Modeling an Enhanced E-Payment Gateway to Empower E-Commerce in Ethiopia

Wobetu Shiferaw, Teshome Fenta

Abstract— E-commerce plays a significant role in the economic and social development of a country. We everyone know how much E-Commerce is important in many aspects of human life but we also know how much risky it is. In e-commerce, more than two parties interact with a given e-commerce platform. In e-commerce, there should be a trusted, secured reliable electronic bank transaction system; a trusted, secured and reliable electronic payment system; and a more technology aware, trusted customer. Since e-banking and e-payment are at infant age in Ethiopia, we couldn't realize e-commerce services in our country. This paper studies the importance of e-commerce for development, the challenges facing in enabling it, the different attempts being made and the gaps discovered in realizing full-fledged e-payment platform in Ethiopia and suggest a new banking model and e-payment framework that can enable development of e-commerce services and suggested the different technology tools for the development of the platform.

Index Terms— E-commerce, E-payment, Application Integration, Web Services.

1 Introduction

E-commerce plays a significant role in the economic and social development of a country. Think of most developed nations experiment. We can't think their economy without their ecommerce platforms. We can't think the US without Amazon, EBAY, PayPal or even Google. We everyone know how much E-Commerce is important in many aspects of human life but we also know how much risky it is. Since more than two parties interact with a given ecommerce platform, a chain of trusted business communication should be established and things must be suitable for this.

There should be:

- A trusted, secured reliable electronic bank transaction system
- A trusted, secured and reliable electronic payment system
- A more technology aware, trusted customer

In our country, since electronic banking system is so at its infant age, and with the above reasons, we could not realize the e-market sector. Customers need to perform everything at the comfort of their home, even they want to purchase online products and services from abroad; developers in the IT industry have ideas to create different e-commerce and e-service platforms. But to realize e-commerce, there should be a platform that have some way to access and perform transaction from the customer's account. But there is no way to do this. Banks don't have trust in their "system security" to provide electronic payment. Actually, there are things being started such as electronic billing for water and electronic consumptions from ATM machines. And Ethiopian Telecommunications Corporation (Ethiotelecom) has some short texting line so called **Unstructured Supplementary Service Data** (USSD) methods to perform payments. But still they didn't realize internet marketing in any means. On the other hand, international foreign banks have interest to work in this country. If it would be, in terms of internet marketing, they can bring big changes since they are more experienced in the area. But this is not possible since our local banking sector policy doesn't allow for foreign banks to invest here.

To solve this problem, we have proposed the different possibilities to design and implement a general-purpose online payment system that allows customers and service providers buy and sell their goods and services using this system as a backbone payment platform.

2 Background and Overview of the Existing System

The astonishing growth and sophistication of information and communication technology (ICT) is changing societies' ways of life in various parts of the world. One of the leading areas where this manifested is the way business is conducted. The growth of the Internet and World Wide Web (WWW) has made electronic commerce (e-commerce) possible. E-Commerce in its simplest sense is *trading electronically* [1]. It offers consumers and merchants convenience and speed.

In the developed countries, today, consumers and businesses have recognized the potential and benefits of adopting computer networks. Consumers now use computer networks to identify sellers, evaluate products and services, compare prices, and exert market leverage. Businesses use them to conduct and re-engineer production processes, streamline procurement processes, reach new customers, and manage internal operations.

The success and growth of e-commerce, however, depends on efficient electronic payment (e-payment) system. The slogan '*it is no e-commerce, if you can't get paid*' witnesses the importance of e-payment for e-commerce. E-payment, the transfer of value electronically, in turn depends on secure ICT infrastructure, efficient legal and regulatory policy, and widespread awareness among the public and business [1]. The commercial banking companies in Ethiopia are showing tremendous developments in adopting different information technology tools for modernization of their financial management and customer services. Near half a decade ago they were using **SmartBank** software technology which was a desktop-based banking automation system that enables to manage customer financial data within the private local area network of computers only within the bank's branch office. And then, most banks adopted new software and computing paradigm, the so-called **core banking technology** that allows connect all computers in all branches of the bank and allows central management of customer data and enable customers to get service from any branch or from any device. And these improvements have grown into inter-bank integrations which allowed customers withdraw money from any private ATM. Some commercial banks have also starting enabling of online payments from customer's account for airline and cinema tickets, water and power service billings and restaurant and supermarkets services using point of sale (POS) machines etc. In general the different payment methods include cash, wire transfer, checks and drafts as well as electronic cards such as ATM, Credit card and Debit Card. These payment systems are more traditional and yet cannot compared to developed countries experience [2].

