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REVIEW ARTICLE

OPTIMIZED MARKETING STRATEGIES IN E-COMMERCE USING MACHINE LEARNING COLLABORATIVE FILTERING FOR COMMERCIAL SYSTEMS

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ABSTRACT

Introduction: Electronic commerce (e-commerce) is the marketing, buying, and selling of merchandise or service over the Internet. It encompasses the entire scope of online products and services from start to finish. E-commerce facilitates the growth of an online business. Online shopping is an e-commerce format. This work helps the user to order their products online. The product provider will get those orders and will make a bag for them and the customers can get their products. Item-based collaborative filtering is used to find the similarities between the products brought by the customer and to recommend the most similar product. This helps in making even the visitor into a customer.

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INTRODUCTION

The overall goal of this work is to develop a website that mainly focuses on the sales of the products, in these users can buy the products which they want. This application allows the user to buy the desired products. All the processes will be handled by the admin and a separate username and password are assigned to the customer. Different database tables for different modules are available to store data properly. It can use any database that is safe and secure like My SQL. Once you registered yourself you will be satisfied with the work and features it provides as everything here in the application is very safe. Application can't be corrupt. These applications are very user-friendly and they use easy terms so they can be understood by any user level. Each and everything is designed properly and serves its purpose. PHP is a server-side scripting language designed for web development but also used as a general-purpose programming language. PHP is now installed on more than 244 million websites and 2.1 billion web servers. While PHP originally stood for personnel homepage, it now stands for PHP: hypertext preprocessor, a recursive acronym. PHP code is interpreted by a webserver with a PHP processor module, which generates the resulting webpage: PHP commands can be embedded directly into an HTML source document rather than calling an external file to process data. It has also evolved to include a command-line interface capability and can be used in standalone graphical applications. PHP is free software released under the PHP license. PHP can be deployed on most web servers and as a standalone shell on almost every operating systems and platforms, free of charge. MySQL is a powerful database. It is very good and free of charge. Many developers in the world selected MySQL and PHP for developing their websites. The MySQL database has become the world's most popular open-source database because of its consistently fast performance, high reliability, and ease of use. It's used in more than 6 million installations ranging from large corporations to specialized embedded applications on every continent in the world. Not only is MySQL the world's most popular open-source database, but it's also become the database of choice for a new generation of applications built on the LAMP stack (Linux, Apache, MySQL, PHP/Perl/Python.) MySQL runs on more than 20 platforms including Linux, Windows, OS/X, HP-UX, AIX, and Netware, giving you the kind of flexibility that puts you in control. This work aims to help the customers to order their products by sitting in their homes. First, they have

to register and create a login id and users can shop for the products they need and can add to their respective carts. Admin will get the details and will make all those products to be available for the customers and customers can collect their bags after paying the cash.

LITERATURE SURVEY

The impact of Online Sales on Consumer and Firms: The main focus of this work estimates a differentiated products demand model to ask three questions regarding the introduction of e-commerce. First, the question arise as whether the online distribution channel has increased total sales, or only diverted sales from traditional channels. To find that there is a market expansion effect but also a considerable sales diversion. Second, question is to which extent consumers and firms benefited from the introduction of the online sales channel. Third, question is to ask how the online channel has affected European market integration. To find that price differences between the EU countries for identical products are large both in the traditional channel and online. Therefore, the introduction of e-commerce did not influence price levels and international price dispersion in the traditional channel.

Analysis on E-Commerce & Internet: The global internet audience continues to grow steadily, with the worldwide base of broadband internet users (including fixed and wireless) reaching more than 4 billion as 2018 began. This vast base of high-speed internet users encourages businesses to innovate to offer an ever-evolving array of online services. Sectors that are growing very rapidly online include the sale of entertainment products, travel, apparel, and consumer electronics. Even groceries have moved into the fast lane, as online grocery sales are growing quickly. Thanks to a growing list of same-day delivery options. The most powerful trends on the internet include access via wireless devices, the migration of entertainment, including TV programming, t,o the web, and cloud-based software-as-a-service.

Today, consumers are more focused than ever on finding the best prices while shopping most conveniently or satisfactorily. Consequently, e-commerce continues to be Amazon, where sales have soared thanks to aggressive discount pricing, free shipping for its "Prime," members, and an ever-growing variety of merchandise categories. Amazon's revenues soared from $34.2 billion in 2010 to $178 billion in 2017.

