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Trading Recommendations System for Non-fungible Tokens

A dissertation by

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ACRONYMS

DL   Deep learning.

ML   Machine Learning.

NFT   Non-fungible Token.
NLP   Natural Language Processing.

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4.1 Chapter Overview

This chapter focuses on identifying possible stakeholders of the project by taking a look at all possible points of interaction with the system with the use of a rich picture diagram, gathering their perceptions to analyse and come up with possible expected use cases, functional and non-functional requirements of the prototype.

4.2 Rich Picture
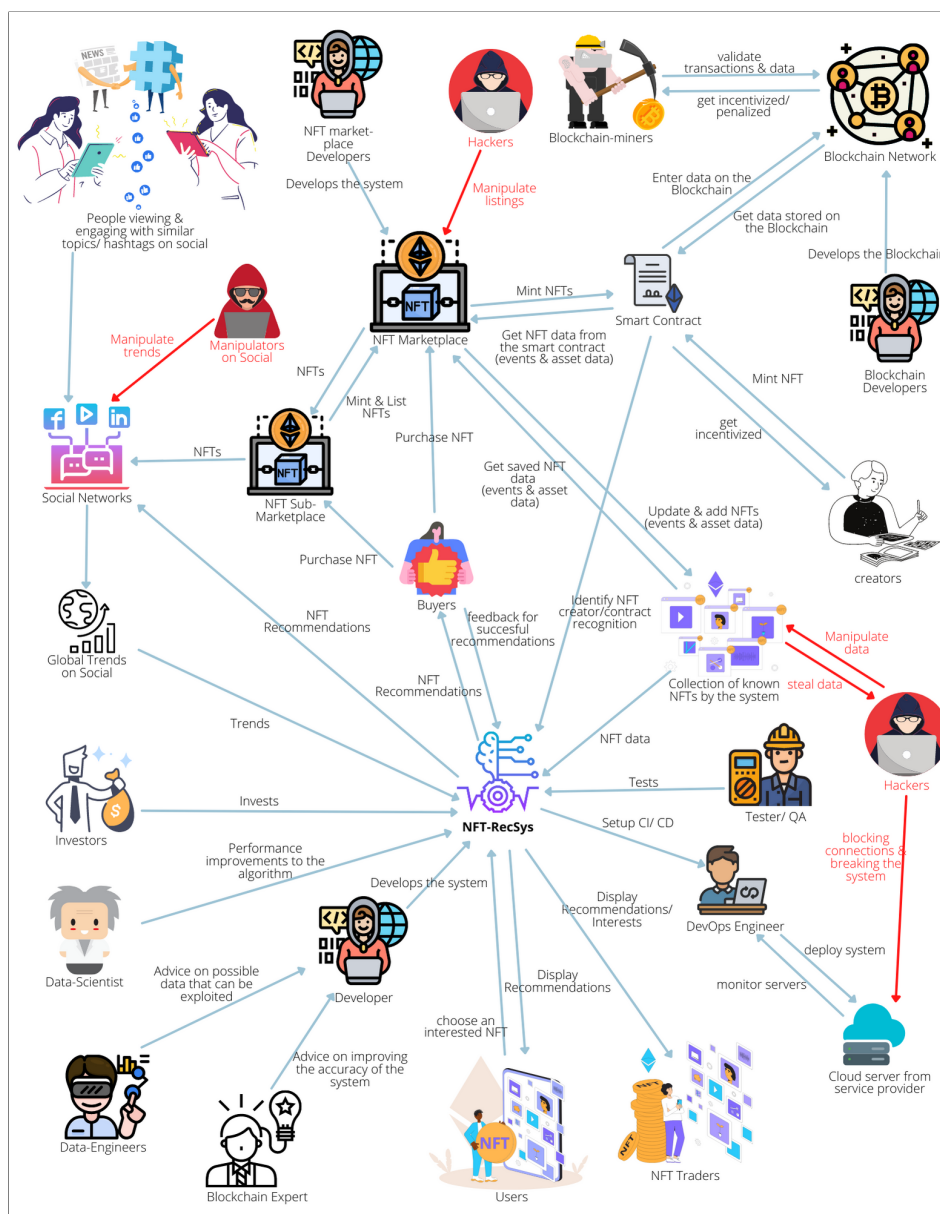
Figure 4.1: Rich Picture Diagram *(self-composed)*

The above Rich Picture diagram shows a helicopter view of how related parties in the rest of the world interacts with the system. It is used to understand the possible interactions that are expected to happen when the system is functional.

4.3   Stakeholder Analysis

The Stakeholder Onion Model illustrates recognized stakeholders who are associated with the system, along with an explanation of each stakeholder's involvement in the system, in Stakeholder Viewpoints.

