ARTIFICIAL INTELLIGENCE BASED PERSONAL COMPUTER PARTS AND LAPTOPS RECOMMENDING ASSISTANT

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Specializing in Software Engineering and Information System Engineering

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Declaration

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ABSTRACT

Most of the computer and laptop users find it difficult to search for the ideal hardware component for themselves. Because there is a number of manufacturers in this sector. Thereby there are a variety of versions and brands available. This has created a need of having an online assistant to help the laptop and PC users to find the ideal hardware component matching their requirement. Another aspect that has created the need for such an assistant is the practice of assembling PCs' by people according to their requirements. This is a common practice, especially in the gaming industry. Because almost all the games demand PC specification if it needs to be played. Considering the above aspects an online assistant to assist you in finding the hardware components is designed in this research. This research was initiated with the deployment of an online questionnaire and interviews with the local vendors (PC and Laptops). With the information gathered an online assistant is designed to suggest compatible parts matching the requirements. In order to find the ideal component customer feedback analysis along with price optimization is used. This platform will provide assistance in finding the compatible PC parts, generating PC plans matching customer's budget and analysis of customer feedback and display the results in a rating format. Laptop users are given the service to compare laptops and based on the computational power the BEST will be recommended. In order to generate compatible PC part plan and laptop recommendation, Expert Systems will be used. For customer feedback analysis Natural Language Toolkit is used along with Python Libraries. Price optimization algorithms will be utilized to generate PC part plans according to the budget. The final output of this research is a web-based application built using Java, JavaScript and Python with Mongo DB as its database. Users will encounter this platform by the name "TechRing"- we make the right choices for you.

Keywords: Web scraping, assembling, expert systems, neural network, price optimization, sentiment analysis, lexicon, opinion mining, comparison, power.

ACKNOWLEDGEMENT

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
PC	Personal Computer
DOTA	Defense of the Ancients
AMD	Advanced Micro Devices
GHz	Gigahertz
GB	Giga Byte
RAM	Random Access Memory
CPU	Central Processing Unit
IT	Information Technology
POS	Part of Speech
MVC	Model View Controller
AWS	Amazon Web Service
API	Application Programming Interface
JSON	JavaScript Object Notation
SDLC	Software Development Life Cycle

1   INTRODUCTION

Initially, computers were used as a tool for calculations, but now computers help people finish many aspects in life [1]. Therefore, computers do play vital role in almost every industry. Among all the industries one of the upcoming industries is the gaming industry. Initially computer games were designed as an entertainment kit. But this industry has achieved a greater success and it is considered as one of the most profitable industries today. Computers are the main backbone of this industry.

It is not a difficult task to find a computer today. But it is a challenging task to find a computer that would satisfy the specific requirements. Therefore, the computers available in the market fail to cater to those requirements. Thus, people tend to assemble their own PC's. But it takes various components to build a PC and with the specifications, components required differ. For example, computers used for editing photos and videos is different from the computers used by a cashier.

As mentioned in the beginning majority of PC's are assembled for gaming purposes. Because most of the games available nowadays have different specifications. For example, the game DOTA requires Processor: Dual core from Intel or AMD at 2.8 GHz, Memory: 4 GB RAM,

Storage: 15 GB available space. Therefore, when they assemble a PC according to a game system requirement they need to look into those aspects and decide on assembling procedure.

People find it difficult to match the PC parts with each other when assembling because the PC parts have compatibility issues with one another. When it comes to compatibility, motherboard plays a major role since it has to work with components like RAM, CPU and more. Mainly it is necessary to check the socket compatibility with the processor.

Assembling a PC is a task with high complexity [2]. Information Technology experts might be capable of identifying the compatibilities and the required remedies. But it is not the same with an average person. We cannot ignore the fact, not only IT experts use computers average people starting from school level also use computers. Thus, they also prefer assembling their own PC's. Through a

background analysis we found out that this Non – IT PC assemblers find it difficult to match the compatibility and proceed the assembling. They use the help of internet, YouTube tutorials, gaming web sites to find the parts.

When purchasing a product, it is better to have options to select with. There are sites from vendors and e-commerce sites displaying the available PC parts. Some site provides both the ecommerce and vendor site together in one as well. Most of the local vendors do not reach to the online market. They believe that having the physical existence is enough for them to reach the market. This might be true couple of decades back but now it is must to have online access to the customers. Thus the need of having a common platform for products from local vendors, ecommerce sites and non-website holders is important. Because this type of platform will help them to choose the best product for the best price.

Laptops are also widely used in the industry. Today there are variety of laptops available. Different brands, models, versions and more. Depending on the requirements the laptop that is needed differ [3]. Due to the variety of options to select with cause confusions to a customer. Because they might have doubt as to which laptop is better. There are sites that provide the function where they can compare two laptops but none of the sites recommends a laptop. This makes the users to do a background checking on the laptops before purchasing. Sometimes people who does not have a reliable source of information will go to a shop and purchase a laptop that is recommended by the shop owners.

Before purchasing a part, customers prefer looking into the customer reviews. There are many open sources available where people have expressed their experiences with the products. One of the sources is Facebook. People who have the access to those sources will go through the comments and have an idea about the product. But it is not easy to go through thousands of comments and get an idea. Most of the time people will go through first couple of comments.

Below diagrams show the data we gathered using an online survey we conducted. Our main motive through the survey was to identify our target audience, the size of the audience and also their expectations.

(3) Do you play computer games?

81 responses
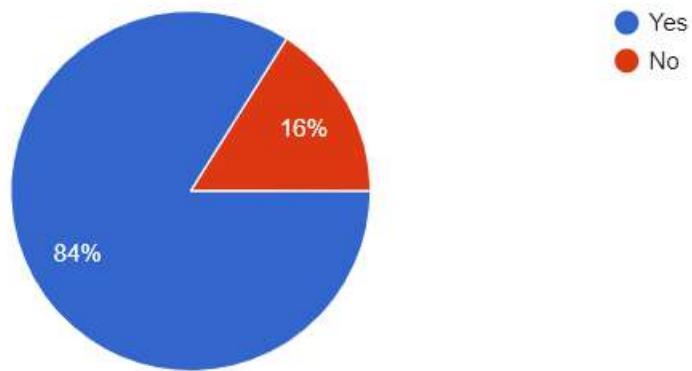
Figure 1. 1 - Survey Result displaying the percentage of gaming community

(5) What do you prefer ?

25 responses
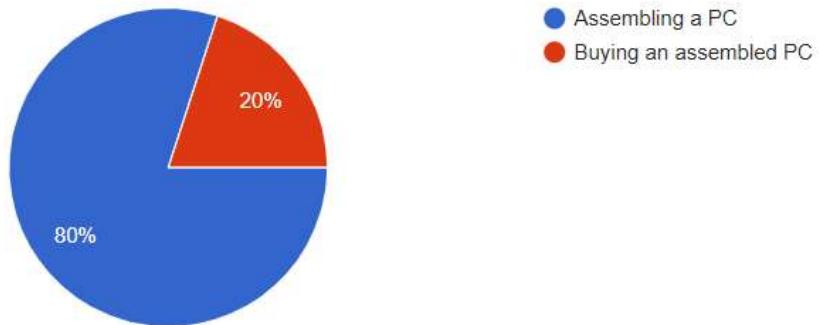
Figure 1. 2 - Survey results of what kind of PC customer prefer for play games

1.1 Background and Literature Survey

1.1.1 Background Context

The concept of having an online assistant for assembling PC's considering the requirements and the limitations is one of the challenging topics that many researches had their interests on. This is an area that is spread worldwide. Because computers and laptops are becoming a need rather than want in their lives. There were many researchers conducted to what we are building. They have used many techniques, concepts, models that is useful for us as well. Some of the research problems aren't related to our area yet the concepts they have used is very useful for us.

1.1.2 Literature Review

• Assembling Sequence

Neural networks and expert systems greatly improve the decision making and reasoning [1]. According Hou, once the assembling sequence is fed to the system through the expert system they can make decisions related to the assembling procedure. In this article they use a layered architecture to find the compatible parts starting from the final product. This step wise approach makes the process efficient and accurate.
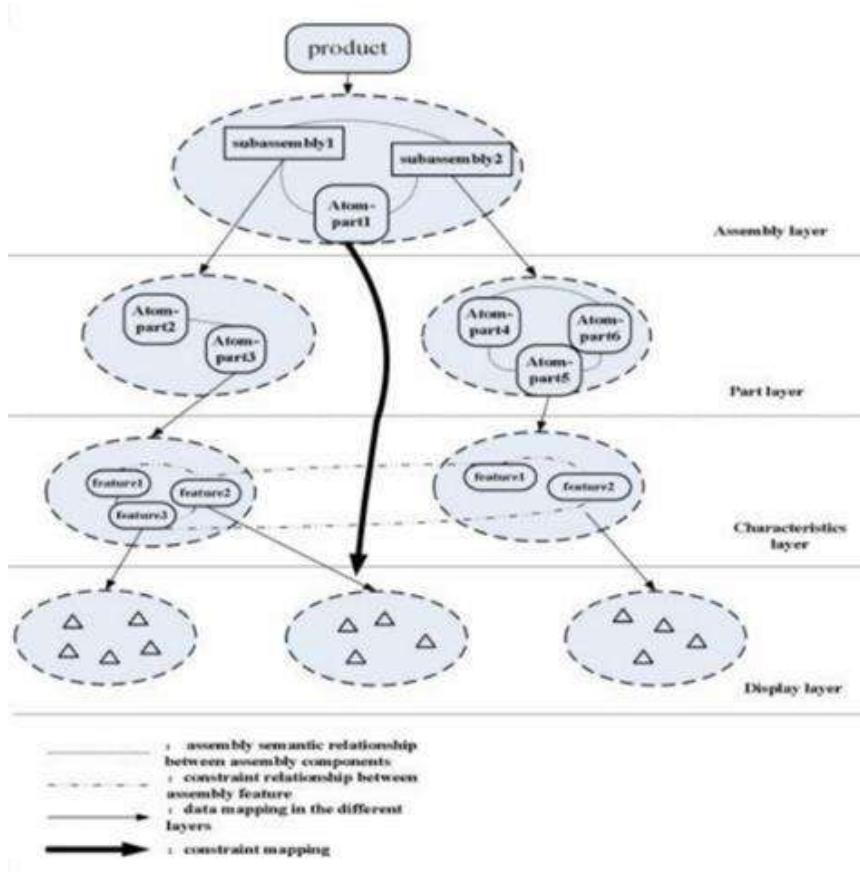
Figure 1. 3 - The Structure of the product assembling model

