Software Agent Systems Serving the E-Commerce System a Comparative Study

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Abstract— Providing security for each online consumer over the internet is a critical issue that may cause a time consuming problem that may cause big load on the website server especially for the large websites at the rush time. This process may generate a variety of issues, including response time delays, client orders being lost, and system crash or deadlock, all of which decrease system performance. This work intends to present a new multi-agent system prototype structure that solves the challenge of security while avoiding issues that might degrade system performance. This is accomplished by installing a software agent on the client's device that handles the purchase and encryption processes without the need for the user to intervene. The suggested agent evades the problems of stalemate (i.e., failure) and request loss, ensuring that information exchanged between all entities is protected. The use of a software agent to manage buying and encrypting operations improves system performance by 10% and increases the reaction time of the system by 30.5 percent (response time, page loading time, transaction processing speed, orders per second) according to test results.

Index Term—Software agent, multi agent, e-commerce security, encryption management, PEAS.

I. OVERVIEW

Electronic commercial sites are now undergoing massive expansions as a result of their critical responsibilities in supporting and supplying a wide range of services and products. As a result, the number of clients interacting with these systems has increased dramatically [1]. As a result, the volume of data carried over the internet via these systems is continuously increasing. Some of this information is deemed critical and might be vulnerable to various types of assaults (especially payment information)[2]. As a result, ensuring the security of this information becomes a need. On the other hand, with the proliferation and branching of information on the internet, maintaining a large volume of data becomes a challenging task [3]. As a result, utilizing a software agent (SA) to improve purchase management in e-commerce systems is regarded a viable option [4].

The goal of this study is to create a safe prototype structure that provides security for the e-commerce environment while also striking a balance between system complexity and speed to create a quick and secure environment. The main contributions of this paper are:

a. Create a multi-task SA prototype framework. It is being installed on the customer's device. Managed by the e-commerce system, the SA is in charge of two jobs: purchase and ciphering management. The encryption procedure is carried out without the involvement of the consumer.

b. Create a separate form called order form that involve the customer order information.

c. Create a one-of-a-kind SA that is exclusively responsible for serving one client, and connect them using the id's of its SA.

d. Define system activities using the PEAS framework (performance, environment, actuators, and sensors).

The remain structure of the paper is: Section II explains theoretical background, section III views the related works, section IV represent the research methodology, section V explains the comparison analysis and section VI represent the conclusions.

II. RELATED WORKS

This section will discuss some of the related works regarding employing agent system for e-commerce system.

The major purpose of this study [34] is to build a platform that permits autonomy, proactivity, and customization. These agents have their own identities. The basic concept is to use a broker to intelligently detect the purchaser's wants based on usual factors that are provided to help solve the challenge of locating things of interest. The suggested ecosystem aims to respond to meaningful requests and supply relevant things to those who want them, when they ask for them, and in a way that satisfies their needs.

This [35] paper aims to provide robustness and scalability to e-market place by using an agent controller pattern. Multiple sellers are allowed to be registered and the buyers' requirements are translated to the e-commerce by means of a mobile purchasing agent. Moreover, the framework is customized to satisfy e-business transactions for customers and vendors.

In this study [36] the agent technology is utilized to better meet the needs of the customer, which include availability, rapid reaction time, and productivity. Agent for e-commerce establishes connections based on any (time-where-device) to provide customers with the specific items they demand based on transaction cost optimization and scalability. A link between the customer agent and the controller agent that allows the controller to control all of the client agent's information. The controller transmits the element information to the customer agent, who picks the needed products and adds them to the shopping cart. This process helped the customers to save huge time for shopping over the internet.

This paper [37] developed a fuzzy-logic based multi-agent e-commerce system technique which is able of accomplishing a mutually beneficial deal between the seller and the purchaser by a negotiation process. A fuzzy logic is used to help customers in expressing their favorites' products using fuzzy terms like low, medium and high. The system evaluates offers depending on a fuzzy utility function and feeds utility scores to a fuzzy inference system to compute its next counter offer. The focus in this study is upon the implementations of the agent systems of different types and roles engaged in actions usually related to the processes of buying and selling in an e-commerce systems.

According to [38], an agent-oriented approach that provides verification to ensure that security objectives and validation requirements are met at various phases of the designed system lifetime is recommended. Furthermore, the system must give security list of risks in order to determine whether any of the dangers on the list may be used to enhance the system. The meta-agents automatically create a security checklist to regulate the operations of the client agent.