4.3.1 Stakeholder Onion Model

Figure 4.2: Stakeholder Onion Model *(self-composed)*

4.3.2 Stakeholder Viewpoints

Table 4.1: Roles and benefits of identified stakeholders

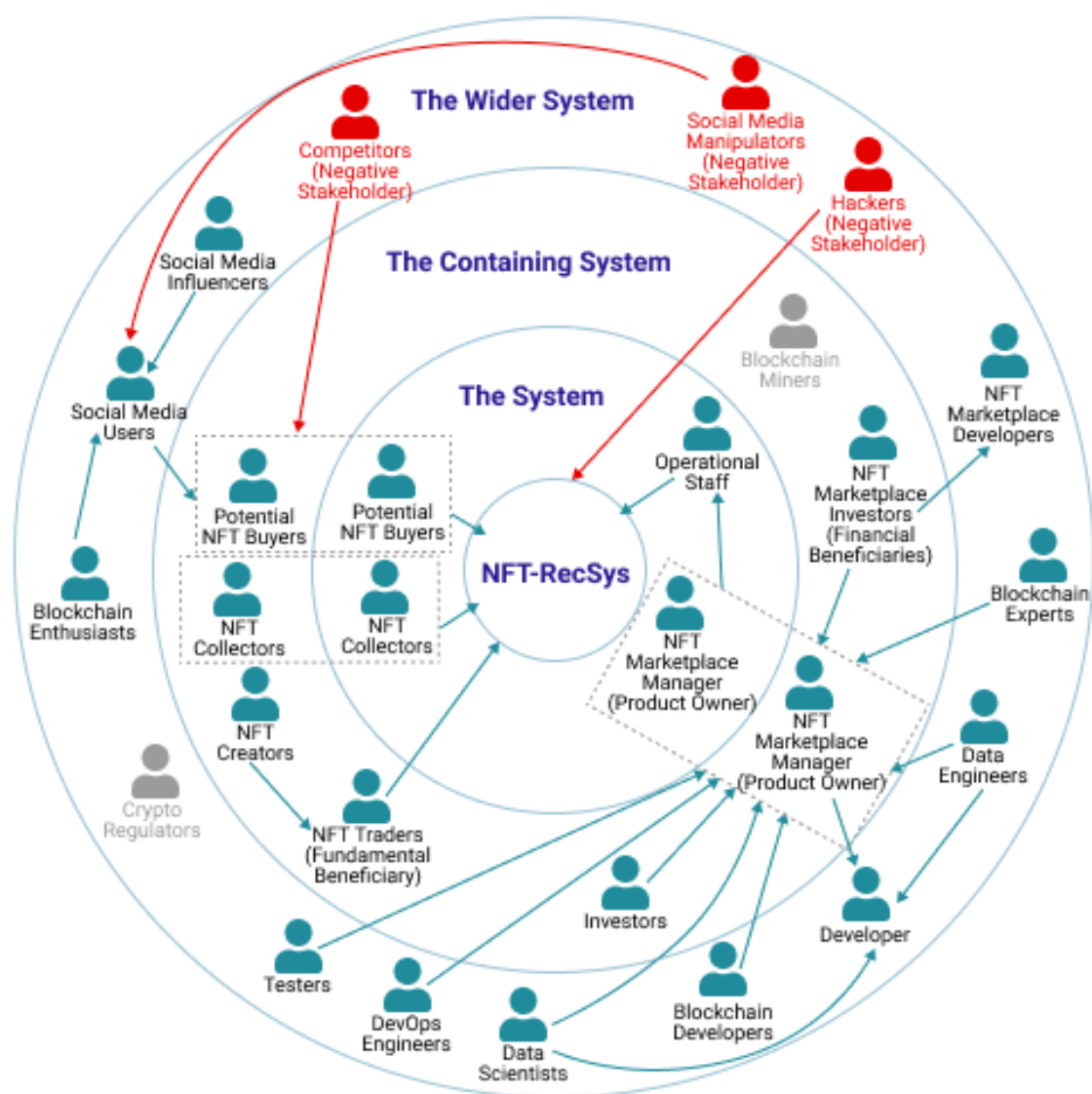| Stakeholder	Role	Benefits/ Role Description
Developer	Financial Beneficiary	Develops the system
Investors		Makes a profit out of the investments put into marketing, deployments and development of the system
NFT Marketplace Developers	Operational - Maintenance	Integrates the system into NFT Marketplaces.
Blockchain Experts	Expert, Quality Regulator	Provides expert advice & insights into domain knowledge, to improve the system's performance.
Data Scientists		Provides performance improvements for the performance of the Data scienc models/ algorithms used.
Data Engineers		Provides advice on possible data that can be exploited, to make the best possible recommendations.
NFT Creators	Financial Beneficiary	Gets a better opportunity to get their creations in the eye of potential buyers. Makes a profit by selling creations to people who are interested in the creations.
NFT Traders	Fundamental Beneficiary	It becomes easier for traders to sell NFTs as well as explore more NFTs to purchase. It also allows them to explore NFTs that may be worth owning for a future trade.
NFT Collectors, Potential NFT Buyers		It becomes more convenient for these parties to explore NFTs that they're interested in.