Source: [1]

Combining the knowledge-based reasoning along with the expert system improve the efficiency and reliability of computer-based reasoning. For decision making based on uncertain factors the researches have used the fuzzy system mechanism [1].

The assembling process for personal computers is long and a complex task [2].In order for students to learn the assembling mechanisms researchers have developed applications to assist them. HALT (Hardware Assembling Learning Tool) is developed for that purposes [2].In identifying the assembling procedures they have used two main techniques known as CBT (Computer Based Training) and CAI (Computer Assisted Instructions). They have incorporated AI techniques such as Intelligent Tutoring Systems.

One of the most difficult task is identifying the 3D objects. Thus it is necessary to have a precise description of the 3D object and matching algorithm to identify the each object [3].The Theory of Recognition by Components (RBC) explains how

human visual system identify objects by decomposing object parts [4] [3]. One of the most appropriate model that was used was the "Superquadric model". This model is capable of describing the parts considering primitive shapes with finite number of parameters which consists of rotation, translation and global deformation [5].

- Comparison Mechanism

According to Krithika and Keerthana, they have compared the two processors considering the computational power. In this to get the computational power of each they have considered the CPU, RAM and motherboard of each component and done the comparison. By comparing the computational power they have estimated the efficiency. Thus based on the efficiency, power and cost the comparison is conducted [6]. "It is a common practice to compare different computational power of different models of computation" as Udi and Nachum [7] describes. As they have analyzed they use two standard methods for comparison. Approach C (Containment) and S (Simulation). For an efficient comparison these two approaches need to work in harmony. In brief,

Approach C is finding the best one based on number of functionalities available.
Approach S comes into action because approach C is not always applicable. This method uses a more detailed analysis of the functions by stimulating each function computably.

- Price Comparison and Optimization

Today there is a high competition within and between heterogeneous retailer groups. Therefore, Cenak Kocas has designed a model to provide an understanding about the market. In this model they investigate the changes that happens in the market and decide on the online price changes [8].

Lucene is one of the popular full text libraries available. This can implement data indexing and retrieving [9]. In Jianxia and Huang's theory they have developed a system with Lucene apache libraries and web crawling to compare prices of products. This proposed system has proved to be efficient by the experiments that are conducted. Their system can conduct price comparison on online products so that they will display the possible products available for them. Figure shows the mechanism that is used by them.
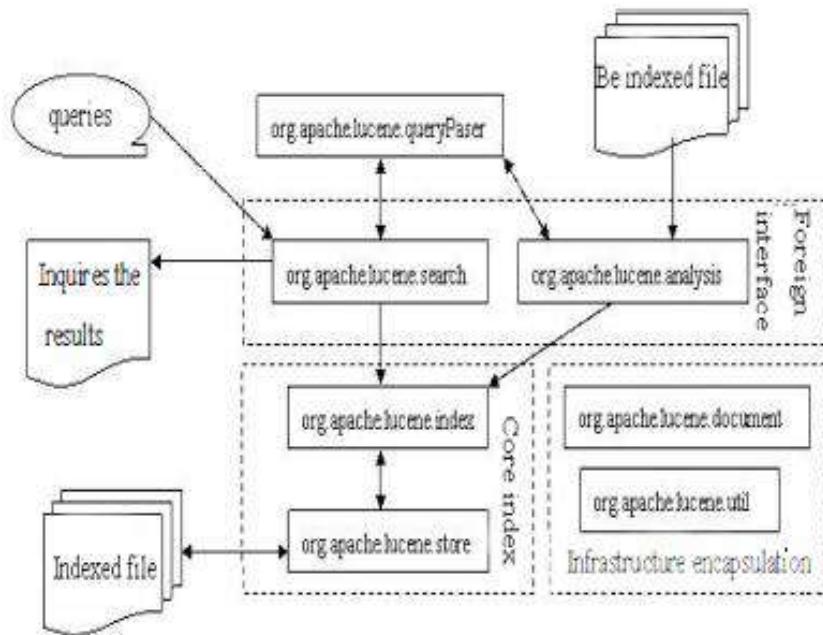
Figure 1. 4 - Lucane Model Diagram

Source: [9]

The market is characterized by rapid variability and high mobility. Therefore it is important to do a prize optimization for the market. Alexey Zalozhnev has done optimization of prices and production volumes using information on the price elasticity. He has calculated price elasticity of demand for each product to identify the model. Price parameters and base period prices is used to determine the profit maximizing prices. [10]

Pricing optimization can be the basis of adequate manufacturer pricing policy. Reasonable prices will contribute accordingly to the promotion and adaptation of products that are especially important for variable and flexible ICT market.

- Sentiment Analysis

Sentiment analysis is one of the main areas that is becoming popular in the society. This method is very useful in many of the areas. This is also known as opinion mining, sentiment mining and sentiment extraction [11]. According to Zeenia Singla sentiment analysis can be considered as a "computational study of extract subjective information from a text". Online reviews are becoming very important since they have become a measurement in quality of businesses. According to Andreea Salinca we should use a large data set for analysis and Yelp Data set provides a large review database. Also, according to this article to improve the efficiency of analysis they use two feature extraction methods and four machine learning models for automatic review analysis. The customer review analysis helps the manufacturers to identify the unrealized potential as well. Therefore, it is useful not only to the customers but also for manufacturers. Online reviews of e-commerce giants like Amazon, Flipkart has large review bases. Thus, the Big Data commerce came into role with them. These parameters help in taking profitable and accurate decisions for a business [12].

To proceed in the review analysis, they have used multiple approaches. In summarizing text Minquin Hu and Bing Lu divided the process into three tasks [13]. Namely, Mining comments based on product features. Identifying the opinion sentence in each review and decide whether it is positive or negative. Summarize the results.
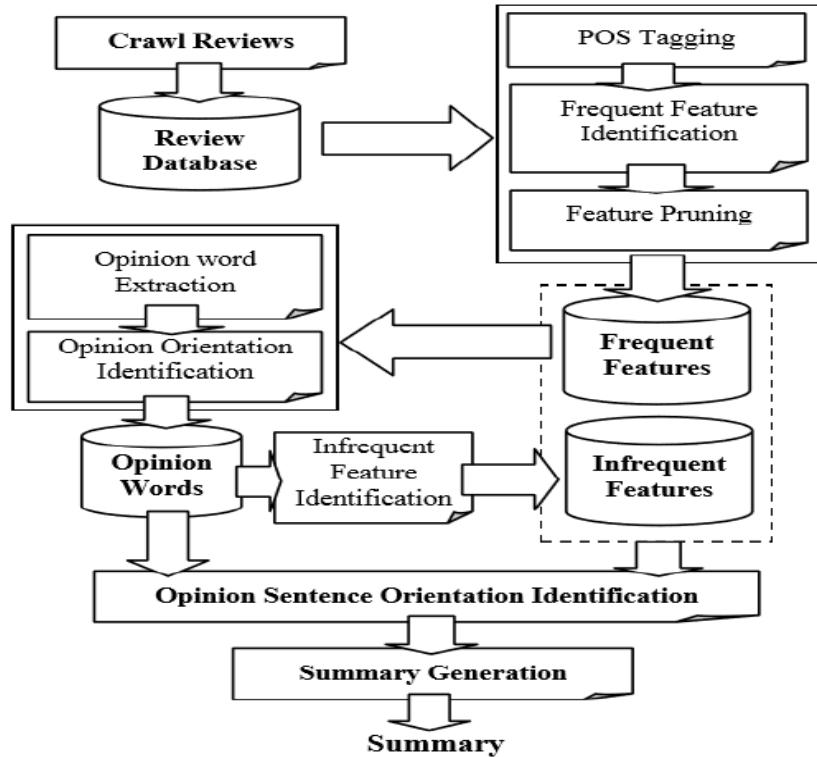
Figure 1. 5 - Model for Feature-based opinion summarization

Source: [13]

