Lab 1 – Load.In Product Description

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1   Introduction

Do it yourself (DIY) movers lack the knowledge to handle the logistics of their move. Professional movers ease the physical burden of moving and handle some logistics for the customer, but their costs can be too expensive (Wood, 2020). DIY movers save money, but it leads to a decrease in efficiency as the DIY movers do not have the same knowledge and experience as the professional movers do in handling the different aspects of a move such as packing and loading of the truck. DIY movers must estimate costs, keep an inventory of all of items being moved, pack all their items, and load the moving truck efficiently and safely. The last being an extremely important part of the moving process. Weight distribution plays an important role in truck safety when transporting items - an improperly loaded moving truck could result in damaged items or a car accident.

Market research has shown that nearly 70% of movers choose to do it themselves (Wood, 2020). This is primarily a result of the high costs that professional movers incur. For example, a four-bedroom household to move within the state they currently live would cost nearly $3000, and if the move is out of state that cost nearly triples (Meyers, 2018). These prices are not affordable for most Americans and therefore many choose to move themselves. Further market analysis has also shown that there is a shift in the market towards software-based solutions for helping with the moving process, while there is currently some software out to help a person move it is barebones and helps with things like inventory, no current software will help the mover as much as Load.In.

This is where Load.In will be a big help in the moving marketplace, Load.In uses computer vision to create 3D models of all the customers items and creates an AI generated loading and unloading plan of how to properly load and unload the moving truck. Load.In also handles all the

logistics behind a DIY move. This fills in the knowledge gap that DIY movers lack and provides

logistical help for the DIY mover. Do it yourself movers with the help of Load.In pay the normal

costs of a DIY move, but now have the expertise of a professional mover.

2   Product Description

Load.In is an application that assists DIY movers by providing 3D modeled loading

instructions and full logistical support for the move. Users take photos of the packed boxes, other

items, and any furniture they will be moving. Load.In then uses these pictures to create 3D

models of all the items and the moving truck to give the user a full visualized plan of how to load

the truck properly.

Load.In's loading and unloading plans are a crucial aspect of the product. A 3D model of the

moving truck, all the mover's items, and instructions of how to load the truck properly are

generated. This guides the user on how to load their moving truck while accounting for important

aspects such as weight distribution, fragility, size, and importance of the item. Users can search

the load plan to find items should they need to know the location once they load the moving

truck. It provides tips and tricks, for properly packing different materials or items, in app to help

the mover. Load.In's time and cost estimates are important features that help the user understand

how much time and money they will spend total on their DIY move.

The goal of Load.In is to deliver a product that allows user to have the expert knowledge and

experience of a professional mover without having to pay the high costs that they charge.

2.1   Key Product Features and Capabilities

2.1.1   Load Plan

The load plan is an important feature of Load.In. After the user takes photos of all items, they

are moving a 3D model of each item is generated with accurate dimensions. The 3D models are

used in combination with a 3D model of the rental truck to generate the load plan for this move.

It breaks the load plan down into separate instructions to ensure the user understands how and

where to load every item on the moving truck. This is revolutionary as this is one selling point

that professional movers have: they possess the knowledge and experience to load a truck

properly. Now with Load.In every user can load the truck like a professional.

2.1.2   Move Inventory

The move inventory is a list of all items that are on the truck. Items are added to the move

inventory when they are entered into the loading plan. Users can add the contents of cardboard

boxes so they can keep track of important items or documents that are already packed during the

move process.

2.1.3   Rental Estimation

Load.In provides users with time and cost estimates based on the number of items they have

and the size of the rental truck they need. Once Load.In has all the 3D models generated for the

load plan, the user can then choose which truck they would like to rent. When they go to do this,

the application provides the costs, the number of trips, and the total time required to complete

their move based on the different truck options available. This gives the user the ability to

customize their move to what works best for their needs and provides all the logistical

information they need.

2.1.4   Expert Tips

Load.In features an expert tips section that provides helpful information from expert packers

and movers. Should a user need help on how to pack something fragile or needs information

about different aspects of moving, they can head to the expert tips section for useful and relevant

information.