[39] Proposed a multi-agent system based on block chain technology in another research. The agent technology in an e-commerce system was introduced first, followed by an explanation of the hidden threats. The second step is to present the information transaction and executive structure. Finally, we'll look at the verification method node in the agent transaction process.

Another study proposed by [40] demonstrated the most common flaws that may occur in multi-agent systems that handle e-commerce applications. They also proposed solutions to the major security issues that these platform systems face. The study's main assumptions are that security measures should optimize and enhance the many security solutions prevent identity theft, access to critical data, and

access control, among other things. As a result, due to the ongoing evolution of various forms of assaults and threats, it is critical to strengthen the security mechanisms used in websites such as e-commerce.

The preceding works simply covered the agents' tasks and did not go deeply into the agent structure. We employed the PEAS (performance, environment, actuators and sensors) paradigm for our software agent. Furthermore, system performance is assessed in terms of what is needed in the environment rather than what the agent is supposed to do. Another benefit of this technology is the encryption procedure which is performed without the involvement of the consumer. It is carried out under the entire direction of the agent. In addition, each client has a unique agent who is assigned to them based on their ID. Another characteristic of our system is that it provides security; previous works did not focus on security issues, instead focusing solely on offering services to customers through agents. Furthermore, security is provided by means of an encryption method, with the encryption process being conducted and handled by the software agent for the first time in this architecture. The proposed method proposes creating a single software agent that will be installed within the customer and will exclusively serve that client. No previous research article has explored or presented the jobs and the structure of the SA in this way.

Table I contains a comparison with the related works according to usability, security, technology, database and agent. These attributes must be considered when designing an efficient, secure and fast e-commerce systems.

TABLE I. COMPARISON ANALYSIS BETWEEN THE PROPOSED SYSTEM AND THE RELATED WORKS ACCORDING TO SOME CRITERIA THAT MUST BE CONSIDERED WHEN DESIGNING THE E-COMMERCE SYSTEM

Criteria	Proposed System	Related Works
Usability	It's mirrored in navigational speed tests, which revealed a high rate of movement between website pages.	Depending on the system structure, each system is different.
Technologies	Used technology (Laravel, HTML, CSS, MySQL) that made the system compatible with different operating systems	Some are compatible and some are not due to used technologies
Security	The language and the agent give extra protection and make working with clients easier, as well as a mechanism to validate the client's identity.	Except for paper number (6) in related studies, nothing is specified.
Database	MySQL For both the e-commerce and the e-bank websites.	The E-Bank site is not considered
Agent	Automate the transaction between the three parties and make work easier for the customers who don't have much experience with computers since the agent saves time and information so the customers don't have to put in extra effort.	Not used

III. THEORETICAL BACKGROUND

This section explains the theoretical background of software agent system.

A. The Software Agent

The SA is a piece of code that works as an agent for a customer or another program in a definite environment, functioning independently and constantly [5]. Other tasks and agents restrict it, yet it may learn from its long-term experience in a given environment. Software agents are computer programs that try to mimic and imitate the human mind and behavior in order to act as stand-ins for human agents [6]. Agents work on behalf of users to do delegated, specialized tasks [7]. They actively engage in the completion of certain missions by taking initiative and acting in accordance with user-specified or automatically created goals. Users are typically required to utilize computing applications [8]. Software agents allow programs to operate independently of the presence and instructions of users, delivering only personalized, user-requested information and services [9]. Traditional programs are normally

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inactive until they are explicitly summoned by user commands, whereas agents are constantly "alive" and ready to function and do not require explicit human input to be activated [10].

B. Characteristics of Software Agents

- Software agents may complete their tasks without the involvement of a source [11].
- Interaction with other software agents and humans on a social level [12].
- Software agents have distinct objectives [13].
- A good software agent is one who is willing to accept and adapt to change [14].
- To convey the rules, the agent must be coded in a sophisticated language. The agent must guarantee the confidentiality of the information [15].
- Efficient use of available resources [16].
- The agent must be an excellent sailor [17].
- When dealing with illegal users, agents must use extreme caution [18].
- The user must have access to the same information to which they are entitled [19].

C. Type of Software Agents

The features of agents are used to classify them into distinct categories. Agents must have distinct qualities like as movement, integration, co-operation, information, stimulation, and so on in order to possess the aforesaid properties.

- **Collaborative Agents:** A collaborative agent is a software program that corrects errors, suggests future steps, and handles low-level details to assist people in solving problems, particularly in complicated or unfamiliar areas [20].