NFT Marketplace Manager	System Owner, Operational - Administration	Makes sure that the system is up & running, while managing the operational staff.
Operational Staff	Operational - Support	Makes sure that the system is up & running, while attending to users' requests & issues.
DevOps Engineers	Product Deployment & Maintenance	Deploys the system to the cloud and make sure that it's up & serving users, without throttling.
Social Media Influencers	Operational - Secondary	Influences users on social media and drives trends.
Social Media Users	Operational - Secondary & Fundamental Beneficiary	Get influenced to search for items of interest and possibly turn into potential NFT buyers.
Hackers	Negative Stakeholder	May manipulate listings in NFT market places.
Competitors		May build competing products that outperform/ undercut pricing.
Social Media Manipulators		May manipulate users on social media & drive trends that a majority of users aren't interested in.
Blockchain Enthusiasts	Operational	Helps drive awareness and keep the public up to date with the latest releases & feature updates.
Blockchain Miners	Operational - Secondary	Helps keep Blockchains up & running by validating the data on the network.
Crypto Regulators	Quality Regulator	May have an impact as a regulator, if the system is used by mainstream networks.
Testers	Quality Inspector	Tests the system & ensures that it's suitable to run in production.

4.4   Requirement Elicitation Methodologies

In order to gather requirements for the development of the research project, there were multiple requirement elicitation methodologies that were followed. literature review, interviews, survey & prototyping were the methodologies chosen for this purpose. The reasons to choosing the specified requirement elicitation methodologies have been discussed below.

Table 4.2: Requirement Elicitation Methodologies

Method 1: Literature Review
At the inception of the project, the author has done a thorough literature review to identify research gaps that are open in the desired field of study and a chosen domain of interest. In order to understand research gaps available in technologies that can be applied, existing systems were studied together with relatable technologies that are possible to be applied to the existing systems that were mentioned in literature.
Method 2: Interviews
Interviews were conducted as a means of gathering expert-insights into domain-specific requirements and also to identify the best possible way to solve the problem at hand while contributing to the body of knowledge through research. Due to the domain being new and the required technical knowledge being specific, interviews were identified to be the best-possible source of knowledge to gather requirements that align with the research gap. This method also allowed to get qualitative feedback on the proposed system making it possible to identify any drawbacks/ challengers that may have to be addressed while prototyping.
Method 3: Survey
As a means of conducting a survey, questionnaire was used as a tool to gather requirements and insights from potential users of the proposed system. This form of survey will aid the author in comprehending people's cognitive processes and the expectations they have for the prototype. It will also allow the author to clarify if the proposed solution would be helpful to intended users.
Method 4: Prototyping
Since the project was chosen to follow the *Agile* Software Development Life-cycle, prototyping would allow the author to recursively try out various alternative implementations to identify any areas of improvement while testing and evaluating the prototype.

4.5   Analysis of Data & Presentation of the Outcome through Elicitation Methodologies

The analysis of data gathered through the chosen means of requirement elicitation have been presented below.

4.5.1 Literature Review

Table 4.3: Findings through Literature Review

Findings
In completion of the review of literature, it was identified that a Recommendations System for Non-fungible Token (NFT)s would benefit the majority of users to make purchase decisions as well as allow them to explore relevant items, that would in return benefit the market places, creators & traders who are selling them as Recommendations Systems have proven to improve sales of e-commerce sites in the past.   When exploring technologies that can be applied to achieve the required outcome, it was understood that the use of Deep learning hasn't been able to improve the output of recommendations compared to other fields of applications, in most cases. It was identified that implementing a custom hybrid ensembled model with the integration of social media trends has not been explored in literature. But, the use of data from similar users' timelines has been mentioned as possible future work. Nevertheless, it was also identified that pricing of NFTs & contract data have not been considered for any previous implementations either. The only study related to recommending NFTs only recommends NFT collections that a user may be interested in, but not actual NFTs themselves.