3 Statement of the problem

Enterprises involved in business strive to survive and prosper in the market and it is inevitable to adopt strategies that would help achieve this goal. Whether small or big, almost all businesses face competitions and need to look for ways to win the requirements of their customers. One of the major developments of our time that could provide the means for businesses to arrive at their desired goals is information and communication technology (ICT) and the Internet. The adoption of ICT and e-business technologies gives features and benefits for growth and improved competitiveness [3]. On the other hand, Levy & Powell [3] claim that there is no much evidence that small and medium-sized enterprises do more than develop websites and adopt e-mail. The main reason behind includes low internet penetration, absence of legal and contractual policies related to the use of ICT, low level of literacy and the absence of modern electronic financial methods to exchange goods and services using the internet and e-commerce technology. Currently there are a number of attempts to create different electronic payment platforms that enable businesses to be part of the e-commerce revolution in Ethiopia. The bad news is, most of these attempts do not fulfill the least requirements of the standard payment systems experienced by many global e-payment methods. Some of the drawbacks of this startups include, they stick only to a single banking company so that they enforce their customers to be **"customer of that specific bank"; use of none standard and traditional system integration techniques;** and **they are more beurocratic.** More importantly they have no standard application programming interfaces (API) or system integration tools and guidelines to enable e-commerce developers to create e-payment module for their e-commerce platform that they are building. The developed countries' experience shows that to entertain e-commerce, there should be a well-defined e-payment platform which has an open application programming interface (API) that provides a middleware functionality to allow customer purchase goods and services and pay the values to the owner using this e-payment platform. However, the emerging payment methods in our country are being developed missing this concept and they are using banks and ethiotelecom services as a backbone and their connection technique is traditional. Based on these facts, this research project aims to develop a secure and universal electronic payment system with clear and well-defined API that enable e-commerce developers to create e-commerce application of their interest with a payment gateway. In general, the e-payment gateway system is aimed to operate as demonstrated below.

1. Develop a secure payment system that allows customers open account, deposit, withdraw and transfer money.
2. Develop a secure API using web services that exposes the functionality of the payment system to external e-commerce applications. The e-commerce applications

can connect to our payment gateway using the API, and allows authenticated e-commerce provider / seller to get access and manipulate buyers account from the payment system.

3. Provide a platform for e-commerce developers for developing any e-commerce application on top of our e-payment gateway.
4. The main process is
    a. Sellers and buyers open account and deposit money available for purchase (especially buyers should have deposit on their account).
    b. Sellers have e-commerce system that allows buyers to manage and order purchase.
    c. When a buyer orders the item from the ecommerce system, payment will be processed with our payment system and money transfer will be done from the buyer to the seller.

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3 Conceptual Discussion and Literature Review

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3.1. E-Payment

Electronic payment or e-payment is a way of making transactions or paying for goods and services through electronic medium without the use of checks or cash [4]. It's conducted mainly on the internet and because of this it's also known as online payment. Depending on its applications, there are a number of requirements that an electronic payment system may need to satisfy, including:

Confidentiality: any data transferred must not be eavesdroppers.

Authentication: communicating parties must be certain of other's identity.

Integrity: communicating parties must be certain that data has not been tampered with;

Non-repudiation: it must be possible to prove a transaction has taken place at a certain time.

Anonymity: the real identity of certain communicating parties is not revealed.

Un-traceability: who spent what and where is not revealed.

Electronic Payment Methods

One of the most popular payment forms online are credit and debit cards. Besides these, there are also other alternatives such as bank transfers, electronic wallets, smart cards or bitcoin wallets (bitcoin, the future of currency). Below is a discussion of the most popular payment systems available worldwide [4]. They are classified mainly into two areas; Credit payments and Cash payments.

Credit payments

Credit Card: a form of payment system which requires the use of the card issued by a financial institute to the card holder for making payments online or through an electronic device without the use of a cash.

E-wallet: a form of prepaid account that stores user's financial data like debit or credit card information to make online transactions earlier.

Smart Card: a plastic card with a microprocessor that can be loaded with funds to make transactions; also known as chip card.

Cash Payment methods:

Direct credit: a financial transaction in which the account holder instructs the bank to collect a specific amount of money

from his account electronically to pay for goods and services.

E-check: a digital version of an old paper check. It's an electronic transfer of money from a bank account, usually checking account without the use of the paper check.