Part of Speech (POS) Tagger is one of the common and efficient methodologies that is used for sentiment analysis. This method identifies the nouns, adjectives, adverbs and verbs in a sentence. Below is one of the Machine learning process that is use
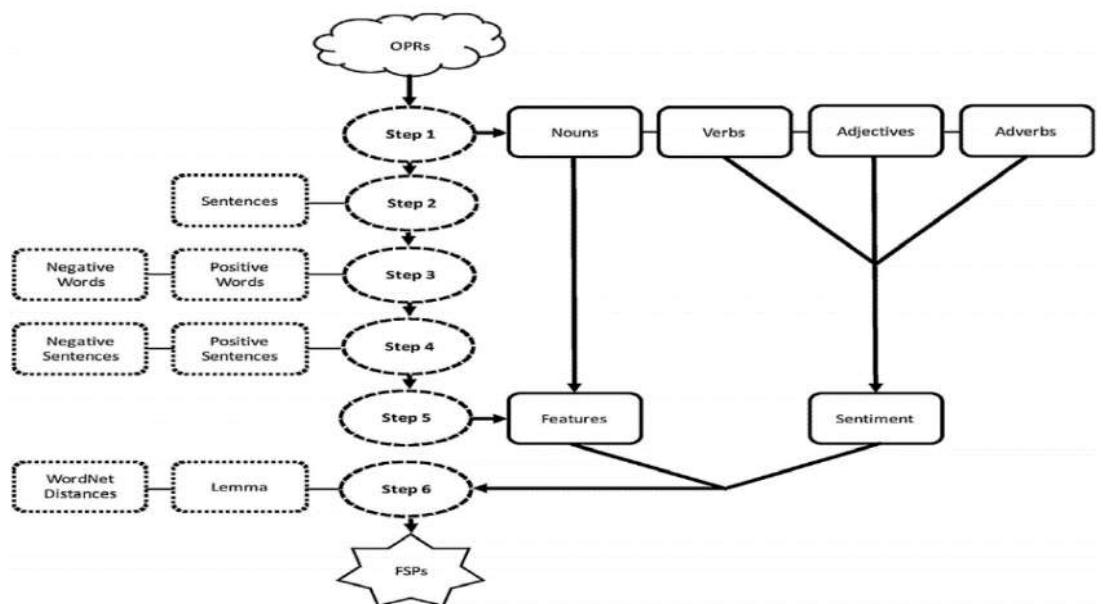
Figure 1. 6 - Cognition process, Source: [14]

By considering the readings it was clear that similar concepts have being used in different areas. Even though some concepts are from different fields the mechanisms that are used can be incorporated in our research as well. Because these mechanisms. Techniques and concepts produce similar outputs as "TechRing". Considering the requirements and knowledge we gathered from the articles there are no prevailing online assistants that provides assembling plans and budget. Thus we believe this assistant will be one time solution for many of the problems faced by people in assembling and finding suitable parts.

1.2   Research Gap and Problem

Through the data we gathered from research articles, observations, surveys and online sources it was clear that most of the sites have seldom approaches to provide solutions to the customers. With the rising demands for computers and laptops necessity of a platform which can provide solutions for customer problems is a must.

There are sites that are built for selling PC parts. Some sites display products/parts that belong to one vendor and some sites do display products from multiple vendors. There are some vendors who do not have online platforms as well. Therefore, this is a disadvantage for both the customer and the vendor. The customers might lose a chance of purchasing a product for a much cheaper price than expected. Because same product might be available for lesser price with another vendor. Figure 1.7 shows that majority of people prefer having an option to compare the prices.

The vendor might not be able to reach the customers who cannot visit them physically when they are not available online. One of the main reason local vendors are reluctant to reach the online market is due to the lack of technological knowledge and they feel safe within their comfort zone. But when we spoke with them, it was clear that they also want to join the online market if someone can provide the required guidance.

(9) Do you need to compare price of computer parts?

25 responses
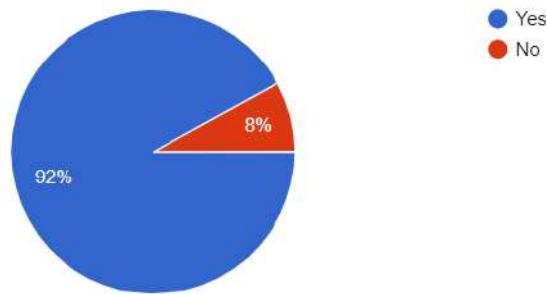
Figure 1. 7 - Survey results of computer parts price comparing

Through the survey we conducted we got to know that people use different methods to find the compatibility of parts. Mostly, online resources are widely used. They have to access these sources separately and get the required details. Below figure show the most common methods people use in order to access the necessary details.

(7) How do you find the compatibility of parts before purchasing?

25 responses
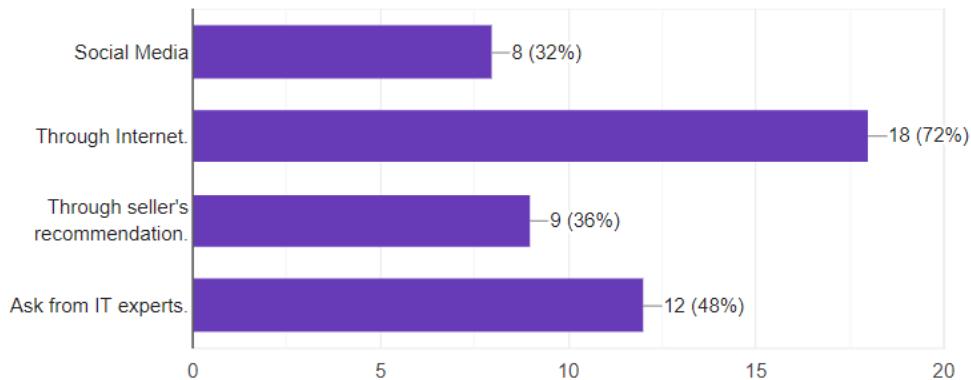
Figure 1. 8 - Survey result of how people check information about PC parts

There are variety of Laptops in the market. When selecting a Laptop these options confuses the customer because they have many functionalities incorporated with one another. Most of the sites which sell laptops have the option where people can compare two or more laptops. But none of those sites recommend the best laptop from them. So the user is left with the compared functions and choose the best one as they believe. Through the survey we were able to gather factors users mainly consider before purchasing a laptop.

(6) What are the features you mainly consider?

56 responses
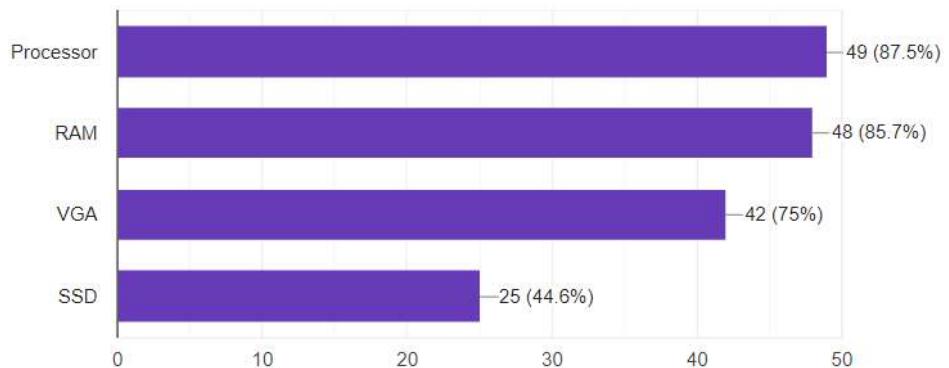
Figure 1. 9 - Survey results of features user mainly consider in a laptop

By going through many of the research articles several approaches were conducted in order to analyze the comments made in the social media. Reason for us to consider this area is customers look into the customer reviews done for products before purchasing. Therefore, this area is important for PC parts and Laptops. Most of the sites either display the comments that were placed by their previous customers or there are Facebook pages that contain customer reviews for products. Customers have limited access for an analyzed customer overview for the products (E.g.: Number of people satisfied with the product).

Functions	PCPartPicker.com	NewEgg.com	Noteb.com	TechRing
Select Compatible PC-Parts	✓			✓
Build PC according to a System requirement Of a Game				✓
Display prices and compare of different vendors	✓			✓
Analyze Comments and display rating based on that				✓
Recommends assemble plan according to budget	✓	✓		✓
Recommend the best PC part in a price range				✓
Notify Price Drops to user	✓	✓		✓
Laptop comparison			✓	✓
Recommending the best laptop				✓

Table 1. 1- Comparison of current available systems with "TechRing".

1.3 Research Objectives

Main Objective

Main objective is to provide an online assistance for people who wants to assemble their PC's by themselves for different purposes and also to empower the users with information related to purchasing laptops and PC parts. The system analyses the requirements through extracting data using web scraping and provide the user with information.

Specific Objective

I.   **Designing an Algorithm to generate an assembling plan based on the user Requirements.**

Most of the computer games have specification and these specifications are mentioned indifferent gaming websites. When a user visits our platform and type the game he or she is interested, our platform will display the set of PC parts that are necessary. If they are searching for a part or parts to assemble a PC, our platform will provide the necessary details as requested.