2.1.5   Chatbot and Live Help

The chatbot that Load.In features is available to help users easily find solutions from the

expert tips section or if there is no answer to their question the chatbot will redirect to a live

expert to assist the user with their inquiry.

2.1.6   Vendor Synchronization

Load.In offers users the ability to see rental truck prices and availability. Load.In pulls this

data from third-party rental companies. These rental companies have access to the rental

management dashboard that Load.In features where they can see analytics regarding their truck

rentals facilitated through the application.

2.1.7   Move Analytics

Load.In has move analytics to look for ways to improve the product. Things such as location

data, costs, and inventory data is analyzed and used to improve the application. Through analysis

of move distances and costs of items such as fuel and rentals, Load.In can improve its time and

costs estimates for future users. Load.In also features a post move feedback system. The

feedback from users after they finish their move is crucial for improving the application and

improving the AI used for generating the load plans.

2.1.8   Heat Map

The heat map will see where on the application users visit the most. This information can help developers identify problem areas of the interface where users run into issues or are driven away by the user interface. The heat map will be valuable for developers to have an insight into how users are using the application and where the application's user interface can be improved.

2.2   Major Components (Hardware/Software)

2.2.1   Database

Figure 1 shows the Major Functional Component diagram for Load.In. This diagram shows how the application works and how it interacts with all the different components. The most important component of Load.In is the database. We created a relational database using Amazon Relational Database Service (RDS). MySQL and Amazon Lambda will handle the database and connections to the back end. The database will be important for data storage and for the algorithms that are needed for Load.In to work properly and generate a load plan.

Figure 1 Load.In Major Functional Components Diagram

2.2.2   Smartphone Client

Load.In, is an Android application that requires access to the user's smartphone camera. The

user's smartphone handles some of the workload for the system. Photos taken for the move will

stay locally on the user's phone. This will require the user to have some available storage on

their smartphone to use Load.In. All other components require a stable internet connection from

the smartphone to be functional.

2.2.3   Website Client

The website client for Load.In serves a few purposes but will not be used for moving process

itself. The first purpose of the website client is to serve as an information tool about Load.In.

Secondly it serves as an analytics tool for administrators. The client displays all the current

analytical data for the administrators to look at and use. The website has very little hardware

requirements and works on any updated browser.

2.2.4   Web API

The Web API for Load.In was created using Java and uses Amazon Web Services Elastic

Beanstalk (AWS Elastic Beanstalk) and Apache CXF with Tomcat.

2.2.5   Web Application

We created the web application using Java and will use AWS Elastic Beanstalk and Spring

Model-View-Controller (Spring MVC) with Tomcat.

2.2.6   *Vendor Synchronization*

Vendor synchronization for Load.In is created using Java and uses AWS Lambda. The vendor synchronization operates on a timed schedule. It brings in data from third-party party vendors such as rental truck companies to provide availability details to the user.

3   Identification of Case Study

Load.In is being developed for people that are moving anywhere in the country that want to DIY their move. The application will work whether the distance is across the town or across the country. For the case study the focus will be on a family of three moving across their current city of residence. The average house size in the United States is 2,200 sq ft (US Census Bureau 2019). The family will use a rental truck to move as their already owned vehicles are not large enough to move the family's possessions. For the case study, larger items such as furniture will be included to get an idea of how well the 3D model generation and load plan works. Load.In for this case study is expected to estimate the costs for the move, estimate the time to complete the move, generate 3D models for all items, and generate a 3D modeled load plan for loading the rental truck. The goal is to ensure that Load.In can complete a relatively basic cross-city move and display the ability to be scaled up in the future for a bigger sized move or a move over longer distances. In the future the technology behind Load.In could be used for bigger DIY moves or even for large scale industrial loading and unloading.

4   Product Prototype Description

The Load.In prototype will be created and tested to be a proof of concept of the key features and ideas behind the application. While the application will have reduced functionality from what was envisioned. It will allow for more work to be done on the key features during the development process. The table below displays what features from the real-world application will be implemented in the prototype.

