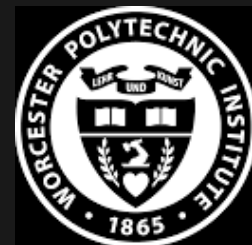


Construction Innovation

Interdisciplinary Qualifying Project
(IQP)

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WPI

Authors & Advisors

Authors:

David Hinckley Jr.

BS: Management Engineering - Civil Engineering Concentration

MS: Management

Ryan Menard

BS: Civil Engineering – Project Management Concentration

Advisors:

Robert Sarnie

Advisor

Foisie Business School: Professor of Practice

Curtis Abel

Co-Advisor

Executive Director of Innovation and Entrepreneurship

Abstract

The construction industry is an evolving industry that continues to make strides towards technological advancement. This project aimed to identify the main challenges and potential advancements in the construction industry. As the project progressed, more interviews were conducted which identified higher priority problems. Rankings were established based on the occurrence and importance of the problems discussed in the first few rounds of interviews. Ultimately, our final project topic was based on feasibility, the consumer need, and potential impact to the industry. As a result of this research, the startup Pallyt was formed. The goal of this service is to provide a convenient, cost-effective way to get much-needed construction materials in a timely manner.

Acknowledgements

The background of the slide is a photograph of a construction site at sunset. A large crane is visible in the upper right, extending across the sky. In the foreground, several workers in high-visibility vests are standing on a concrete slab, looking at a set of plans. The sky is a mix of orange, red, and blue, and the overall scene is illuminated by the warm light of the setting sun.

We would like to thank our advisors Robert Sarnie and Curtis Abel for their support, encouragement, and guidance throughout this project. We would like to thank all of our survey and interview participants, for helping to establish challenges within the construction industry for us to solve. Our I-Corps mentors and program coordinators for assisting us through the customer discovery process. Lastly, we would like to thank Joshua Alasso, Eva Bruklich, Nathaniel Klingensmith, Rober Mankaryous, Margaret Reiter, and Zachary Wong for joining the project and starting the process so early to ensure that the result of Pallyt is much more than an Interdisciplinary Qualifying Project or a Major Qualifying Project Grade.

Executive Summary

The purpose of this project was to identify how our group could innovate within the construction industry through meetings, interviews, surveys and research that were conducted. The challenges and hardships that are experienced in the construction industry were well documented, and the project ideas were assembled as possible solutions to the problems. After 24 interviews, a project was chosen, and 22 additional interviews were conducted.

The research that was collected allowed the Interdisciplinary Qualifying Project team to set up three Major Qualifying Project (MQP) teams to create a physical product starting in A term of 2021. Originally this project began with an idea to utilize virtual reality to show a building during its pre-construction phases to customers. Providing a virtual walkthrough prior to the construction of the project beginning. However, after several interviews and a detailed analysis of the data that was collected, we realized that innovation within this area was not practical nor was it needed, as many companies are currently working toward this goal.

Executive Summary Continued

Due to this realization, our team conducted another round of interviews and produced several potential new topics for our project. These new potential topics were then reviewed and presented to several more industry professionals in additional interviews. Ultimately, our team was able to select a project we would move on with following these interviews. The project that was selected focuses on the bidding and scope phases of construction, an area in which there is no procedure or industry standard. The focus of this project was to develop a plan to create an industry standard for the bidding, procurement, and scope parts of the construction industry. After deciding to focus on estimating the team joined NE I-Corps, with that came another pivot. Ultimately the team decided to focus on the location and delivery of materials and create the “Uber Eats” of construction materials. This project is called Pallyt and will be the project for three Major Qualifying Project teams during the 2021-2022 academic year.

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Introduction



Introduction

Construction Innovation is a project much different than the typical Interdisciplinary Qualifying Project (IQP). Construction Innovation was established because of David and Ryan's mutual interest in construction and the desire to solve problems within an industry that has been neglected as technology evolves. The project came to life with our original idea of "VR Blueprints". VR Blueprints was an idea to make a software that would allow clients or other people to virtually walk through a building prior to it being built. However, as a team we quickly realized that there is little need for this type of software in the industry. We pivoted by beginning research within the industry to identify new problems to try and solve.

From that point on, the project took a different course from the typical IQP, as this project did not have a defined problem to solve. Instead, the team was tasked with identifying the problems in the construction industry and finding a way to solve them. Throughout the remainder of the project the ideas grew along with the opportunities. Construction companies were excited by the chance of a new product to make their lives easier. However, we knew that not every challenge could be solved, and ultimately the opportunities had to be narrowed down to one project. **That project is Pallyt, a construction delivery service that can save time for contractors and homeowners with quick and efficient delivery at the tips of the customers fingers.**

Project Data Dashboard

A Long journey to the project arrival

29 Week Project
Duration

46 People
Interviewed

30 Companies
Interviewed

11 Different Job
Positions interviewed

51 Survey
Responses

8 Identified
Challenge Categories

13 Possible
Project Opportunities

4 Project Ideas

46 Software's
Used in Industry

More information can be found in the Appendix section. *Appendix A* has the Job positions, *Appendix B* has Company Type, *Appendix C* has software's used in the industry, and *Appendix D* has the Pallyt Survey Data.

Methodology



Methodology

The goal of this project was to identify **pain points** existing in the **construction industry** and ways to solve them. Upon the collection of various pain points in the industry the team began identifying ways to improve or even fully solve some of them in the form of potential new software's. Most of our market research was done in the form of **interviews**. The team interviewed people from various roles in the construction industry, ranging from construction managers to estimators to business developers and sub-contractors. Interviewees were contacted through various ways including: **cold calling**, **LinkedIn posts**, **existing contacts**, and other forms of **networking**. Prior to each interview consistent contact was kept in the form of sending invitations, agendas, Microsoft Teams links...etc. An example of the agenda which was sent out prior to an interview that was being conducted can be seen on the next page in *Figure 1*. Each interview was conducted by a minimum of two team members, with one member who took notes and the other who ran the interview by asking questions and leading the discussion.

Figure 1: Example Agenda

Construction Innovation

A revolution in construction pricing

Meeting Agenda

Objective: Construction Interview

Date: **Time:**

Location: Microsoft Teams

Facilitators: David Hinckley Jr. & Ryan Menard

Attendees: Interviewee(s)

The information that is shared during this meeting will not be tied to your name or company in any way. With your permission can we record this meeting for note taking and data purposes only.

Introduction: Brief introduction of meeting attendees.

Meeting Goal: To have an open dialogue about challenges in the construction industry.

Context: At Worcester Polytechnic Institute, students are tasked with a project known as the Interactive Qualifying Project (IQP) to solve a problem that faces an industry or group of people. Our project is focused on identifying ways to eliminate inefficiencies and spur innovation within the construction industry. Additionally, this project will inspire our Major Qualifying Project (MQP), where we will create a solution for this problem.

Statement: We will use this time to get information about the industry, specifically challenges in Preconstruction, Operations, and material distribution/ locating phases. This information will be used to design and produce a software based solution. We will base the discussion on the topics below, additionally we have attached some questions that may be asked.

Topics/Themes:

- Personal/Job Information
- Company processes/ operations
- Challenges in the industry
- Material Delivery and Locating Process
- Future of the Industry
- Follow-up Interview/ Additional People to Interview

Conclusion/Next Steps: To develop a software/program to address the gaps within Estimating in the construction industry.

Interview Process

Prior to starting each interview, our team sought approval to record the meeting. We stated that the recording is solely for our team and will not be shared. The purpose of recording was for note taking and **data collection**, and all recordings were kept internally between the team. After approval for recording was gained or declined each team member present at the meeting gave a short introduction, followed by the interviewees **introduction** along with them providing **background on the company**. Once introductions were completed, the interview moved into a discussion about the **topics/themes** (listed in *Figure 1* above), the objective was to keep the conversation very open and follow a discussion basis, rather than questions and answers. *Figure 2* has some example interview topics, and *Appendix E*, has the interview questions that were used to guide each interview. Upon completion of each interview the **pain points** and **challenges** as well as the ideas were recorded in the interview data and Idea's sheet (Challenges are in *Appendix F*, while the Idea Parking Lot is in *Appendix G*). The purpose of the idea parking lot, located in *Appendix G*, was to keep track of potential project ideas and evaluate the need for them. Additionally, the idea parking lot allowed us to help guide the potential approach in addressing the pain points and problems.

Figure 2:

Example Interview Question Topics

Background
and Experience

Industry
Challenges

Preconstruction
Process

Use of Software

Typical Project
Procedures

Material
Delivery

Material Supply
Chain

Use of
Technology on
Site

Technological
Innovation in
the Industry

Our interview questions can be found in *Appendix E*.



IRB

Institutional Review Board

The Institutional Review Board is an organization at WPI that promotes and supports efforts to conduct innovative research. The purpose of the board is to ensure that any research being carried out with human subjects complies with ethical and regulatory requirements. Prior to any research involving human subjects being conducted the IRB's approval must be obtained. Approval is achieved through a variety of steps, the first was taking a series of training videos and tests which help the researcher understand ethical and regulatory requirements. Once the trainings had been completed then an exemption application was submitted to the IRB. The application contained write ups such as methodology, potential interviewee's, data storage and usage, recording consent, and a variety of other things.

Due to our project involving human subjects we were required to submit an IRB application for the board to review. The trainings were first completed, and their certificates were uploaded with our application. After a couple of weeks of submitting our application, we gained approval to conduct our research. The process was very straight forward and quick. Items from the IRB process can be found in *Appendix H*.

Interview Rounds 1 & 2



Interview Rounds

Round 1

Aimed at our original
Idea of VR Blueprints

Round 2

Aimed at discovering
gaps in software's
currently used

Round 3

Aimed at procurement of
materials and pre-
construction

Round 4

Aimed at procurement
and delivery of materials

Round 5

Aimed at our service/app
idea of Pallyt

Interview Round 1

Initial Discovery & VR Blueprints

3

Interviews
Conducted

3

Companies
Interviewed

Purpose: The objective of this initial round of interviews was to test the needs of the Virtual Reality (VR) Blueprints Software in the industry. During this round we asked questions directly pertaining to the idea that produced answers which would guide the idea.

Additionally, during this round of interviews lots of research was completed outside of the interviews for the VR Blueprints idea.

Findings: Through the first rounds of interviews, we were able to conclude that our original idea of VR Blueprints was one not worth pursuing. We were able to discover that there would not be as much demand for this type of software as we originally thought there would be. Additionally, there are currently software's out in the market like our idea, we found these software's were not widely used. Ultimately, these interviews did benefit us as we were able to discover different areas and ideas to break off into. Due to this realization, we began the next round of interviews.

