EUROPEAN MECHANICAL SCIENCE

Research Article

e-ISSN: 2587-1110

Semantic web oriented personalized electronic commerce product suggestion system

Fatih Çağatay Baz[1*], **Hilmi Cihan Meral**[1]

[1]Management Information Systems/Osmaniye Korkut Ata University, Türkiye

Orcid: F.Ç. Baz (0000-0002-6398-9851), H.C. Meral (0000-0002-3873-6692)

Abstract: With the studies on semantic web technology, the interest in this technology has increased over time. Today, the importance of data has increased to be used for purposes such as optimization, increasing user experience and improving. This increase has brought with it the need for the readability of data. At this point, the semantic web has increased the readability of information by putting large data sets in a format that machines can interpret like humans. In this study, an electronic commerce system has been developed that can suggest related products to users by making use of the literature review in which semantic web technology is used. In the system development phase, firstly accepted ontology creation methods were examined, and a method was selected to create the needed ontology. Within the scope of the study, first, the capabilities of the semantic web to meet technological needs are introduced. Then the semantic web and the technologies used in it are explained. In addition, the tools needed to develop applications with the semantic web are explained. Application development steps are explained in the study. Information about the successfully developed system is given and thus the use of the semantic web is exemplified. Finally, suggestions were shared to improve the designed system. Due to the rapid developments in electronic commerce in recent years, it can be stated that this study is important.

Keywords: Electronic Commerce; Semantic Web; Ontology; Web 3.0.

1. Introduction

In the age of Industry 4.0, competition in the marketing world has increased. The field of marketing has begun to affect daily activities in different ways. Therefore, marketing has come to play an important role in economic development and growth. Thus, an effective marketing system has become to contribute to the future of a country. It has been observed that to be successful in marketing, customer satisfaction must be observed. Along with the changes in civilization, there has been a change in the social environment and the behavior of people. These behavioral changes have changed the service expectations and satisfaction scale of the users. Thus, to meet the expectations of the users and increase their satisfaction level, the electronic commerce environment that allows easy shopping over the internet network has developed.

In similar studies in the literature, electronic commerce has been defined as a set of technologies that enable parties to trade through electronic transactions over computer networks without the need for physical contact with each other [1-3]. The need for technological developments and new inventions has increased in many areas such as information technologies, education, health, and electronic commerce. Electronic commerce, which is used intensively and conceptually developing today, aims to upgrade traditional shopping transactions by using electronic and information technologies [4].

The increasing number of users has led to an increase in the number of transactions. This increase has created new needs for the service to be offered to users. The fact that the budget needed for technological developments is high, the emergence of new inventions takes a long time, and they must pass a series of tests before they become usable, and the inapplicability of continuous hardware or software development in data science studies have led service providers to seek alternative solutions. With the developments in the field of optimization and performance, solutions have been offered and the needs have begun to be met. The capacity and speed of operations that can be done on large data sets have increased with the studies carried out in the field of the semantic web [5], which aims to create an internet network where documents can be recognized with their meanings as well as being interconnected. Thus, in areas where fast and accurate transactions are important in large data sets such as electronic commerce, it is possible to alleviate the burden of hardware or software upgrades by using well-optimized semantic web technology.

In the literature, a semantic network-based drug rec-

* Corresponding author.
Email: fatihcagataybaz@osmaniye.edu.tr

European Mechanical Science (2023), 7(2): 82-88
https://doi.org/10.26701/ems.1261229
Received: March 6, 2023 — Accepted: May 23, 2023

ommendation system has been developed [6]. To introduce the semantic network concept, studies were carried out to introduce the tools and technologies that may be needed [7]. Studies have been carried out on the ability of the semantic network to share over multiple information services [8]. The semantic network has been studied in the effect of human-machine interaction on users' data storage, processing, and access to data [9,10].

It has been observed that the product recommendations made in the electronic commerce systems used today are based on the previous preferences collected through cookies rather than the preferences of the users, and because of this, the recommendations made may be irrelevant. In this study, a product recommendation system has been developed by integrating the java programming language and with-it technologies such as spring framework, thymeleaf, bootstrap with the apache jena fuseki server and jena-related libraries needed to develop with the semantic web. With this designed system, it is aimed to make more consistent product recommendations by making sense of the data, instead of the product recommendations made based on previous visits.