II.   **Enabling to display the products (PC parts) from both local vendors and in e-Commerce sites.**

For each PC parts there are suppliers both in local and foreign market. Our platform acts as a common base for both parties. When the user searches a part, our platform will display the vendors who are supplying the product and the rate at which they are providing.

III.   **Design of an algorithm to generate an assembling plan according to a budget.**

Mostly different vendors provide different rates for the same part. Sometimes there might be alternative parts cheaper than the part they are looking to purchase. But due to lack of awareness they might miss those products.

Therefore, in our platform we will provide a plan which includes the parts that needs to be used to assemble a PC according to the user's budget. User will enter the budget and the required specification. We will recommend the parts they need to purchase within the budget. We also recommend the vendor they need to select in order to be with their budget.

IV.   **Designing an algorithm to pick the best PC part in a price range.**

Most of the time cheapest product is not the best product. Users want to get the best product as well as the cheapest product. In order to do that, this system will have the ability to analyze the product features along with user feedbacks and the price. After analyzing, customers will get the best PC part in that price range.

V. Generating a comparison between two laptop options selected by the user.

Users have a difficulty in choosing a laptop due to the similar features available in different brands. When the user type two laptops they are looking we will provide a functionality comparison of the two laptops in the same interface. This representation will provide a clear idea about the features.

VI. Recommending the best laptop to work with.

Laptops can be graded based on the computational power and that is one of the main feature users look into before purchasing a laptop. Thus, our platform will use a separate grading algorithm to decide on which laptop is best from the selected options.

VII. Display an analyzed overview of the customer reviews on the particular product.

Customers who have purchased the parts will post their experiences in social media platforms. There are Facebook groups for this purpose. But these pages do not have an overview of the comments.

We will access those comments and analyze them. After that, these comments will be categorized as positive expression and negative expressions. Through an algorithm a count of those categorized comments will be taken. Finally, we will display a summary of the customer feedback.

2 METHODOLOGY

2.1 Methodology

The goal of the "TechRing" was to develop an AI based PC parts and laptops recommending assistant that customers to help for buy best suitable PC component and laptops. This platform provide several main services to customers. Those are get PC parts list for the user system requirement, analyze customer feedback in

social media platforms, price optimization and comparison of the products and get best computational power laptop. "TechRing" is a web based platform we developed using microservices architecture which provide scalability and maintainability to our platform. To implement the platform selected latest technology stack. The web client is developed using AngularJS it's an efficient framework that used to build single page applications. The API and back end development used Python, JAVA Springboot framework with MVC architecture. Git will be used to manage version control of the platform and GitHub used as the source code repository.
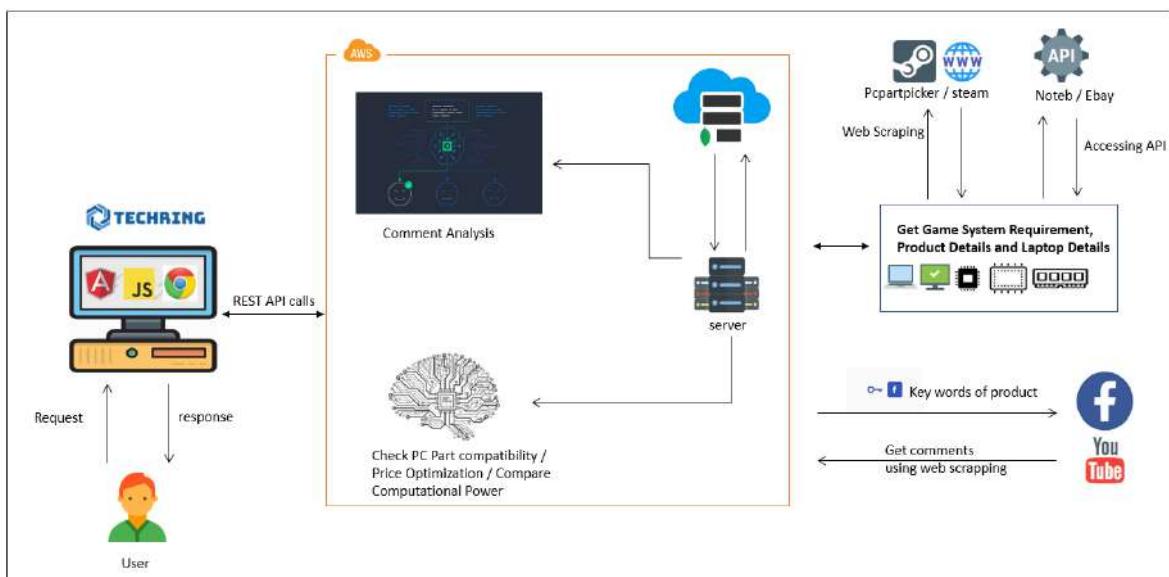
Figure 2. 1 - High level architecture diagram of "TechRing"

2.1.1   PC parts Assembly Sequence
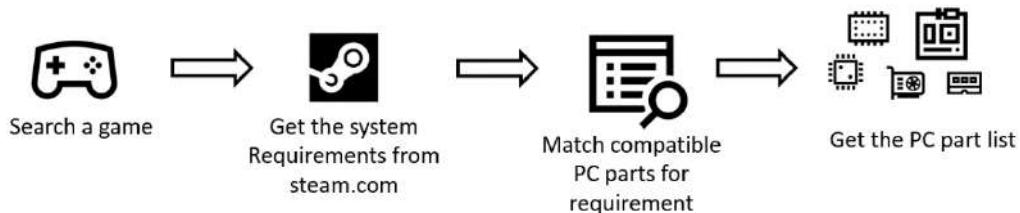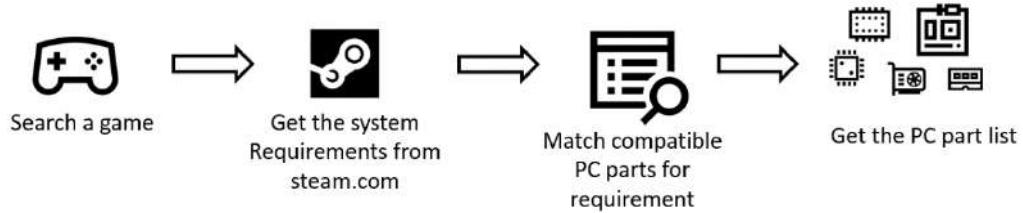
Figure 2. 2 – Steps of the assembly sequence

This platform is focusing on building the assembly plan according to customer's gaming requirement. After analyzed the gaming requirement by point base expert system given points for each required parts. After that matched with the existing compatible PC parts with our platform that satisfy with the points / user requirements. One user input the game that he/she wants to play even that game not in our system it will be real time extract from the Steam.com and get the system requirements. Steam.com is a gaming platform which is update every day so we can get the newest gaming that user needs to play.

The build sequence is used in order to analyze the final product (assembled PC) and check the compatibility of each component. The build sequence will analyze the final product (assembled PC) as several sub-components and match those specifications. After the points given to the requirement begin to search for the PC parts those parts also assigned the points based on their specification. In the algorithm we match the points and compatibility of the product then finally customer can get the PC part list that compatible and also that list satisfied user requirements.

To assign the values to PC parts and system requirements used rule based expert system. The expert system can resolve many issues which generally would require a human expert. [15] We can add rules to the system and if rule is satisfied desired outcome will be fired. To implement the rule base expert system we allocate points for the PC parts if the specification is contain that part otherwise the point isn't allocated. After allocate points we get summation of those points and compare with the System requirement to get the matching part that satisfy the user requirement.

2.1.2   Price Comparison and Optimization

Price Comparison and Optimization is one of the key aspects of 'TechRing' and it focuses on giving the best products for customer requirements. People are able to get a list of good products under their budget limitations, search for products by analyzing them, compare different prices with different vendors and track the prices of products. Most of the time cheapest product or the most expensive product may not be the best product in the given budget limitations. In order to find out that we have to analyze the product features, price and customer feedbacks. The price of a product is not a constant. It is changing all the time. When it goes high people are not able to buy it. Therefore they need to get to know when the price drops happens in order to buy them.