Interview Round 2

New Challenges/ New Ideas

4

Interviews
Conducted

4

Companies
Interviewed

Purpose: The objective of the second round of interviews was to shift the interview into a conversation where all areas of the construction industry were talked about along with pain points within them. This was done through producing questions which would direct the interviewee into talking about the many different areas in the industry. The purpose of this was to begin to understand what other problems exist in the industry, as this would guide us to our next steps of our project.

Findings: This round of interviews was very helpful in beginning to understand the pain points/problems being experienced within the construction industry. The main problems that were identified during this round of interviews were within the preconstruction phases of construction. However, a few others were identified in different phases/areas. In addition to the specific phases/areas of construction another area which was commonly mentioned as having problems was the communication between people and departments. This round of interviews allowed us to see what direction the next round of interviews should be.



Project Ideas

Project Evolution

1

VR Blueprints

A Virtual Reality software which allows construction buildings to be seen prior to construction.

3

BPS

Software focused on Bidding, Procurement and Scope for construction.

2

Project Data Dashboard

Project Data Dashboard which allows information to be centrally stored.

4

Pallyt

A location & delivery service for construction materials.

Although many of the project ideas are not solving the same problem, they were all built from different challenges that were emphasized from members of the industry.

Idea 1

VR Blueprints

Our team's **original project idea** was to create a **software** that inputs a **CAD model** for immediate **virtual reality** use. Additionally, the user would have the ability to input blueprints with some additional information to further strengthen the virtual reality simulation.

The purpose of this software would be to allow customers to **walk through a building prior to it being built**. This project idea came after David Hinckley Jr. experienced project owners having a **misconception** in what the building would look like prior to when construction begins, along with companies citing challenges with **accurate presentation of buildings**. This software would solve this problem as it would allow customers to have a general idea of what the building would look like and make any changes or additions to the building prior to construction starting. Additionally, we would work to create **functionalities** within the program that would allow customers to do things such as change paint color, flooring, and other changes which would be more of **small-scale changes**.

Idea 2

Project Data Dashboard

One of the more commonly cited problems in the construction industry was that most companies use **several** different **software/programs**, this makes the **flow of information** a challenging aspect. Additionally, larger scale projects companies will have numerous employees assigned to the project, which makes accessing documents that other people on the project produced challenging. Our second project idea was aimed at tackling this problem by creating a web-based software that would allow information to be stored in a **central place** and be **easily accessed by multiple people**.

The software would also have the capability of storing multiple projects in it allowing an entire company to access multiple projects in one central place. The plan is to allow **data to integrate with other software's through one centralized dashboard** making every type of file that a company may use or produce during the construction phases accessible in one place. **Data** from **estimates**, to **project photos** to **CAD files** and **PDF's** can be accessed here.

Idea 3

BPS

Our third project idea focused on solving challenges within the **bidding**, **procurement** and **scope** processes of construction projects. One of the things that was commonly stated during our many interviews was that the **process of bidding on a project is very painstaking** and there is **no good program out there to assist in it**. Most companies produce their own spreadsheets for each project which can be **very tedious** and **time consuming** to complete the bidding process. Additionally, when companies send out division sections of the project to subcontractors to be bid on there is often very little **uniformity** in the bids they receive back from them, making it hard to level contractors against one another.

BPS, which stands for bidding, procurement and scope, aims to **fix the challenges** of the bidding process by creating a program which **simplifies** the creation of the **bid sheet**. This would allow for **custom templates** to be made and used by companies providing a uniform way for subcontractors to send back bids. This will allow the **process** to be more **efficient** through both **cost** and **time** and allow for an easier bid leveling process.

Idea 4

Pallyt

Our fourth project idea focuses on solving challenges within the **location** and **delivery** of **construction materials**. This project will be a delivery service offered to **homeowners** and **contractors** to get the **materials** for a **project delivered**. Essentially it is will be like Uber Eats, DoorDash or GrubHub, however, it will be focused on the construction industry. The project will be app based, with a website as well, which will connect **consumers** to **materials** at **nearby stores**.

Consumers, whether they be homeowners or general contractors, will be able to identify the **items** they want and then have them **delivered** to **their home** or **project site** in a **short amount of time**. This will allow little delay in projects and keep people on site, working rather than leaving for materials. We will aim to focus on central Massachusetts at first and target people/stores within that area. **Delivery drivers** will be **gig workers**, like ones used for Uber, and will handle the delivery aspect of the product.

Interview Round 3



Interview Round 3

Construction Process/ Procurement

17

Interviews
Conducted

14

Companies
Interviewed

Purpose: The objective of our third round of interviews was to narrow down the 4 ideas we had produced. In order to do so a new set of questions was produced which aimed to address the need of each of the 4 ideas. As the interview process progressed this round, it became clear that certain ideas had better grounds than others. Therefore, the questions were revamped to cater those ideas over the previous question set.

Findings: This round of interviews was very helpful in shaping the direction of our project. During the first few interviews **it became very clear that ideas 3 and 4 (BPS & Pallyt) had the most need in the industry.** Due to this, the remaining interviews were shifted towards those ideas. The proceeding interviews allowed us to arrive at the project which we ended up choosing. We found that there was no specific need for a new software in the bidding, procurement, and scope side of the industry. Additionally, we found a large need for the Pallyt idea. Therefore, we went with idea 4.



Project Arrival

Findings

Interviews Rounds 1-3

Problems Faced in the Construction Industry:

People Problems

- Lack of communication within the industry.
- People struggle and resist the adaptation of new software's; would rather stick with outdated ones they know.
- There is a technology gap between the new members in the industry and the seasoned veterans.
- People needing to head offsite to track down and pickup materials, brings productivity way down.

Industry Problems

- There are too many software's out there, in the interviews we conducted over 50 software's were being used across all the companies.
- Majority of the problems were in the preconstruction side of the industry, suggests that that side may be too difficult to fix.
- All needs seem to be covered by an existing software; integration just seems to lack.

Project Decision Process

After the first round of interviews, it was clear that VR Blueprints was not a needed product in the industry, as other companies have already begun the process and it hasn't been adopted yet. During round 2, many interviewees mentioned the lack of consistent data. A solution was the Project Data Dashboard, the issue though, was that existing programs do not export similar data types and there are not industry standard construction processes, making it impossible to have all data work together.

After we finished the first two rounds of interviews and produced project ideas based off those first two rounds of interviews, we went into round three using BPS as our lead project idea. Through our first three rounds of interviews, we were able to determine that most of the problems within the construction industry linked back to the people and management themselves. Something commonly cited in interviews was that people struggle to adopt and adapt to new software, resulting in less innovation in the construction industry. This is due to several factors such as the high median age in the industry, technology being on the newer side in the industry and several other factors. Most of the project ideas we discovered were in the pre-construction side of the industry.

Project Decision Process Continued

During the first three rounds of interviews, we identified all the software's being used by the respective company. We then categorized them by the subject it was associated with, whether that be preconstruction or another division. After conducting the first two rounds of interviews we identified upwards of 50 different software's were used by all the companies that we interviewed, specifically in the pre-construction sector. Ultimately, our team decided that there is no need to introduce yet another preconstruction software into the industry. Our reasoning behind this was due to a few reasons, such as the software's that currently exist in the industry cover many of the needs but are not used to their full strength or capabilities. We also found that it would be unfeasible to integrate all the existing software's together, and people in the industry struggle to accept change. Due to this more rounds of interviews were held to further explore project possibilities.

Arrival at Pallyt

Ultimately, we arrived at the idea of creating a material delivery service that would utilize store's inventory and gig-economy drivers to service the needs of the construction industry. This idea came after several interviewees stated that a common pain point is having their superintendents or other workers head off site to pick up materials, reducing the amount of work that the contractors can do during the workday. This is a problem since these workers on a job site cannot work on the site or aid others in working, while they are off picking up material. This leads to decreased productivity, and many times causes project delays, as materials are needed almost daily, causing someone to leave each time. When a job site worker heads out to get more material, they can no longer focus on their responsibilities on the job site or finish their work on time resulting in delays. Additionally, if the worker is responsible for other people on the job site their leaving may result in decreased productivity for those people. Pallyt also solves problems for homeowners, allowing them to keep working on a project, and not go to the store numerous times.

Strage Award

Early on in our development of Pallyt, an award called the Strage Award was brought to our teams' attention. The Strage Award is an annually award that was first awarded in 2005. It encourages WPI undergraduate students who are interested in innovation and turning new ideas into viable new projects or ventures. The application consisted of things such as a description, funding impact, benefit to society, market strategy, amongst many other things, and was due Monday March 15th, 2021. The application were review by a panel of judges, and selections were made on who would advance to the next round. The winner of the award would win a prize amount of \$5,000.

Unfortunately, during the first round of selections our team was not selected to advance to the competition day. However, the application process allowed us to further strengthen our idea as it contained many aspects we had not considered yet. Our application for this award can be found in *Appendix I*.



Interview Rounds 4 & 5

Interview Round 4

Material Delivery

10

Interviews
Conducted

8

Companies
Interviewed

Purpose: The objective of this rounds of interviews was to begin narrowing in on Pallyt and the exact needs in the industry for it. In order to do so we created a list of questions directly aimed at location and delivery of materials within the construction industry. Additionally, we began contacting stores to better understand the procurement side of things, along with to begin forming connections.

Findings: This round of interviews was very helpful in shaping the direction of the IQP and Pallyt. We were able to interview numerous people, mostly in the commercial side of the industry. Through these interviews we gained great insight on how the service should be structured and whether people would the service. Additionally, many great questions were raised during the interviews which helped further understand and strengthen the idea. Towards the end of this round, we began interviews with stores to gain information from their point of view. These interviews had varying results, but overall proved to be a success in advancing the project

Interview Round 5

Pallyt

51

Survey Responses
Recorded

11

Interviews Conducted

3

Categories
Interviewed


Purpose: During this round of interviews, we began shifting from the commercial side of the industry to more of the residential side. In order to do so we conducted interviews and sent out surveys to homeowners. The purpose of this was to gain insight on the need for this type of service in the **residential/homeowner** sector of the industry. The survey was designed to both gain insight into how many DIY projects people do and how they source their materials for them.

Findings: This round of interviews/surveys allowed vast amounts of information pertaining to Pallyt to be gathered. Ultimately, the survey proved to be very helpful as we were able to gather information from over **50 homeowners** on the project. The information gathered from these surveys varied, however, for the most part pointed to a need for this type of service. This round included phone and video interviews, which allowed for more in-depth conversations, digging deeper into the idea. To end this round of interviews we met with a store to partner with Pallyt.