4.5.2 Interviews

In order to get opinions of technical as well as domain expertise, interviews were conducted with experts from the respective fields. Experts & researchers in Machine Learning (ML), Recommendation Systems and Blockchain were chosen to be interviewed in order to establish project requirements. 3 Blockchain experts, 1 NFT Creator, 1 Senior Data Engineer, 2 PhD students in ML and a Data science engineer were interviewed. The outcome of interviews were processed to a **thematic analysis** based on the following themes.
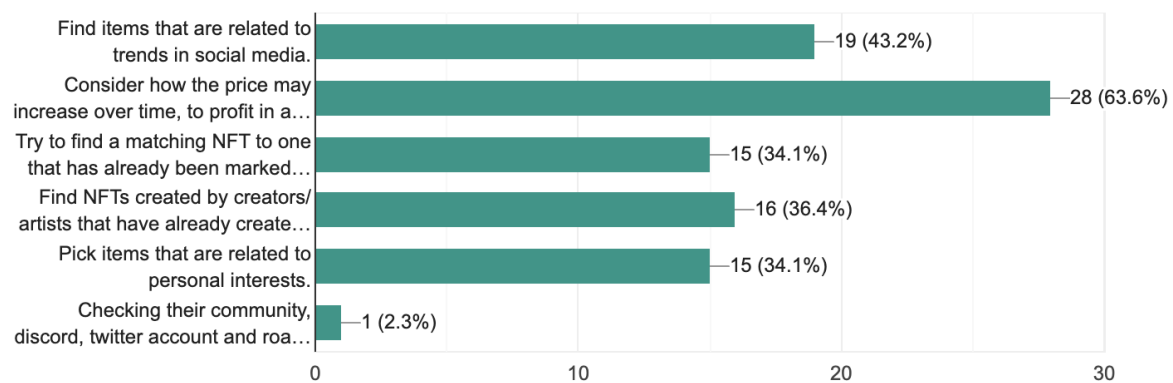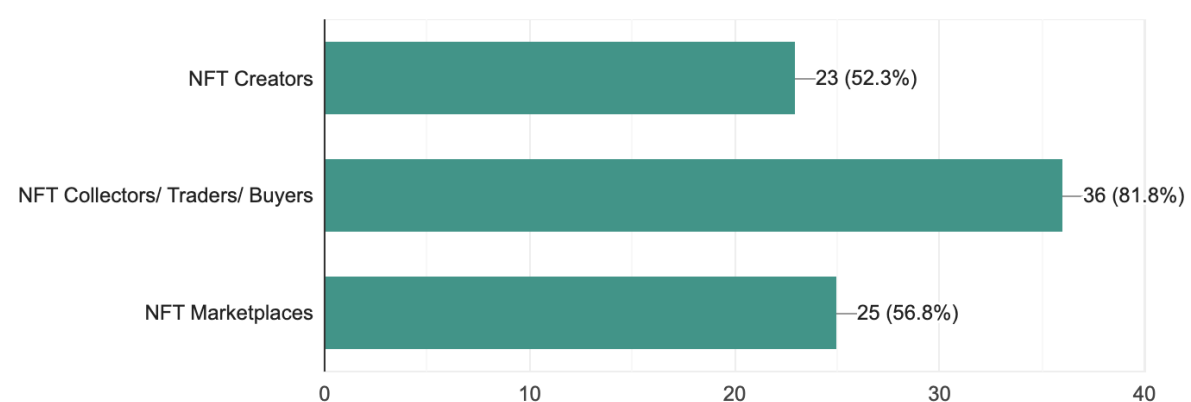
Table 4.4: Thematic analysis of interview findings