Industry Market Research on Computers, Software & Hardware: The technology breakthrough that enabled the modern computer occurred shortly after the end of World War II when researchers at Bell Laboratories in New Jersey created the first working transistor on December 16, 1947. William Shockley, John Bardeen, and Walter Brattain later received a well-deserved Nobel Prize in Physics for their groundbreaking work. What started with one transistor has grown at an astonishing rate. The Semiconductor Industry Association estimated that in 2008, a total of 6 quintillion transistors were manufactured that's six followed by 18 zeros). That was only a minor down payment for the future. Consider the steady evolution of chips from Apple and Intel: In 1978, Intel's wildly popular 8086 processor contained 29,000 transistors, an immense leap forward in desktop computing. The first Pentium processor was introduced by Intel in 1993, with 3.1 million transistors. In February 2010, Intel launched an Itanium chip with 2 billion transistors. By 2015, the Apple iPhone 6 contained an apple "A8" microprocessor with 2 billion transistors, in a piece of equipment small enough to carry around in your pocket. By one estimate, Apple's product sales alone were launching about 100 quintillion transistors into the market every year as of early 2015.

Working of Traditional System: The existing system consists of a manual process i.e., users need to search the grocery stores for getting the products. Because of that, it is a time-consuming and less effective process. From the point of view of an overall sales process engineering effort, customer service plays an important role in an organization's ability to generate income and revenue. From this perspective, customer service should be included as part of an overall approach to systematic improvement. One good customer service experience can change the entire perception a customer holds toward the organization.

Gaps in the Existing System: As we know manual systems are quite tedious, time-consuming, and less efficient and accurate in comparison to customized systems.

So following are some of gaps identified in literature survey of the old system:

- Time-consuming
- Less accurate
- Less efficient
- Lot of paperwork
- Slow data processing
- Not user-friendly environment
- Difficult to keep records

PROPOSED SYSTEM

To overcome existing problems a new system is developed that can be easily searched with better security features. The proposed work is used to sell groceries online. It reduces time consumption and it is an automated process. In this current work, the admin collects the products ordered by the customer and makes them ready to be delivered to the customer. System work flow is shown in Fig 1.

Workflow of Proposed Method

- Input design is the process of converting a user-oriented description of the input into a computer-based system.
- This design is important to avoid errors in the data input process and show the correct direction to the management for getting correct information from the computerized system.
- It is achieved by creating user-friendly screens for data entry to handle the large volume of data. The goal of designing input is to make data entry easier and to be free from errors.
- The data entry screen is designed in such a way that all the data manipulates can be performed. It also provides a record viewing facility.
- When the data is entered it will check for its validity. Data can be entered with the help of screens.
- Appropriate messages are provided when needed so that the user will not be in maize of instant. Thus the objective of input design is to create an input layout that is easy to follow.

Feasibility Requirement of Proposed System: The feasibility of the work is analyzed in this phase and a business proposal is put forth with a very general plan for the proposed system and some cost estimates. During system analysis, the feasibility study of the proposed system is to be carried out. This is to ensure that the proposed system is not a burden to the company. For feasibility analysis, some understanding of the major requirements for the system is essential.

Three key considerations involved in the feasibility analysis are,

- Economic Feasibility
- Technical Feasibility
- Social Feasibility

Economic Feasibility: This revision is carried out to check the economic impact that the system will have on the organization. The amount of funds that the company can pour into the research and development of the system is limited. The expenditure must be justified. Thus the developed system is well within the budget and this was achieved because most of the technologies used are freely available. Only the customized product has to be purchased.

Technical Feasibility: This revision is carried out to check the technical feasibility, that is, the technical requirements of the system. Any system developed must not have a high demand for the available technical resources. This will lead to high demands on the available technical resources. This will lead to high demands being placed on the client. The developed system must have a modest requirement, as only minimal or null changes are required for implementing this system.

