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1 About W-Harmony

1.1 Problem Statement

All across America, an ambitious, entrepreneurial spirit manifests itself within small business owners, driving the growth and success of their companies. Millions of families outgrow the bounds of their small households and yearn for a spatial solution to their congested environment. College students and others with temporary residencies are forced to pay inflated rates from large businesses taking advantage of their desperate situation. With each thriving business, cramped family, and college student in need, sufficient storage space becomes a necessity. W-Harmony, founded in September of 2018, makes it easy for storage seekers and warehouse owners to connect. Using W-Harmony, business owners can find the industrial environment to store their materials, families can search for a secure space to keep their precious belongings, and those in transit can expect reasonable prices for their small scale storing needs. To eliminate wasted space and maximize user profits, W-Harmony uses a “shared space” model to find renters that can fill every square foot of warehouses. This ensures renters only pay for the space they use and no more. Additionally, this allows multiple renters to fill each warehouse allowing owners to maximize their storage space with multiple contracts. Our “shared space” model allows W-Harmony to cater to consumers of all sizes from business owners with industrial sized equipment to bachelors looking to store an old couch.

In many industries, collaborative consumption has become the preferred method for exchanging goods and services. The goal of collaborative consumption is to make use of underutilized resources by making them available to consumers, usually through the use of a third party online platform. W-Harmony provides an online platform where this type of shared economy can take place within the warehousing and storage industry. It does not provide storage space, it provides a community to connect and support modern storage seekers and providers.

1.2 Business Model

W-Harmony’s business model is simple. There is no sign-up fee for creating an account, although users are required to input credit card information to ensure a streamlined experience for contract creation. A new user will be given the option to register as either a warehouse owner or a warehouse renter. As a warehouse owner, one can enter their warehouses’ information to be viewed by potential renters, as well as look for warehouse space to rent if they so desire. As a warehouse renter, one would only have the option to look for warehouse space to rent. Warehouse owners will pay a fee each time they add a new warehouse to the site. This fee is based on ranges of square feet of space that will be available for renters to utilize. Ranges are 50,000 square feet or fewer, 50,000 to 100,000 square feet, and 100,000 square feet or greater with fees of \$5, \$10, and \$15 per warehouse respectively. Additionally, W-Harmony automatically takes 2.5% from each total contract price.

1.3 Investor Information

With the increasing demand for storage and fulfillment spaces to accommodate the recent boom in e-commerce and next day delivery, warehouses have never before been in such high demand. According to Jc.com, “...net absorption in 2018 is projected to exceed 240 million square feet” and “currently there

are 267.2 million square feet of industrial space...” being built (Mongelluzzo, Joc.com). W-Harmony aims to capitalize on this growing demand and maximize the millions of storage space waiting to be used. By focusing on new warehouse developments, W-Harmony plans on contracting 2% of newly built warehouses every year. With an average of 2.5 contracts per warehouse adding to a total worth of approximately \$756,000 a year, this would earn W-Harmony and its investors, on average, \$1,400,000 every year. This calculation is based on the average capacity, price, and time length of our current contract database. All investments will contribute to the continued growth of our network in order to serve more communities in a way that best suits their storing needs.

2 Website Features

A user begins by going to the W-Harmony webpage by following the URL <http://web.ics.purdue.edu/~g1090445/wharmony.php> and viewing the home page. Next, their W-Harmony experience continues to a streamlined registration form, identifying themselves as a warehouse owner or renter. After registration, they are brought to their personalized homepage allowing them to access all the different features of W-Harmony. Users can access and edit their account information, view their existing storage contract details, and learn more about W-Harmony.

Warehouse owners will have the ability to add warehouses to their page, detailing key features to give potential renters a complete understanding of each facility and easily compare their options. All users will have access to the search page where they can submit their specific storage needs and search for the most compatible warehouses in their area. The website utilizes a database backbone and an algorithm that carefully selects and ranks warehouse choices to give the users a streamlined and customized experience. Each warehouse is ranked by its compatibility score calculated by comparing each of its features with renter preferences. Figure 1 shows an example page resulting from a user’s warehouse search. This algorithm also reorganizes warehouse search results to ensure all warehouses are given the opportunity for selection. It does this by featuring warehouses with the fewest contracts in their respective areas. This optimizes warehouse usage and increases customer satisfaction.