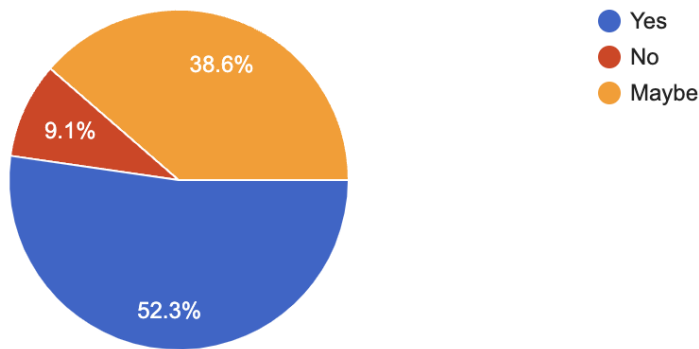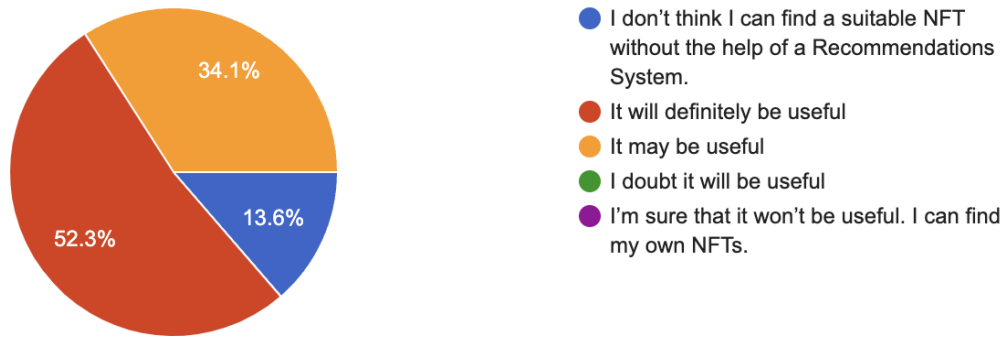| Theme	Analysis
Collection & pre-processing of available data.	As this is expected to be a Data science project, the main concern that all participants had was the availability of data. Clustering of available data was suggested to identify possible patterns by ML experts, while Blockchain experts suggested the use of publicly available data on the Blockchain such as details from Smart-Contracts to be used to improve the quality of recommendations.
Applicable Recommendation Techniques	The opinion of majority of the interviewees was that this project would benefit more by the use of rule-based algorithmic recommendation models instead of Deep learning (DL) models due to the constraint of . According to technical experts, having a specialized recommendation model built using algorithms is very highly accepted in industrial applications. They seem to perform better in most new domains according to PhD researches. Even some of the biggest e-commerce organizations in the world seem to benefit a lot by custom-built recommendations algorithms tailored to specified use-cases according to research & development experts in Recommendation Systems.
Integration of Opinion Mining into Recommendation Systems	Domain experts thought that integrating trends and other social opinion will add value to the recommendations. They were also interested in identifying a possibility of checking for the sentiment represented by the opinions as well. When considering social sentiment, Tweets/ opinions of well-known influencers may play a bigger effect into the value of curtain NFTs.
Research gap & scope	The technological experts thought that the method that the author proposed was very innovative and that according to their knowledge, they haven't seen a similar integration to the suggested architecture in previous applications.

Creating the bias for a Hybrid Recommendations Model	While some of the interviewees suggested the use of a fixed weighted bias, others suggested a variable bias. The method applicable for variable bias or the best-possible fixed bias can be tested via continuous prototyping & evaluation. The use of user-input was also suggested to identify a possible expected bias.
Prototype features & suggestions	The Data science experts were very interested in seeing a Recommendations System built purely using custom algorithms with the help of vectorization functions that many ML libraries support. The use of transfer learning or pre-trained models were suggested for Natural Language Processing (NLP) parts of the implementation.
Understanding a buyer's decision making for automation	The value proposition was identified to be created by an external entity based on contract & token Ids stored on the blockchain. Due to the difference in real world trust and blockchain trust, this may have to be inferred from the available data such as past contract data and social sentiment from trends.
The necessity of NFT-RecSys & contributions	As the first research study related to a Recommendations System for NFTs, the interviewees thought that the contribution to the domain will be of great value and also, since the hybrid architecture of the proposed system is novel, the contribution to the technological domain would help the advancement of the quality of recommendations in future implementations. It was also understood that it's difficult to find specific NFTs based on tags/ characteristics. Furthermore, it was revealed that Sri Lanka does not have Machine Intelligence/ Data science driven Recommendation Systems in all local e-commerce stores.

4.5.3 Survey

Table 4.5: Analysis of replies to questionnaire

Question	How will you decide which NFT to purchase?

Aim of question	To understand how a potential buyer would proceed to purchase an NFT.
Findings	

A majority of the participants thought that considering the price increase over time would be the primary factor of consideration when purchasing an NFT, while the second most impact to be considered was trends in social media. Finding NFTs that have been created by creators/ artists who have created valuable NFTs in the past, an NFT that is similar to what is already highly valuable and picking items related to personal interests saw similar weightings when making purchase decisions.

Question	**Who do you think will be benefited from using this system?**
Aim of question	To identify the beneficiaries of the proposed system.
Findings	

While more than 50% of participants aggreed that the proposed system would benefit the suggested beneficiaries, 81.8% thought that NFT collectors/ traders/ buyers would benefit. Since, they are the ultimate target users, it's satisfying to see such positive responses.

Question	**Do you think that this system would benefit people who have no expertise in Blockchain/ NFTs as well as people who have a decent amount of expertise in Blockchain/ NFTs?**
Aim of question	To identify how valuable the system would be to people of all levels of expertise in Blockchain/ NFTs

Findings

With he majority of responses saying that people of all levels of expertise in Blockchain/ NFTs would benefit from the system depicts that the proposed system would be beneficial for above-average users as well.

Question	**How much do you think that a Recommendations System would benefit you, if you ever plan on purchasing an NFT?**
Aim of question	To identify if the respondents think that the system would benefit them.

Findings

52.3% of users thought that a Recommendations System would definitely be useful to them if they plan on purchasing an NFT, while 34.1% thought that it may be useful. Meanwhile, 13.6% of users thought that they don't think that they could find a suitable NFT without the help of a Recommendations System. 100% of the results were aligned towards seeing a possible benefit of the proposed system.