E-cash: is a form of electronic payment system, where certain amount of money is stored on a client's device made accessible for online transactions.

Stored-value card: is a card with a certain amount of money that can be used to perform the transaction in the issuer store. A typical example of stored-value cards are gift cards.

3.2. E-Commerce and E-Services

Electronic commerce or e-commerce also known as e-business is the buying and selling of goods and services, or the transmitting of funds or data, over a computer network, primarily the internet [5]. It is the sharing of business information, maintaining business relationships, and conducting business transactions by means of telecommunication networks [6]. The ideal e-commerce business transactions occur either as business-to-business, business-to-consumer, consumer-to-consumer or consumer-to-business.

History of e-commerce

The beginning of e-commerce can be traced back to 1960s, when businesses started using Electronic Data Interchange (EDI) to share the business documents with other companies. In 1979, the American National Standards Institute developed ASC X12 as a universal standard for businesses to share documents electronic networks. After the number of individual users sharing electronic documents with each other grew in the 1980s, the rise of eBay and Amazon in the 1990s revolutionized the e-commerce industry. Consumers can now purchase endless amounts of items online, from e-tailors, typical brick-and-mortar stores with e-commerce capabilities, and from one other [5].

Types of e-commerce

Business-to-Business (B2B): e-commerce refers to electronic exchange of products and services between businesses rather than between businesses and consumers.

Business-to-Consumer (B2C): is a type of e-commerce when businesses sell products, services and information directly to consumers.

Consumer-to-consumer (C2C): is a type of e-commerce in which the consumers trade products, services and information with each other online. These transactions are generally conducted through a third party that provides an online platform on which the transactions are carried out.

Consumer-to-business (C2B): is a type e-commerce in which consumers make their products and services available online for companies to bid on and purchase. This is the opposite of the traditional commerce model of B2C.

Business-to-administration (B2A): refers to transactions conducted online between companies and public administration or government bodies. Many branches of government are dependent on e-services or products in one or other, especially when it comes to legal documents, registers, social security, fiscals and employment. Businesses can supply these electronically. B2A services have grown considerably in recent years as investments have been made in e-government capabilities.

Consumer-to-administration (C2A): refers to transactions conducted online between individual consumers and public administration or government bodies. The government sometimes buys products and services from its citizens in areas such as education (disseminating information, distance learning or online lectures), social security (distributing information,), Taxs (filling tax returns, making payments), health (making appointments, providing information about illness, making health service payments)

E-commerce applications

E-commerce is conducted using a variety of applications, such as email, online catalogs and shopping carts, EDI, the File Transfer Protocol (FTP), web services and mobile devices. More companies now try to entice consumer online using tools such as digital coupons, social media marketing and targeted ads.

The benefits of e-commerce include its around-the-clock availability, the speed of access, the wide availability of goods and services for the consumer, easy accessibility, and international reach. Its perceived downsides include sometimes limited customer service, consumers not being able to see or touch a product prior to purchase, and the wait time for product shipping. The rise of e-commerce has forced Information Technology (IT) personnel to move beyond infrastructure design and maintenance to consider numerous customer-facing aspects, such as applications to accommodate e-commerce activities, data, governance-related regulatory rules and information protection protocols must be considered.

3.3. Application Integration and Web Services

Enterprise Application Integration

Enterprise Application Integration (EAI) is one of the most important trends in information technology which has been introduced to enable more than two independent enterprise applications communicate and share data, information and computing capabilities to each other. EAI solutions enable an organization to integrate business processes internally with business partners and to create dynamic environments that support current and evolving business requirements, thereby creating a global organization [7]. It assists in unrestricted sharing of data and business processes among any connected applications or data sources in the enterprise without making major changes to the applications or data structures. It integrates multiple and independently developed applications using incompatible technologies into a single enterprise wide system with information flows seamlessly. Organizations are attracted to adopt EAI to get advantage of improved e-business communication with their business partners; extending of already existing legacy systems with new functionality; implementation of Enterprise Resource Planning (ERP); Supply Chain and customer relationship management (SCM and CRM) and so on. E-commerce is one of the main application areas where the concept of EAI is leveraged with which different applications on the web need to interact to facilitate business transactions and the buying and selling of goods and services. In e-commerce there are a number of independently developed applications that need to interact to share data and processing capability to each other. EAI uses a technology known as middleware to implement integration of two different applications. Efforts have been made in different times to develop better middleware tools and technologies among which Common Object Model (COM), Distributed COM (DCOM), Component Object Request Broker Architecture (CORBA), Remote Procedure Call (RPC) and Java Remote Method Invocation (RMI) can be mentioned. These different technologies have their own strength and drawbacks. The major issues behind the evolution of these technologies are implementation of hardware, operating system and language independent tool that allows heterogeneous applications to talk to each other. With respect to this, the technologies discussed above have issues that hinder leveraging a full-functional integration capability of applications. Among this, COM and DCOM are Microsoft-only platforms, CORBA is platform independent but it depends on specific ORB architecture on which it is designed to run on. And Java RMI as the name implies is language specific which indirectly restricts developers to stick to a single programming language, Java. The motivation of developing a more flexible middleware technology leads to the creation of Web services, which become hardware, OS and language independent way of communication of applications on the web.