W-Harmony recognizes that every renter has the same basic needs: enough space and enough time. This is why the algorithm values the warehouse capacity and time available as the most important factors for matching users. On the other hand, every renter has needs unique to their desired experience. To support these needs, W-Harmony offers specific options such as a temperature controlled environment, loading docks, extra security, and 24 hour access, which a warehouse owner is required to list whether or not their warehouses provide these services.

After a renter selects a warehouse, they can create a contract with their individual terms that is sent to the warehouse owner for review. This method of proposal ensures both parties approve any agreement but otherwise removes W-Harmony’s role in the details of contract creation. Once this contract is created, users can view its details, rate / review the other parties involved, and owners can terminate the contract if necessary. Each renter and owner can be reviewed by other users with either a qualitative text review or a numerical evaluation of their interaction. Warehouses and their owners can be evaluated based on warehouse condition, quality of match, owner communication, and relationship with owner. W-Harmony aims to foster a community centered around trustworthy and responsible individuals. Therefore, every user’s review and ratings are made public to ensure our customers know they are contracting with quality business partners. Figure 2 shows the form used by a renter to rate a warehouse.

Figure 1: Warehouse Search Results

The screenshot shows the W-Harmony website interface. At the top, there are navigation links for "View Contracts", "Contact Us", and "Team". The main heading is "W-Harmony". Below this, there are two main sections: "Your search results:" and "Featured warehouse:".

Your search results:

Please be patient while your results load

Result 1

Warehouse ID: 1906
Owner ID: 1047
Address: 8326 Windfall Ave. West Lafayette, IN 47906
Price per square foot: \$ 0.82
Loading docks: Yes
Temperature controlled: No
Increased security: No
24 Hour access: Yes

No reviews.

.....

Result 2

Warehouse ID: 1905
Owner ID: 4883
Address: 37 Willow Dr. West Lafayette, IN 47906
Price per square foot: \$ 1.12
Loading docks: Yes
Temperature controlled: No

Featured warehouse:

Warehouse ID: 1905
Owner ID: 4883
Address: 37 Willow Dr. West Lafayette, IN 47906
Price per square foot: \$ 1.12
Loading docks: Yes
Temperature controlled: No
Increased security: No
24 Hour access: No

Warehouse Review:
NAPW3FAWBqhQyUij2RgZ
Average warehouse rating (out of 5): 1.75

Warehouse Review:
Nice space but a little dusty. Owner was very helpful and responded quickly to all my questions. .
Average warehouse rating (out of 5): 3.5

Figure 2: Rate a Warehouse

The screenshot shows the "Rate a Warehouse" form. It has a title "Rate a Warehouse" and several input fields and rating sections.

Enter Warehouse ID:

Enter ID here

Enter Warehouse Review:

Enter review here.

Warehouse condition score:

1 2 3 4 5

Warehouse matching description score:

1 2 3 4 5

Owner communication score:

1 2 3 4 5

Owner Relationship score:

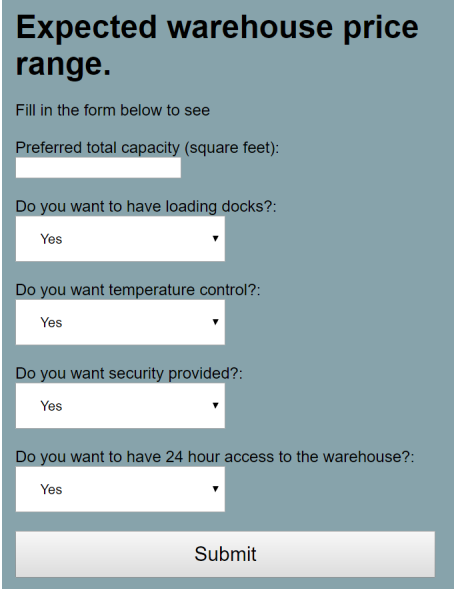
1 2 3 4 5

Submit

Return to Homepage

W-Harmony offers users a unique opportunity to competitively compare storage pricing across the industry. Using machine learning technology, the entire W-Harmony warehouse database is leveraged in order to predict appropriate storage pricing based on specific features of a warehouse. Renters can access this feature on the search page as a way of comparing their potential renting prices to the industry expected price. Warehouse owners can use the machine learning feature to compare their warehouse against their competitors and ensure their prices are competitive. Internally, this feature can help W-Harmony evaluate the current customer base and predict the revenue gained from different users as the market grows. Figure 3 shows the form supported by the machine learning to predict pricing.