A photograph of a construction site at sunset. Several large tower cranes are visible against a bright, hazy sky. In the foreground, there is a dirt area with some construction equipment. In the background, a modern building with many windows is partially visible. The overall scene is bathed in the warm, golden light of the setting sun.

What's the Problem

Challenges Discovered



Through our many interviews we were able to identify numerous challenges in the construction industry. One of the challenges that stood out was material procurement. Companies generally have materials shipped out in bulk to their project site prior to the start of the project or during different stages of a project. Throughout the project they will bring in more material in shipments to start different sections of the project such as framing or painting. The challenge companies often face is forgetting to order a certain material on that delivery or not ordering enough of a certain material. When this happens the company often must send out one of their own workers to a nearby store to buy the needed material. This is because many of the stores who deliver in bulk have requirements for delivery size and often take significant amount of time to ship material out.

Challenges

Challenges in material location & delivery

Forgetting Material

Sending people out to get material

Wasting time getting materials

Some stores only deliver past a certain amount of material

Finding stores with the material in stock

Often higher ups leave project sites for material

More detailed material and delivery challenges can be found in *Appendix J*.

Detailed Solution



Detailed Solution

The Pallyt application will expand the accessibility to products and materials that are needed for a customer's home or project site. The location and delivery of materials through the Pallyt app will allow for greater productivity on the project at hand. The service will be aimed at two main consumer segments of homeowners and contractors. When a consumer is either missing material or will need material soon for the project, they will be able to use Pallyt to have the materials delivered in a timely manner. This would allow for minimal time wasted in completing the project, as they can continue to work on it while waiting for materials. Additionally, if the person is a paid employee this service will allow their employer to not have to pay for their employees to make unnecessary trips to and from stores and keep their employees working.

For all of this to work a phone-based app will be developed to connect the users to the service in an accessible manner. The exact structure of the software's and apps involved with the project will continue to change and evolve as the project progresses. As the service continues to become more in depth we will begin partnering with stores, as they will be the ones supplying the materials for this service. Delivery drivers will be in the form of gig economy workers, like Uber and Grub Hub, who will pick up the materials from the partner stores and then deliver them to the location identified by the user of the service. Depending on the store we plan to either have the stores employees pull the material from stock or have the drivers go inside and gather the delivery. *Appendix K* has some of the desired program functionalities for Pallyt.



Recruitment Process

Recruitment Process

Building the Team One Step at a Time

This project had a unique format, much different than the traditional IQP at WPI. Rather than just being a project, it became more of a business venture. In November of 2020, David and Ryan began recruiting students to join the project. It was decided that computer science and industrial engineering students would be the best fit to join us with our existing business, management, civil engineering, and construction backgrounds. Additionally, we did look at adding additional business students and even math students prior to deciding the project path. The process began at the department level, in which administration and professors were contacted to make sure that the project fit the Major Qualifying Project requirements for the student's majors.

Recruitment Process

Building the CS Team

Upon meeting with Professor Wong of the Computer Science department, we were provided with a list of highly recommended students to meet with to see if they would be interested in joining the team. We met with 6 students who were on the list and selected 5 students. Unfortunately, after a few weeks a student and the team decided to mutually part ways. Nathan Klingensmith, Eva Bruklich, Robear Mankaryous and Zachary Wong were selected to join the construction innovation team. Their development, design, and coding skills, complied with their desire to work and want to truly make an impact on the industry made it a clear choice to have them join the team to revolutionize the industry.

Recruitment Process

Building the Operations Team

To build the team up on the industrial engineering side, we met with Professor Towner to get an idea on the requirements for an Industrial Engineering MQP. Upon approval to the project and the goals, recruiting students within that major began. Joshua Alasso, a management engineering student with a concentration in industrial engineering and operations, proved to be a great candidate for the project. His marketing skills and operational tactics made a great fit for the team.

Margaret Reiter was the next IE student that David and Ryan met with, her desire to learn about the industry and identify the inefficiencies that could be solved made it clear that she had a spot on the team. Additionally, Joshua and Margaret had an existing working relationship, from working on their Interdisciplinary Qualifying Project together. This made for a seamless transition into their roles and gave comfort to David and Ryan as they knew their ability to work together.

Recruitment Process

It's Bigger than a Project

It goes without saying that the recruitment process does not always go smoothly. During the process we met with a few students that showed interest in the project and would be helpful to getting the project moving. However, due to the unknowns of the direction of the project and the requirements of some majors, we could not have them join the team.

Throughout this process it was important that we kept the project goals in mind, while also realizing that this project meant different things to everyone on it. At first to some it might have seemed like this was just a very interesting Major Qualifying Project opportunity, but as the team received more recognition and met with more members of the industry, everyone started to feel like there was more than just a project here. Of course, this project is far from complete, but it is important to see how far the team has grown in only a matter of months.

Team and Organization



Team & Organization

Roles and Responsibilities

The recruitment process was rather encouraging for David and Ryan as we found many students were interested and excited in the opportunity. This process allowed us to select the best students for the project team. To ensure that all the students and advisors were on the same page with the project, a weekly report was sent out every week. Examples of the reports are in the Appendix, the original report style (*Appendix L*) was rather long and became repetitive. To change that a new 1-page report was made, and can be found in *Appendix M*.

Upon the completion of the recruitment process a discussion needed to occur on the hierarchy for decision making. Ultimately, it was clear that with eight team members there was always going to be some sort of issue when it came to decisions and the direction of the project. After meeting with our advisors, we decided to establish a roles and responsibility matrix (*Figure 3*).

Figure 3: RACI

Roles and Responsibility Matrix

Responsible <i>The team member who does the work to complete the task.</i>	Accountable <i>The person who delegates work and provides final review on a task or deliverable before it's deemed complete.</i>	Consulted <i>People who provide input on a deliverable based on the impact on their work or their domain of expertise.</i>	Informed <i>People who need to be kept in the loop on project progress.</i>
--	--	--	---

RACI Roles and Responsibility Matrix								
Project Tasks	David Hinckley Jr. President	Ryan Menard Vice President	Eva Bruklich Head of Product	Nathan Klingensmith Head of Design	Zachary Wong Chief Architect	Robear Mankaryous Head of Development	Maggie Reiter Operations Consultant	Josh Alasso Operations Consultant
Business								
Branding	A	C	C	R	I	I	I	C
Logo Design	A	C	C	R	I	I	I	C
Marketing	A	C	I	C			I	C
Business Operations	A	C	C	I	I	I	C	C
Legal	R	R	C					I
Accounting/ Finance	R	C	C					C
Team Management	R	C	R	C			C	
Business Development	R	R	R	I				C
Time Value of Money	A	I	I				R	R
Development								
Story Mapping and Delegation	C	C	R	A	C	C		
Architecture Design and Modeling	I	I	R	R	R	R		
Backend Development	I	I	A	A	R	C		
Frontend Development	I	I	A	A	C	R		
Quality Assurance	A	A	R	R	R	R	C	C
Product								
Construction Research	A	R	I	I	I	I	I	
Market Research	C	C	R	A	A	A	I	I
UX/UI Design	C	C	A	R	C	C	I	
Customer Engagement	R	R	C	A				C
Product Requirements	R	R	C	C	I	I	I	
Product Optimization	A		C	C	I	I	I	I
Axiomatic Design	A	C	C	C			R	R


Team & Organization

Roles and Responsibilities

The RACI or Responsible Accountable Consulted Informed matrix was a great way to clearly see who is involved in what steps of the project. The RACI allows for an easy understanding of the roles in which each member of the team can follow and see who the lead is for each item and or major decision. In addition to the RACI, the team decided to run the project like how a business or startup is run. David and Ryan lead the project and work to guide the Development and Business Operations teams on the critical items. Within the Development team, Eva Bruklich and Nathan Klingensmith are team leads, they engage in daily conversations with David and Ryan to establish the crucial items and work through problems that occur throughout the process. Joshua Alasso and Margaret Reiter are acting as unbiased consultants to the team. They will look at the business, operations and development side of the project and make the necessary recommendations. Joshua will also assist on the marketing campaign for the Pallyt.

Team & Organization

Skills Chart



To highlight the many skills of the team a skills chart was made to identify areas of strength and weakness for the team (*Figure 4*). The skills chart allowed for members to quickly identify who in the team has a skillset in a certain area and obtain assistance from them.

By making the skills chart, David and Ryan had a better understanding of who can work on certain parts of the project and who can teach other members. Between the RACI and the Skills chart the team was broken into separate teams to lead different areas of the project. The main breakup of members falls within their major and who their advisor is for MQP. *Figure 5* is a breakdown of the team based on major.

Figure 4: Skills Chart

Team Skills Chart

Construction Innovation Team Skills Chart

Skills	Team Member							
	David Hinckley Jr	Ryan Menard	Eva Bruklich	Nathan Klingensmith	Zachary Wong	Robear Mankaryous	Maggie Reiter	Josh Alasso
Leadership	Can Coach	Skilled Enough	Highly Trained	Skilled Enough	Skilled Enough	Skilled Enough	Skilled Enough	Highly Trained
Communication	Can Coach	Skilled Enough	Highly Trained	Highly Trained	Skilled Enough	Basic Training	Highly Trained	Highly Trained
Presentation	Can Coach	Skilled Enough	Highly Trained	Highly Trained	Highly Trained	Skilled Enough	Highly Trained	Highly Trained
Management	Can Coach	Skilled Enough	Highly Trained	Skilled Enough	Basic Training	Basic Training	Skilled Enough	Highly Trained
Decision making	Highly Trained	Skilled Enough	Skilled Enough	Highly Trained	Skilled Enough	Skilled Enough	Highly Trained	Skilled Enough
Problem solving	Highly Trained	Skilled Enough	Skilled Enough	Highly Trained	Highly Trained	Highly Trained	Highly Trained	Skilled Enough
Negotiating	Skilled Enough	Skilled Enough	Skilled Enough	Training Requested	Basic Training	Basic Training	Training Requested	Skilled Enough
Agile PM	Training Requested	Training Requested	Can Coach	Can Coach	Highly Trained	Highly Trained	Training Requested	Training Requested
Customer service	Highly Trained	Skilled Enough	Can Coach	Skilled Enough	Training Requested	Skilled Enough	Training Requested	Skilled Enough
Networking	Can Coach	Skilled Enough	Highly Trained	Training Requested	Basic Training	Basic Training	Skilled Enough	Skilled Enough
Construction PM	Can Coach	Highly Trained	Training Requested	Basic Training	Training Requested	Training Requested	Training Requested	Training Requested
Software Development	Training Requested	Training Requested	Highly Trained	Can Coach	Can Coach	Can Coach	Training Requested	Training Requested
Marketing	Basic Training	Training Requested	Basic Training	Highly Trained	Training Requested	Basic Training	Training Requested	Highly Trained
Excel	Highly Trained	Highly Trained	Basic Training	Skilled Enough	Can Coach	Can Coach	Skilled Enough	Skilled Enough
PowerPoint	Skilled Enough	Highly Trained	Skilled Enough	Skilled Enough	Can Coach	Can Coach	Skilled Enough	Highly Trained
Word	Skilled Enough	Highly Trained	Skilled Enough	Skilled Enough	Can Coach	Can Coach	Skilled Enough	Can Coach
Outlook	Highly Trained	Highly Trained	Highly Trained	Skilled Enough	Can Coach	Can Coach	Skilled Enough	Can Coach
Organization	Highly Trained	Highly Trained	Highly Trained	Highly Trained	Highly Trained	Skilled Enough	Highly Trained	Highly Trained
Teamwork	Highly Trained	Highly Trained	Can Coach	Highly Trained	Highly Trained	Skilled Enough	Highly Trained	Highly Trained
Collaboration	Highly Trained	Highly Trained	Highly Trained	Highly Trained	Highly Trained	Skilled Enough	Highly Trained	Highly Trained
Public Speaking	Can Coach	Basic Training	Basic Training	Highly Trained	Can Coach	Training Requested	Skilled Enough	Skilled Enough
Branding	Skilled Enough	Training Requested	Basic Training	Can Coach	Basic Training	Basic Training	Training Requested	Skilled Enough