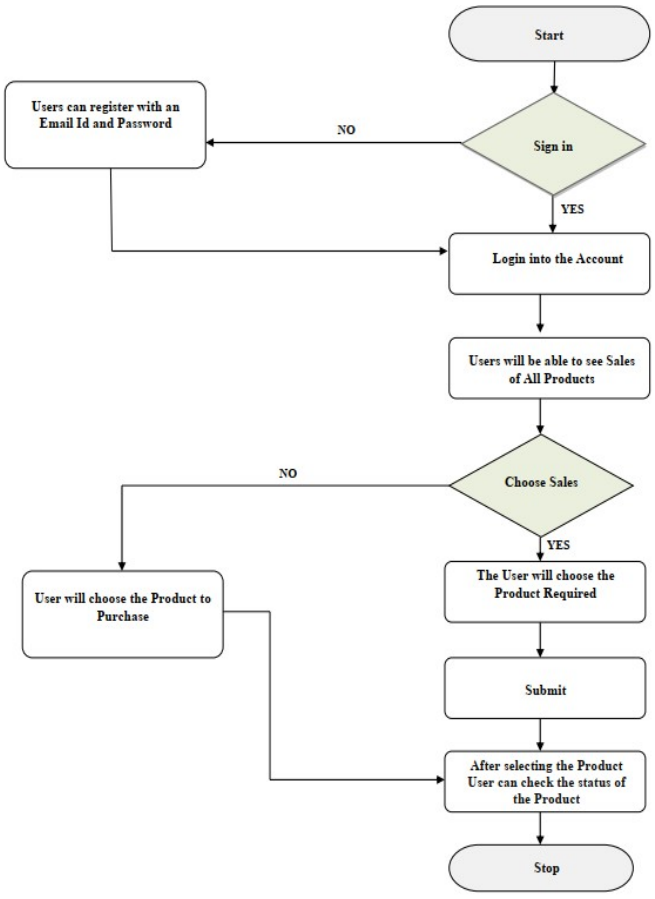

Fig. 1. Proposed System Design Workflow

Social Feasibility: The aspect of revising is to check the level of acceptance of the system by the user. This includes the process of training the user to use the system efficiently. The user must not feel threatened by the system, instead must accept it as a necessity. The level of acceptance by the users solely depends on the methods that are employed to educate the user about the system and to make him familiar with it. His level of confidence must be raised so that he is also able to make some constructive criticism, which is welcomed, as he is the final user of the system.

Installation Steps of XAMPP

Follow these steps for installing XAMPP

Step 1: Disable your anti-virus as it can cause some XAMPP components to behave erratically.

Step 2: Disable User Account Control (UAC). UAC limits write permissions to XAMPP's default installation directory, forcing you to install in a separate directory. You can learn how to disable UAC here (Optional).

Step 3: Start the installation process by double-clicking on the XAMPP installer. Click 'next' after the splash screen.

Step 4: Here, you can select the components you want to install. Choose the default selection and click 'next'.

Step 5: Choose the folder you want to install XAMPP, which holds all your web application files, so make sure to select a drive that has plenty of space.

Step 6: The next screen is a promo for BitNami, an app store for server software. Deselect the 'Learn more about BitNami for XAMPP' checkbox unless you enjoy receiving promo mails.

Step 7: Setup is now ready to install selected components, which takes a few minutes. You may be asked to approve Firewall access to certain components during the installation process.

Step 8: Installation is now complete! Select the 'Do you want to start the control panel now?' checkbox to open the XAMPP control panel.

Proposed Recommendation System: The amount of information in the world is increasing far more quickly than our ability to process it. All of us have known the feeling of being overwhelmed by the number of new books, journal articles, and conference proceedings coming out each year. Technology has dramatically reduced the barriers to publishing and distributing information. Now it is time to create the technologies that can help us sift through all the available information to find that which is most valuable to us. One of the most promising such technologies is collaborative filtering. Collaborative filtering works by building a database of preferences for items by users. Collaborative filtering has been very successful in both research and practice, and in both information filtering applications and E-commerce applications. However, there remain important research questions in overcoming two fundamental challenges for collaborative filtering recommender systems. The first challenge is to improve the scalability of the collaborative

filtering algorithms. These algorithms can search tens of thousands of potential neighbors in real-time, but modern systems demand to search tens of millions of potential neighbors. Further, existing algorithms have performance problems with individual users for whom the site has large amounts of information.

For instance, if a site is using browsing patterns as indications of content preference, it may have thousands of data points for its most frequent visitors. These “long user rows” slow down the number of neighbors that can be searched per second, further reducing scalability. The second challenge is to improve the quality of the recommendations for the users. Users need recommendations they can trust to help them find items they will like. Users will“ vote with their feet" by refusing to use recommender systems that are not consistently accurate for them. In some ways these two challenges conflict, since the less time an algorithm spends searching for neighbors, the more scalable it will be, and the worse it's quality. It is important to treat the two challenges simultaneously so the solutions discovered are both useful and practical. To address these issues we have to apply item-based collaborative filtering.

Collaborative Filtering-based Recommender System: Recommender systems apply data analysis techniques to the problem of helping users find the items they would like to purchase at E-Commerce sites by producing a predicted likeliness score or a list of top–N recommended items for a given user. Item recommendations can be made using different methods. Recommendations can be based on the demographics of the users, overall top-selling items, or past buying habits of users as a predictor of future items. Collaborative Filtering (CF) is the most successful recommendation technique to date. The basic idea of CF-based algorithms is to provide item recommendations or predictions based on the opinions of other like-minded users. The opinions of users can be obtained explicitly from the users or by using some implicit measure

Working of Proposed Collaborative Filtering: The goal of a collaborative filtering algorithm is to suggest new items or to predict the utility of a certain item for a particular user based on the user's previous likings and the opinions of other like-minded users. In a typical CF scenario, there is a list of m users U = {u1, u2... um} and a list of n items I = {i1,i2,..., in}. Each user ui has a list of items Iui , which the user has expressed his/her opinions about. Opinions can be explicitly given by the user as a rating score, generally within a certain numerical scale, or can be implicitly derived from purchase records, by analyzing timing logs, mining web hyperlinks, and so on. Note that I ui $\subseteq$ I and Iui can be a null set. There exists a distinguished user ua $\in$ U called the active user for whom the task of a collaborative filtering algorithm is to find an item likeliness that can be of two forms.