Prototype Features Table

Feature	Description	Implementation
	UI	
Login Page	Create a landing page for the login screen.	Full Functionality
Guess User Interface	Ability for a new user to view the application without being logged in.	Full Functionality
Admin User Interface	Ability to have super user privileges when interaction with the application.	Full Functionality
DIY User Interface	Create a user role for the end user with normal privileges.	Full Functionality
	Authentication	
User Registration	Create an account inside of the load.in application.	Full Functionality
User Login	Authenticate with the server that an account exists.	Full Functionality
Reset Login	End user to be able to reset his/her own password inside of load.in application.	Partial:
	Move Inventory	
Furniture/Item Measurement	Ability to measure items using the phone camera.	Partial: Ability to manually type in dimension of boxes.
3D Model Generation	Generate a 3D Model based on item measurements	Partial

Box Locator Search Feature	Ability for the user to find the location of a box via search	Full Functionality
	Move Plan	
Load Plan	Generate a plan that will show users where and how to load boxes	Partial: Preloaded data inside of the database
	Logistics Planning	
Estimated Number of trips	Calculate the number of trips one will take based on the truck size.	Full Functionality
	Expert Help	
Packing Tips and suggestions	A list of tips will be suggested to the user on how to load the truck properly.	Full Functionality
Tips Search	Ability to search items a end user need additional help loading.	Full Functionality
Move expert articles	Expert level tips written by professionals.	Full Functionality
	Analytics	
Feedback data	Ability for the end user to provide feedback for a move.	Partial: User can only give a thumbs up or down.

Figure 2, Load.In Prototype Features Table. This figure shows the implementation of the Load.In prototype.

4.1 Prototype Architecture

The prototype for Load.In will run on a virtual machine operating on the Ubuntu Linux operating system. The prototype will use Docker containers running Apache Tomcat, Apache CXF, and MySQL. Apache Tomcat and CXF will be used for the web server and web API. The MySQL container will be used for the database to store user data and move data. Using the web

API the phone application will be able to connect to the MySQL database. A test harness will be

created to allow for extensive testing of the system and to demonstrate the functionality of the

different features of Load.In.

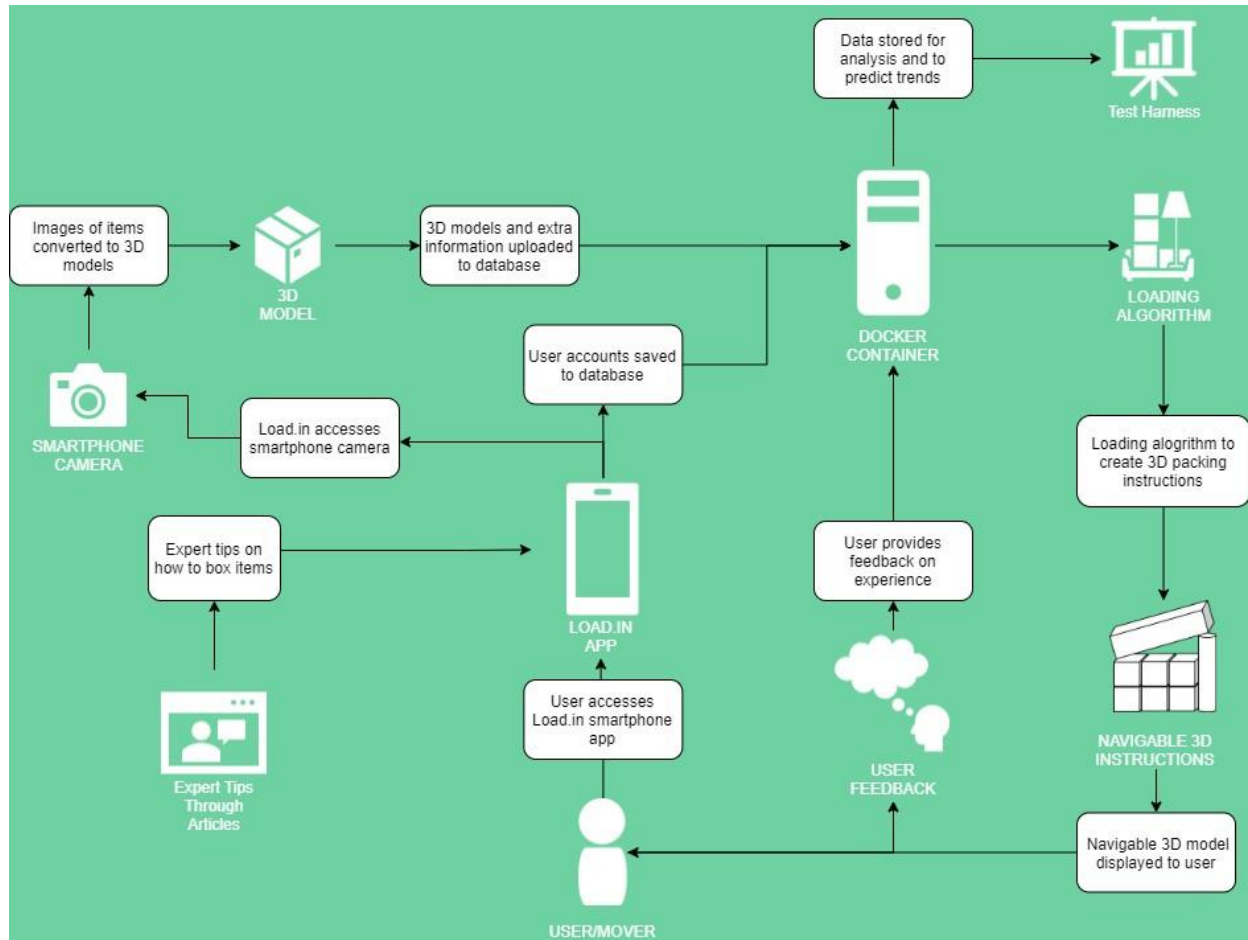*Figure 3, Load.In Prototype Main Functional Component Diagram.*