One of these components gives the facility to change the budget range and according to that price range, the system suggests most wanted PC parts such as RAM, VGA, CPU, Motherboard and Hard Disks in order to build a PC for the optimum budget plan. It doesn't give the random products. In fact it searches the best products in the given price range and then it sorts that list and display the list. When giving a build sequence, an item from each category will be selected. That is the best product in the given price range for that category. After giving a budget plan, it is divided into 5 prices according a research has been done. It showed that from the total number of amount, RAM takes 8%, VGA 40%, CPU 20%, Hard Disk 12% and Motherboard 20%. Those amounts are the considered values when selecting an item from each category. Compatibility is very important when assembling a PC. Each and every part cannot be integrated. Therefore looking for the compatibility is very important. How does it happens is mentioned in the later part of this section with the algorithm.
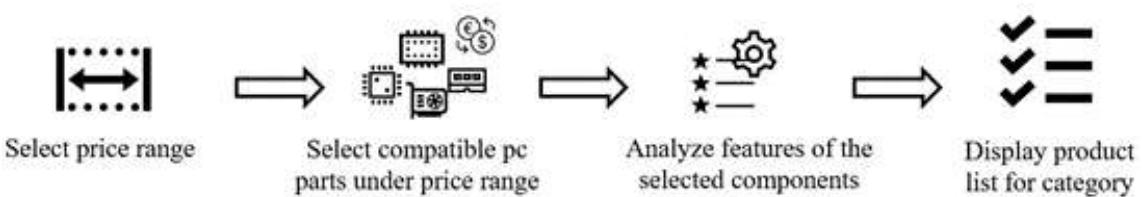
Figure 2. 3 – Steps of Build PC for price range

When customers search for products, it again looks for the best products. For example, if the customer wants to get a CPU products list, the system sorts the items according to the best. Customers are also able to sort that list according to the features, price and user reviews as well.
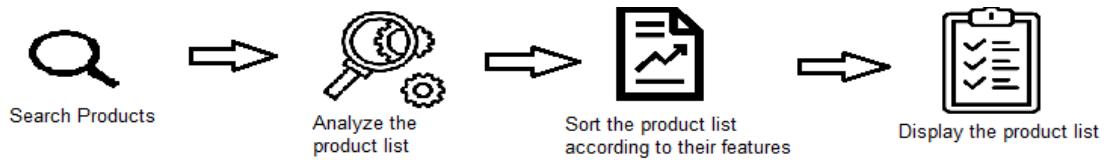
Figure 2. 4 – Steps for searching product

If the price is too high, customers are able to track the price of certain products. They can select certain products and stay on alert. When a price drop happens they will be notified. This is happening during the web scraping and inserting to the database.

A programmatic schedule has been implemented for the purpose of web scraping. The web scraping is happening 24 hours to 24 hours and those data is stored in the database after validating. In order to get the best products in a given list, I have designed a new sorting algorithm which is looking at the product features, the price of the products and user reviews. This algorithm runs just after the web scrape is done. User reviews will be gotten from the Sentiment analysis component at that time. It gives a rating for each and every product. In addition to this process, a point mechanism will be used as well. In order to analyze, some certain features of each category will be selected. The considered features are as follows.

- RAM : size, speed, type
- VGA : size, chipset
- CPU : cores, clock speed, socket
- Motherboard : type, socket, memory type
- Hard Disk : capacity

The algorithm sorts the products feature by feature. For example it first sort according to the size in descending order. All the products contain a position. Those

positions will be added to the point of the product. Again checks for the speed and the sort. After that position of the sorted list will be added to the point column. In order to get the best products, the algorithm sorts the products by looking at the points. The products with the lowest points are the best products that we do have since it took first places in every feature. When giving the build sequence according to the budget, compatibility needs to be checked. For that, the algorithm takes Motherboards first. For that motherboard, the algorithm checks for the compatible CPU parts in the given price range. Then for that requirements, RAM and VGA will be picked. After all hard disks will be selected by looking at the compatibility.

2.1.3 Customer Feedback Analysis
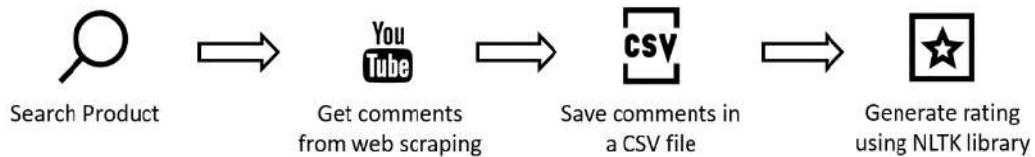
Figure 2. 5 - Customer feedback analysis process

This function starts when the user enter a name in the search bar. Once the user enter the name it will be broken down to key words. Using these key words the video related to the name will be searched automatically by our platform. For this purpose key words entered is used as the Search Tag. The path to access YouTube is a predefined path. This will run whenever the user enter a name.

There are many YouTube videos available for each keyword. From all the videos the one with the highest views will be chosen. Then it will scroll down to the video and extract the comments posted by the people related to the product. These extracted comments will be saved in a CSV File. This file will be recreated every time user search for a product.

This CSV file will be then used for analysis. Each comment holds three characteristics with themselves. They are,

- o Polarity: Positivity or Negativity
- o Subject: What is it about?
- o Opinion holder: Person or the entity who express the opinion.

In the analysis I focus on the Polarity of the comment. Before the analysis the data set needs to be preprocessed. This will be done in two segments using the Natural Language Toolkit in python. Because then we can reduce the observation space of the comment. The segments are,

Uniform Spelling.

For human beings the two words, "Good" and "good" carry the same meaning. But for the system this appears as two different words due to the capitalization in the first letter. Therefore the first thing that will be done is convert all words in to the lower case.

Removing Special characters.

Special characters like "! @,?, < " doesn't contribute for sentiment analysis. Therefore these characters will be removed in the preprocessing.

Tokenization.

Next step is the tokenization. This process breakdown the sentence into smaller part called **Tokens.** These tokens are important for finding the pattern in the texts. This form the base of stemming and lemmatization which can be considered as cleaning process of textual data. In tokenization there are two options. Namely,

      Word Tokenization.

      Sentence Tokenization.

In my function I used Word Tokenization. In word tokenization it spilt each comment into word sets. Final output of word tokenization is can be converted in to a Data Frame which will be easily understood by the machine learning algorithms. For this step text cleaning methods such as lemmatization and stemming is added. Thus it will remove the punctuation and numerical values.

Analysis

In order to conduct the comment analysis I used the Natural Language Toolkit in python. In there they have in built python libraries for sentiment analysis. In these libraries they have used the model Recurrent Neural Network. RNN is capable of using the sequential information in a text. Since a sentence has grammatical structure and an order, each word depend on the previous word. Thus if the neural

network needs to know the order the words came in. RNN is an extended version of the Neural Network. In this model the same task is repeated for each word and RNN captures and store the memory of each which have being calculated previously. Below diagram display the functioning of a neural network. Using this model accuracy of analyzing the comment was high.
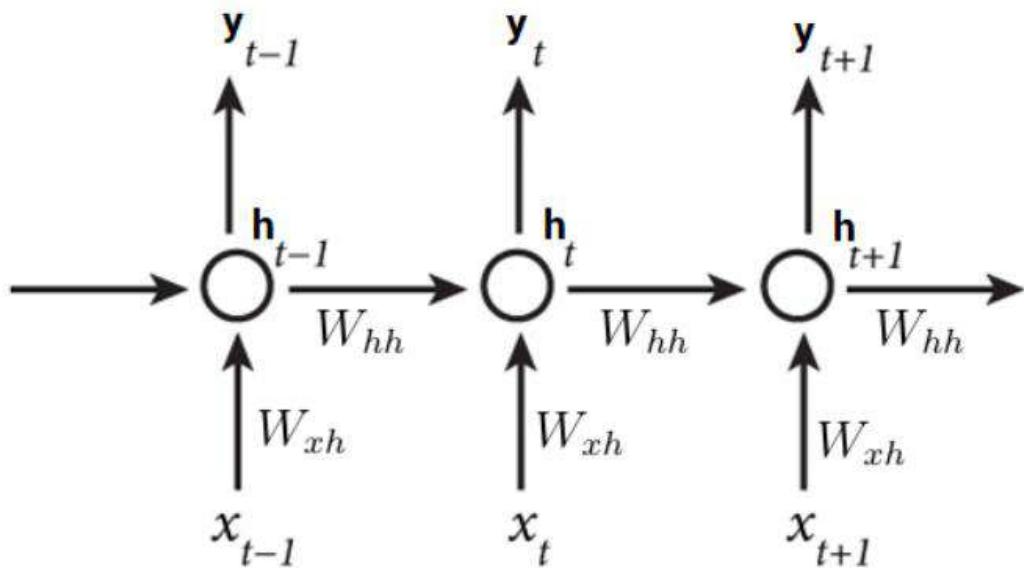

Figure 2. 6 - RNN architecture.

Through the RNN model each comment will be analyzed and categorized as either **positive** or **negative.**

Then a count of each will be taken. Number of positive comments in the CSV file and vice versa. Finally the counts will be displayed in a Rating format for each product.

2.1.4 Laptop Comparison
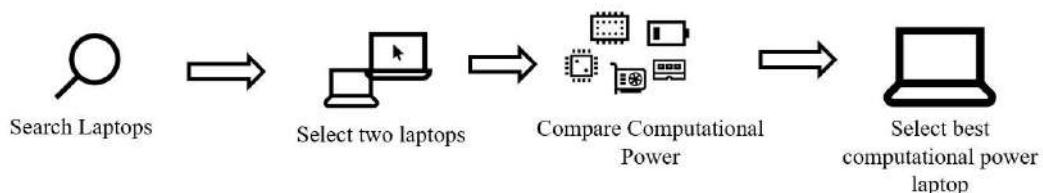
Figure 2. 7 - Laptop Comparison Process

Nowadays, there many laptop manufacturers in the world. These manufacturers have a high competition among each other. In order to compete with one another these brands introduce different versions of laptops every year. In a way this is beneficial for the customers. Yet due numerous options available customers become confused. Because they don't have an idea what is the BEST from the available options. There are online platforms that allow the users to compare two laptop versions or brands. For an example platform like, Noteb.com, NewEgg.com. But these platforms have two main limitations. One is that these platforms only allows to conduct a comparison. Other aspect is that the comparison is based on limited functionalities.