- Prediction is a numerical value, Pa,j , expressing the predicted likeliness of item i j $\in$ Iua for the active user ua. This predicted value is within the same scale (e.g., from 1 to 5) as the opinion values provided by u a.
- The recommendation is a list of N items, Ir $\subset$ I, that the active user will like the most. Note that the recommended list must be on items not already purchased by the active user, i.e., Ir $\cap$ Iua =. This interface of CF algorithms is also known as Top-N recommendation.

Challenges of User-based Collaborative Filtering Algorithms

User-based collaborative filtering systems have been very successful in the past, but their widespread use has revealed some potential challenges such as:

- Sparsity in practice, many commercial recommender systems are used to evaluate large item sets (e.g., Amazon.com recommends books and CDnow.com recommends music albums). In these systems, even active users may have purchased well under 1% of the items (1% of 2 million books is 20, 000 books). Accordingly, a recommender system based on nearest-neighbour algorithms may be unable to make any item recommendations for a particular user. As a result, the accuracy of recommendations may be poor.
- Scalability. Nearest neighbour algorithms require computation that grows with both the number of users and the number of items. With millions of users and items, a typical web-based recommender system running existing algorithms will suffer serious scalability problems.

Item-based Collaborative Filtering Algorithm: The item-based approach looks into the set of items the target user has rated and computes how similar they are to the target item i and then selects k most similar items {i1,i2... ik}. At the same time, their corresponding similarities {si1,si2... sik} are also computed. Once the most similar items are found, the prediction is then computed by taking a weighted average of the target user's ratings on these similar items.

SYSTEM IMPLEMENTATION AND RESULT ANALYSIS

Implementation is the stage of the work when the theoretical design is turned out into a working system. Thus it can be considered to be the most critical stage in achieving a successful new system and in giving the user, confidence that the new system will work and be effective. The implementation stage involves careful planning, investigation of the existing system and its constraints on implementation, designing of methods to achieve changeover, and evaluation of changeover methods. It makes the new system available to a prepared set of users (the deployment), and positions ongoing support and maintenance of the system within the Performing Organization (the transition). At a finer level of detail, deploying the system consists of executing all steps necessary to educate the Consumers on the use of the new system, placing the newly developed system into production, confirming that all data required at the start of operations is available, and accurate, and validating that business functions that interact with the system are functioning properly. Transitioning the system support responsibilities involves changing from a system development to a system support and maintenance mode of operation, with ownership of the new system moving from the Project team to the Performing Organization. System implementation is the important stage of the work when the theoretical design is tuned into a practical system. The main stages in the implementation are as follows

- Planning
- Training
- System testing and

- Changeover planning

Planning is the first task in system implementation. Planning means deciding on the method and the time scale to be adopted. At the time of implementation of any system people from different departments and systems, and analyses involve. They are confirmed to practical problems of controlling various activities of people outside their data processing departments. The line managers are controlled through an implementation coordinating committee.

The committee considers ideas, problems, and complaints of the user department, it must also consider

- The implementation of the system environment
- Self-selection and allocation form implementation tasks
- Conclusion with unions and resources available
- Standby facilities and channels of communication

The following roles are involved in carrying out the processes of this phase.

- Service Manager
- Service Personal
- Business Analyst
- Data/Process Modeler
- Technical Lead/Architect
- Application Developers
- Software Quality Assurance (SQA) Lead
- Technical Services (HW/SW, LAN/WAN, Telecom)
- Technical Support (Help Desk, Documentation, Trainers)
- Customer Decision-Maker

The purpose of preparing for system implementations is to take all possible steps to ensure that the upcoming system deployment and transition occur smoothly, efficiently, and flawlessly. In the implementation of any new system, it is necessary to ensure that the Consumer community is best positioned to utilize the system once deployment efforts have been validated. Therefore, all necessary training activities must be scheduled and coordinated. As this training is often the first exposure to the system for many individuals, it should be conducted as professionally and competently as possible. A positive training experience is a great first step toward customer acceptance of the system. During system Implementation, everyone involved must be synchronized with the deployment plan and with each other. Often the performance of deployment efforts impacts many of the Performing Organization's normal business operations. Examples of these impacts include:

Consumers may experience a period in which the systems that they depend on to perform their jobs are temporarily unavailable to them. They may be asked to maintain detailed manual records or logs of business functions that they perform to be entered into the new system once it is operational.This working methodology is applied in real world corporate domain Eyal Marketing. Sample web pages are listed below

