providing a high degree of confidentiality. SSL protocol uses a combination of public-key and symmetric key encryption for this purpose.
SSL also provides higher degree of message integrity by using message digest or hash functions. Message digest provides a mechanism for ensuring a message that has not been changed in transit.
One of the interesting features supplied by SSL is authentication of servers and optionally clients. SSL server authentication allows clients to confirm a server's identity through their digital certificate. A digital certificate securely binds the identity of an entity to a particular public key. This binding is validated by a trusted third party named as certification authority (CA). A digital certificate is signed with the private key of the certification authority.

SSL has got several versions but SSL version 3 is the most widely deployed version. It is supported by all major web servers and web browsers like Netscape, and recent version of Microsoft Internet explorer. TLS (Transport Layer Security), the specification of ITF proposed in RFC 2246 is almost identical to SSL version 3.

DBMS

The DBMS used in the prototype is MySQL version 4.0.13. MySQL is a popular open source relational database management system. It can run on Windows, UNIX and Linux. It is commonly used for web-based applications.

Servlets

Java servlets are used to implement the business logic of the prototypes. Java servlets are java programs that run within web server, acting as middle layer between requests coming from a web browser or other http client and databases or applications on the HTTP server. Although there are other programming or scripting languages that provide similar functionalities, Java‘s robustness, its rich APIs and its object orient nature make it ideal to develop a full-fledged e-commerce application.

Servlets run in a Java-enabled web server. Within the web server the part that is responsible to execute servlet is called servlet container or servlet engine. Servlet

engine is a single process that runs a JVM (Java Virtual Machine). Servlets are also portable. Major web servers such as Apache HTTP Server, Internet Information Services (IIS), WebLogic application server and WebSphare support Servlets.

Servlets are responsible to accept any data sent by clients. Based on the data sent by a browser the servlet performs different actions. It may interact with a database or other applications. It may invoke another servlet. Finally it may generate a dynamic html page and send it back to the client.

Web Server

The prototypes use Tomcat *5.0.16* as a primary web server. Tomcat can be used standalone as a web server or plugged into a web server like Apache, IIS, etc. When used alone Tomcat will be used both as web server and servlet container.

Before used as a web server, Tomcat must be configured. In this paragraph steps taken to configure Tomcat for Windows XP are explained. After downloading the binary file running the .exe version provides a typical windows installer. Tomcat installs easily and quickly using the same dialog windows as other applications. But before Tomcat is installed Java Software Development Kit must be installed. During the installation Tomcat requests the location of Java SDK. We also need to set JAVA_HOME environment variable to tell Tomcat where to find Java. This is done by adding the statement ‘set JAVA_HOME=c:\j2sdk1.4.0_02’ in the c*:\autoexec.bat* file.

After this we need to make some changes to server configuration (*server.xml*) file. This file is located in the directory ‘… \Tomcat 5.0\conf ’. In this file we have to add our own context invoker for application to be recognized. This is done by adding the following statement near the root context invoker. The following statement will add context named billpayment.

```
</context path="/billpayment" docBase="billpayment" reloadable="true"/>
```

The next step is to create web applications. To create the web applications we have to create a directory inside the webapps directory. In this directory we have to create a directory called *WEB-INF*. All programs and configuration files used in the prototype are stored in this directory. One important required element in *WEB-INF* is the file *web.xml*. The *web.xml* file controls everything specific to the current web

application. Programs used in the prototype have to be registered here. After these configurations the web server becomes ready to accept client/browser request.

Integrating SSL in Tomcat web server

This section explains steps carried out in integrating SSL in Tomcat web server. To install SSL in Tomcat Java Secure Socket Extension (JSSE), server certificate keystore and an HTTPS connector are needed.

JSSE (Java Secure Socket Extension)

JSSE is a set of Java packages that enables secure Internet communications. These packages implement a Java version of SSL and TLS protocols and include functionality for data encryption, server authentication, message integrity, and optional client authentication. JSSE has support for built-in algorithm such as RSA, RC4, DES, 3DES, DH, DSA, SHA, MD5. JSSE has been integrated into the Java 2 SDK, Standard Edition v 1.4.

Server Certificate keystore

In order to implement SSL, a web server must have an associated certificate. Certificate is typically purchased from a well-known *Certificate Authority* (CA) such as VeriSign. Such certificates can be electronically verified. The SSL service of the Tomcat server will not run unless a server certificate has been installed. In the prototypes self-signed certificates are used. Self-signed certificate is simply user generated certificate which has not been officially registered with any well-known CA. Self-signed certificate is acceptable for most SSL communication. To generate the certificate java provides command-line tool called keytool. Keytool stores the keys and certificates in a so-called *keystore*. To generate the certificate the following command was executed.

```
%JAVA_HOME%\bin\keytool -genkey -alias tomcat -keyalg RSA
```

-keyalg RSA specifies that the RSA algorithms are used in the SSL. The keytool utility that is shipped with the J2SE SDK version programmatically adds a Java Cryptographic Extension provider that has implementations of RSA algorithms.