Figure 3: Machine Learning Pricing Tool



The image shows a web form titled "Expected warehouse price range." The form is set against a dark teal background. It contains the following elements: a heading "Expected warehouse price range.", a sub-heading "Fill in the form below to see", a text input field for "Preferred total capacity (square feet):", and four dropdown menus for "Do you want to have loading docks?:", "Do you want temperature control?:", "Do you want security provided?:", and "Do you want to have 24 hour access to the warehouse?:". Each dropdown menu currently shows "Yes". At the bottom of the form is a "Submit" button.

In addition to the machine learning tool, users have access to a number of data analytics displays to further their understanding of the W-Harmony database, their own contracts and warehouses, and other key features. The first plot (Figure 4) is a histogram of contracts start dates by month of the year which helps warehouse owners compare their own contract trends against that of their competitors. Identifying “slower” seasons of the year can help owners allocate facility usage more efficiently. The next display (Figure 5) is a pie chart of the distribution of warehouse prices which can offer renters a holistic view of all the warehouses on the market and allow them to better appraise options. The last display (Figure 6) shows the percentage breakdown of users by renter or warehouse owners. This display is key for W-Harmony to understand its client base and determine where to focus advertising efforts to balance those providing and searching for storage space. Warehouse owners and renters can also utilize this display to understand the current community in their area and determine how competitive the market is for finding their contract counterparts.

Figure 4: Contract Start Dates by Month

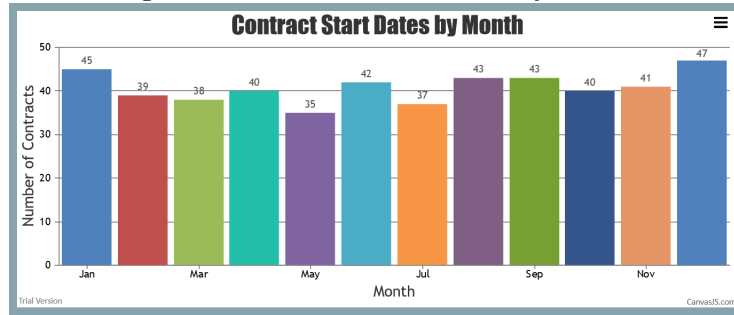


Figure 5: Price Range for Warehouse

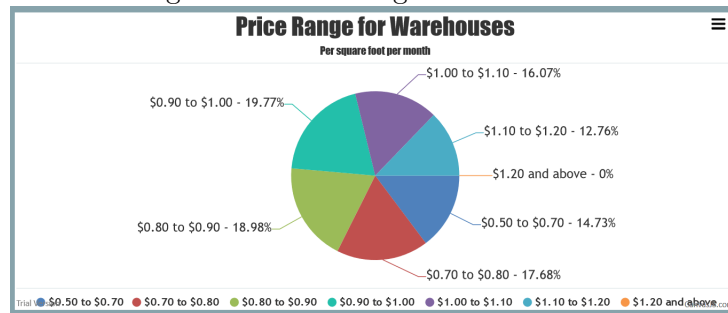
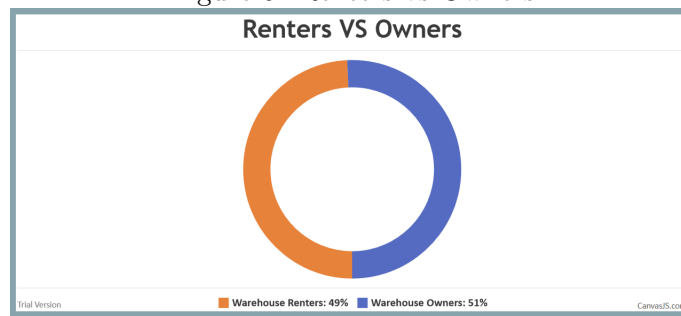


Figure 6: Renters vs Owners



The satisfaction and success of customers is at the heart of W-Harmony’s business because its success is dependent on the success of the storage community. The website’s functionality is fueled by network growth and effective user connection. Therefore, the feedback and input of customers drive all decisions made in the company and is continually evaluated. Every user can easily email the W-Harmony team with any questions or concerns to improve the website’s service. If any user is unsatisfied with their experience, they have the freedom to permanently terminate their W-Harmony account at any time with one caveat. Users cannot terminate their account until all their current contracts are completed or terminated. This is to ensure all users are held responsible for their previously committed obligations. After a user’s account is terminated, their account information is permanently removed from the database to ensure their information is secure.