TESTING PHASES

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub-assemblies, and/or a finished product. It is the process of exercising software with the intent

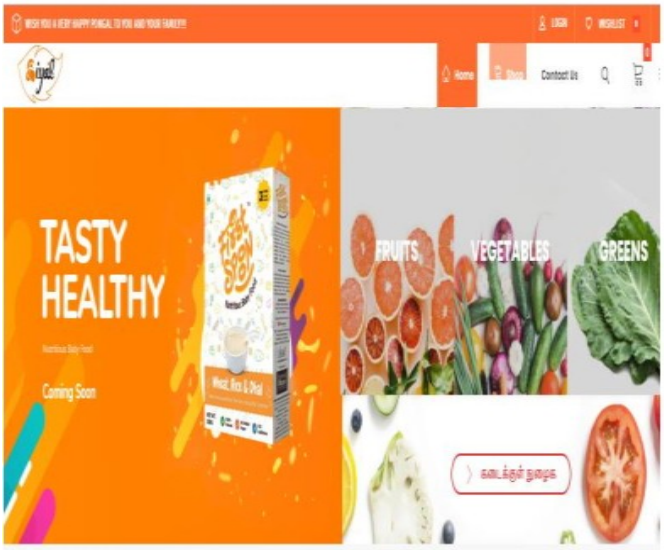

Fig. 1. Front View of Web Page

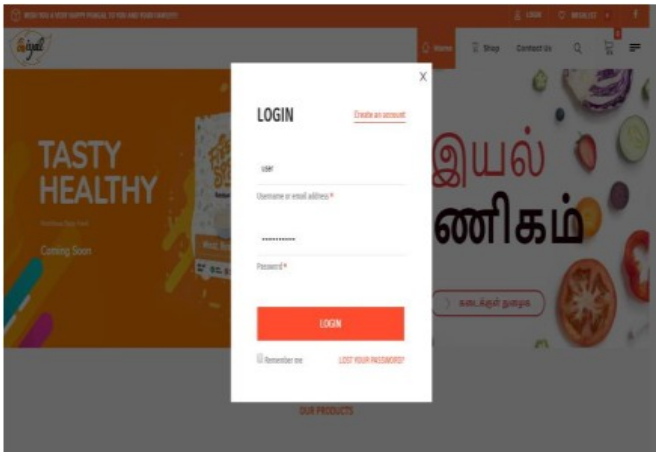

Fig. 2. Login Page

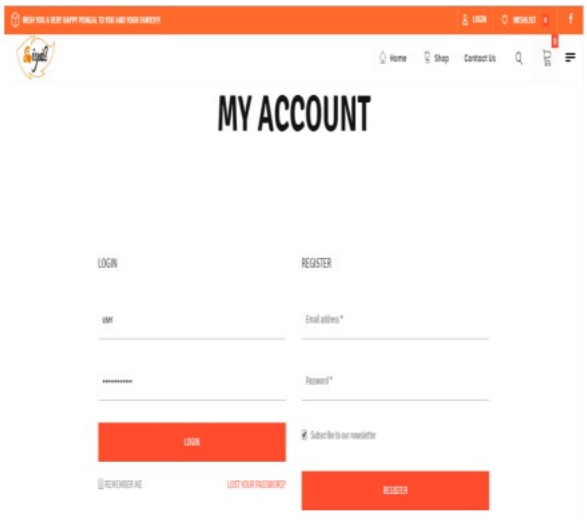

Fig. 3 Sign Up Page

of ensuring that the software system meets its requirements and user expectations and does not fail unacceptably. There are various types of tests. Each test type addresses a specific testing requirement.