When the command line is executed it will prompt for general information used to construct certificate, such as company name, organization, and so on. This information will be displayed to users who attempt to access a secure page.

HTTPS connector

The *server.xml* file must be edited to enable https connector. By default https connection is disabled in Tomcat. In the prototype the port used for SSL is 8443(the default port number used in Tomcat for https). For maximum security it is possible to close the connection that operates through port number 80(non SSL web connection). But in this prototype the applications are responsible not to accept connection through port number 80.

Browser must use *http**s*** instead of *http* to initiates SSL connections. In the prototype address like *https://localhost:8443billpayment/...* are used.

JDBC

JDBC (Java Database Connectivity) is a set of classes and interface that allows access to SQL based DBMS. It allows integration of SQL statement into programming environment by providing library routine which interface with the database. The dependent part is the driver used for each database. Since the DBMS used in this project is MySQL we have used MySQL Connector/J 3.1.1 driver. This driver uses MySQL's C API in the background to talk to MySQL. The jar file of this driver must be stored in the directory`...\j2sdk1.4.2_08\jre\lib\ext` in order to be accessible.

5.4 Functionalities of the Prototype

This section describes functionalities provided by the prototypes. The first subsection describes functionalities provided by the prototype of the e-payment for e-commerce. The next subsection is about the functionalities of the prototype that is used for bill payment.

E-payment for e-commerce

This prototype provides e-payment services for e-commerce customers and merchants. Both customers and merchants need to get registered before paying or accepting money. Through the registration process the system gets basic information from the users. To get the registration page use the following URL `http://localhost/projects/won/RegisterForm`

Users need to provide the correct information when they get registered. After users have filled this form a conformation page will be displayed to confirm registration. Up on successful registration the system will generate unique login id. This login id is used as primary means of identifying users of the system. After the users get

registered they can login and start to use the system. To get the login page use the following URL
`https://localhost:8443/projects/won/LoginForm`

After users have provided their password and login name correctly they will be directed to their home page. From their home page users can transfer to pages that enable to fill their virtual account, to pay to other user of this system or view their payment history.

Users fill their virtual account using internet cash card. After users have properly filled the secret code of the card, their e-payment account will increase based on the amount of the cash card. To avoid brute-force attack to the system, users can only make three successive attempts before their account is suspended. If users do not correctly enter the secrete code in the first attempts, they will be given first warning. If they fail to enter the secret code in the second attempt they will be given final warning. But if they can't provide the correct secret code in three consecutive attempts their account will be disabled.

In order to pay to someone users must provide the payment id of the payee and the amount to be paid. If payment is successful, a confirmation page will be presented to the payer. The payee knows about this payment by viewing his payment history.

E-payment for Bill Payment

This prototype provides the functionalities that enable to view and pay bills. Users that want to pay their bills using this system need to get registered first. In addition users must also get register their meter.
To get the users registration page users need the following URL
https://localhost:8443/billpayment/UserRegisterForm
To get the meter registration page users need the following URL
http://localhost/billpayment/meterRegistrationForm
After the users get registered themselves and their meter, they can login to get the functionalities of the system. In order to login users need the following URL
https://localhost:8443/billpayment/loginform
After users provide the correct password and login name correctly they will be transferred to their home page. In their home they can view any bill issued to them

for a meter register under them if there is any. They can also fill their virtual account using internet cash card. This is similar to the prototype of the e-commerce. Their home page also provides them a link to page which enables to view and pay their bills.

Administrative Page

Both prototypes provide administrative pages. In the case of the prototype that is used for bill payment, the administrative page is used to generate secret code of the internet cash card and to issue new bills. In the case of prototype used for ecommerce it used to generate a secret code of the internet cash card. The password and Login Name used for this purpose are login Name= admin, password=123abc.

The URL to used to access these pages are

For bill payment https://localhost:8443/billpayment/adminPage

For e-commerce https://localhost:8443/projects/won/adminPage

Steps needed to configure the prototypes

1. Java JDK installations

   Download and install the Java Software Development Kit (SDK). It is best to download Java 1.4.

2. Download the Mysql- java connector, which is used to connect MySql with the Java Servlets through JDBC. The jar file must be put in …\jre\lib\ext of the jsdk.
3. Install the Mysql DBMS
4. Create the tables that are used in prototypes. (The scripts used to create the table is found in the root in the same directory as this file with a name
5. Install and configure Tomcat web server.
6. Copy the two folders (*project* and bill *payment*) and put them in …..\Apache Software Foundation\Tomcat 5.0\webapps folder. They are already contained preconfigured so they do not need configurations.