3 Conclusion

Investors in W-Harmony will have the unique opportunity of helping to pioneer this innovative system that will vastly change the storage industry. Investing in W-Harmony means investing in small business, supporting American families, and disrupting the control of commercialized storage corporations. This personalized storage industry is currently an untapped market and promises immense returns. The website is already fully functioning and has been providing storage finding services for over a month. However, W-Harmony strives for continual improvement and hopes to discover new methods for users' specific needs. Every renter deserves a storage experience that is easy, personalized, and affordable, all of which W-Harmony aim to provide. In order to remain at the forefront of this technological era, W-Harmony must constantly grow its customer network, gain user feedback, update its interface, and improve its algorithms. Technology has revolutionized the way people purchase goods, why not use it to revolutionize the way they store them?

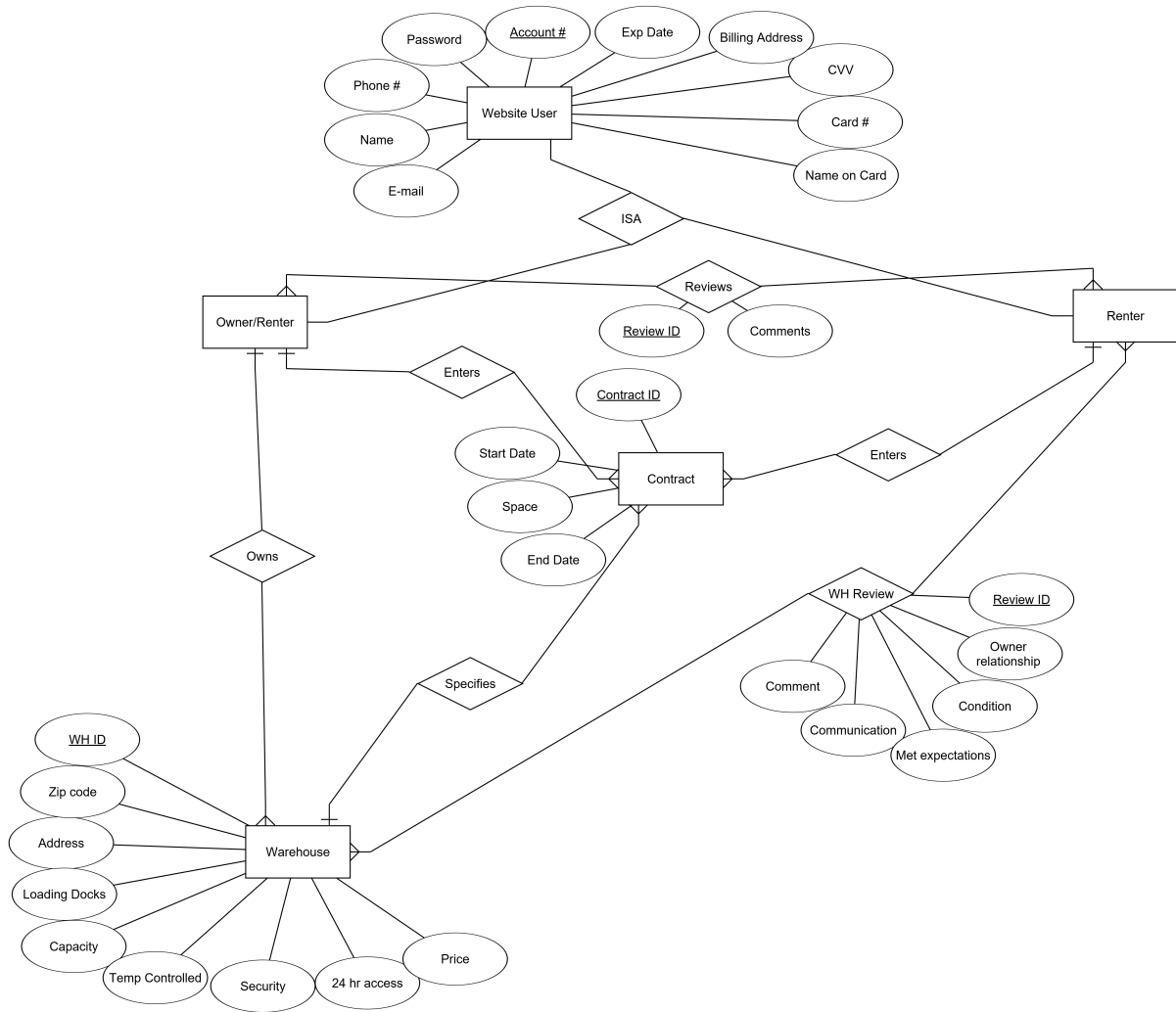
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5 Appendix