Web Services

A web service is a software system designed to support interoperable machine-to-machine interaction over a network. Web service is a service offered by electronic device to another electronic device by communicating with each other over World Wide Web. It is a self-contained, modular, distributed, dynamic applications that can be described, published, located or invoked over a network to create products, processes and supply chains [8]. These applications can be local, distributed, or web-based services that are built on top of open standards such as TCP/IP, HTTP and XML or JSON. It's a collection of standards or protocols for exchanging information between two devices or applications. Applications can be developed using either of the two types of web service implementations: SOAP (Simple Object Access Protocol) based web service or RESTful (REST=Representational State Transfer) web service which SOAP is mainly based on XML (eXtensible Markup Language) data exchange whereas REST is based on JSON (JavaScript Object Notation) data.

Web services-based EAI integrates multiple individual applications together, while each application still maintains its own business functionality. In a Web services-based EAI system, each application is a service-oriented, distributed component module. The EAI system can integrate applications from multiple enterprises. This type of framework can be seen in the figure below.

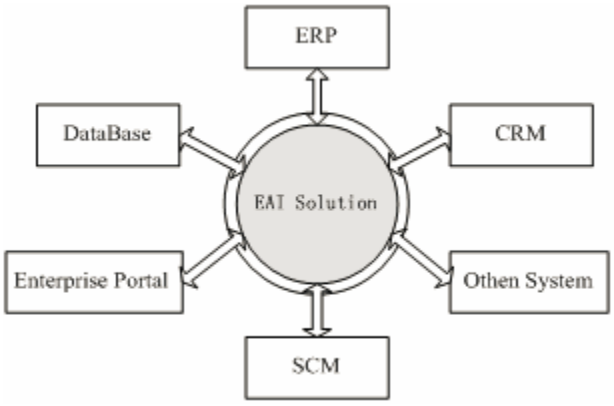

Fig. 1. An EAI-solution system which integrates multiple software components *[9]*

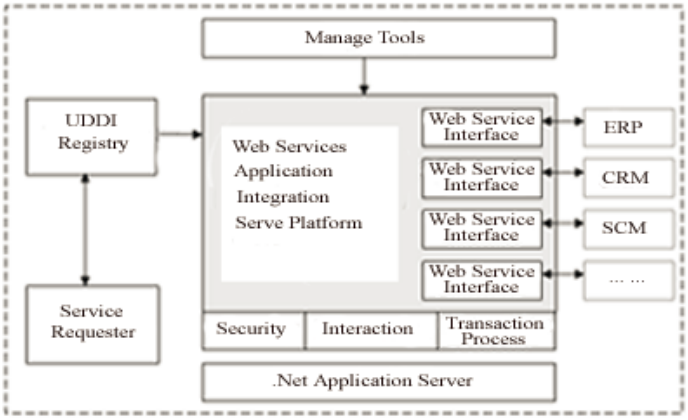

Figure 2: EAI framework based on Web Services [9]

Likewise, web services can be used for development of an interoperable electronic payment gateway systems which can integrate and allow an online commerce firms and provide payment and transaction services to their customer so that they can be used as a bridge between the buyer and the seller.

4 Related Works

M-Birr [10]: is a mobile money service introduced in 2014 and used by individual agents and in collaboration with major microfinance institutions in Ethiopia such as Amhara Savings and Credit institution (ACSI), Addis Credit and Savings Institution (ADCSI), Dedebit Credit and Savings Institution (DESCI), Oromia Credit and Savings (OCS) and so on. It provides services such as deposit cash at an agent, withdraw cash at an agent, transfer money, buy mobile top-up, pay bills, buy goods from agents and repay loans [10]. M-Birr is one of the pioneer digital financial services in Ethiopia despite it has some drawbacks in providing a modern digital financial solution. One of the important areas we were looking into was whether it is suitable to provide e-commerce functionality or not. M-Birr is limited in that it's only restricted to management of customers financial information and the transfer of money from one customer to another and can't provide payment services as a digital trusted third party by buyers and sellers. It uses Ethiopian Telecommunications Corporation (Ethiotelecom) network to operate and does not run on the internet. Its operation is part of the hosting microfinance institution and is not independent software system that acts as third party between sender and receiver. Because of this and others M-Birr is not for a full-functional e-commerce service.

