Abstract—Customer profiling has gained much recognition in the e-commerce domain because of the benefits it is capable of bringing to online businesses. Online businesses utilise customer profiles to assist implementing one-to-one marketing strategies in order to attract new customers and retain existing customers. Personalisation is one successful method used by online businesses to implement one-to-one marketing strategies and research has revealed that personalisation can improve customers’ satisfaction levels, purchasing behaviour, loyalty and consequently increase sales. Organisations are increasingly adopting and implementing e-commerce systems using service-oriented architecture (SOA) principles. Incorporating customer profiling into SOA e-commerce systems is vital for survival and success in the competitive Internet environment. This research sets out to investigate how a customer profile can be developed and implemented using SOA and how customer profiles can be used to provide appropriate personalisation in a SOA environment. The research further endeavours to complete a comparative study on customer profile implementation in SOA and other existing architectures such as client-server. In this paper, a customer profile model using SOA is discussed.

Index Terms—Customer profiling, Service-oriented architecture, Web services, e-commerce.

I. INTRODUCTION

Recent studies have indicated that e-commerce businesses have recognised the importance of building personalised profiles of individual online customers [2]. Customer profiles contain information about a customer’s demographic details, preferences, characteristics and activities [10]. Customer profiles can help online businesses perform effective personalisation and further enable personal product recommendations to be made [23].

Organisations are implementing business critical systems following the service-oriented architecture (SOA) paradigm. SOA can be defined as a set of patterns and guidelines for creating loosely coupled, standards based, business-aligned services that provide a new level of flexibility in responsiveness to business threats and opportunities [5], [15]. SOA is made up of a collection of services and can be implemented using several techniques, however, web services are the most commonly used implementation technique for SOA in the e-commerce domain [27]. A recent survey conducted by Computer Economics and a press release from Gartner indicate that SOA adoption will continue to grow in the next few years [8], [12].

This paper discusses the customer profile model using SOA. The paper presents part of a research study that aims to investigate, propose, implement and evaluate a customer profile in a SOA environment using open source SOA implementation tools. SOA research is currently on the increase; however, little attention is being given to the role customer profiles can play in a SOA environment [15], [31].

In this paper it is envisaged that having a customer profile model incorporated in the cutting edge technology using SOA can improve customers’ satisfaction levels and loyalty. Online businesses can take advantage of the benefits of SOA and increased online sales and profits since research has shown that customer loyalty is vital for success of online businesses in the competitive web environment.

The subsequent sections of the paper are structured as follows: Section II discusses the literature review by investigating e-commerce customer profiling and SOA. Section III explores the proposed customer profiling model in SOA and Section IV discusses the development of the model. Section V discusses the SOA implementation frameworks and Section VI concludes the paper.

II. LITERATURE REVIEW

A. E-commerce Customer Profiles

Research studies indicate that the e-commerce environment is competitive and opportunities for e-commerce success exist; however, failures also exist [21]. E-commerce has enabled businesses to extend to a global market thereby increasing the customer base, sales and consequently profits. Online businesses face a number of challenges, one major challenge being to determine online customers’ preferences. Several techniques have been developed as solutions, for example, one-to-one online marketing strategies. These techniques assist e-commerce businesses to survive on the Internet by increasing customer loyalty and turning e-commerce website visitors into customers [2], [21]. Increasingly online businesses have recognised the vital role customer profiles play in determining online customers’ needs and preferences.

A customer profile is a snapshot of who your customers are, how to reach them and why they buy from you. In short, a customer profile is a collection of information that
describes the customer [1]. Customer profiling is the process of developing a profile using relevant and available information to describe the characteristics of an individual customer and to identify discriminators from other customers and drivers for their purchasing decisions [24].

Customer profiles can be classified by two sets of information namely factual or static and behavioural or dynamic [1], [10]. Factual or static profile information contains specific facts about the customer, including demographics, for example, age, gender and name. Behavioural or dynamic profile information models the behaviour of the customer and this is done using conjunctive rules such as association and classification rules [1]. An example of behaviour is when shopping on weekends, customer X usually spends R100 on groceries [1].