2. Theoretical Background

The semantic network creates a semantic link between the data and prepares the ground for it to be understandable by machines. The semantic web is expressed by Tim Berners-Lee as a way in which data is made sense of in a well-defined way so that humans and computers work in a better collaboration. It was established in the W3C to develop, expand, and standardize the semantic web today. The semantic web has given us a common framework by sharing and reusing information across applications, businesses, and community boundaries. Thus, the semantic network has been defined as the set of technologies and standards that will make the information available on the internet meaningful and understandable by machines [7]. The semantic web is made up of collaborative technology groups that contain different types of design principles. Thus, it has made the information labeled through addresses meaningful by moving beyond just being visible [11]. It has been observed that the studies on the Trust, Evidence and Logic layers, which are in the first place of the architectural structure of the semantic network and are mostly related to security, are not sufficient. It has been determined that each of the layers in the architectural structure should be carefully prepared and presented in order for the studies to be carried out with semantic network technology to be supported by logical evidence and to be reliable [6].

Electronic commerce has been one of the first information technologies field to take advantage of the potential of the internet. Thanks to the permissions it has within electronic data exchange standards, it has enabled the business to be done on an unprecedented scale. The semantic network aimed to form the basis of the information exchange between the parties in the digital market. It is desired to create an environment where the meanings of data can be collected and semantically exchanged on behalf of smart tools and users with the shareable conceptualized structures to be created through ontologies. Semantic network-oriented electronic commerce is defined as commerce that works with semantically enriched data exchanges and makes use of the systematic applications of semantic network technologies in information management [9].

3. Materials and Methods

In this study, the methods used in information technologies were applied by examining the published documents about the software technologies to be used, considering the scientific research methods. In this study, concepts such as software development, network and server operation, database management are included.

3.1. Ontology Creation

With the standardization of the ontology language, the field of internet usage has expanded to large areas such as health, biology, geography, astronomy, defense, and the aviation industry. In the ontology-based data access paradigm, an ontology provides users with a high-level global schema and a dictionary that they can use in their queries [7,10].

Figure 1 shows the hierarchical view of the classes created using the developed Protégé application.

Figure 2 shows the structure of ontologies created using the Protégé application. Thanks to this view, the interactions of the classes in the ontology with each other can be controlled. Object properties are used in an ontology so that classes under different hierarchical frameworks can interact with each other.

In Figure 3, the object properties of the classes are shown. For example, when specifying a computer and its acces-