"TechRing" has overcome the above problematic situations. This platform allows to conduct a comparison between two laptop versions or brand. But the service does not limit only to comparison. It also recommends the BETTER of the two options based on their computational powers. In order to conduct the comparison "TechRing" will be looking into both the common features that people look in plus the important Technical aspects that people aren't aware of.

Internal process of laptop comparison model we must pass specific features below table show what are the mainly considered feature in our system for compare two laptops.

Feature Names	
• CPU model	• Core size
• Cash size	• Boost speed
• Ram type	• Ram size
• Storage type	• Storage size
• Battery type	• Battery size
• GPU size	• GPU boost speed

Table 2. 1 - Features consider by User when comparing laptops

In order to compare two laptops, we created rule based expert system. The selected two laptops will be sent through this rule based mathematical model. This mathematical model generates points for each laptop.
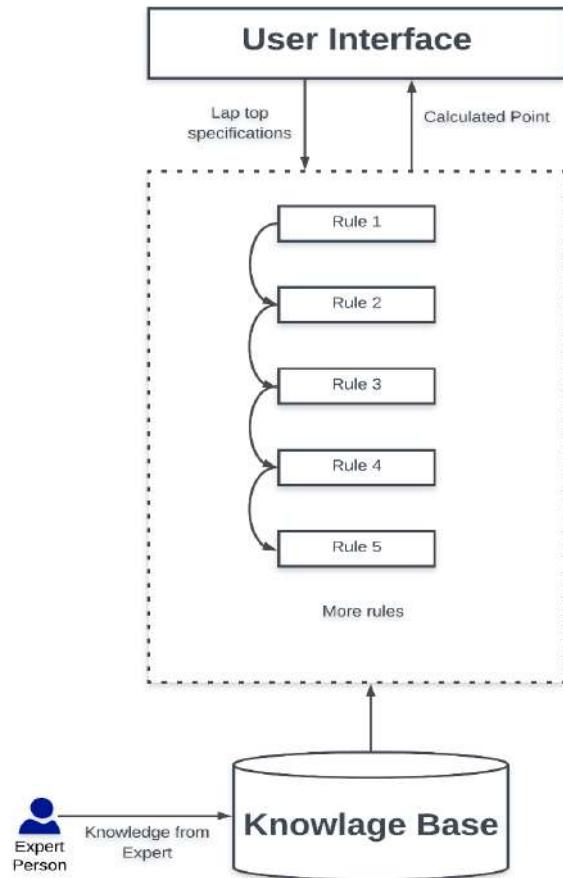
Figure 2. 8 - Mathematical Rule Base Model (Expert System)

2.2   Commercialization Aspects of The Project

The target market for this platform is consisting of two segments. That is the PC parts and Laptop seekers and the PC parts and Laptop vendors. Currently "TechRing" is focusing only the local market. The seekers category is then sub divided in to two categories as

- Gaming population.
- Student population.

From the total Sri Lankan population, that is 21.44 Million, 18% of the population represent the school community and 14% represent the Gaming population in Sri Lanka. Thereby our user base will be approximately 32% of the total Sri Lankan population.

Considering the vendor sector, this is considered as an industry in Sri Lanka. Governmental Industrial Statics conducted in 2016 stated that this is placed 26th among the industries in Sri Lanka. By the year 2016 there are 32 establishment under this category. Under these establishments there are 3226 people involved. This set of people will be our target vendors that needs to be onboard.

Initially we will be using a cost effective Market Plan. Thus the most effective marketing platform is the Digital Marketing. We will be using the Facebook, Instagram and YouTube for our marketing purpose. Below is a diagram of our Business Canvas that we have designed.

Key Partners	Key Activities	Value Proposition	Customer Segments	Customer Relationships

• Local PC parts Vendors
• Local Laptop Vendors
• E-Commerce Web sites
• Facebook
 	
Key Resources
• Online Platform
• Registered Users
• Local Vendors
• YouTube Data
	• Provide vendors for each product
	• Provide assembling plans
	• Price Optimization
	• Display updated and analyzed customer reviews
		• Assembling plan customized according to game preference of customers
		• Convenience – One stop for both PC parts and laptop requirements
		• Speedy and on time assistance
		• Trustworthy Suggestions. Notify customer about the price drops
		• Real time data extraction
			• We will be dealing with a Mass market. Thus our customer base will be ranging from school students to professionals.
			• Both expert and Non-expert person will be using this platform.
			• Our target age range will be 15yrs to 60yrs or above
				• **Automated Service**
				  • Customer Requirements are detected and then the system will provide necessary responses.
				  E.g. – Provide product Suggestions
				
				• **Customized Assistance**
				  • Solutions provided will be based on each customer requirements
				  E.g. – Games specified Assembling Sequences

Cost Structure	Revenue Streams			Channels
• Platform development costs • Vendor acquisition cost • Marketing the platform and services	• Initially, we plan to build our revenue streams through customers • The registered users are allowed o have one assembly plan build for free. This free test sample is given for them to identify our service. But for other plans, they need to make a payment and afterwards, only we provide them with the assembly plan. • Later on, with our development rate and increased publicity we will ask the new vendors to pay a registration fee to enroll with our platform. • In future we plan to advertise their products if there are any special promotions campaigns conducted.			• Our main purpose is to direct the buyer to the best seller. Product delivery is the vendor's responsibility • We will market our services initially using social media platforms such as Facebook Instagram and YouTube

Table 2. 2 - Business Canvas

2.3 Testing and Implementation

2.3.1 Implementation

In our platform used below technologies and services for implementation.

- Server Requirements
  - AWS Cloud Computing Services

- Software Requirement
  - AngularJS
  - JAVA Spring boot framework
  - Python

- o MongoDB
- o Jupitar Notebook
- o VS Code
- **PC parts Assembly Sequence**

I.   Scrape Game System Requirements from Steam.com

In the assembly sequence identify the pc parts to satisfy the user requirement. To get the gaming system requirement used python script with selenium web driver. Selenium is an automating web applications tool that used to build automation testing on web applications. After user enter the game name and send those keyword in to backend API. From the API keyword pass to the python script by command line arguments. The gaming requirements are scrape from the Steam.com. After search the game in the site and extract the system requirements. In the script create a JSON object and send it to the backend API.

II.   Based on system requirements assigns points

Figure 2. 9 – System requirement of the game

To match the platform parts used to point based expert system so system requirements and parts assigns points based on the specifications of the components and the system requirement.

III.   Match the Compatible PC parts

After initializing the points for products and the system requirements compare the points and compatibility suggest the suitable product list for user. Then user can purchase those product and don't need to worry about the compatibility or the requirement.

2.3.2 Testing

To validate the system need to implement test cases to make sure the functionalities of our system is produce the expected outputs. Before deploy the system its necessary to identify the weaknesses and vulnerabilities of the system. So that we can fix the bugs earliest stages without interruption to customers. Each iteration of our development process we test the product to make sure the functionalities are working properly. From the beginning of the project we have to identify the critical tasks and need to develop test cases for validate those components. In this section will be discussed the mechanisms and procedures we followed to test our product.

- Unit Testing

The objective of the unit testing is to isolate a section of code and verify its correctness. In the SDLC unit testing is the first level of testing before doing the integration testing. [16] Our product "TechRing" has different sub units so we have to test the units before integration with other unit/ components. We divide our sub components into several units and implement those as a logically separated units. So that we can easily test the units and make sure the unit will produce the expected output. Once individual unit is developed by a person himself or herself checked the component before integrate with the system. During the development of our application we have to test all the units.

- Integration Testing

After the unit testing we do the integration of the components and begin the integration testing. Integration testing is designed as a type of testing modules integrated locally and test the product as a group. In the four main components of

our system were developed by four members in our group. Some components depend on the other component output so we have to test those parts while the integration of the system. These tests ensure the communication of data between the components of the system.

- System Testing

One of the black box testing method. After integrated all the components we have to do the system test to check whether the system functionalities meet the expected output. These testing enhanced the user user's experience with the application. These test done before introduce to the market.

2.3.3 Test Cases

Test Case No	Test Case - 01
Description	Check whether expected game system requirements scrape from the steam.com and save to the database.
Pre-Conditions	1. There should be a proper internet connection access to the application to get that system requirements real time.
Test Procedure	1. Visit the "TechRing" build for system requirements section. 2. Enter the game name in the search bar. 3. Check the game system requirement showing after scrape the requirements of the game.
Input	Game name
Expected Output	1. System requirement of the game should be stored in the database.

Table 2. 3 – Test Case 01

Test Case No	Test Case - 02
Description	Get the compatible PC parts that satisfy the user requirements
Pre-Conditions	1. System requirement of the game should be scraped and saved in the database.