Figure 5:MQP Team

Students and Advisors

Student Team			
Team #	Student	Major	MQP Terms
1	David Hinckley Jr.	Management Engineering	1/3 A, 2/3 B
		Civil Engineering	
	Ryan Menard	Civil Engineering	
2	Nathan Klingensmith	Computer Science	A, B, C
	Zachary Wong	Computer Science	
	Eva Bruklich	Computer Science	
	Robear Mankaryous	Computer Science	
3	Josh Alasso	Management Engineering	A, B, C
		Industrial Engineering	
	Maggie Reiter	Industrial Engineering	
Advisor Team			
Team #	Advisor	Department	MQP Terms
1	Rob Sarnie	Business/ MGE	1/3 A, 2/3 B
	Carrick Eggleston	Civil Engineering	
	Curtis Abel *	Innovation & Entrepreneurship	
2	Wilson Wong	Computer Science	A, B, C
3	Wally Towner	Industrial Engineering	A, B, C
	Edward Gonsalves	Business/ MGE	
* Advising on the entrepreneurship portion of the project with Team 1			

Team Breakdown

Additionally, we have broken the team up into the following sub teams, Development Team, Business/Operations Team, Management Team, and Operations Consulting. *Figure 6*, shows the teams and the members within them. These teams are based on skills and experiences rather than a members major. They serve to identify key roles in the project and who is assigned to those respective roles.

Figure 6:
Sub Teams

Sub Teams	
Team	Member
Development Team	Nathan Klingensmith
	Zachary Wong
	Eva Brukich
	Robear Mankaryous
Business/Operations Team	David Hinckley Jr.
	Eva Brukich
	Ryan Menard
Management Team	David Hinckley Jr.
	Ryan Menard
	Nathan Klingensmith
	Eva Brukich
Operations Consulting	Josh Alasso
	Maggie Reiter

I-Corps



New England I-Corps

Class Format

The I-Corps program provided us with financial and mentoring support allowing us to further develop and progress our idea of Pallyt. During this program, a total of 4 classes were held which focused on our products value proposition, customer segment amongst other things throughout the course of 10 weeks. The program also required all its participating groups to test and refine their idea by conducting numerous interviews with people relating to the idea. Each class a total of 10 new interviews were requested from each group, our group was consistently able to surpass that amount. Between and during classes our assigned mentors kept constant contact to help refine and point our idea in the right direction.

I-Corps classes ran from 5-7:15pm every 3-4 weeks, all which had varying agendas. During every class each of the 10 teams presented 5-10 minutes, which was followed by questions and feedback from the mentors along with other teams. These presentations allowed for the project to progress in a meaningful manner as lots of feedback was able to be received during class. Once all the teams completed their presentations the class would move towards more of a lecture style. During this time topics such as creating strong interviews, business operations, value propositions, along with a variety of others were covered. The class was finished up with each of the teams meeting with their respective mentors for 15 to 30 mins, in which a more specialized conversation was held.

New England I-Corps



WPI



NE  **I-Corps**

New England Regional Innovation Node @ MIT

The Following pages (52-58) have our final presentation for the I-Corps program sponsored by the National Science Foundation and run through a partnership between MIT and WPI.



Pallyt

Final I-Corps Presentation

Worcester Polytechnic Institute

TEAM SUCCESS



David Hinckley Jr.
Entrepreneurial Lead



Ryan Menard
Team Member



Nathan Klingensmith
Team Member



Eva Brukllich
Team Member

Additional Team Members:

Joshua Alasso, Robear Mankaryous, Margaret Reiter & Zachary Wong

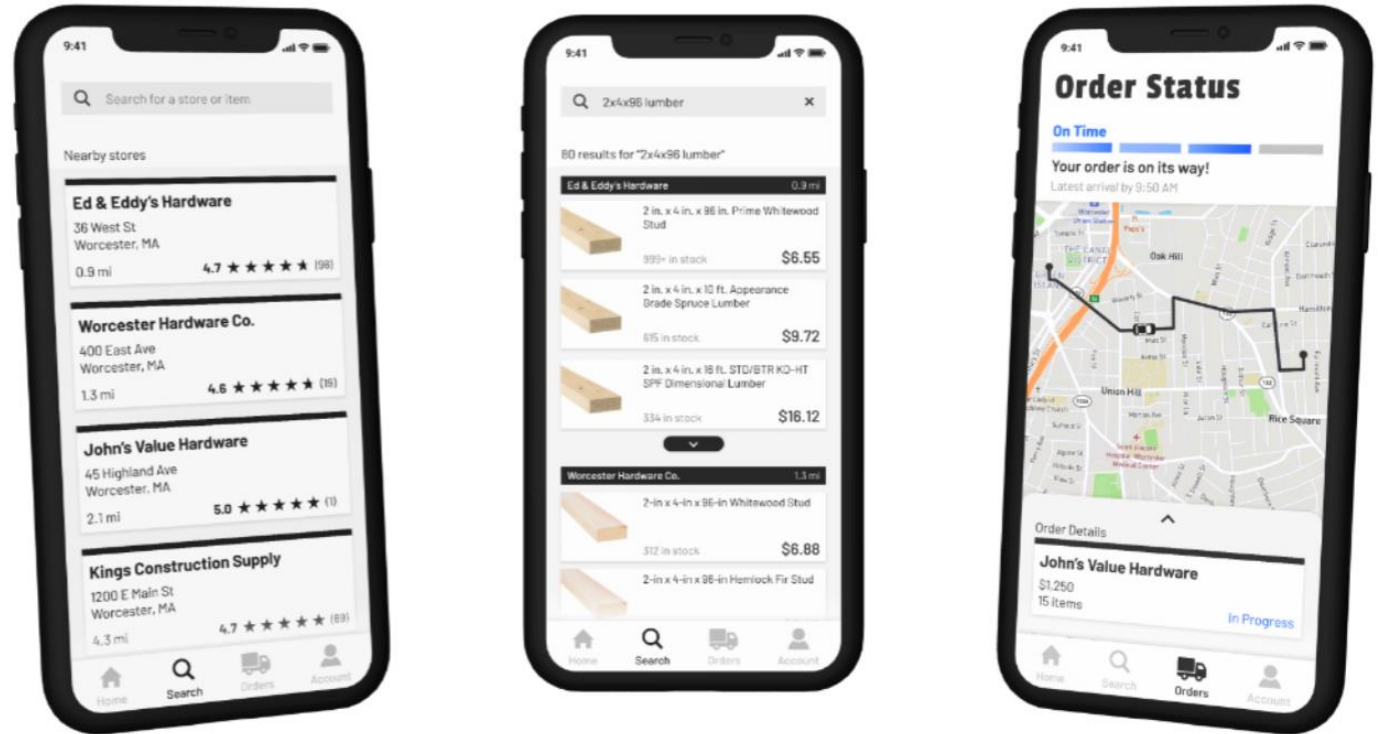
	Interviews	Physical	Online	Phone
New	12	1	6	5
Total	46	3	35	8

	Surveys	Online	In-Person
Total	51	51	0

Pallyt Technologies

OUR PRODUCT

Through the **Pallyt** app, customers will be able to search for and order construction materials from local hardware stores and supply houses. Orders will be picked up and delivered directly to the customer by local gig-economy drivers.



Pallyt Technologies



CRITICAL INSIGHTS

Pallyt Technologies

1

The homeowner customer segment will have real benefits from this app, and they are likely to use it.

2

We are on the right track with our preliminary product designs. People think the app would be easy and intuitive to use.

3

Stores have expressed interest on the service and think it will serve many benefits. Many of the stores would like to see the service evolve.



MARKET SEGMENT #1

Pallyt Technologies

Homeowners

CUSTOMER SEGMENT

Pallyt's first customer segment will be middleclass *homeowners*, ages 25-50, who do home improvement and other DIY projects.

VALUE PROPOSITION

For *homeowners* that want to get their home projects done faster. Pallyt gets you the materials you need, when you need them. Saving you multiple trips.



MARKET SEGMENT #2

Pallyt Technologies

Construction Contractors

CUSTOMER SEGMENT

Pallyt's second customer segment will be construction supervisors and foreman, ages 30 - 55, in the central and eastern parts of Massachusetts.

VALUE PROPOSITION

For *construction contractors* looking to avoid costly trips to the store when materials are missing. Pallyt is there when you need it, helping you avoid those costly roadblocks.



NEXT STEPS

Pallyt Technologies

1 Continue User Research

Continue conducting user research into the needs of our customer segments.

2 Continue Prototyping

Continue prototyping app designs and begin user testing to get feedback on usability.

3 Find Partners

Find 2 - 3 stores willing to partner with us and give us access to their inventory data.

4 Acquire Funding

Acquire funding to begin marketing and development stages. As well as Legal fees and IPO costs.

Key Learnings



Key Learnings

- The Construction Industry has made strides in technological advancement over the past few decades, however, still has some distance to go in terms of technology, compared to other industries.
- The Industry has a vast number of programs and software for all the sub sections associated with it, especially in the preconstruction area. Therefore, there is little need to produce a new software to aid in the industry.
- Material location and delivery can be a challenging aspect in the industry, both for present and future material needs.
- The recruitment process and selection of team members has much more to it than someone being able to complete specified work, it dives deeper into leadership skills, time management, teamwork, reliability...etc.
- Throughout this process we have learned that there is no one way to build a business. It is important to listen to advisors and mentors, but ultimately, we need to make the decisions.