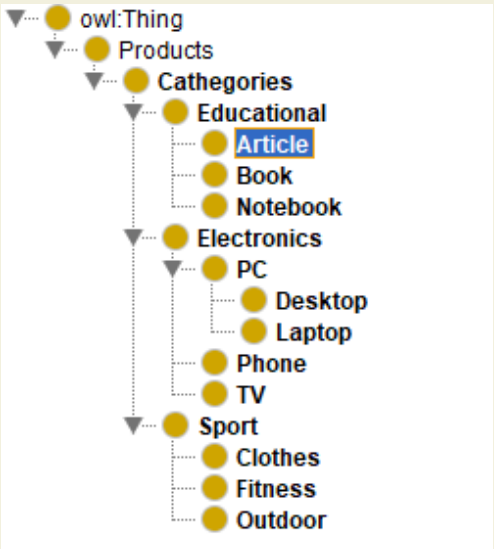

Figure 1. View of classes created in ontology

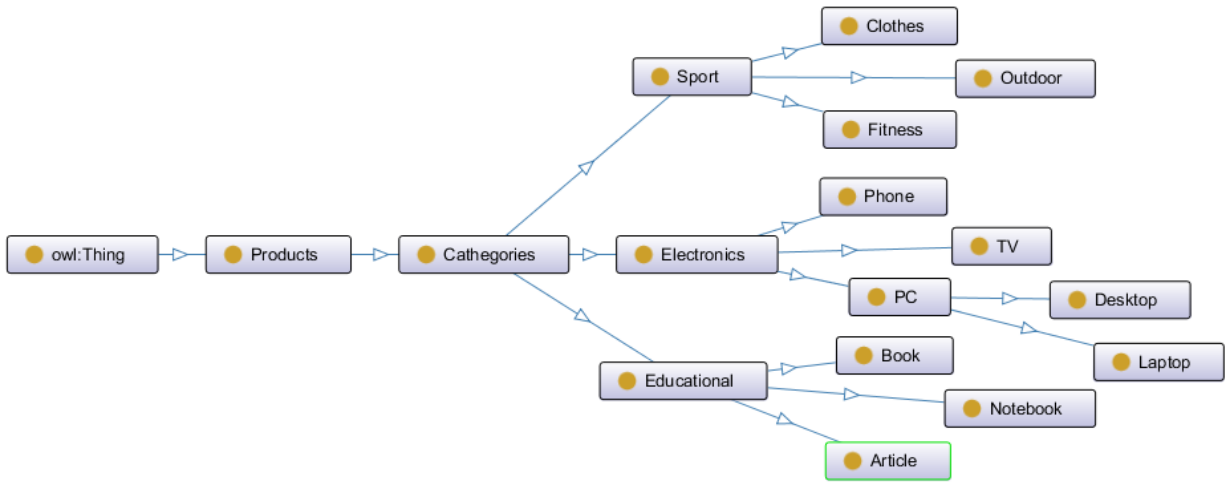

Figure 2. Structure of application ontology

sories, the "hasPCAccesory" object property is used for the computer, and the "isPCAccesory" object property is used for an accessory belonging to the computer.

3.2. Apache Jena Local Server Creation

Apache Jena Fuseki was used to meet the server requirement to use the ontology developed with Protégé as a database. The ontologies created with this server have been uploaded to the server as datasets, making it possible to interact with different applications and SPARQL queries.

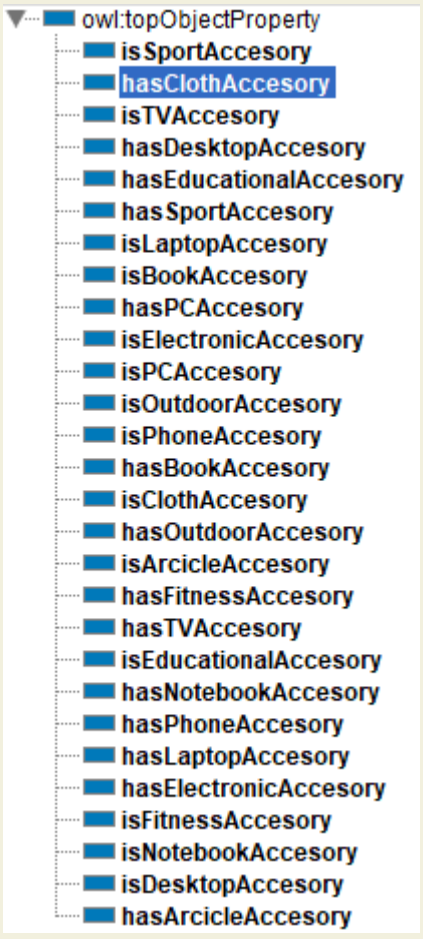

Figure 3. Object properties of classes used in ontology

In Figure 4, the main screen of the Apache Jena Fuseki server, where operations such as adding a new data set, writing a query, and information about the server can be performed, is shown.

3.3. Creating a Spring Project

A Spring Framework was used to perform database-level operations using the Java programming language.

In Figure 5, information about the Spring project created via Spring initializr to be used in the application development phase is shown. After the project was created, it was loaded into the development environment and made ready for use.

In Figure 6, the location of the project created using Spring initializr is indicated, and the loading screen into the application development environment is shown.

3.4. Adding Jena API to Java Library

With the Spring project created to provide communication in the background, Jena libraries have been loaded into the project to be able to operate on the ontology to be used in the semantic network application. Thus, the queries used directly on the Apache Jena Fuseki server have become available at the application layer as well.