Question	**How much would you expect a Recommendations System that considers social media trends to be beneficial for businesses to integrate into their online platforms?**
Aim of question	To identify the importance of the technological contribution in the project

Findings
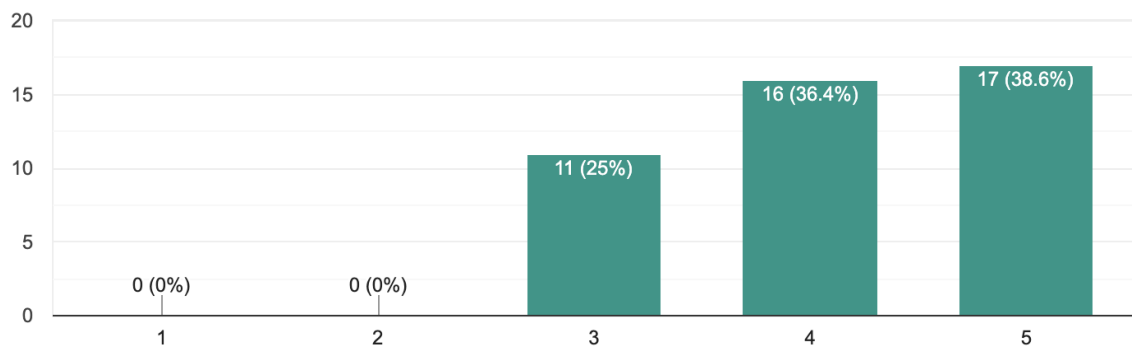
The results from this question suggests that the technological contribution that has been highlighted in this project, which addresses an advancement of development of Recommendation Systems is expected to be extremely beneficial for business applications.

Question	**Do you think that a user would benefit more if one platform provides recommendations that differ from another platform with the same dataset?**
Aim of question	To identify if the proposed Recommendations System will benefit from implementing a Reinforcement Learning technique or a variable bias to adapt and suite different platforms.
Findings	
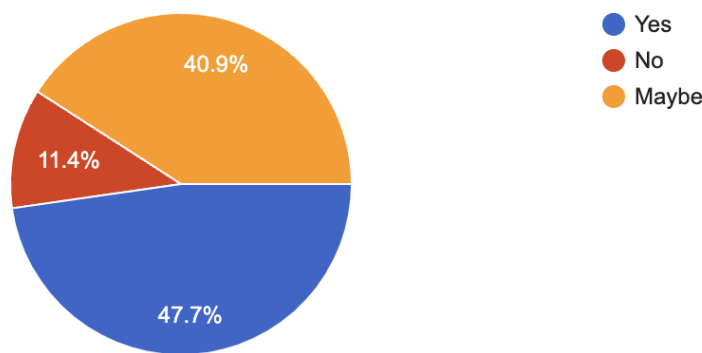
A majority of participants thought that having varied recommendations in different platforms, using the same recommendations algorithm. This leads to the requirement of implementing a variable bias towards the factors considered for recommendations or implementing a reinforcement learning technique, for the model to adjust based on user-inputs. Having a pre-configurable bias will also allow to achieve this, but the results from recommendations may not be optimum.

Question	**What functionalities would you like to have in a Trading Recommendations System for Non-fungible Tokens?**
Aim of question	To identify the non-function requirements of the system, that would make the system as user-friendly as possible

Findings

Most responses form the participants revolved around considering price-predictions when making recommendations. There were also suggestions to integrate trending crypto news to the system. Suggesting potential NFTs that suit a person's personal interests were also suggested to be integrated.

4.5.4 Prototyping

Table 4.6: Findings through Prototyping

Findings

4.6 Summary of Findings

Table 4.7: Summary of Findings

Id	Finding	Literature Review	Interviews	Survey	Prototyping
1	The proposed system would benefit experienced & inexperienced users searching for NFTs as well as NFT creators, traders & market places	✓	✓	✓	
2	The limits of Recommendation Systems can be pushed without the use of Deep learning, by the application of various hybrid ensemble models	✓	✓		
3	The integration of social media trends would be beneficial to improve recommendations produced by a Recommendations System	✓	✓	✓	✓
4	The identified research gap would contribute to both the Blockchain-NFT domain as well as the advancement of Recommendations Systems & ML	✓	✓	✓	
5	Building custom use-case specific algorithms for the Recommendations System is prefered over the use of pre-built models from a business application perspective		✓		
6	Having a method of price-prediction & using the prediction data to make decisions on recommendations would benefit users		✓	✓	
7	Using data-clustering techniques to identify contract-recognition & data tags are expected by advanced-users		✓		
8	Personalized recommendations could be achieved by the use of information extracted from the Blockchain with related to a user's public key. Past purchases of NFTs made by users can be considered.	✓	✓		
9	It would be good to have a user-interface that allows the user to choose the bias/ his primary concerns when expecting a recommendation, to provide the perfect recommendation for each user.		✓		
9	Having a adaptable, variable Recommendations Model that allows different platforms to have varied recommendations is preferred.		✓	✓	

| 10 | Having a sufficient set of well-cleaned & pre-processed data would be vital for the performance of the system | ✓ | ✓ | | ✓ |
| 11 | Opinions of well-known influencers could have a bigger impact on the decision-making process of a majority of users. | | ✓ | | |