Key Learnings Continued

- The construction Industry needs organizational changes, which can be highlighted through the many people and management problems we identified.
- Most companies struggle with the preconstruction area, specifically in estimating, scheduling and material location and delivery, however, software alone will not solve all these problems.
- The project duration of 3 terms allowed us to home in and make sure that we were preceding with a solution that would solve the problems of the industry.
- Many communicational problems exist across the industry, whether they be between people, teams, or companies.
- Through conducting our many teams' meetings, both at the IQP and MQP level, we were able to better understand how to run a well-functioning team
- Currently locating materials and obtaining them at a reasonable time is very hard for both homeowners and contractors.

Conclusion



Conclusion

Construction Innovation overall was very successful and evolved greatly up through the IQP's conclusion. The project began with the vision of creating VR Blueprints, a software which shows buildings in VR prior to them being built. However, we quickly pivoted and began exploring other options once we realized VR Blueprints was not practical nor needed in the industry. From that point on 46 interviews were conducted and several project options were considered. Ultimately, Pallyt was selected as it had the most need and was the most practical for the industry. From the moment Pallyt was selected on our team quickly brought the idea to life, putting in many hours a week beginning to execute the idea. During this time, we were able to interview more people, record over 50 survey responses, form a partnership and beginning mapping out the road to success for Pallyt.

Although the Construction Innovation Interdisciplinary Qualifying Project is over, the IQP team and the MQP team that was built for this are just getting started. The MQP will get this application built and the goal is to establish a startup. The project has provided significant networking and business development opportunities, which has allowed the project to grow and evolve with the assistance from the industry. The construction industry needs a service that can get items at a moment's notice and deliver them to the site allowing for contractors to remain on site and work. Pallyt is going to establish itself as a major player in the gig-economy delivery force. It all started with a vision and the service starts in Central Mass.

Next Steps for the MQP

- Develop an MQP schedule and timeline.
- Make a business plan for Pallyt Technologies.
- Do a cost analysis for Pallyt Technologies.
- Develop the Pallyt Application.
- Find partnering stores for the Pallyt application.
- Establish a marketing plan for the product.

The Future of Pallyt

The Future of the MQP and the Business



This project is far from over; the team will be working to make the Pallyt app over the summer of 2021. After the team plans to do the Major Qualifying Project (MQP) throughout the 2021-2022 academic year to continue to evolve Pallyt. Our goal is to start Pallyt Technologies as a startup business at the conclusion of our time at WPI in the summer of 2022.



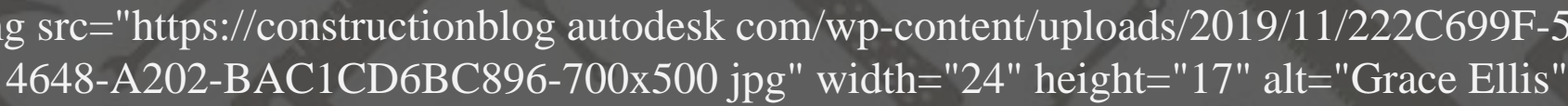
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Appendix

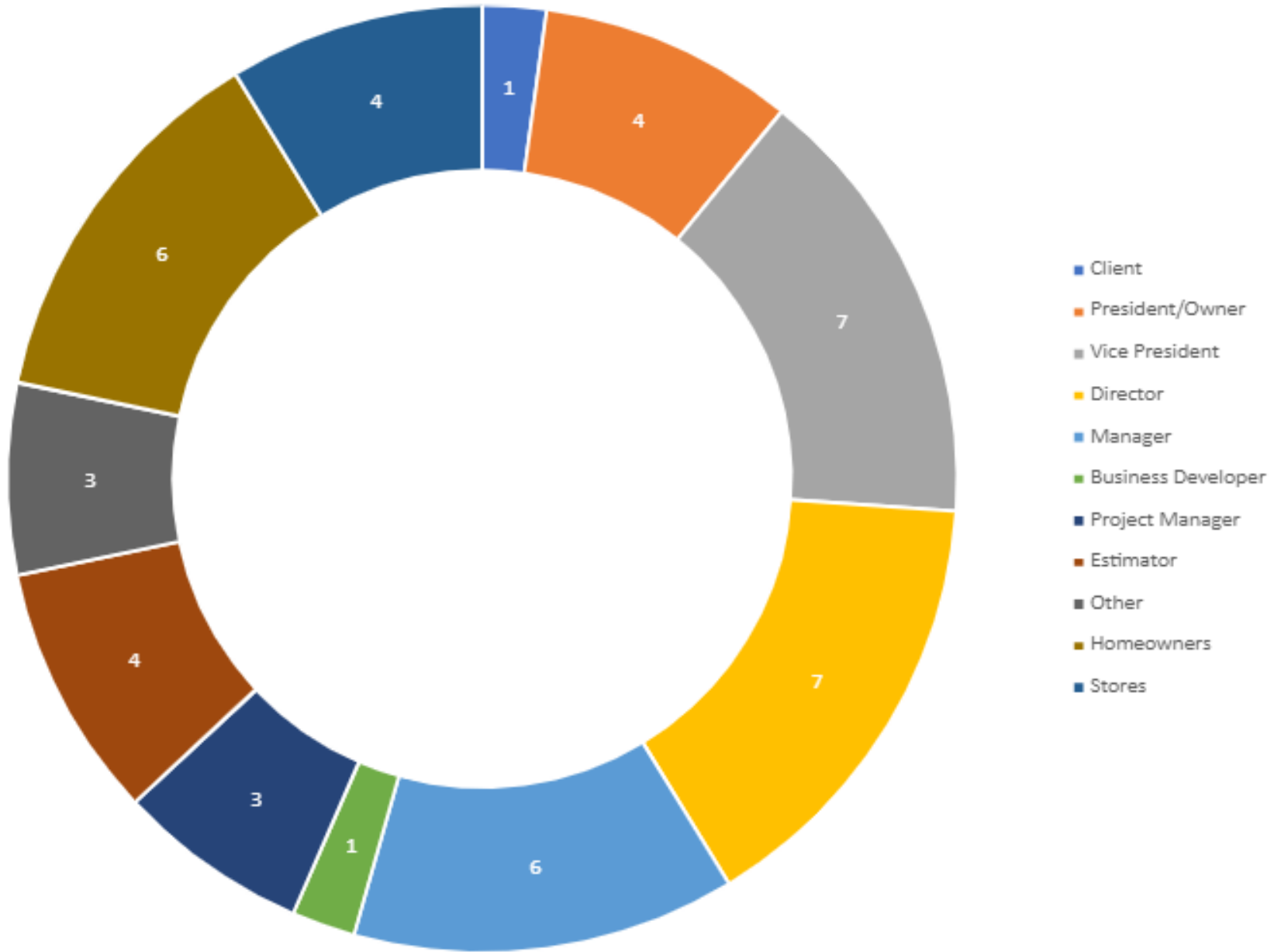


Appendix A

Interviewee Positions



Interview Positions

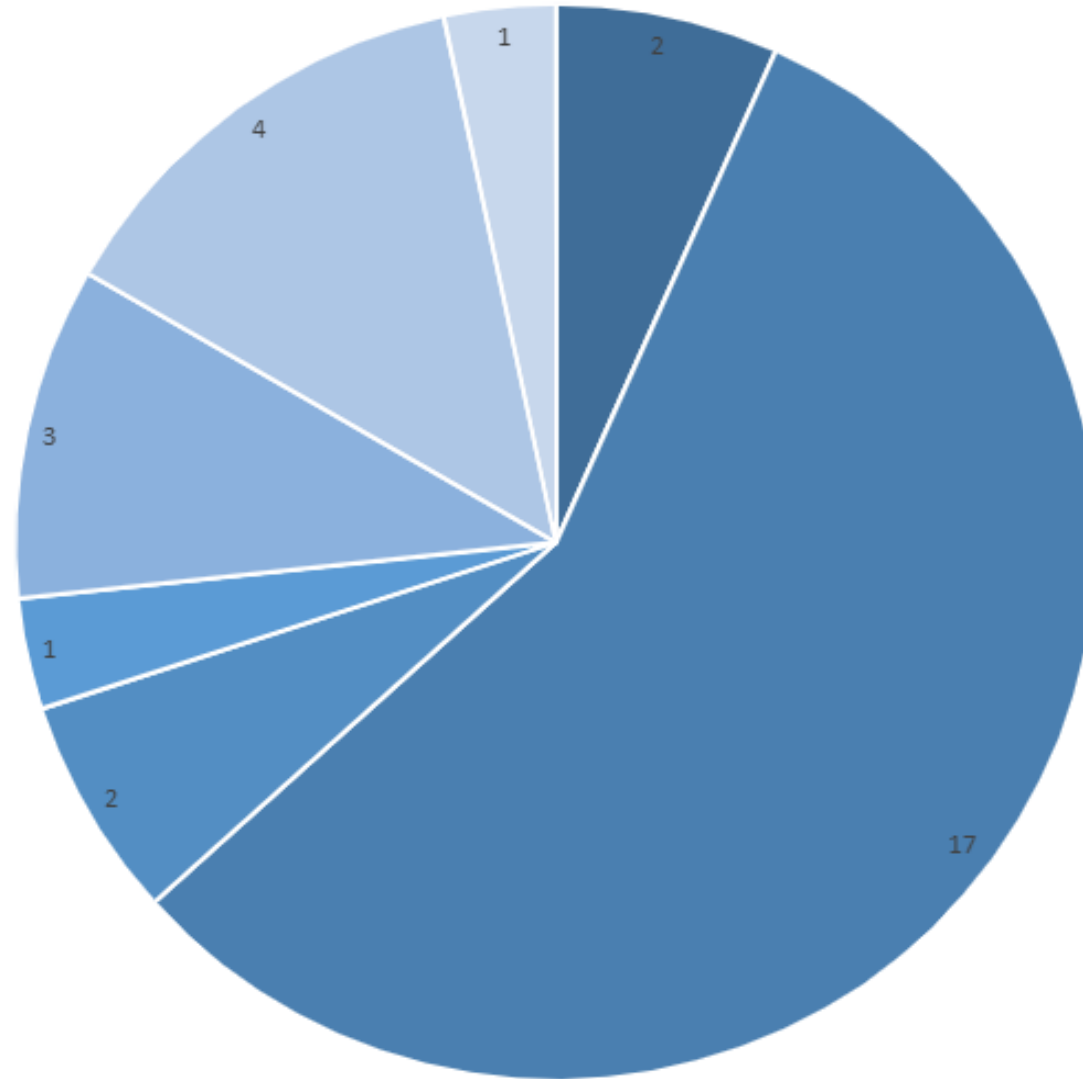


Appendix B

Company Types



Company Types



■ Manufacturing ■ General Contractors ■ Sub Contractors ■ Clients/Owners ■ Real Estate Developers ■ Store ■ Distributor