Kifiya [11]**:** is another digital financial service provider based in Addis Ababa. Kifiya was established in 2010 and is providing different services such as single window service delivery, mobile money, online payment for social duties (edir and ekub, stadium, bus) using remitance, automatic fare collection. They provide all this services by different brands such as LEHULU, MELA, YENE GUZO, stadium e-ticketing and airtime distribution. Clients use these services via Kifiya agents at various locations and service providers such Lehulu, airtime distribution, ticketing by outsourcing these services to kifiya. Kifiya played a step further in introducing digital financial services. But still it has some drawbacks in delivering a full functional digital system. Its negotiations with service provider organizations is manual and does not leverage electronic integration of systems, it's simply a paper written agreement to take the jobs done on behalf of the organizations. Clients must contact the branch agents to use their services. They have no any means to deliver an electronic interface that provides an autonomous service for service providers to provide services by themselves.

YenePay 12]**:** is a new startup financial service provider which provides services such as online payments, online shopping, and integration with customer's bank account. It allows for developers to integrate their system with YenePay and start making money from their system. YenePay is better in that it is developed considering e-commerce service development and enhanced digital payment system. This is very important step because it sees e-commerce functionality as a gap missed by other financial service mentioned above. For realizing e-commerce, they developed integration services which allow developers to develop e-commerce applications on top of their platform. But we see that the integration model is very difficult to realize because YenePay is designed as a middleware between customers and commercial banks. As their documentation manual says [12] "**Step 1: Register for free. Step 2: Authorize bank account (instruct your bank to allow internet and mobile banking, Step 3: Done**", their service forces customers to connect their bank account and on the other hand force commercial banks to allow expose customer data to YenePay which is impossible for the current model of most commercial banks in Ethiopia.

There are also a number of emerging digital money services started recently such as CBE birr, Ethiotel SMS systems, commercial banks' mobile and internet banking services but in one

way or another, these systems lack full functional online payment that can realize e-commerce functionality.

5 Objective of the Research Project

5.1. General Objective

The main objective of this research project is to study and identify the problems, experiences, challenges and opportunities of e-commerce and e-payment system Ethiopia and design an e-payment framework of e-payment gateway.

5.2.1. Specific Objective

- Study e-commerce and payment systems from global and Ethiopian perspective.
- Study the major attempts and experiences of e-commerce development and use in Ethiopia and the major challenges faced
- Study the different payment methods and major drawbacks they are having
- Design a framework and develop a prototype of an e-payment gateway system.
- Develop an API that allows to connect sellers' e-commerce application to connect with the payment gateway
- Develop an e-commerce application prototype and test it with the payment gateway
- Provide recommendation to develop a full-fledged payment gateway system

6 Significance of the Research Project

As we argued so far, e-payment is a backbone for enabling e-commerce in a country. It's ideal that digital services play a key role in the economic and social development of a nation. When we have easy to use, state of the art payment system, it is ideal that a number of services can be transformed into electronic services such as e-commerce, e-learning, e-healthcare, e-governance, and e-agriculture etc. The development of e-payment systems brings such advantages as:

- Introduces a new business model that promotes e-commerce development in our country
- Supports Technology enabling service systems
- Solves copyright related issues in the arts and electronic products marketing
- Helps the introduction and increment of online services such as e-commerce, e-learning, e-healthcare, agriculture, consultancies, collaborations, work from home etc
- It's a just a payment middleware for any service, allows anyone to build his / own online service on top of this platform.
- Creates great job opportunities from the perspective of different parties

7 Tools and Methodologies

Upon the study of the research project, the researchers conducted the following tools and methodologies from data collection and tools comparison and selection to modeling the proposed framework.

7.1. Data Collection

Interviews

We have conducted open ended interviews with major players of financial service sectors and startup financial companies who are working on electronic financial services in Ethiopia. The objective here is to fully understand how different financial services are being operated and finding out if there are important things missed so that we can introduce a new financial service framework that includes what have been missed by those companies and to share experience in the area.