4.7 Context Diagram

Prior to development, the system's boundaries and interactions should be determined. The system's context is depicted in the diagram below.
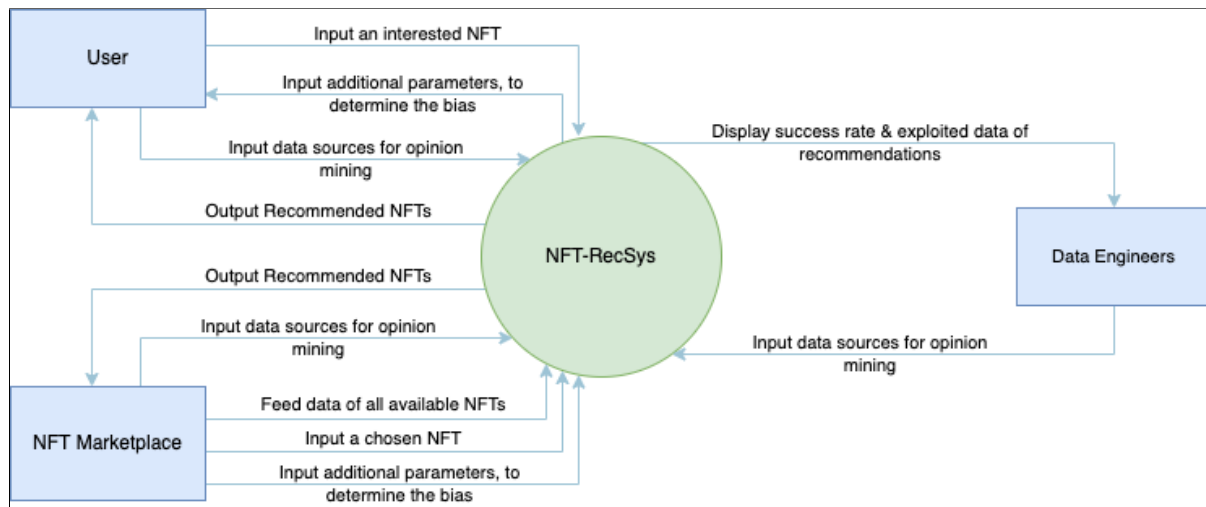