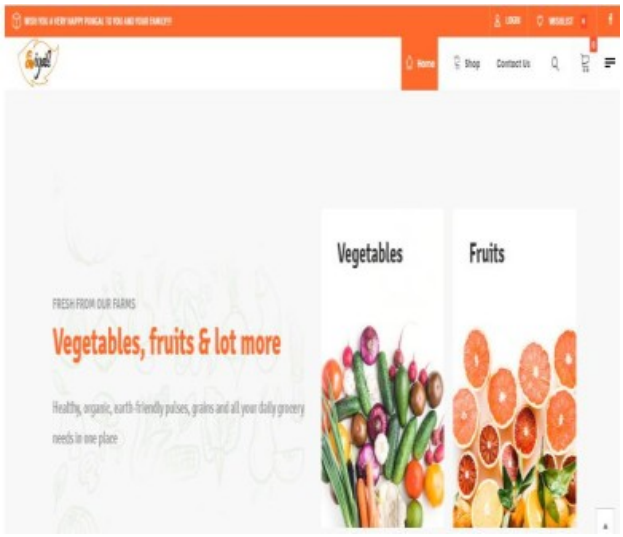

Fig. 4. Home Page

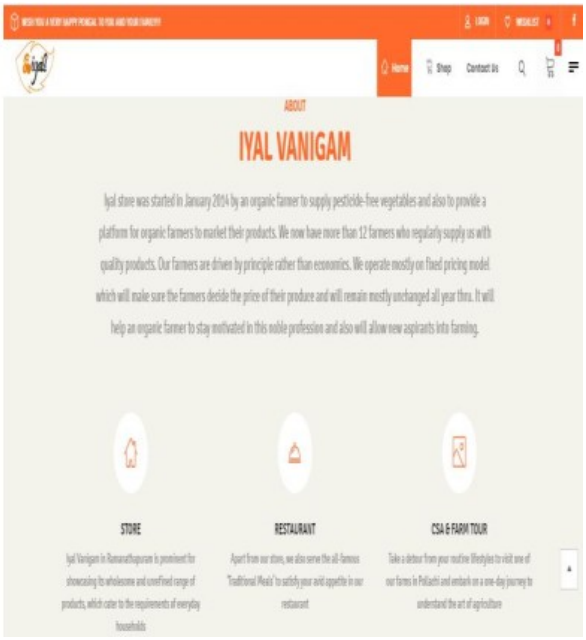

Fig. 5 About the Web Page

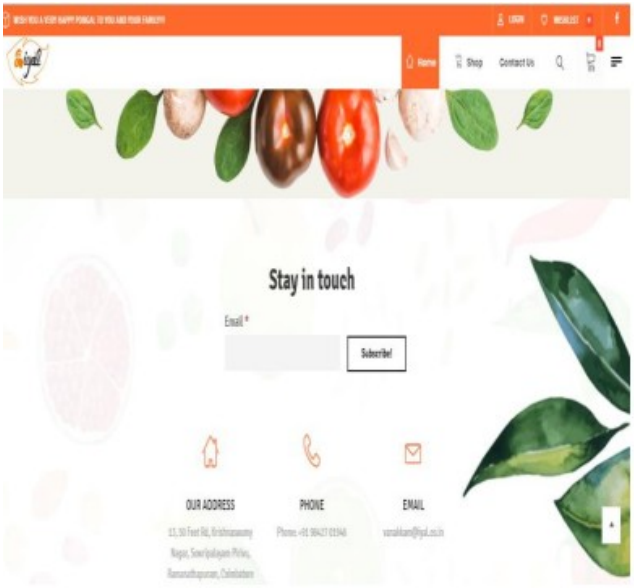

Fig. 6 Store Information Page

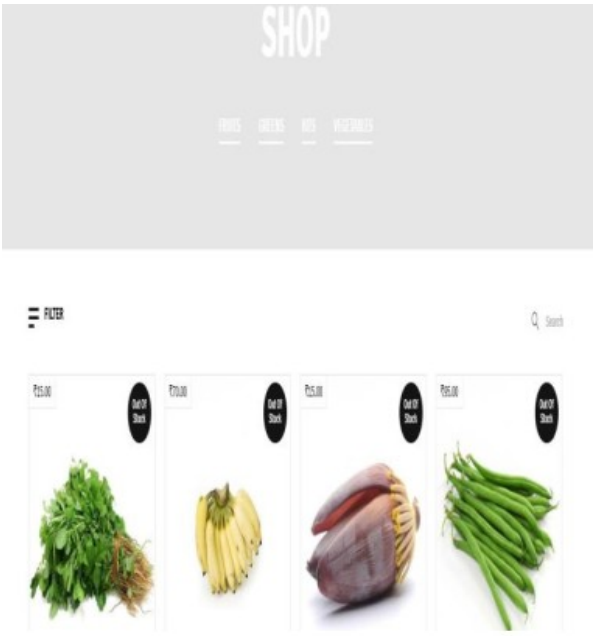

Fig. 7. Dashboard page

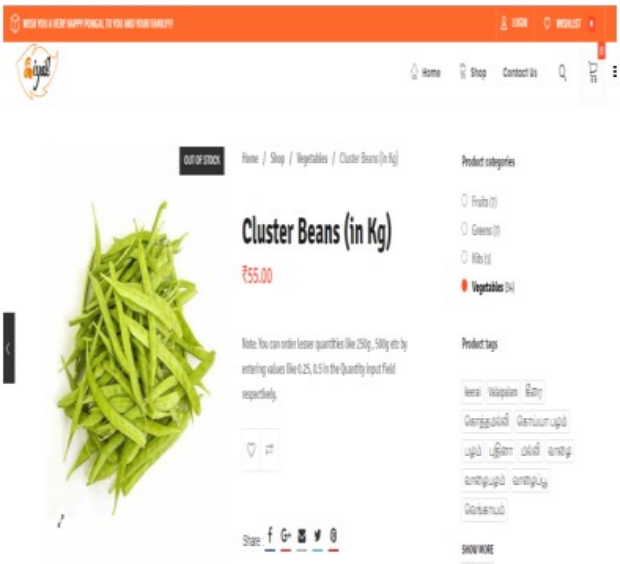

Fig. 8. Product Details Page

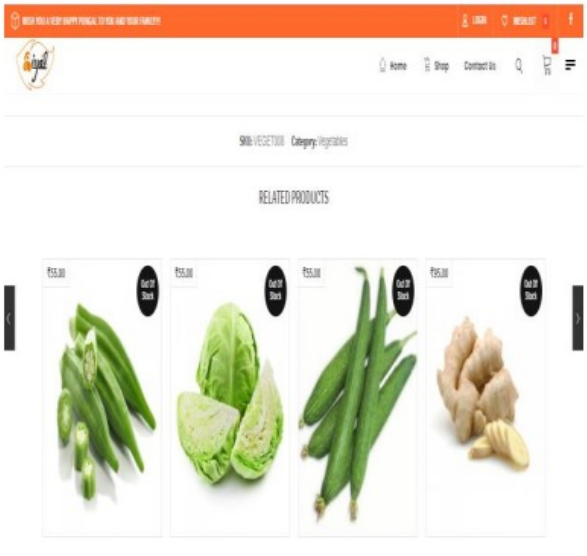

Fig. 9. Related Products Page

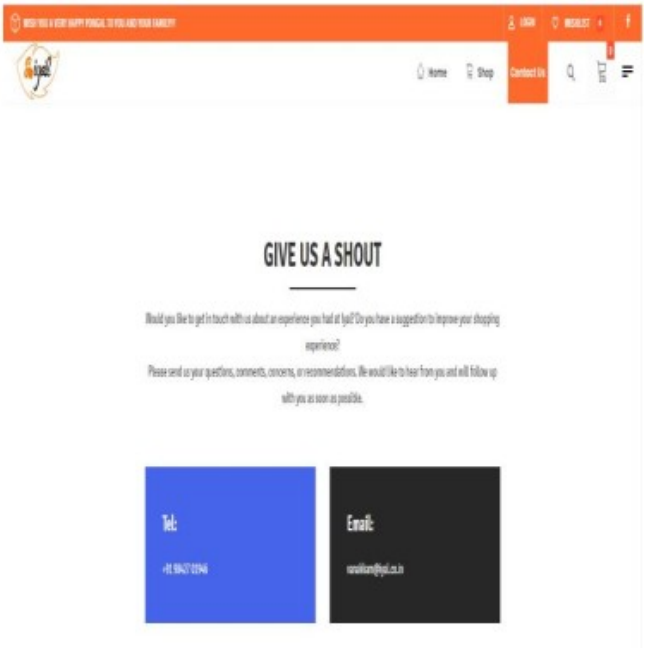

Fig. 10. Contact Page

Proposed Prototype Testing

Unit Testing

Unit testing involves the design of test cases that validates that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application. It is done after the completion of an individual unit before integration. This is structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at a component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

Integration Testing

Integration tests are designed to test integrated software components to determine if they run as one program. Testing is event-driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfied, as shown by successful unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

Functional Testing

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.

Functional testing is centered on the following items:

- **Valid Input:** Identified classes of Valid Input must be accepted.
- **Invalid Input:** Identified classes of Invalid Input must be rejected.
- **Functions:** Identified functions must be exercised.
- **Output:** Identified classes of application outputs must be exercised.
- **Systems/Procedures:** Interfacing systems or procedures must be invoked.

Organization and preparation of functional tests are focused on requirements, key functions, or special test cases. In addition, systematic coverage about Identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

Proposed System Testing: System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration-oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

Black Box Testing: Black Box Testing is testing the software without any knowledge of the inner workings, structure, or language of the module being tested. Black box tests, like most other kinds of tests, must be written from a definitive source document, such as specification or requirements document, such as specification or requirements document. It is a testing in which the software under test is treated, as a black box. You cannot "see" into it. The test provides inputs and responds to outputs without considering how the software works.

Proposed Unit Testing: Unit testing is usually conducted as part of a combined code and unit test phase of the software lifecycle, although it is not uncommon for coding and unit testing to be conducted as two distinct phases.

Test strategy and approach: Field testing will be performed manually and functional tests will be written in detail.

Test objectives

- All field entries must work properly.
- Pages must be activated from the identified link.
- The entry screen, messages, and responses must not be delayed.

Features to be tested

- Verify that the entries are in the correct format.
- No duplicate entries should be allowed.
- All links should take the user to the correct page.

Proposed Integration Testing

Software integration testing is the incremental integration testing of two or more integrated software components on a single platform to produce failures caused by interface defects. The task of the integration test is to check that components or software applications, e.g. components in a software system or – one step up – software applications at the company level – interact without error.