4.2   Prototype Features and Capabilities

The Load.In prototype is being built to demonstrate a proof of concept of the important

core features of the application. The first useful feature that will be helpful in the move process is

the packing tips and expert articles the user will have the ability to search for help on how to

pack different items around their house should they need it. In the prototype there will be a search function that will return example articles and tips to prove that it works.

The next important feature in the prototype is the measuring of the boxes. The user will be able to use their smartphone camera and take a picture of the boxes they have packed. The application will then use the image to generate measurements and a 3D model of the box. Should they have any issues with this the user will also be able to input the measurements manually. This will demonstrate our ability to generate 3D models of boxes even if there are issues with the phone's camera measurements.

The next feature that will be demonstrated in the prototype is the load plan. Once all the 3D models of the boxes have been generated the application will create a simple load plan showing the user how to properly pack their boxes on the moving truck. If the user makes any mistakes during the loading process, they can go back a step of the load plan, and if the user does not like the load plan created, they will have the option to generate a new one.

The prototype will also feature trip estimation to allow the user to see the estimated time for their move based on the number of items, distance to travel, and how many people they have to help them. This will be important to allow the user to see an estimate of how much time their total move will take. At the end of the move, we will have a feedback page to allow the user to provide feedback on their move experience. This feedback will allow for improvement of the application by learning where the application may need small changes to improve the process.

The goal of the Load.In prototype is to show that the key ideas and features behind Load.In are feasible on a smaller scale. By doing this we can demonstrate to users the potential usefulness of the application in a real-world situation.

4.3   Prototype Development Challenges

While the prototype for Load.In has been scaled down to allow for the demonstration of the more key concepts and features, there will still be many challenges during the development process. Moving involves a lot of different variables and it would take years of development to build an application that addresses and handles all these different variables. To handle a lot of this we will be building and using the test harness. This will allow for the developers to set and change different values in the database of items such as boxes, truck sizes, and more when testing the different features of Load.In. Testing will be an important part of the development process for Load.In as there are so many different aspects of the move. If one thing goes wrong the whole move process can be affected by it. By having the test harness and repeatedly testing the application we can address as many of the issues as possible.

5   Glossary

3D – Three Dimensional

Administrator – Someone who will access elevated features of the Load.In system in order to maintain and detect issues.

Amazon Lambda - a serverless compute service that lets you run code without provisioning or managing servers

Amazon RDS - Amazon relational database service

Amazon Web Services (AWS) – A cloud platform on which Load.In's databases are hosted.