- **Interface Agents:** are computer programs that use machine learning techniques to assist a user engaging with a specific application. Before they start working, these agents spend enough time understanding and learning human behavior. In spite of their artificial learning thoughts they are limited co-operative with other agents [21].

- **Mobile Agents:** In a heterogeneous network, a mobile agent is an executing program that may migrate from one computer to another during execution. Mobile agents are used to handle a variety of network computing problems while using the least amount of bandwidth and connectivity possible. "Give program the power to move," is the premise of these agents [22]. The following are the key advantages of a mobile agent over a stationary agent: (a) it is not restricted to the system on which it runs. (b) Has the ability to transfer from one network system to another. (c) The state as well as the code are transferred.

- **Information/Internet Agents:** Information agents are the intelligent parts of software that can automatically search for information on a website. A knowledge base system is a type of information system [4]. These agents are characterized by what they do [23].

- **Reactive Agents:** are in charge of provoking a reaction to the current condition of the environment in which they are implanted. These agents communicate with one another in a very basic and straightforward manner. The critical elements that sustain reactive agents. (a) Because emergent complexity is the result of dynamic interaction, there is no previous definition of these agents' behavior. (b) Reactive agents are in charge of a group of modules that work independently. (c) Reactive agents are more likely to work with representations that are similar to raw sensor data. (d) Intelligent behavior is how these beings interact with their surroundings [24].

- **Hybrid Agents**: By combining two or more of the above-mentioned agent philosophies, hybrid agents can perform better [25]**.**

- **Heterogeneous Agents:** Unlike hybrid agents, heterogeneous agents refer to an integrated collection of at least two or more agents from two or more different agent classes. Two or more hybrid agents may also be present [26].

- **Deliberative Behaviors:** Deliberative agents have an internal reasoning model and use

planning and negotiating abilities to attain their goals while interacting with other agents. Reactive agents, unlike deliberative agents, lack an internal thinking model and instead operate on the environment through stimulus response behaviors [27].

- **Smart Agents:** This type communicates with other agents to construct an artificial intelligence System for Managing Agents in Real Time. The fundamental principle here is that not every single agent has to be clever. However, by cooperating intelligently, the agents can produce a sort of emergent intelligence that looks to be intelligent [28].

D. Applications and Benefits of Software Agents

- Agents reduce the amount of labor required by the user and the application developer.
- With time, the agent can adapt to the customer's preferences and tastes.
- It will be shared with the community in a sensible manner [29] .
- When it comes to reactive agents, the gaming and entertainment business is the most popular.
- Agent Builder agents are perfect for use as shopping agents. These agents can help you find [30] goods, compare pricing, and place orders, among other things.

E. Issues with Software Agents

In General we described their different promises as well as the obstacles they face. However, there are some concerns that society will have to deal with through various laws, and these will be difficult. The following are some of them [31]:

• **Privacy:** How can you ensure that your agents respect your privacy when operating on your behalf?

• **Responsibility:** Be mindful of the authority that is being transferred to software agent(s) when you yield some of your responsibilities to it/them. How would you like to return home after a long day at work as the happy owner of a used automobile that one of your software agents negotiated and purchased for you? How can you avoid the agent racking up a massive credit card charge on your behalf?

• **Legal issues:** Continuing on from the previous point, suppose your agent gives faulty advise to other peer agents, resulting in liabilities to others. Who is to blame? Who authored the agent's letter? It was you who personalized it, right? or a combination of both We believe that in the future, a new set of laws will be needed to encompass software agents.

• **Ethical considerations:** they would also need to be taken into account. Norman [32], [33] is already worried enough about software agent ethics that he has developed an agent etiquette for information service and user agents gathering information on the World Wide Web.

IV. THE PROPOSED SYSTEM

The research methodologies and processes are described in this section. *Fig. 1* and *2* depict system operations and data flow among system entities as block diagrams.
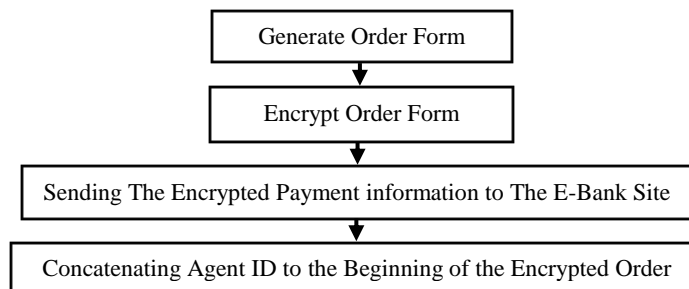
Generate Order Form

Encrypt Order Form

Sending The Encrypted Payment information to The E-Bank Site

Concatenating Agent ID to the Beginning of the Encrypted Order

FIG. 1. WHEN A CUSTOMER PLACES AN ORDER FOR A PRODUCT, THE AGENT PERFORMS OPERATIONS ON THE CLIENT'S DEVICE.