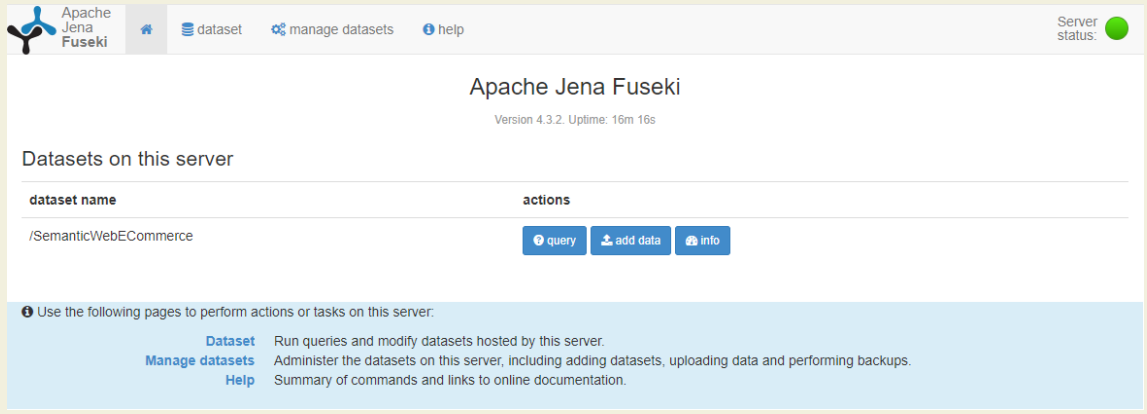

Figure 4. Appearance of apache jena fuseki server

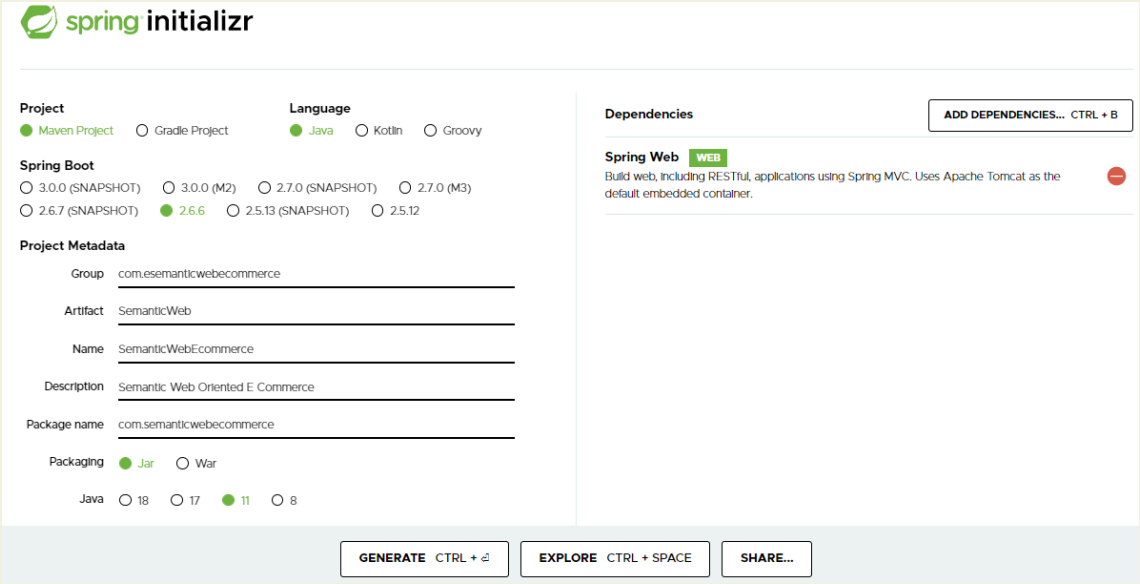

Figure 5. View of spring project build page

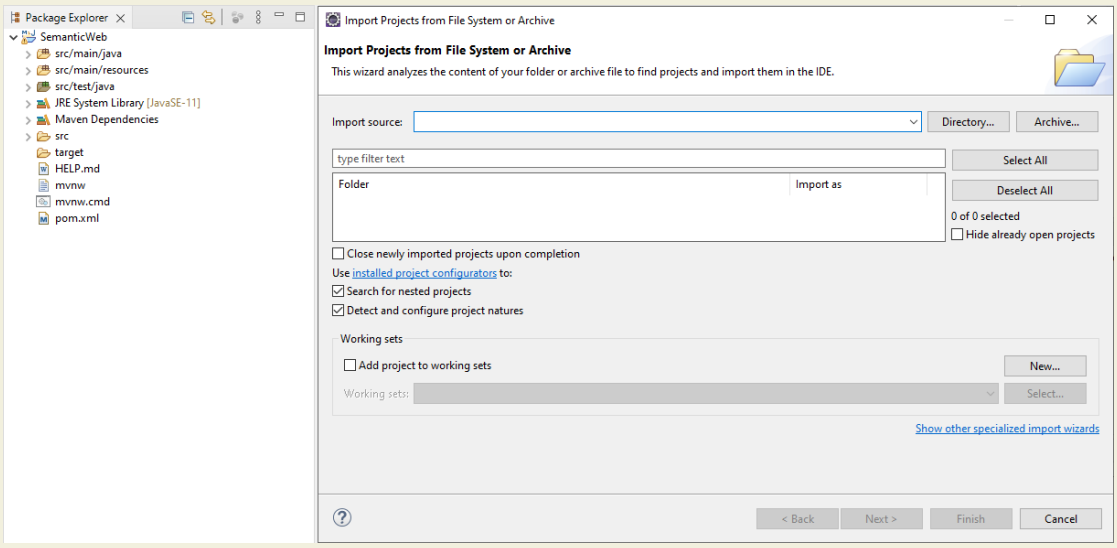

Figure 6. Spring project loading screen into the application development environment

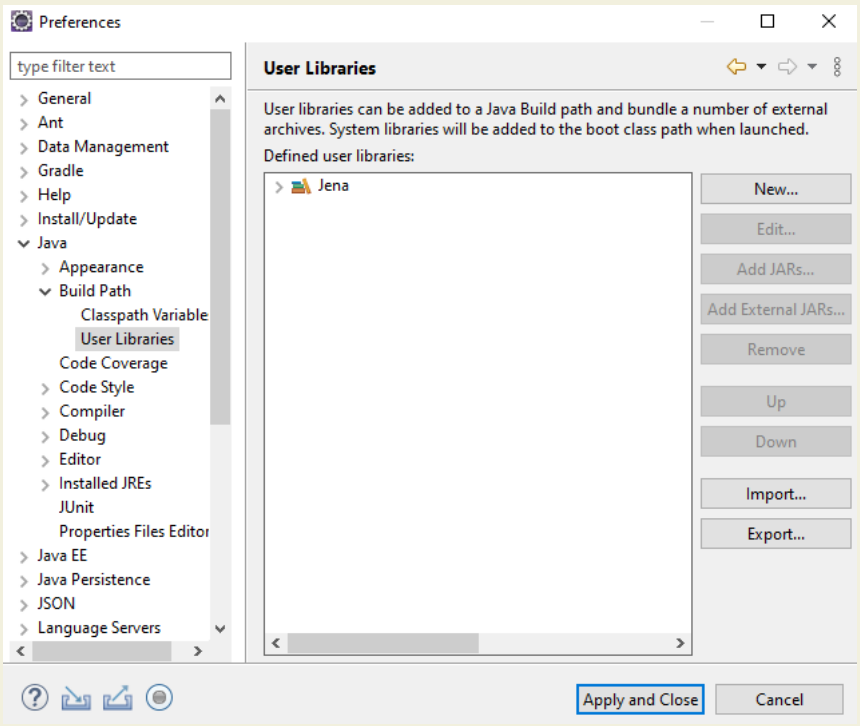

Figure 7. Loading jena library into the project screen

In Figure 7, adding the libraries needed during application development to the project using the preferences screen of the Eclipse development environment is shown.

3.4. Creating a Java Development Environment