Appendix C

Software's Used in Industry



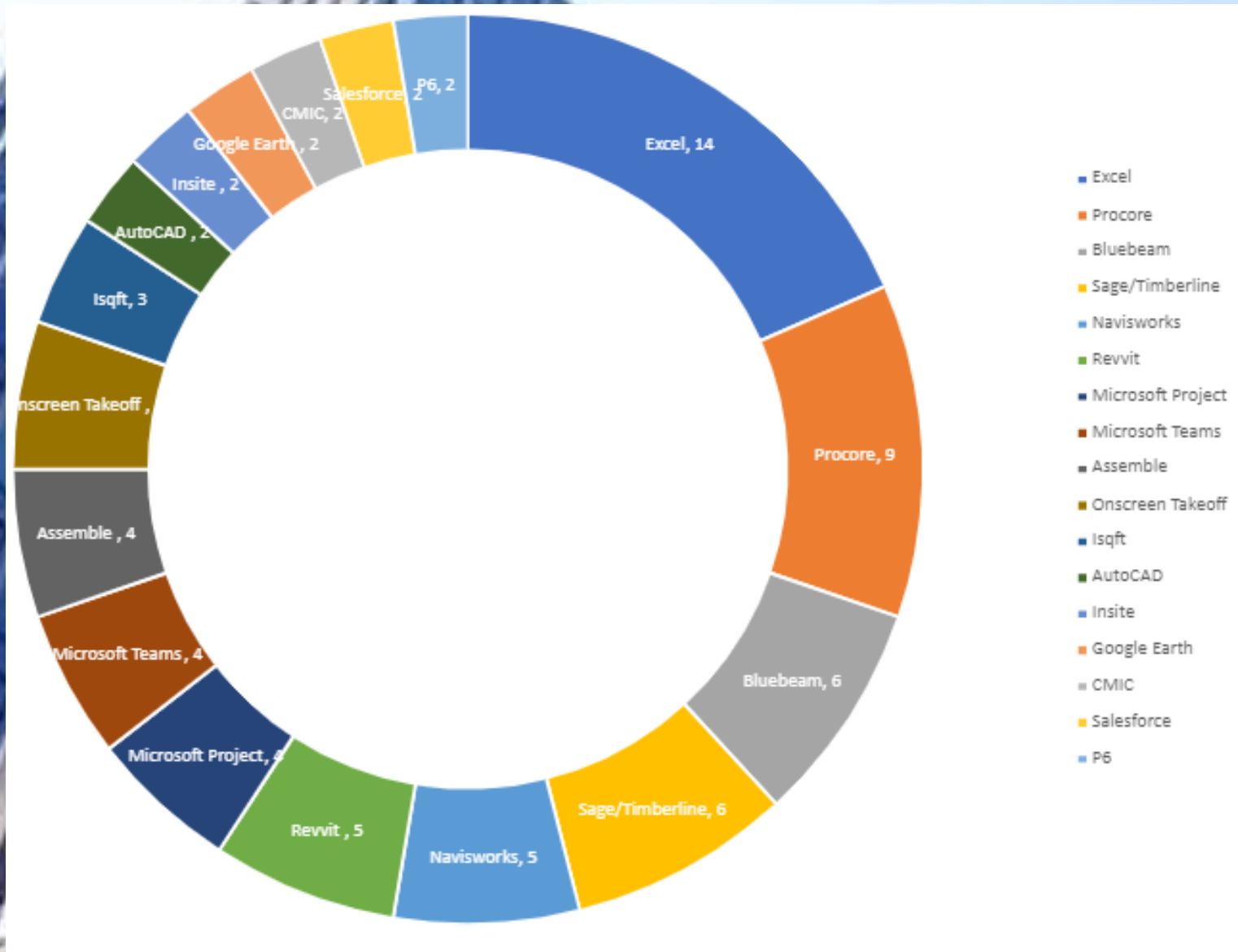
Software's Used

Software	Amount	Percent
Excel	14	13.2%
Procore	9	8.5%
Bluebeam	6	5.7%
Sage/Timberline	6	5.7%
Navisworks	5	4.7%
Revvit	5	4.7%
Microsoft Project	4	3.8%
Microsoft Teams	4	3.8%
Assemble	4	3.8%
Onscreen Takeoff	4	3.8%
Isqft	3	2.8%
AutoCAD	2	1.9%
Insite	2	1.9%
Google Earth	2	1.9%
CMIC	2	1.9%
Salesforce	2	1.9%
P6	2	1.9%
SmartBid	2	1.9%
Revizto	1	0.9%
SmartBid	1	0.9%
Textura	1	0.9%
Cosential	1	0.9%
Winest	1	0.9%
Destiny	1	0.9%
Rocktech	1	0.9%
SmartApp	1	0.9%
Vista	1	0.9%

Gradebeam	1	0.9%
Planswift	1	0.9%
Hammertech	1	0.9%
Building connected	1	0.9%
Kahooha	1	0.9%
Latasta	1	0.9%
Fieldwire	1	0.9%
Facilitygrid	1	0.9%
Trimble	1	0.9%
Pro Project finacials	1	0.9%
MS Flow	1	0.9%
Cocentral	1	0.9%
Quickbase	1	0.9%
ERP	1	0.9%
VisionSoft (EBM)	1	0.9%
plangrid	1	0.9%
Extranet	1	0.9%
BIM360	1	0.9%
Coins	1	0.9%

Note: These are the software's which were used by the companies interviewed & their occurrences.

Top Software's Used



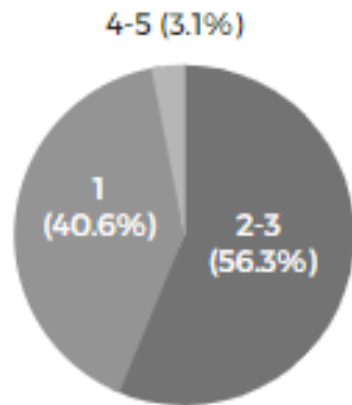
Note: These are the top software's used by the companies interviewed

Appendix D

Pallyt Survey Data

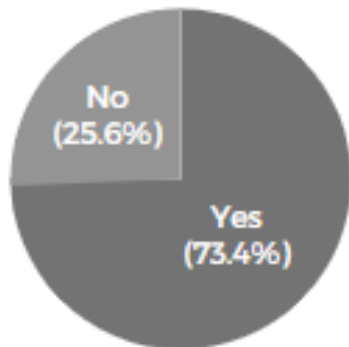


Survey Data

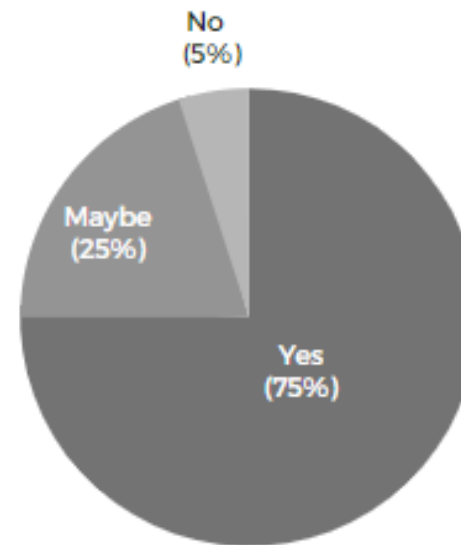
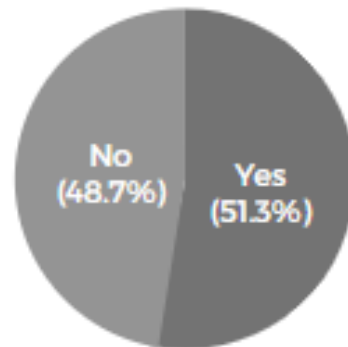


56.3% of homeowners reported having to go to the store **2 - 3 times a day** while working on a project. That's the pain point **Pallyt** hopes to solve.

Do you ever search for materials online?



Have you ever ordered materials online?



According to our survey, **75% of homeowners** would use an app like **Pallyt** to locate and purchase materials. This has matched the enthusiastic sentiment seen in our interviews with homeowners.