The suggested system intends to provide an integrated system that can alleviate the shortcomings of prior systems, such as time consumption, stalemate, and an insecure transaction, which reduces customers' trust in the electronic commerce applications. This is accomplished by installing an agent application on a customer's device, causing each customer to navigate and buy from a certain e-commerce site that allows the customer's identity to be verified. The agent is made up of two primary components: The first part is in charge of handling the customer orders into a form that can be transmitted to the website at any time, as well as decreasing deadlock by gathering these orders in the cloud to avoid losing these orders due to website server overload during peak hours. The suggested system's second component is in charge of creating safe communication channel between the customers and the e-commerce site. This is accomplished by giving an encryption method (given by the commercial website) that may be modified on a regular basis, as well as a key exchange offered for each client by the commercial website. The security is divided into two layers for this purpose:

- Key exchanges that happen on a regular basis.
- A higher degree of security is responsible for encryption using a specific ciphering method that may be altered as needed on a regular basis.
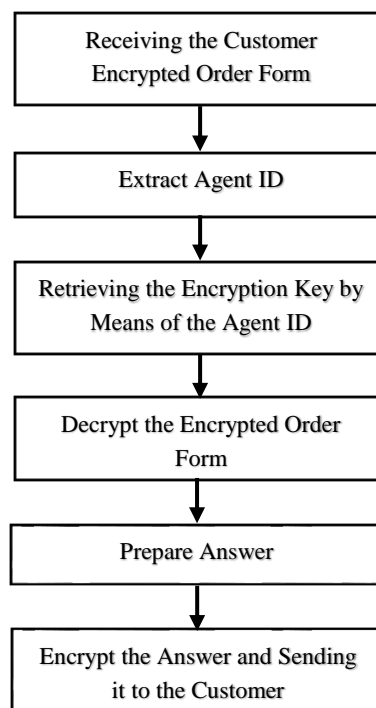
```
┌─────────────────────────┐
│   Receiving the Customer │
│   Encrypted Order Form   │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│     Extract Agent ID     │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│ Retrieving the Encryption Key by │
│   Means of the Agent ID  │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│  Decrypt the Encrypted Order │
│           Form           │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│      Prepare Answer      │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│ Encrypt the Answer and Sending │
│     it to the Customer   │
└─────────────────────────┘
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FIG. 2. ACTIVITIES OF RECEIVING AND DECRYPTING A MESSAGE AT THE COMMERCIAL WEBSITE.

A. System Structure

The important requirement to maintain security for sent data via the internet, particularly invoice information, is a major concern. Supporting the security for each individual consumer that visits the e-commerce site places a significant demand on the e-commerce server, perhaps causing a system crash. This study proposes SA structure that handles two jobs: purchasing and security management, to decrease and avoid such harm. The following is a description of the procedure:

- For each client with an account, there is a SA who is already installed on his device. The e-commerce generates this agent, which is configured to handle two tasks: buy and security.
- For each purchase, the agent will create an order form, which comprises the purchase data in the form of an invoice.

- This invoice is encrypted before being submitted to the e-commerce site to secure the customer's information from tampering or theft.
- To minimize time, the encryption operation is carried out using the lightweight AES algorithm. The form is decrypted at the receiver using the agent Id, which relates to the client data. It's a way to get the encrypting key back.