MVC software architecture was used in the Java development environment to create the project structure in the application layer.

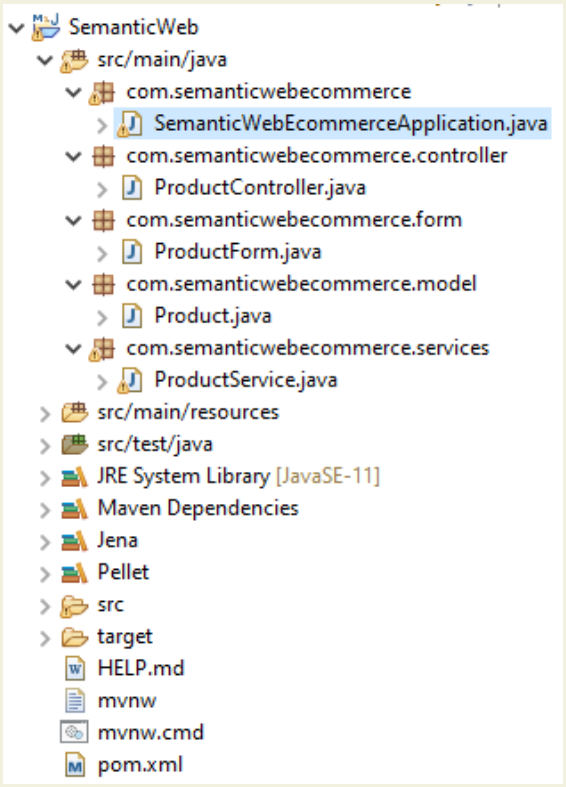

Figure 8. Project view of the application

In Figure 8, the project view of the application using MVC architecture is shown. Architectural patterns are used to display the structural format while developing any application. The MVC architectural pattern consists of three major components: the "Model", which controls the core operation of the system, independently of the user interface, the "View" where the presentation will be made, and the "Controller", where the inputs to be sent to the application are arranged [12].