By establishing customer profiles, businesses can filter and analyse information to help understand and endeavour to meet the needs and preferences of each specific customer or a group of customers based on their profiles [23]. Customer profiles provide a suitable tool to analyse and determine customers’ needs and preferences that can be used to implement one-to-one online marketing strategies. Some notable online businesses that utilise customer profiles include kalahari.net in South Africa and Amazon.com in the United States of America.

Explicit and implicit feedback are two common methods used by online businesses to establish a customer profile [17]. Explicit feedback is the simplest method to establish a customer profile. Customers are openly asked to register their details on the website using an online questionnaire. Information that is captured during this process normally includes factual or static information such as name, gender, age and other demographic details.

In some instances the registration continues by asking the customer to provide preferences, answer a specific questionnaire or rate items or products on the website [19], [25]. These sections for registration include behavioural or dynamic information that is used to model the users’ online behaviour [3], [9], [19].

Figure 1: Behaviour customer profile questionnaire

Figure 1 is a screenshot example of how behavioural customer information can be obtained from the customer using a questionnaire [25]. Research shows that questionnaires are the most commonly used method to establish an initial customer profile [25].

The benefits of creating individual profiles for customers include assisting personalisation, customisation and recommendation to be accurately performed on online websites.

Personalisation refers to the use of technology and available customer information to tailor e-commerce interactions between a business and each individual customer [2], [20]. Personalisation helps to make a website more responsive to unique and individual needs of each user [2], [7].

Customisation is a widely used method to remove a burden of website information overload on the part of the online user [20]. Customisation refers to a process whereby end users are given an opportunity to select requirements from a set of comprehensive options and the online businesses provide products and services based on users’ explicitly selected requirements [32].

Recommendation refers to the use of available customer information to propose what users will be interested in on the website. A recommender system is a system that attempts to assist users making decisions in various domains by offering suggestions about items to users by employing various methods [6]. A major difference between personalisation and customisation, and recommender systems is that in recommender systems, suggestions are made to customers in suggestions form and the customers have a choice of whether to view or ignore recommendations.

The following methods are commonly used to derive recommendations in online websites:

- **Collaborative filtering**: Collaborative filtering determines the contents for a specific customer profile based on the customer’s profile and reference to other customers with similar profiles;
- **Content based filtering**: The content based filtering technique is done based on the customer’s profile created from what the customer has done in the past [20]; and
- **Knowledge based or Hybrid filtering**: The knowledge based filtering technique is a combination of content based filtering and collaborative filtering techniques [2].

**B. Service-oriented Architecture**

A number of SOA definitions exist, however, in this paper SOA is defined as the set of architectural patterns and guidelines for creating loosely coupled, standard-based, business-aligned services that provide a new level of flexibility in responsiveness to business threats and opportunities [5], [15]. SOA can be explained as a set of architectural tenets for building autonomous, yet interoperable, systems. The fundamental idea of SOA is that systems are designed and implemented using loosely coupled components called services [4], [5]. Services thus form the basis for SOA implementation.

A service is an implementation of a well-defined business functionality [16], [18]. The complexity of the functionality can vary from being simple, such as retrieving customer address, to complex, as processing customer orders. The following service classification can be done: basic,
composed and process services [18]. Fully implemented services in SOA must possess the following characteristics [11], [16]:

- A well-defined function;
- Self-contained; and
- Should not depend on the context or state of other services in the architecture.

Services in SOA use the find-bind-execute paradigm as shown in Figure 2 to interact and exchange messages between each other [11], [16]. There exist a number of formats to enable services exchange data, for example, JavaScript Object Notation (JSON) and eXtensible Markup Language (XML); however XML is widely used in SOA environment [11]. In the find-bind-execute paradigm, service providers register their functions in a service registry using web service description language (WSDL) and service requestors find out about the available services by inquiring from the service registry using universal description, discovery and integration (UDDI) as shown in the figure. Figure 2 also shows how services communicate and exchange messages using XML standards for example SOAP and hyper text transmission protocol (HTTP).