- The encryption process is done out without the consumer's input (the customer does not know the encrypting key).
- Without the customer intervening, the ciphering key is produced and transmitted to the SA.

B. The Agent Structure Description

In an e-commerce setting, the connection between the agent and the consumer can be stated as follows:

The relation is Tuple <SA, C, E > where:

SA= the software agents group

C= the customers group

E= E-commerce site

Each agent is engaged with a single user (is installed into the customers device) such that:

$\square$ c_i in {C} , $\exists$ an sa_i in {SA} where a_i:

a. Has a distinct ID

b. Completes two missions.

c. The agent's behavior is governed by a set of rules:

• C_i must be a registered user on the e-commerce site.

• c_i has no effect on the encryption procedure.

• To activate the agent duties, c_i must enter a password.

• Each a_i is owned by a single c_i

C. The Agent Features

- Between the electronic site and the user, the agent acts as a legitimate vendor. It is genuine because: a. it is created and regulated by the owner's rules (the e-commerce site).
- It is genuine since it is settled by the customer's consent.
- It operates similarly to cookies in that it remembers the URLs that have been visited before and vice versa.
- It is simple in that it keeps the password inside it, limiting the chances of it being taken by an attacker. It's not a token since it won't operate without the customer's activation password, even if the gadget is taken.
- The encryption procedure is carried out in accordance with a policy that the e-commerce system has created and implemented.
- Eliminate the difficulty of picking a week password since each customer's password is generated and updated with an expiration date (10 times to be used)
- Due to the common benefits, the client assures that his critical information is safeguarded by a certified side.

The suggested agent is in charge of two key responsibilities: buying and security management.

D. The Task Environment

When creating a SA, the initial step should always be to clearly define the task environment. The task environment is described by PEAS which stands for Performance, Environment, Actuators and Sensors. Which is shown in Table II.

TABLE.II. PEAS DESCRIPTION OF THE PROPOSED SOFTWARE AGENT

Agent type	Performance measure	Environment	Actuators	Sensors
Client Agent	-Security	Customer PC	-Agent Activation	-Customer log in
	-Reduce time consuming		-Recognize the URL	-Add item to cart
	-Increase no. of served order per (unit of time)		-Generate order form	-Confirm payment
	-Prevent deadlock		-Encrypt order	-e-shop confirm reception
	-Increase reliability (prevent loosing of orders)		-Sending packet -Stop	

E. Purchasing Management

This procedure can be described as follow:

- A customer navigates an e-commerce site.
- An item is selected to be purchased.
- The agent's conversion of the selected item into a unique form. This is referred to as a Record Form, and it contains information such as User ID, Agent ID, Product ID, Quantity, Address, and Time. As indicated in *Fig. 3*, the form is delivered to security management when these processes are completed.
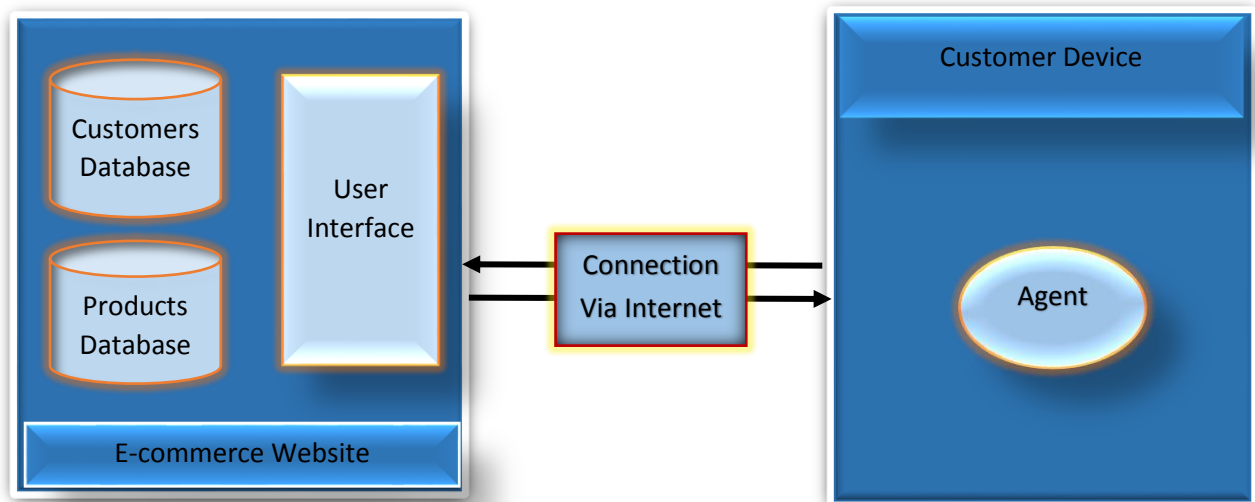

FIG. 3. THE PROPOSED SYSTEM DESIGN.

F. Security Management:

This process involves two tasks as follows:

a. Key management: During this stage, a unique key is created and sent to each consumer. It is possible to refresh this key on a frequent basis. Under the control of the e-commerce website, agent aids are used to produce and exchange keys. This is a technique that does not include the client.

b. Order form encryption: This activity entails receiving the order form from the purchasing phase and encrypting it using a block cipher technique and encryption key. The agent id is attached to the cipher text when the encryption procedure is completed, and the encrypted text is then transferred to the e-commerce site to be decrypted using the agent id. For decrypting the received message, the right encryption key will be determined.

This is done because an e-commerce website has a database that stores the consumer's data who have created an account. This data includes agent ids, user ids, encryption keys, and other details.

G. System Algorithms

The system activities are described by the two algorithms below:

Algorithm 1: Creating and encoding order form
Input: User order (string)
Output: Encrypted order (string)
Begin
Step 1: A user creates an order
Step 2: An agent creates a Record Form
Step 3: AES block cipher algorithm is used for encrypting the form
Step 4: Append the software agent id to the beginning of the encrypted form
Step 5: The encrypted form is sent to the commercial site.
End

Algorithm 2: Receiving and decrypting a client's form
Input: An encrypted order (string)
Output: A decrypted order (string)
Begin
Step 1: The customer's order is received by the e-commerce site.
Step 2: Extract the agent id.
Step 3: From the site Database, Retrieve the password regarding the agent id.
Step 4: Decrypting the order.
Step 5: Creating the required answer.
Step 6: Encrypting and sending the answer to the customer depending on the agent Id.
End

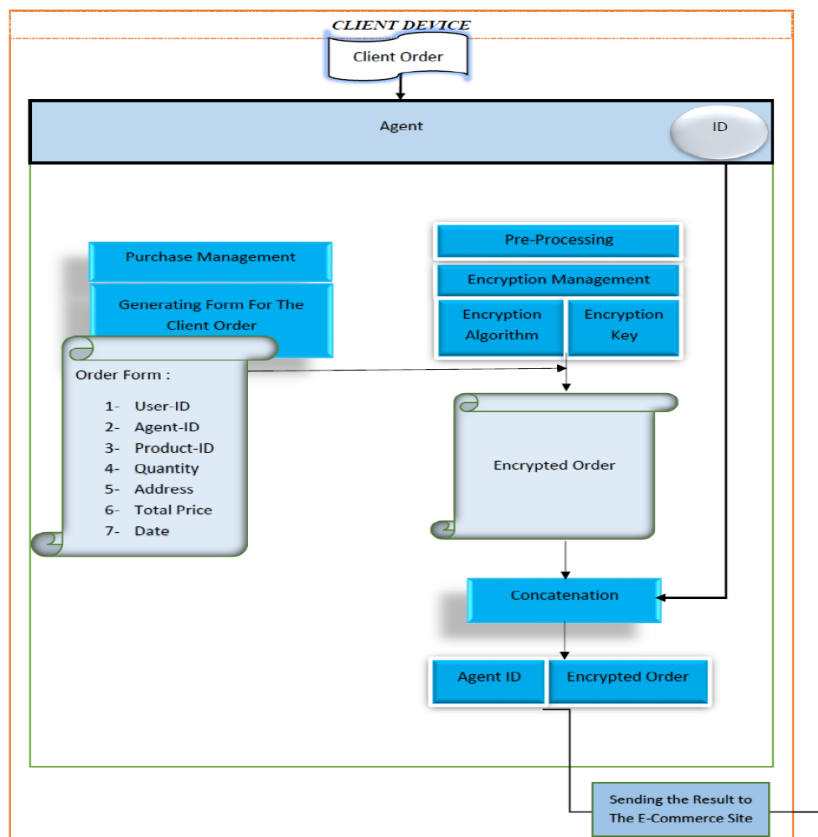The suggested software agent design is depicted in *Fig. 4*.

FIG. 4. THE PROPOSED AGENT STRUCTURE AND INGREDIENTS.

V. CONCLUSIONS

Providing e-commerce platforms with security is critical. The proposed system suggested a SA for each user to control shopping and security tasks in effective manner to improve system security and performance, as well as alleviating the problem of system crash, which was the primary purpose of this study. In addition, the network load has grown, resulting in an increase in the number of transactions and consumers serviced. As a result, achieve optimal system performance to assure consumer happiness, leading to repeat visits to the same commercial site. Agent characteristics are used in a secure e-commerce multi-agent system to ensure high security, high performance, and consumer happiness. The system performance is improved by designing the SA to be installed on the customer's device to control the shopping and encryption duties. This is evident in the experimental findings, which demonstrate that the suggested system reduces time spent serving customers by 0.02717, number of orders by 2.241, and time spent servicing requests by 2.49.In the future, we want to use a more complicated encryption technique to give a better level of security. As a restriction, installing the SA on the customer's device takes up space. It is regarded as a task that consumes more CPU resources.

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