3.5. Adding Thymeleaf and Bootstrap to the Application

"Thymeleaf" and "Bootstrap" have been added to the project so that the objects to be used in the front-end layer of the developed application and their related operations can be performed.

The dependencies of thymeleaf and bootstrap technologies, which are desired to be used in the application, as shown in Figure 9, are added to the "pom.xml" file shown in Figure 8, making it usable in the project.

4. Developed Application

In this study, an application using Web 3.0 technology was developed by using accepted methods in the field of semantic network.

4.1. Purpose of the Application

It has been observed that the options offered by the electronic commerce systems used today to the users after choosing a product to buy, consist of the products that

```
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-thymeleaf</artifactId>
</dependency>
<dependency>
    <groupId>org.webjars</groupId>
    <artifactId>bootstrap</artifactId>
    <version>5.1.3</version>
</dependency>
```

Figure 9. View of thymeleaf and bootstrap dependencies

the user has browsed in their previous browsing rather than being related to the product that the user is about to buy. As a solution to this, table associations that can cause a complex structure in existing database systems are simplified by using ontologies that we encounter in semantic network technology. Thus, it is aimed to save businesses from additional costs by increasing the performance of the system during the development phase and to save time by recommending more relevant products to users because of this development.

4.2. Application Interface

In Figure 10, the outputs of the queries sent from the application to the Apache Jena Fuseki local server are shown.

5. Conclusions

In recent years, electronic commerce has gained importance for consumers. Online shopping is taking the place of shopping in stores. In this sense, consumer behavior has found a place in research topics. In terms of information technologies, subjects such as semantic web and ontology development have an important place in the use of electronic commerce.

In this study, information about semantic web technology, tools used in this technology and examples of how to use these tools are shared. In the first stage of the study, the tools that will be needed for an application to be developed using semantic web technology were determined and the accepted methods related to these tools were researched. To develop an ontology, first, general concepts about ontologies and ontology preparation rules were examined and OWL was preferred as the ontology development language suitable for the system to be developed, and Protégé was preferred as the development environment. Apache Jena Fuseki server was used to access the developed ontology over the local network. To work on ontology over this server, queries written in the SPARQL language of services created with Java programming language in the Eclipse development environment were used. Apache Jena Fuseki is run on the application server layer. To use Spring Framework and semantic network technology in the middle layer, the necessary libraries have been developed with the Java programming language. In the front-end layer, Thymeleaf was preferred to access the server through the services developed with Java, and Bootstrap was preferred to make visual improvements. The character-based problems that occur when querying the database in expressions such as classes and variables used in the application and ontology have been resolved. Due to the old and scarcity of the guides, a significant part of the time spent in application development was spent on the integrated operation of the tools to be used in semantic network technology and the java programming language.

It is seen that there are conceptual studies on the semantic web [13,14] and ontology development [15,16] in the studies conducted in the field. It is expected that the current studies to be carried out will be practical. It is predicted that the semantic network in the field of electronic commerce will facilitate consumer behavior.

In this study, when an application is wanted to be developed with the semantic web, the tools that will be needed and how to use them are explained. Technology allows for the emergence of new methods and approaches every day. Therefore, it will be convenient for developers to choose the latest or stable version of the tools used in this study during the application development period. The use of a common language while developing ontology will be useful in preventing confusion that may occur due to the characters used in different languages if it is used worldwide.