Test Procedure	1. Visit the "TechRing" build for system requirements section. 2. Enter the game name in the search bar. 3. Click the "get pc parts" button to get the compatible pc parts.
Input	Game name
Expected Output	1. There should be a compatible PC parts list showing to the user

Table 2. 4 – Test Case 02

Test Case No	Test Case - 03
Description	Suggest compatible PC part for product
Test Procedure	1. Click the product 2. Get the compatible part list
Input	Product name
Expected Output	1. There should be a compatible PC parts list with the product showing to the user

Table 2. 5 – Test case 03

Test Case No	Test Case - 04
Description	Scrape the product user comments from the YouTube
Pre-Conditions	1. System should be internet connection access to the application
Test Procedure	1. Visit the "TechRing" search the product 2. Click the product to view more details 3. After analyze the comments rating display bottom of the product image
Input	Product Name
Expected Output	1. Customer feedback rating should be calculated and display

Table 2. 6 – Test Case 04

Test case Id	Test Case 5
Test scenario	View selected one laptop more details.
Test steps	1. Go to TechRing site. 2. Navigate to laptop comparison page. 3. Select laptop brand 4. Click selected laptop among the displayed laptops 5. Click more button.
Test data	Laptop
Expected result	User should display popup window with additional details.
Actual result	As expected, one

Table 2. 7 - Test case 05

Test case Id	Test Case 6
Test scenario	Check laptop search properly working with valid laptop name.
Test steps	1. Go to TechRing site. 2. Navigate to laptop comparison page. 3. Enter laptop name in search field. 4. Click search button.
Test data	Laptop name = hp
Expected result	User should navigate laptop comparison page. Then he/she must enter laptop name and click search button. Then he/she can see matching result in the web page.
Actual result	As expected, one

Table 2. 8 - Test case 06

Test case Id	Test Case 7
Test scenario	Check two laptops are selected for comparison.
Test steps	1. Go to TechRing site. 2. Navigate to laptop comparison page. 3. Select laptop brand and select two laptops.
Test data	Laptop one

	Laptop two
Expected result	User should select minimum two laptop then he/she can see compare button is enabled. Otherwise display disabled button.
Actual result	As expected, one

Table 2. 9 - Test case 07

Test case Id	Test Case 8
Test scenario	Check two laptops are selected for comparison.
Test steps	1. Go to TechRing site. 2. Navigate to laptop comparison page. 3. Select laptop brand and select two laptops.
Test data	Laptop one Laptop two
Expected result	User should select minimum two laptop then he/she can see compare button is enabled. Otherwise display disabled button.
Actual result	As expected, one

Table 2. 10 Test case 08

Test case Id	Test Case 9
Test scenario	Check whether expected item attributes are there in the site.
Pre-Conditions	There should be a proper internet connection to scrape data.
Test Procedure	1. Visit 'TechRing' website and go to the browse items and select a product. 2. Check whether most important item attributes are there.
Input	Product id
Expected result	Product details

Table 2. 11 Test case 09

Test case Id	Test Case 10
Test scenario	Get PC parts for customer budget.
Test Procedure	1. User enters their price (budget) 2. Click submit button 3. User gets major components to build a PC under his budget limitations.
Input	Budget limitations
Expected result	Display relevant computer parts.

Table 2. 12 Test case 10

3 RESULTS AND DISCUSSION

3.1 Results

"TechRing" is the platform which is recommend the most suitable and best product to the customer out of various brands and components. Therefor our platform should have more accuracy of the tasks in order to be trustworthy to the customer.

When user search the game and get PC part list the game will extracted from Steam.com using a web crawler. To get the system requirements of a game the crawler will spend average 135 seconds to extract the data and save it in the platform database.

Game Name	Time Taken to extract the System Requirement(Seconds)
Far Cry® 5	130
Need For Speed: Hot Pursuit	140
Call of Duty® 4: Modern Warfare®	135

Table 3. 1 – Crawler web scraping time comparison

Using the crawler we could get 80% accuracy results. When we extract the data from the Steam.com we send the keyword of the game name sometime the game is not in their database if so our crawler get the matching game system requirements to the keyword.

Time take for comment analysis vary with the number comments that needs to be extracted. It will take an average time of 123 seconds to extract set of comments ranging from 100 to 1000.

Will be taken in order to extract the comments from YouTube. We tested the time taken to extract some sample sets of comments.

Video	Number of Comments.	Time Taken.
Sample - 1	150 comments	64 Seconds
Sample - 2	500 comments	125 Seconds
Sample - 3	700 comments	180 Seconds

Table 3. 2 – YouTube Comments crawler time comparison

3.2   Research Findings

In order to understand our user base we initially conducted a survey. According to the results, it was proved that our user base will range from 10 to 35+ years. It also showed that our user base will be consisting of two sectors. That is the gaming population and the student population. Basically from the analysis and document reviewing it was proved that around 32% of the total Sri Lankan population will be "TechRing" user base.

We found that in order to scrape the gaming system requirements we tried different technologies. But those were in capable of scraping system requirement due to some limitations. Using selenium we were able to scrape the game system requirements with more accuracy within less time. Using the full game name we could get higher accuracy than the partial name.

In order to conduct sentiment analysis there are number of tools, techniques and algorithms available. From all the Natural Language Processing tools available it is said that Natural Language ToolKit is the most usable and is considered as the

mother of all NLP's. For the sentiment analysis I have also used the NLTK [17]. Thus the accuracy of the results are guaranteed.

One of the most common social media platform used by the society is Facebook. Earlier the rules of Facebook allowed to access the Facebook data by a Third party. But now they have tightened the rules and regulations. This resulted for us to use another social media platform to retrieve the customer feedbacks like YouTube and Twitter.

Machine learning models cannot be directly applied to any problem. Because if we take such approach it will be difficult to manage the future developments. First step we need to follow, is study the data set properly. Above mentioned is one of the aspect that we used an expert system implemented using Python for Laptop Comparison.

It is said that Expert systems are capable of making decision similar to that of a human being. Such accuracy is predicted to have from a well-trained expert system. Another reason for us to use an Expert system is that through this system it is easy to implement and we can do the implementation faster. Expert system can be implemented and developed using language such as JAVA, Python, C++ and CLIPS.

When I compared the results gained from a trained neural network and expert system, it was clear that results of Expert system holds a high accuracy.

3.3   Discussion

This research will be highly beneficial for all most all the industries prevailing in society. Because PC and Laptops are vital components in every industry. Depending on the requirements people either tend to purchase a preset computer or assembly their PCs, by themselves. PC assembling is a common practice, especially in the Gaming Industry. Even though the Gaming industry was for mere entertainment purpose, nowadays it is one of the highest profit earning industries. More than 60 percent of the population around the world are gamers. By analyzing the online articles, blogs, and video it was evident most of the gamers assemble their PCs' by purchasing parts based on the gaming requirement. As mentioned

earlier it is now the games who demand specifications from PCs' of the gamers need to play the games. Apart from PCs' since we focus on the laptops, people find it confusing when they need to find the ideal laptop for their purpose. Because day by day new versions, models are introduced to society. Thus finding what is best for the users is complicating. Considering the above-mentioned aspects of the final outcome of this research is designed. That is the final output is an online assistant which will assist any user in finding the best hardware solution for them. This will be a web-based application which goes by the name "TechRing".

Basically, this platform will consist of two components. That is frontend and backend. Services provided by the platform is categorized into four key areas and detailed overview of these four areas in a functional perspective is given in the Methodology section.

There are similar platforms like "TechRing". But these platforms only cater to only one hardware perspective. Before the development of this platform, authors conducted a study on the functioning of the prevailing platforms. Authors' consideration mainly focused on three such platforms which either cater for PC part requirement or Laptop. The main aspect that "TechRing" stand out from the prevailing aspects is it provides three unique aspects that none of the considered platforms provide. One aspect is the special attention given to gamers. Where users provide assembling sequences customized according to the games. Base on the game that the user enters to the platform, the required hardware specifications will be displayed. This will saves the time where users have to search and find the parts. Moreover, through the observations and surveys authors conducted it was clear that not all gamers are technical experts. They find it hard to assemble the PCs' by themselves according to the gaming requirements. Thus this platform will provide solution for this aspect. Since the parts that are mentioned in the sequence is already available with the same platform users can find the outlets who sell these product for the best price. Thus the PC assembly requirements will be solved from just one platform. Since sequence will be displayed in an easy clear manner any user with average technical knowledge will easily understand the sequences.

"TechRing" – AI Based Recommending Assistant

Most of the available sites either allow the people to post their comments on the site or they will display the comments as it is extracted from a social media platform. One of the prominent aspects customers look in before purchasing a product is to look into the customer comments. But most of the time people do not have time spend on reading these comments in order to get an idea. Thus they will just skin through the most relevant comments and get an idea. Another problem that is faced is the language barrier. People find it difficult to find the comments from the language they are familiar with. Thus "TechRing" have implemented a common language to overcome these problems. That is the use of graphical representation. It provides the customer comment overview at once. Thus this saves the time plus people need not have sound knowledge about the languages. Since "TechRing" will analyse the comments and do the needful. This will be an efficient and effective method for both users and implementers. The reliability of the analysis is guaranteed since the comments will be extracted from the most famous social media platforms and reliability will be emphasized by displaying the most descriptive comments in the interfaces if users prefer a detailed overview. This whole process will be achieved using Neural Networks along with expert systems and also by using the NLP tool kit. The graphical representation will help the users to make quick decisions as to purchase or not. In an industrial perspective, this will be highly beneficial since they need to make quick yet accurate decisions when it comes to bulk purchases.

There are many online platforms for laptops. There are sites where they allow the users to conduct comparisons among two laptops. Yet none of these platforms recommend which of the two selected item is the best. Authors have looked into these aspects and designed "TechRing" for this purpose as well. Most of the laptops comparisons are conducted superficially. But this will conduct the analysis using both superficial features and also non-superficial features. Thus the users need to spend hours searching the best laptops by watching YouTube videos done on product reviews. Because once you enter the products that you need to compare "TeachRing" will compare and recommend the Best from the two. Also to build faith in customers comparison result on each product will also be displayed. To accomplish this task special algorithms are designed especially for this using Python and Expert Systems techniques.