Android - a mobile operating system based on a modified version of the Linux kernel and other open-source software

Application Programming Interface (API) – An interface for programs to share information and functionality with one another through a series of call or connections.

AWS Elastic Beanstalk - an orchestration service offered by Amazon Web Services for deploying applications which orchestrates various AWS services, including EC2, S3, Simple Notification Service, CloudWatch, autoscaling, and Elastic Load Balancers

AWS Elastic File Storage – an AWS service that provides file storage with the ability to auto-scale up with increased demand.

Apache CXF – A popular library for hosting web APIs.

Apache Tomcat - an open-source implementation of the Java Servlet, JavaServer Pages, Java Expression Language and WebSocket technologies. Tomcat provides a "pure Java" HTTP web server environment in which Java code can run

Chatbot – A feature within Load.In that provides information to users and guides them towards helpful articles and other resources interactively.

Cloud – A term used to describe several computing models such that a company or individual can purchase resources for hosting a variety of things in a centralized location accessible from anywhere in the world.

Computer Vision – a subclassification of Artificial Intelligence that involves computing information about the world from various sensory data, such as images. Techniques of this classification are used throughout Load.In to observe real world objects.

CPU – Central processing unit.

CSS – Cascading style sheet.

Do-It-Yourself (DIY) Mover – Non-professional movers that rent a truck for their move, but and handle all packing, unpacking, manual labor themselves. This is the primary end user of Load.In

Expert Tips – Feature of Load.In that allows for a mover to search for helpful articles pertaining to a variety of useful information on how to accomplish various tasks during a move.

GHZ – Gigahertz

Guest – Someone who is accessing the Load.In system anonymously and has not registered for an account or someone who has registered but has not authenticated to the system at the time of access.

GUI - graphical user interface, the aspect of a software program that the end user interacts with.

HTML5 – Hyper Text Markup Language version 5

Java - a set of computer software and specifications developed by James Gosling at Sun Microsystems, which was later acquired by the Oracle Corporation, that provides a system for developing application software and deploying it in a cross-platform computing environment

JavaScript - A scripting language that runs in the browser and performs one or more function to animate an otherwise static HTML document.

Linux - An open-source and community-developed operating system for personal computers and workstations.

Load Plan – A set of instructions on how to optimally load a container, generated automatically by Load.In from the boxes and furniture input into the system by the user.

Logistics Planning – A feature of Load.In that assists the mover with determining what rental trucks cost, how many trips the truck might need to take and whether the truck is available to rent based off proximity to the mover.

Mbps – Mega-bits per second, a unit of measurement for network speeds.

Megapixel – One million pixels, typically used to measure the size and quality of images

Move Inventory – A feature of Load.In that catalogs all boxes and items the mover intends to move.

MySQL - an open-source relational database management system

MacOS - An operating system used on Apple's MacIntosh line of personal computers and workstations.

Operating System (OS) – A collection of programs designed to provide a platform on a device to run other applications and typically provides a layer of abstraction from the hardware it interacts with.

Pixel – A small square of color that is part of a larger display screen or image.

Photogrammetry – A computational method of deriving three-dimensional information from images. This method is used in Load.In to construct 3D models of boxes, furniture, and other items from pictures taken from the end user's cell phone camera.

Portable Network Graphics (PNG) – Portable Network Graphics, a common image file format that Load.In uses.

Professional Mover - Professionals who handle the physical labor of loading and unloading a moving truck, as well as driving the truck to the destination.

Real World Product (RWP) – The actual Load.In solution as it was intended.

Rental Administrator – A representative of a rental company who will access the Load.In system on behalf of the rental company.

Rental Company – Any company which rents moving vehicles for a Do-It-Yourself Mover to assist them with their move.

Smartphone – A device, typically handheld, which can act as both a cellular phone and a computer by running one or more applications through typically a touch screen interface.

SPRING MVS - an application framework and inversion of control container for the Java platform

Test Harness – A set of special features used during the development of Load.In to enable testing and demonstration of the application.

Vendor Synchronization – A feature of Load.in that brings in truck sizes and availability of rental information from third party moving company websites.

Windows – An operating system developed by Microsoft for use on personal computers and workstations.

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