Test Results: All the test cases mentioned above passed successfully. No defects were encountered.

Proposed Acceptance Testing: User Acceptance testing is a critical phase of any work and requires significant participation by the end user. It also ensures that the system meets the functional requirements.

CONCLUSION

A quality output is one, which meets the requirements of the end user and presents the information. In any system results of processing are communicated to the users and another system through outputs. In output design, it is determined how the information is to be displaced for immediate need and also a hard copy is provided. It is the most important and direct source of information for the user. This work explains implementing the website which will help to sell organic products to the customers. In this work, the customer requirements will update the status to the admin and the admin will change the status task. Once the customer orders any product it will be delivered to the address mentioned within the specified time and the customer can either make the payment online or offline.

REFERENCES

Ajaegbu C. An optimized item-based collaborative filtering algorithm. *Journal of Ambient Intelligence and Humanized Computing* 2021; 12: 10629–10636. doi: 10.1007/s12652-020-02876-1

Bin C. A collaborative filtering recommendation algorithm based on restricted random walk.In: Tuba M, Akashe S, Joshi A (editors). ICT Systems and Sustainability.Springer; 2022. pp. 763–773.

Ahmed E, Letta A. Book recommendation using collaborative filtering algorithm. Applied Computational Intelligence and Soft Computing 2023; 2023: 1514801. doi: 10.1155/2023/1514801.

Andika HG, Hadinata MT, Huang W, et al. Systematic literature review: Comparison on collaborative filtering algorithms for recommendation systems. In: Proceedings of the 2022 IEEE International Conference on Communication, Networks and Satellite (COMNETSAT); 3–5 November 2022; Solo, Indonesia. pp. 56–61.

Fkih F. Similarity measures for collaborative filtering-based recommender systems: Review and experimental comparison. Journal of King Saud University—Computer and Information Sciences 2022; 34(9): 7645–7669. doi: 10.1016/j.jksuci.2021.09.014

Snyder H. Literature review as a research methodology: An overview and guidelines. Journal of Business Research 2019; 104: 333–339. doi: 10.1016/j.jbusres.2019.07.039.

Sarwar, B.M., Karypis, G., Konstan, J.A., Riedl, J.: Item-based collaborative filtering recommendation algorithms. In: Shen, V.Y., Saito, N., Lyu, M.R., Zurko, M.E. (eds.) Proceedings of the 10th International World Wide Web Conference, WWW 10, Hong Kong, China, May 1-5, pp. 285–295. ACM (2001).

Koren, Y., Bell, R.M., Volinsky, C.: Matrix factorization techniques for recommender systems. IEEE Computer 42(8), 30–37 (2009).

Huang, Z., Zeng, D., Chen, H.: A comparison of collaborative-filtering recommendation algorithms for e-commerce. IEEE Intelligent Systems 22(5), 68–78 (2007).

Choi, S.M., Ko, S.K., Han, Y.S.: A movie recommendation algorithm based on genre correlations. Expert Systems with Applications 39(9), 8079–8085 (2012)

Linden, G; Smith, B; York, J (22 January 2003). "Amazon.com recommendations: item-to-item collaborative filtering". IEEE Internet Computing. 7 (1): 76–80. doi:10.1109/MIC.2003.1167344. ISSN 1089-7801

Hofmann, T. "Latent Semantic Models for Collaborative Filtering", *ACM Trans. Information Systems*, vol. 22, no. 1, pp. 89-115, 2004.

Papagelis, M. D. Plexousakis and T. Kutsuras, "Alleviating the Sparsity Problem of Collaborative Filtering Using Trust Inferences", *Proc. 3rd Intl. Conf. Trust Management (iTrust 05)*, pp. 224-239, 2005.

Huang, Z. H. Chen and D. Zeng, "Applying Associative Retrieval Techniques to Alleviate the Sparsity Problem in Collaborative Filtering", *ACM Trans. Information Systems*, vol. 22, no. 1, pp. 116-142, 2004.

Deshpande M. and G. Karypis, "Item-BasedTop-N Recommendation Algorithms," ACMTrans. Information Systems, vol. 22, no. 1,2004, pp. 143–177.

Ungar L.H. and D.P. Foster, "A Formal Statistical Approach to Collaborative Filtering, "Proc. 1998 Conf. Automated Learning and Discovery (CONALD 98),1998; www.cis. upenn.edu/~ungar/papers/CONAD.ps.

Kleinberg, J. "Authoritative Sources in aHyperlinked Environment," J. ACM, vol. 46,no. 5, 1999, pp. 604–632.

Brin S. and L. Page, "The Anatomy of a Large-Scale Hypertextual Web Search En-gine," Proc. 7th Int'l World Wide Web Conf., Elsevier, 1998, pp. 107–117.

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