Accordingly considering the above facts the uniqueness of the platform is built. In addition to this, there are other features where the users are provided with ample product and vendor solutions to select with. All the products are displayed in accordance with the grade they are given from the algorithms designed. Moreover another feature the authors prefer to highlight is that user is given sequences algorithms not only based on their technical requirements but also based on their budget requirements.

One of the most common platforms for customer feedback is Facebook. But the authors have selected the Youtube platform due to the hardships they faced in accessing Facebook to extract comments. Facebook comment analysis could not be conducted due to their current security regulations. As per their new rules, they have limited access for their data by a third party software. Because Facebook has taken measures to protect the privacy of Facebook users.

Thus "TeachRing" will be the ideal solution for any person who is looking for a hardware component. Authors guarantee the reliability and accuracy of the recommendations given by this platform. Efficiency and effectiveness will be achieved with the use of the algorithms used and designed. Each function is designed based on the users' requirements. The front end is designed in a way where any person who has access to the internet and who is comfortable in the use of the internet can find what they want from a few clicks. Eye-catching and friendly interfaces are designed in order to attract new customers along with the motive keep the existing customers attracted to our services. All these described functionalities are proven to be capable of satisfying the user needs that are mentioned by the authors previously.

3.4   Summary of Each Student's Contribution

Tasks	Component	Member
o **Extract system requirements for games.** o **Identify compatible PC parts needed to build a PC.** o **Build the PC according to the system requirement.**	Build PC plans customized to the gaming requirement.	H.K.S.P.Gunadasa
o **Identify the comments on products on social media.** o **Categorize the comments by processing them.** o **Summarize the comments.**	Customer Feedback analysis.	Sewwandi E.D.D.
o **Price comparison.** o **Assembling PC according to the user budget.** o **Pick the best PC part considering the features.** o **Notify price drops to customers.**	Price Comparison and Optimization	M.A.V.L.Gunathilaka
o **Extract laptop details.** o **Analyze the computational power and features of them.** o **Compare and identify the best laptop.**	Laptop Comparison and recommendation.	Tharaka K.K.S.

Table 3. 3 – summery of each student contribution

4   CONCLUSION

This document contains a detailed overview of the online assistant that is developed. This is an artificial intelligence-based PC parts and Laptop recommending assistant. This platform currently capable of catering to hardware suggestions (PC parts) to the customers based on their gaming requirements and budget limitations. When the user enters the game this platform will generate the build sequence required. The accuracy of this result is proven since the gaming

specifications are extracted from a very reliable gaming website. These sequences will be generated by considering their compatibilities of one another. Thus the assembling process will satisfy the gaming need and the assembling procedure as well. Another aspect that is overlooked is the users are allowed to have a choice in a purchase. Since for each product, multiple vendors with their prices will be displayed. Thus this also gives an opportunity for local vendors to compete with the global market and also local vendors are given the opportunity to reach the customers breaking the geographical barriers. As another aspect users look in before purchasing is the previous customer experiences when the brand or the version is not familiar. This platform gives an analyzed customer overview in a rating format since the users can have an idea at a glance. In order to satisfy the customers need to have a detailed idea of the customer experiences, a few of the most related comments will be displayed below each product. In suggesting the products, they will be arranged by considering both the price and the results of customer ratings. Apart from that laptop comparison helps the users to figure out differences between two laptop versions and recommend the better of the compared two.

In future development is expected to further customize the build sequences based on the soft wares used and editing purposes. So that the customer base will consist of a variety. Currently, comments from Youtube is utilized. Later on, to generate the rating customer reviews from other social media such as Instagram, Twitter, etc. is expected to be utilized. For advanced analysis, it is planned to generate overviews based on the blogs as well. In the future, it is anticipated to provide the facility have multiple laptop comparison simultaneously. Also to recommend laptops based on user requirements customized based on the gaming, software or editing needs.

Apart from the functionality development "TechRing" possess a long term goal. Currently, the platform's focus is on the local market. But with time and increased publicity, the authors plan to expand themselves to the global market by onboarding the foreign outlets for this platform. Through such approach, "TechRing" will be capable of being a customized service provider around the world for anyone who is looking for PC parts or a Laptop.

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6   APPENDICES

6.1   Appendix A : User Survey

- **Survey**

https://docs.google.com/forms/d/1kcaZ96I1M7lUrWDbo9UqmquWT8q9dlo-mg8O4J8HT68/edit#responses

- **Survey Results**

https://drive.google.com/file/d/1COKVjgpRApagijZNzkqG1XN5q-IMzPJn/view?usp=sharing

6.2   Appendix B : User Interfaces

Figure 6. 1 – User Interface: Laptop comparison
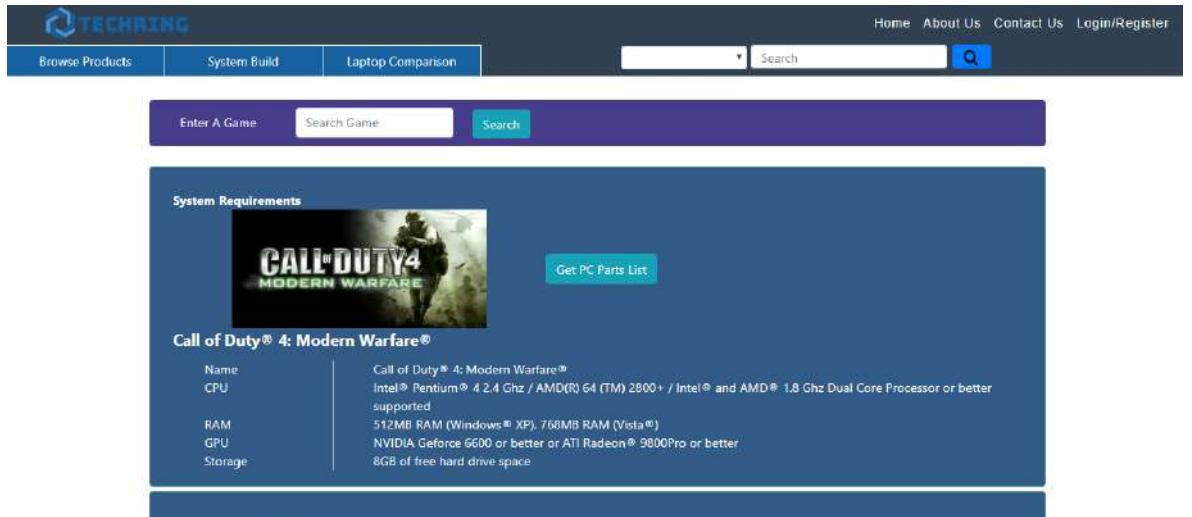
Figure 6. 2 – User Interface: Search Games
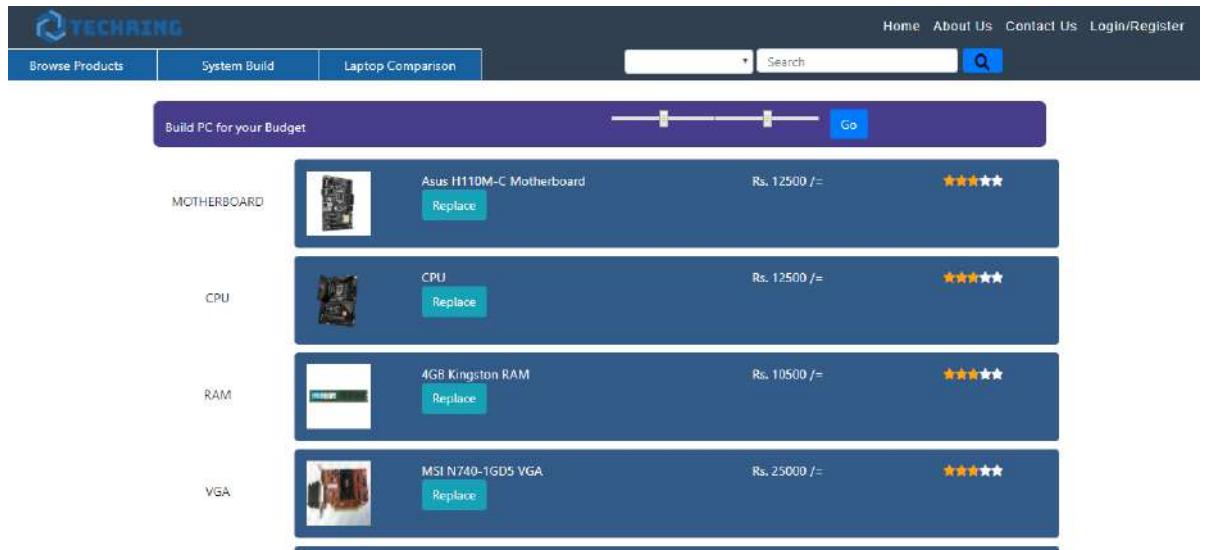
Figure 6. 3 – User Interface: Build PC for Customer Budget

Figure 6. 4 – User Interface: View more details product

Figure 6. 5 – User Interface: Laptop browse