![Figure 2: Service interaction model](image)

A number of technologies that can be used to implement SOA exist, however, web services is the commonly used method. A web service is defined as a software system designed to support interoperable machine-to-machine interaction over a network [28], [30], [31]. Web services are self-contained, modular applications that can be described, published, located and invoked over a network or the Internet [13]. Web services enable services in SOA to communicate by exchanging messages expressed in XML [11]. A number of XML-based standards such as SOAP, WSDL, UDDI and business process execution language (BPEL) exist in SOA. These standards enable services implemented using different programming languages and running on different platforms to successfully communicate and work together to achieve a goal or complete a business process.

SOA being a distributed architecture allows services to be located and executed at distributed computers connected to a network. An enterprise service bus (ESB) is a widely implemented communication framework that most organisations use to integrate distributed systems.

An ESB is a software infrastructure that enables the integration and reuse of business components. It is a highly distributable communication and integration backbone generally required to implement a SOA [18], [26]. Several software vendors have developed commercial and open source ESB, which can be used to implement SOA, for example, Sun Java and Oracle. An ESB does not implement a SOA; however, it physically provides an implementation backbone for SOA [15], [26].

Using an ESB is beneficial as compared to the usual point-to-point connections. ESB is capable of relieving the consumer of knowing the actual address of the provider [18]. The communication cost when using point-to-point can be calculated as follows: for n points, each node will need (n-1) connections which brings the total connections to \( n(n-1)/2 \) [18]. When ESB is used only one connection is required for each node and hence for n nodes the connection cost is reduced by a factor of \((n-1)\) [18].

SOA promises a number of benefits to organisations if properly implemented and governed. Some of the notable benefits include [11], [15]:

- Improved integration and interoperability;
- Loosely coupled services improve component re-use;
- Leveraging of critical business legacy systems;
- Provides the best of breed alternatives for organisations to choose from; and
- Promotes organisations responsiveness to changes in business environment (agility).

### III. CUSTOMER PROFILE SERVICES

A literature review was conducted on customer profiling. Similar customer profiling systems were analysed and evaluated. The analysis focused on how customer profiles are created by looking at parameters used to store customer profile information, how customer profiles are updated to capture changes that can take place and how the profiles can be used to provide accurate personalisation to customers [25]. Table 1 shows parameters used by selected e-commerce websites to store customer information in a form of a profile [3], [9], [19].

<table>
<thead>
<tr>
<th>Required Fields</th>
<th>Field name</th>
<th>kalahari.net</th>
<th>Amazon.com</th>
<th>eBay.com</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>e-mail address</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Phone number</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Country</td>
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<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Password</td>
<td>Yes</td>
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<td>Yes</td>
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</table>

<table>
<thead>
<tr>
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<th>No</th>
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<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Mobile alerts</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Customer profile parameters

The most difficult question SOA architects have to answer is what services should be built to achieve the business goals [11], [14]. Traditional object-oriented analysis and design methods have been proven not to be helpful in a SOA.
environment. Service-oriented analysis and design (SOAD) is a process that has been invented to assist the analysis and design of services in SOA [11]. IBM’s service-oriented modeling architecture (SOMA) was used to identify the service for the customer profile [14]. SOMA is a method that assists SOA architects to analyse and design services in a SOA environment. SOMA sub-processes include service identification, service specification, service realisation and SOA governance. In this study a customer profiling model using SAO was analysed and designed using SOMA.

The customer profile model proposed has the following services:

- Register customer;
- Identify customer;
- Get profile;
- Monitor customer activities;
- Update profile; and
- Delete customer profile.

The following subsections will discuss each service. The services can be invoked by any service client, running on any platform and implemented using any programming language.

A. Register customer service

The main function of this service is to perform the registration of a new customer. Generally when a customer visits an online website for the first time, he or she is requested to register [3], [19]. The registration process is normally optional as customers can browse and purchase without having a user account or a profile on a web site. The goal of the project is to investigate the creation of customer profiles using SOA and it was, therefore, vital to have each user registered in the system. Registration is done by customers first completing an online questionnaire for biographical details and completing an online questionnaire to create customers’ initial profile with preferences [25].

B. Identify customer service

Identify customer’s main function is to find out if a customer is registered or not within the system. Get profile service is invoked if the customer exists, otherwise register customer is invoked to ask the customer to register in the system. The service can be called and accessed by any other service when the required parameters are provided.