Appendix E

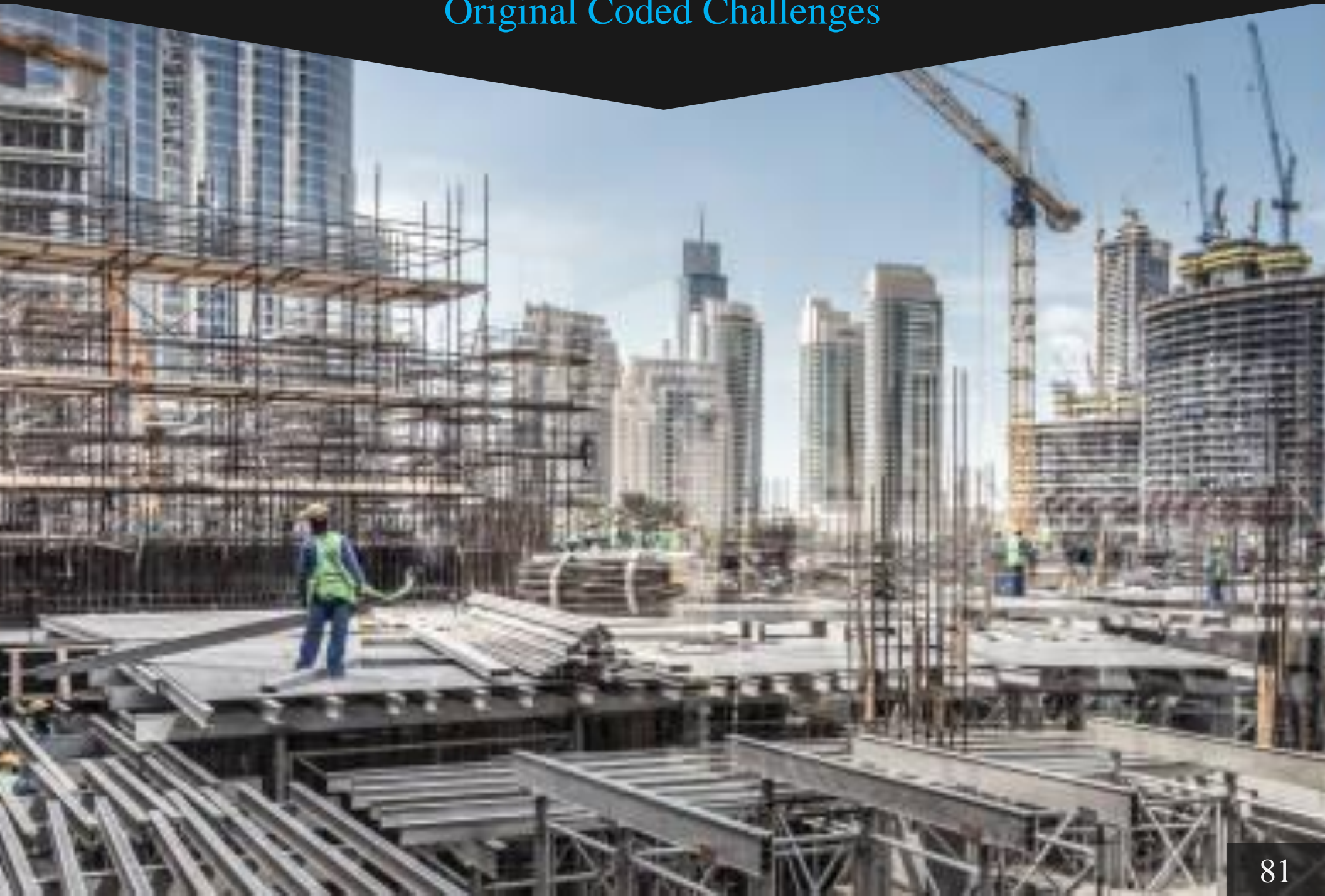
Sample Interview Questions



- **Could you provide us with some of your background and role at the company?**
- **Could you walk us through your project process, or life-cycle, including the software's you use throughout?**
- **What are the biggest challenges that you or your company face in this process?**
- **Who are the people that are generally located on your construction sites? (Example: PM, Supers, Project engineers, Etc.)**
- **What devices do people use on the construction site? (Laptop iPad, iPhone Android etc.)**
- **How willing are employees to test, try or use new technology on such devices?**
- **What process do you go through to locate materials? How do you have these materials delivered?**
- **How often are materials missing, or in short supply?**
- **Who is responsible to obtain the missing or short materials?**
- **Do you think there is an opportunity for a “Door Dash” Or “Uber Eats” style material delivery service for the small items needed by Subcontractors or General contractors?**
- **Where do you think the construction industry is in technological innovation?**
- **What do you think will change in the construction process in 5 to 10 years?**

Appendix F

Original Coded Challenges



Original Coded Challenges

Coded Interview Challenges	Communication	Software	Bidding & Leveling	Materials	Subcontractor Prequalification	Tracking	Modeling
Communicating with subcontractors	Getting complete bid information from subcontractors	Communication is always a problem	Getting subcontractor bids in, getting people interested in the project	Keeping track of subcontractors and their information	Margin is too low to do R&D like other industries	Most softwares aren't that good	
Getting people's bids in	Communication with subcontractors is cumbersome for both sides	Getting materials and man power during pandemic	Communicating with subcontractors	Receiving all of the bids is an issue	VDC models received are inconsistent	Hard to track a lot of employees on a job site	
Using many different programs	Optimizing and keep track of material delivery	Holding subcontractors accountable	Getting bids in the right form (on ProCore)	Poor communication between subcontractors and GC's is a problem	Reducing handoffs between preconstruction stage would be much more efficient	Hard to keep track of what material are on site and where they are	
Creating scope sheets manually	Commuting between jobs	Too much email and phone calls	There's not good integration between softwares for different parts of the process	Estimating a project manually is time consuming	So many different softwares that it's hard to see how each part connects	Bad communication/everyone always on the phone try to get information	
Analyzing subcontractor bids	How information is organized and where it is kept not being consistent across projects	Prequalifying subcontractors	Currently, some softwares aren't easy to use and have a large learning curve	Prequalifying subcontractors is key	Software not being simple or not having high QoL solutions	Interfaces between stages are fundamentally inefficient	
	Not having one place to get information (having to open up a lot of different windows)	Struggled to get different softwares to communicate together		Incomplete drawings/design			
	Having to check a software everyday	Trying to limit how many different programs people have to use		Keeping project on schedule			
	Prequalifying subcontractors						
Tough to track communication between people	Keeping track of supplies/material distribution (especially during struggles of COVID)	Communication is always the issue	Bidding is hard process to streamline and digitize	It is hard to unify all data into one space	There needs to be a software for making bidding and bid leveling easier	Bids with 30-40 tabs become very hard to compare	
No easy way for owner/developers to track progress of a project	Skilled labor is expensive, not a lot of people in trades	Softwares are constantly updating	Managing contact information is very time consuming			Making sure subcontractor specs are correct for leveling is hard to do	
There are too many tools in the industry for each part		Softwares sometimes display too much and become confusing					
Bids are not standardized and thus, hard to level and review							
Contractor qualification can be a challenge before a relationship is established							

Note: Each Column represents a different company
(For privacy reasons company names were removed)