Onsite observation

We have bought and used the services provided by the companies thereby observed and learnt the services being provided, how they are operating and find out if there are somethings, we can make improvements.

Document analysis and web survey

We have collected and analyzed forms, reports and documents describing the operations and natures of these financial services from the organization's office and their website. We will also study the different digital financial service experiences and trends of the global perspective from the web as well as from published scientific papers.

Conducting a need assessment survey

We have conducted a need assessment survey that assesses how much clients need this kind of software service if they have the opportunity to get and use it. This is very useful and it helps us for the development of a full-fledged e-payment system and e-commerce applications. For this task, we will take 150 samples from 3 cities (Addis Ababa, Bahir Dar and Debre Markos).

8 Develop the System Architecture

Based on the studies we have conducted; we have developed a detailed system architecture and framework that can demonstrate the working software as if it is completed. To achieve this, we have developed two separated systems that can be able to integrate to each other. The first application simulates the payment backbone / gateway application and the second one is an e-commerce application that can be able to use this payment gateway services. The proposed birds-eye view of the system will look as demonstrated in figure 3 and the detailed system architecture of the system is demonstrated in **figure 3.**

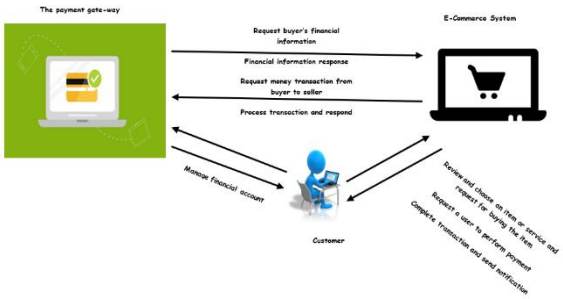

Fig. 3. Birds-eye view of the proposed system architecture

Detailed System Architecture

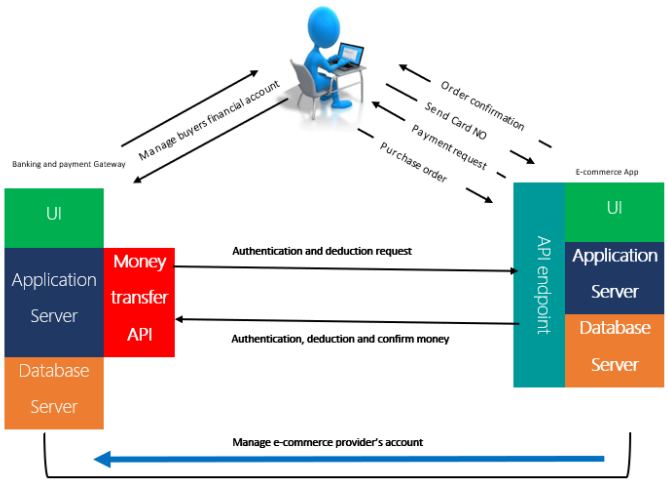

Fig. 4. Birds-eye view of the proposed system architecture

9 Tools and Technology Selection

For the development and testing of the prototype, we have suggested the following tools and techniques.

Development platform	Web application
Programming Languages and Software Requirement	
Frontend development	HTML, CSS, JavaScript
Backend development	PHP
Database Server	MySQL Server (Available as WAMP stack)
Web Server	Apache Web Server (available as WAMP stack)
Software Development Kits (SDK tools) and Frameworks	
Frontend development	HTML5, CSS bootstrap v4.0 or above, VueJS 3.0 or above
Backend development	Laravel PHP framework V7.x or above
API Development and App Integration	
Web Service Development	RESTful based web service

10 Conclusion and Future Work

Digital services are changing the way we live. Digital financial services enable us to perform everything from home; to purchase goods and service, to pay our bills whenever we go and so on. Implementing digital services is not easy specially in developing countries where there are a number of restricting factors such as government laws, absence of hardware, software and network infrastructure. In this paper we have studied how we can enable e-commerce in Ethiopia with the introduction of a new banking model which includes digital payments for e-commerce products and services. We have recommended a new data integration and business processing framework to enable e-commerce in the consideration of current banking policies for data interchange.

The framework we have suggested is a new bank system that can provide banking services as well as digital payment services that can be integrated with external e-commerce services to enable a customer / buyer to buy and sell a product via his / her accounts. But in the future when government policies for e-commerce improved the framework can be extended to act as a middleware for more than two banks so that a buyer can pay from any bank where he has created his / her bank account.

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