C. Get profile service

The basic functionality of this service is to read the customer profile database and retrieve a customer’s profile. This service provides its functionality to any service that sends a request, provided the requestor meets the conditions for the interaction. Only registered customers have their profiles available to be accessed and used.

D. Update customer profile service

The service is responsible for updating individual customers’ profiles. The clients for this service are responsible for the provision of legitimate parameters that define the customer’s profile. The update profile implemented in this research is a composed service using three other implicit services that would be running within the service client’s environment, namely:

- Monitor customer activities: This service monitors and record customers’ behaviour during the interaction sessions on the clients’ side;
- Analyse customer activities: This service is responsible for analysing and classifying the recorded activities of the customer and derive a new temporary profile; and
- Compare profile: This service use the get profile service to get a customer’s old profile and compare it with the new temporary profile. When the two profiles differ, the update profile service will be called to update a particular customers’ profile, otherwise the update will be abandoned.

E. Delete customer service

Delete customer service will be accessed and invoked when a customer opts to remove his details from the system. A number of websites that store customer profiles do not provide an option for customers to remove their details once they have registered [3], [19]. In this research, this service will be used to determine:

To what extent can optional deletion of customer profiles improve a customer’s trust and honesty in providing details for customer profiling?

Research indicates that customers do not trust online websites that collect their personal information and as a consequence they provide information that does not reflect their true opinions [22]. The authors propose that when users have more control over their profiles, for example, knowledge of how the system rates them, editing and deleting their profiles, the more they will be willing to provide relevant and accurate information for profiling.

IV. CUSTOMER PROFILE MODEL

Figure 3 is a UML composite and deployment diagram of the proposed model showing the relationship between its classes and physical configuration of software and hardware. The figure shows the three main nodes, namely: customer profile server, application server and client interface and four components, namely: customer profile web services, customer profile service registry, application, and application interface.

![Figure 3: Customer profile using SOA model](image-url)
Nodes are connected using TCP/IP protocol on an ESB. Components are connected to each other using various technologies, for example, a client interface will connect to the application using HTML, ASP.NET or JSP, running on a PC or mobile environment. An application interface accesses the customer profile web services using SOAP over HTTP protocol. Connection between the service registry component, customer profile component and application component is handled by the WSDL and UDDI respectively. Java Database Connectivity (JDBC) and Database driver are used to connect the customer profile database and application database respectively. The model’s services interaction is based on the find-bind-execution of service interaction model discussed in Figure 2.

V. SOA IMPLEMENTATION FRAMEWORKS

A number of commercial and open source SOA implementation frameworks exist. Commercial SOA implementation frameworks include the IBM Tivoli Composite Application Manager for SOA, Microsoft BizTalk server, and Oracle SOA suit. This study, however, concentrated on open source SOA implementation tools, such as, Sun Java Glassfish ESB, Elemenope ESB and Apache Service Mix. An evaluation was conducted based on metrics such as dependability, service re-usability, security and learnability [29].

Sun Java’s Glassfish ESB is the selected implementation framework being used in this research because of its integrated development environment; for example, Glassfish ESB is integrated in Netbeans 6 together with Glassfish application server. This made Glassfish more user friendly, easy to learn and more secure than the other frameworks.

VI. CONCLUSION AND FUTURE RESEARCH

Conducting business on-line is challenging when it comes to customer retention, as there are more competitors and customer loyalty is lower in electronic commerce than traditional commerce [21]. Online businesses implement methods such as personalisation, recommendation and customisation to assist improving customer loyalty on the web. Customer profiles provide a basis on which recommendation and personalisation decisions can be made. As SOA is the cutting edge technology being used by businesses to implement business critical systems, more research needs to be conducted in this field.

In this paper a customer profile model using a SOA is proposed. The customer profile model developed using SOA can help businesses to establish online customer needs and easily react in response to them, thereby improving customers’ loyalty, sales and consequently profits. Future research will involve evaluating the customer profile model in SOA. Furthermore, a comparative study in customer profile implementation in SOA and other distributed systems architecture such as client-server architecture will be conducted.

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REFERENCES


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