5.1 Entity-Relationship Diagram



5.2 Ranking Algorithm

The ranking algorithm appears in lines 30-42 of the “sorting_ranked_WH.R” file and is supported by line 12 of the “rank_score.R” file. This code orders the warehouses in the selected zip code by their calculated “ranking scores” from highest to lowest scores which are given by the “rank_score” function. This ordered list is then returned and used to order the search results on the user interface.

rank_score.R line 12: Total score = availability score + price score + rating score + loading score+ security score + 24hr access score + temperature control score

This code calculates each warehouse’s “rank score” by summing the score points from each of the following warehouse features: availability, price, rating, loading dock access, security, 24 hour access, and temperature controlled environment. The score for each feature is calculated by giving a warehouse points according to how well it matches the search preferences of the user. This is shown in line 5-11 of the “rank_score.R” file. Features are weighted as follows:

Availability - Points given out of 7 based on percentage of time warehouse can provide the requested square feet of space for the requested time frame.

Price - Points given out of 5. 5 points given if warehouse price is below requested rate. If rate exceeds request, points deducted from 5 by percentage that warehouse price exceeds requested rate.

Rating - Points given out of 3 based on the average rating of the warehouse. Average rating out of 5 is converted to a percentage and applied to the 3 possible points.

Loading dock access - 1 point given if warehouse feature matches user request.

Warehouse security - 1 point given if warehouse feature matches user request.

24 hour access - 1 point given if warehouse feature matches user request.

Temperature controlled storage - 1 point given if warehouse feature matches user request.

This approach guarantees that each potential warehouse is individually evaluated based on the specific criteria provided by the current user search. The feature weights ensure that a warehouse’s display rank is impacted more by features of greater importance such as availability and price. Yet, the lesser weighted features and rating consideration ensures similar warehouses can still be ordered to truly separate the most compatible facility. Furthermore, these scores are recalculated every time, which allow results to be reordered for every new set of preferences applied by users.

5.3 Data Generation

Our data generation for our contracts can be found in ‘random data generation.R’ lines 126-140. Pseudocode for contract generation:

Contract ID: randomly sample from 10000 to 99999 without replacement

Start Date: randomly sample from 01/01/2015 to 01/01/2017

End Date: randomly sample from 01/01/2018 to 01/01/2020

Space: randomly sample from a normal distribution with a mean of 77,500 square feet and a standard deviation of 25,800 square feet

Renter Account Number: randomly sample renter account numbers from the database

Owner Account Number: randomly sample owner account numbers from the database

The generated contracts are realistic because our generation ensures that no start dates occur after the generated end dates. In addition to this data, any contracts which add up to be over the total capacity of the warehouse were deleted from our database, and any contracts where the renter’s account and owner account’s are the same were deleted as well. Our website ensures that these two instances are not possible when creating new contracts.

The scheduling algorithm is the percent availability calculator which also references the daily capacity calculator. The daily capacity calculator calculates the amount of space left in a warehouse by subtracting the space taken up by each contract from the total capacity for that day. The percent availability calculator does this for each day within the dates of the user’s search and returns a percent availability overall for that warehouse. If the warehouse is 100% available for the requested space and dates then it will get a higher score in the ranking algorithm which will move it closer to the top of the search results page.

The website will not let a user request a contract for a warehouse if there is not enough available space in that warehouse during the requested dates. This is to ensure none of the warehouses go over capacity and all contracts that are requested are valid.