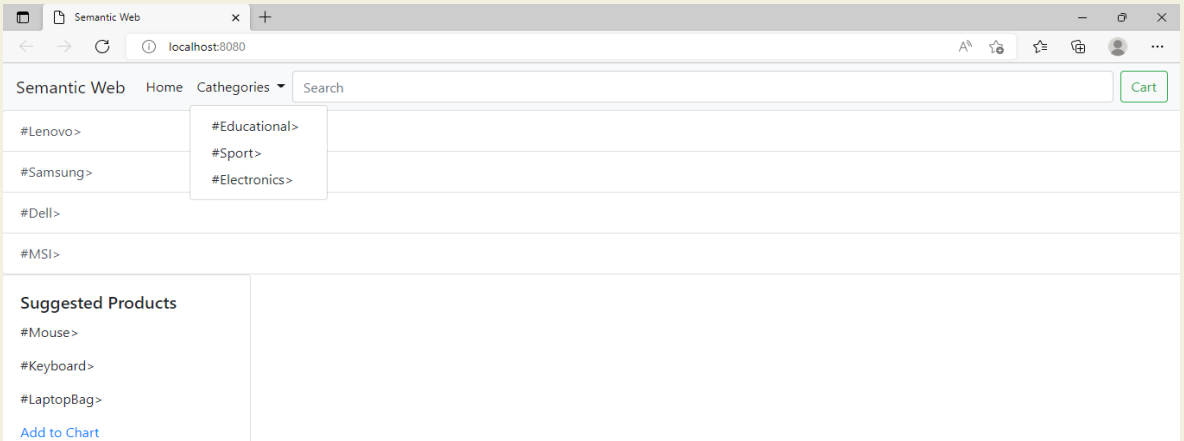

Figure 10. View of the Application Interface

Conflict of Interest

All authors have read and agreed to the published version of the manuscript.

References

[1] Purwanto, A. (2022). What is the role of customer behavior for electronic e-commerce and modern market visit intention? Journal of Information Systems and Management (JISMA), 1(6): 46-57.

[2] Peng, L., Zhang, W., Wang, X., Liang, S. (2019). Moderating effects of time pressure on the relationship between perceived value and purchase intention in social e-commerce sales promotion: considering the impact of product involvement. Information & Management, 56(2): 317-328.

[3] Qureshi, I., Fang, Y., Ramsey, E., McCole, P., Ibbotson, P., Compeau, D. (2009). Understanding online customer repurchasing intention and the mediating role of trust–an empirical investigation in two developed countries. European Journal of Information Systems, 18(3): 205-222.

[4] Qin, Z. (2009). Introduction to e-commerce. Tsinghua University Press, 4-8.

[5] Berners-Lee, T. Tim Berners-Lee's Semantic Web, (accessed date 15 September 2022). https://www.researchgate.net/publication/307845029_Tim_Berners-Lee's_Semantic_Web.

[6] Hazer, B. (2015). Semantic web based pharmaceuticals recommendation system. Erciyes University, Graduate School of Natural and Applied Sciences. Computer Engineering Department.

[7] Yu, L., Gerstner, R. A. (2014). Developer's Guide to the Semantic Web, Publisher: Springer.

[8] Hebeler, J., Fisher, M., Blace, R., Perez-Lopez, A., Dean, M. (2009). Semantic Web Programming, Publisher: Wiley inc.

[9] Badr, Y., Chbeir, R., Abraham, A., Hassanien, A.E. (2010). Emergent Web Intelligence: Advanced Semantic Technologies, Publisher: Springer.

[10] Rodriguez-Muro, M., Kontchakov, R., Zakharyaschev, M. (2013). Ontology-Based Data Access: Ontop of Databases, Publisher: Springer.

[11] Baz, F. Ç., Meral, H. C. (2021). Web 3.0 – The use of semantic web studies in different fields: an application development example. Osmaniye Korkut Ata University Journal of the Institute of Science and Technology, 4(3): 408 – 421.

[12] Kalelkar, M., Churi, P., Kalelkar, D. (2014). Implementation of model-view-controller architecture pattern for business intelligence architecture. International Journal of Computer Applications, 102(12): 14.

[13] Berners-Lee, T., Hendler, J., Lassila, O. (2001). The semantic web. Scientific American, Inc.

[14] Uschold, M. (2003). Where are the semantics in the semantic web? AI Magazine, 24(3): 25 – 36.

[15] Gomez-Perez, A., Corcho, O. (2002). Ontology languages for the semantic web. IEEE Intelligent Systems, 54 – 60.

[16] Missikoff, M., Navigli, R., Velardi, P. (2002). Integrated approach to web ontology learning and engineering. IEEE Computer, 60 – 63.