Figure 4.3: Context Diagram *(self-composed)*

4.8   Use Case Diagram
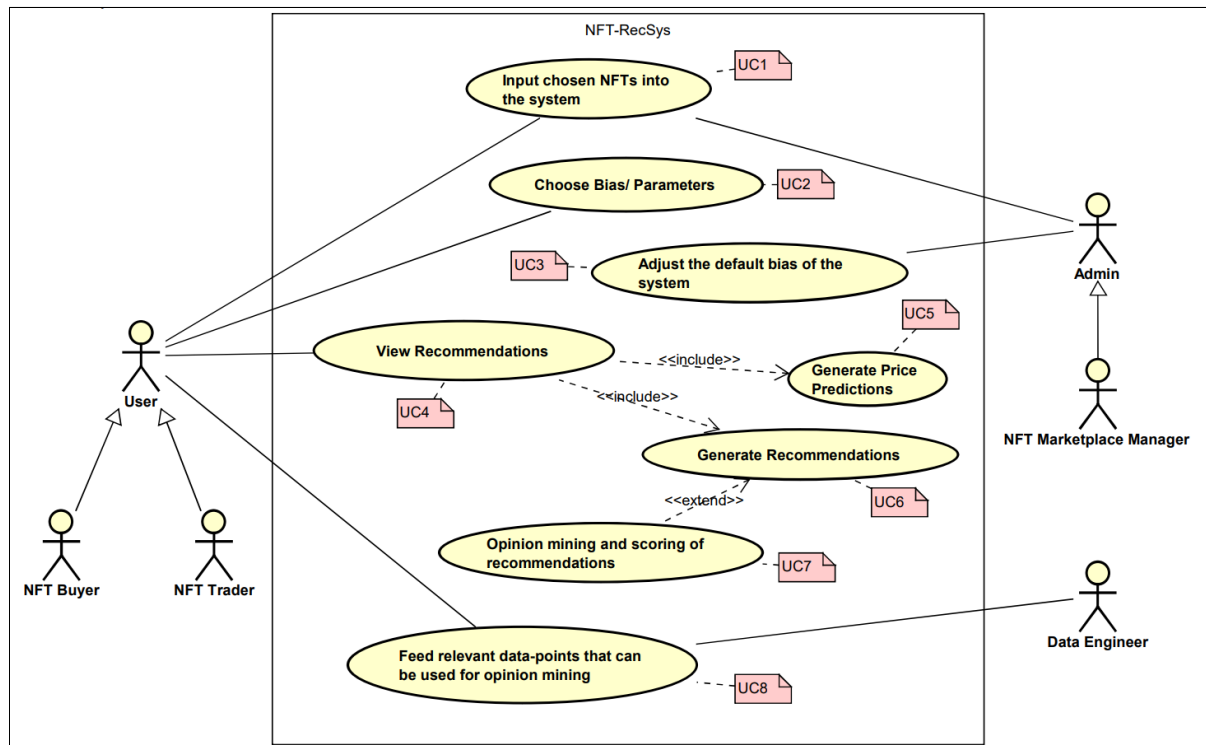
Figure 4.4: Use Case Diagram *(self-composed)*

4.9   Use Case Descriptions
4.10   Requirements
4.10.1 Functional Requirements

The MoSCoW technique was used to determine the priority levels of system needs based on their importance.

Table 4.8: Levels of priority according to the "MoSCoW" technique.

Priority Level	Description
Must have (M)	This level's requirement is a prototype's core functional requirement, and it must be implemented.
Should have (S)	Important requirements aren't absolutely necessary for the expected prototype to work, but they do add a lot of value.
Could have (C)	Desirable requirements that are optional and aren't deemed essential critical to the project's scope.
Will not have (W)	The requirements that the system may not have and that are not considered a top priority at this time.

Table 4.9: Functional requirements

FR ID	Requirement	Priority Level	Use Case
FR1	Users must be able to add a chosen NFT to be considered as the reference point to generating recommendations.	M	UC1
FR2	Admins should be able to add a collection of NFT to be used as recommendations.	S	UC1
FR3	The system could be able to fetch relevant data of the NFT using an entered token Id.	C	UC1
FR4	Users must be able to set/ adjust the bias and parameters to be used by the Recommendations System using parametric selections prior to generating recommendations.	M	UC2
FR5	Admins should be able to adjust the default bias of the Recommendations System.	S	UC3
FR6	Users must be able to view recommendations with the click of a button.	M	UC4
FR7	The prototype could have an option to receive user feedback regarding the satisfaction level of the generated recommendations by the system.	C	UC4
FR8	The system could show the reasons for recommending each item to users.	C	UC4
FR9	The system should generate price predictions and consider the results for recommendations.	S	UC5
FR10	Opinion mining trends data must be used to generate NFT recommendations.	M	UC7
FR11	A user could be allowed to feed data-points such as interested public figures, websites to use as opinion mining data for recommendations.	C	UC8
FR12	Admins should be able to feed data-points such as interested public figures, websites to use as opinion mining data for recommendations.	S	UC8

| FR13 | User-input could be aggregated and used as a reinforcement learning bias for the Recommendations Model. | C | |
| FR14 | The system will not act as a decentralized system. | W | |

4.10.2 Non-functional Requirements

Table 4.10: Non-functional requirements

NFR ID	Requirement	Description	Priority Level
1	Performance	Although recommendations should be provided upon user-input, the recommendations matrix & opinion-mining data can be pre-procesesd and stored in-memory to be used. Real-time processing isn't essential.	Desirable
2	Quality of Output	The quality of the output should be of the highest possible level, utilizing all the available data.	Important
3	Security	The application should prevent any attackers from manipulating results and extracting user-inputs. Security could be assured by means of testing.	Desirable
4	Usability	Since the purpose of the system is to automate and make it easy for the user to explore NFTs, the usability of the system must be easy for users of all levels of expertise.	Important
5	Scalability	The prototype may open up for testing for many users. Considering the hype around NFTs and the interest in the project, the system may have to support many concurrent user-requests.	Desirable

4.11 Chapter Summary

In this chapter, a Rich Picture Diagram was drawn to illustrate how the system connects with the society to understand the stakeholders of the system. Saunder's Onion model was used to

represent the stakeholders with the flow of influence of each stakeholder. Requirement gathering techniques were utilized to gather all the required data and opinions of possible stakeholders of the system. Lastly, the system's use cases, functional, and non-functional requirements were specified based on the insights derived from the requirement elicitation techniques.

APPENDIX A - CONCEPT GRAPH

Figure 5: Concept Map *(self-composed)*