Appendix G

Idea Parking Lot



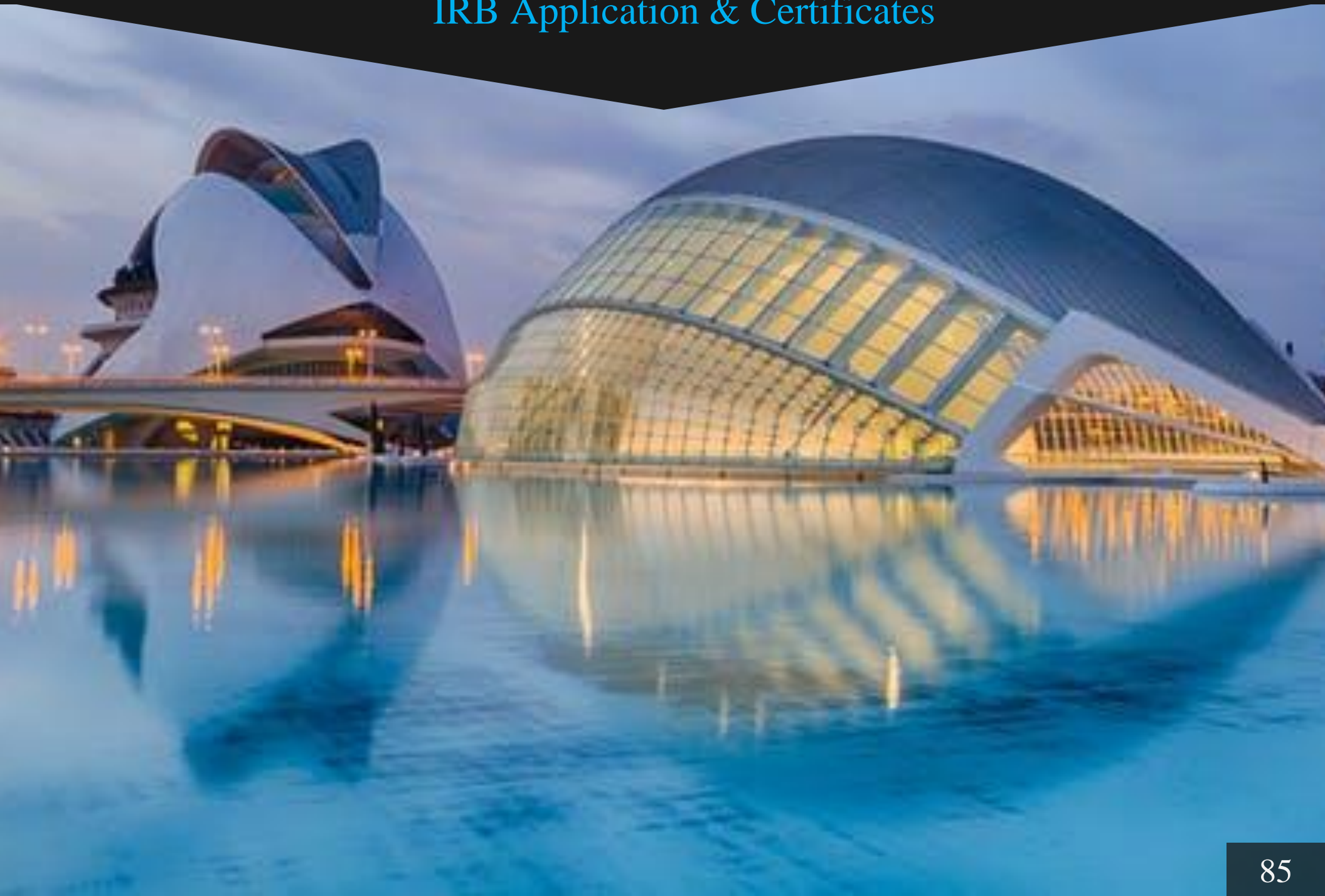
Idea Parking Lot

Idea Parking Lot

Business Development	Pre-Construction	Distribution & Materials	Construction	Facilities Management	All Phases																																				
<p>Project Pipeline</p> <p>A way to identify project leads and what will be required of the project. Is it small work like adding a wall or a new building. Essentially an area for client and builder communication of the project</p> <table border="1"> <thead> <tr> <th>Market Demand</th> <th>Feasibility</th> <th>Y/N</th> </tr> </thead> <tbody> <tr> <td>#</td> <td>2</td> <td></td> </tr> </tbody> </table>	Market Demand	Feasibility	Y/N	#	2		<p>Unit Cost Database</p> <p>A database specifically for unit costs and labor costs. Something that can be used and easily accessed by all, but is updated constantly.</p> <table border="1"> <thead> <tr> <th>Market Demand</th> <th>Feasibility</th> <th>Y/N</th> </tr> </thead> <tbody> <tr> <td>#</td> <td>2</td> <td></td> </tr> </tbody> </table>	Market Demand	Feasibility	Y/N	#	2		<p>Way of tracking Material/Inventory</p> <p>Often times on jobs sites workers will have no clue where materials are or the amount/qty that are on site as they are generally not the ones in charge of buying material. Some sort of software which tracks the amount and location of materials would help a lot. Would make less confusion in communication and a more efficient construction process.</p> <table border="1"> <thead> <tr> <th>Market Demand</th> <th>Feasibility</th> <th>Y/N</th> </tr> </thead> <tbody> <tr> <td>#</td> <td>2</td> <td></td> </tr> </tbody> </table>	Market Demand	Feasibility	Y/N	#	2		<p>Jobsite Worker tracking</p> <p>Some way of tracking workers from different divisions/companies on the job site. Mason may say that he will have 10 guys working on site for 3 weeks but no good way of actually confirming 10 people are on the jobsite each day, may only be 8 one day.</p> <table border="1"> <thead> <tr> <th>Market Demand</th> <th>Feasibility</th> <th>Y/N</th> </tr> </thead> <tbody> <tr> <td>#</td> <td>1</td> <td></td> </tr> </tbody> </table>	Market Demand	Feasibility	Y/N	#	1		<p>Systems Use Tool</p> <p>Some way of passing off systems/equipment such as a HVAC system to the owner of the project while keeping in touch/letting them have the ability to learn how to use it and continue to operate it.</p> <table border="1"> <thead> <tr> <th>Market Demand</th> <th>Feasibility</th> <th>Y/N</th> </tr> </thead> <tbody> <tr> <td>#</td> <td>1</td> <td></td> </tr> </tbody> </table>	Market Demand	Feasibility	Y/N	#	1		<p>Project Data Dashboard</p> <p>One Area for all parts of the project to be located. The data for the entire project can be collected and used in multiple applications or softwares. A collaborative space to see all parts of the project, including progress and data. (seamless integration of all data)</p> <table border="1"> <thead> <tr> <th>Market Demand</th> <th>Feasibility</th> <th>Y/N</th> </tr> </thead> <tbody> <tr> <td>#</td> <td>6</td> <td></td> </tr> </tbody> </table>	Market Demand	Feasibility	Y/N	#	6	
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<p>Hot Lead Database</p> <p>An area to go to find project leads. Business developers from General contracting companies can go and identify possible leads for their next project.</p> <table border="1"> <thead> <tr> <th>Market Demand</th> <th>Feasibility</th> <th>Y/N</th> </tr> </thead> <tbody> <tr> <td>#</td> <td>1</td> <td></td> </tr> </tbody> </table>	Market Demand	Feasibility	Y/N	#	1		<p>Qualification of Sub Contractors</p> <p>Software/Database which allows sub-contractors from various disciplines to upload their information. This would allow them to get pre-qualified for different sizes/scopes of work. They would be able to upload project limits (money/size wise), safety records, certifications...etc..</p> <table border="1"> <thead> <tr> <th>Market Demand</th> <th>Feasibility</th> <th>Y/N</th> </tr> </thead> <tbody> <tr> <td>#</td> <td>1</td> <td></td> </tr> </tbody> </table>	Market Demand	Feasibility	Y/N	#	1		<p>Material Delivery</p> <p>Creating the Uber eats of construction, a tool that will give real time updates on exactly where project materials are and how soon you will get them. If a truck has your items and you need them sooner, you may be able to get them at a different stop. Additionally there could be a tool that like uber eats or door dash, will deliver construction materials to you.</p> <table border="1"> <thead> <tr> <th>Market Demand</th> <th>Feasibility</th> <th>Y/N</th> </tr> </thead> <tbody> <tr> <td>#</td> <td>1</td> <td></td> </tr> </tbody> </table>	Market Demand	Feasibility	Y/N	#	1		<table border="1"> <thead> <tr> <th>Market Demand</th> <th>Feasibility</th> <th>Y/N</th> </tr> </thead> <tbody> <tr> <td>#</td> <td></td> <td></td> </tr> </tbody> </table>	Market Demand	Feasibility	Y/N	#			<table border="1"> <thead> <tr> <th>Market Demand</th> <th>Feasibility</th> <th>Y/N</th> </tr> </thead> <tbody> <tr> <td>#</td> <td></td> <td></td> </tr> </tbody> </table>	Market Demand	Feasibility	Y/N	#			<p>Communication Tool</p> <p>One tool to access all of the communication for an entire project. This can be a dashboard for emails, text messages, and other communication tools</p> <table border="1"> <thead> <tr> <th>Market Demand</th> <th>Feasibility</th> <th>Y/N</th> </tr> </thead> <tbody> <tr> <td>#</td> <td>6</td> <td></td> </tr> </tbody> </table>	Market Demand	Feasibility	Y/N	#	6	
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Appendix H

IRB Application & Certificates



Informed Consent Agreement for Participation in a Research Study

Investigators: David Hinckley Jr. & Ryan Menard

Contact Information: dmhinckley@wpi.edu, rwmnard@wpi.edu and rsamie@wpi.edu

Title of Research Study: Construction Innovation

Introduction

You are being asked to participate in a research study. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks, or discomfort that you may experience because of your participation. This form presents information about the study so that you may make a fully informed decision regarding your participation.

Purpose of the study

The purpose of this research is to understand the different challenges that the construction industry faces, and the technology that is used to provide solutions. The goal is to develop and understanding of the industry, to try to solve some of the shared challenges.

Procedures to be followed

In this specific study, our method of collecting data is by interviewing. You will be asked to answer questions that have to do with the challenges in the industry and the day-to-day practices of your company.

Risks

There are a few risks that we anticipate could occur during the study:

Overall, the risks are low, as we would like to collect data to help us identify the largest issues in the industry. The information that you provide will not be publicly displayed, the results will be shown, to get industry data and will not be company specific. Some risks are as followed:

- There is a risk that you may feel uncomfortable with sharing company information
- There is a risk you may feel anxious or pressured to answer questions

Benefits

This study will help us analyze the challenges that the construction industry faces and the practices of people within the industry. From these we will be able to establish a solution that can potentially solve the issues and help improve the industry.

Compensation for participation

Participants will not receive any compensation at this time.

WORCESTER POLYTECHNIC INSTITUTE

100 INSTITUTE ROAD, WORCESTER MA 01609 USA

Institutional Review Board

FWA #00015024 - HHS #00007374

Notification of IRB Approval

Date: 08-Apr-2021

PI: Abel, Curtis A

Protocol Number: IRB-21-0451

Protocol Title: Construction Innovation

Approved Study Personnel: Menard, Ryan~Hinckley, David~Abel, Curtis A~Sarnie, Robert~

Effective Date: 08-Apr-2021

Exemption Category: 2

Sponsor*:

The WPI Institutional Review Board (IRB) has reviewed the materials submitted with regard to the above-mentioned protocol. We have determined that this research is exempt from further IRB review under 45 CFR § 46.104 (d). For a detailed description of the categories of exempt research, please refer to the [IRB website](#).

The study is approved indefinitely unless terminated sooner (in writing) by yourself or the WPI IRB. Amendments or changes to the research that might alter this specific approval must be submitted to the WPI IRB for review and may require a full IRB application in order for the research to continue. You are also required to report any adverse events with regard to your study subjects or their data.

Changes to the research which might affect its exempt status must be submitted to the WPI IRB for review and approval before such changes are put into practice. A full IRB application may be required in order for the research to continue.

Please contact the IRB at irb@wpi.edu if you have any questions.



Completion Date 12-Mar-2021
Expiration Date 12-Mar-2023
Record ID 41533898

This is to certify that:

David Hinckley

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Human Subjects Research

(Curriculum Group)

Human Subjects in Undergraduate Student Projects

(Course Learner Group)

1 - Basic Course

(Stage)

Under requirements set by:

Worcester Polytechnic Institute



Verify at www.citiprogram.org/verify/?w27aa0d82-bb15-4e64-ba2a-0a7df6e987e0-41533898



Completion Date 12-Mar-2021
Expiration Date 12-Mar-2023
Record ID 41533897

This is to certify that:

Ryan Menard

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Human Subjects Research

(Curriculum Group)

Human Subjects in Undergraduate Student Projects

(Course Learner Group)

1 - Basic Course

(Stage)

Under requirements set by:

Worcester Polytechnic Institute



Verify at www.citiprogram.org/verify/?w6653679e-495c-4ae6-b88f-b8a87aad2c64-41533897

Appendix I

Strage Award/Application



Name: BPS (subject to change)

Area: Service

Stage: Idea Stage

Intent: Start a new business

Industry Served: Construction, Retail

Target Customers: Construction Site Managers, Homeowners

Description: *Describe product, service or process in 1 - 3 brief paragraphs*

Our service is an application designed to allow anyone to search for and order construction and home improvement materials from local hardware stores and supply houses. Like other platforms such as *Uber Eats* and *GrubHub*, gig-economy drivers would be contracted to retrieve orders and deliver them to the end customer. The goal of this service is to provide a convenient, cost-effective way to get much-needed construction materials ordered at a moment's notice and delivered in a timely manner.

The platform would specifically target local construction site managers and homeowners who would find great convenience in quick delivery of these types of products. As such, our marketing plan would strive to help contractors avoid unforeseen roadblocks and homeowners get their home projects done faster. This app will evolve both the professional and home construction industry to be more efficient and accessible.

Funding Impact: *How will funding allow you to make an impact with the idea or project?*

Currently, we do not have substantial means for funding our project; the Strage Innovation Award would be our first boost towards making our product a reality. Funding would provide us a runway for creating a new startup and building the technology we think is possible. The money would be put towards continuing our market research, developing a prototype of our app, building new customer relationships, and beginning to market our platform.

Benefit to Society: *How does this product, service or process benefit society?*

Our mission with this service is to help digitize an industry that has largely been left behind in technological innovation, providing new value to our partnered supply businesses and gig-economy drivers, as well as our end customers. The growing body of research we are conducting has thus far justified the need for this type of platform as in an industry that lives by costs and schedules, every minute wasted from a project is money and time lost. Based on this, we believe our service will make strides towards making construction more convenient, accessible, and efficient, ultimately reducing construction build time and costs. Benefits to society will be realized four-fold in the new sales to businesses, new opportunities for drivers, new efficiency in construction sites, and new support for home projects.

Market Strategy: *How will you take this to market?*

We plan to gradually take our service to market, starting off with one customer segment and moving to the next as we grow and receive feedback. We will first market to personal contacts we have

in the industry by showing how we can aid them in making their project sites more efficient. We will then use digital marketing through platforms like YouTube, Instagram, and Facebook to reach out to people interested in home construction, highlighting about ability to make their home projects easier.

Additionally, we will also have to market to the key partners of our platform. This will include connecting with people interested in freelance driving by offering competitive work opportunities, especially to those currently working for similar apps like *Uber Eats* and *GrubHub*. Finally, we will develop our list of available stores by first partnering with smaller, local supply businesses that we could offer the great potential for new sales and outreach.

Background: *What in your background qualifies you to invent or lead this?*

Our team is made up of a multi-disciplinary group of Worcester Polytechnic Institute students, studying in the areas of management engineering, civil engineering, management, industrial engineering, and computer science. We have culminated our skills to tackle the unique needs of the construction industry. From working with advisors at WPI and in the I-Corps program and conducting numerous interviews with industry professionals, we have amassed a significant amount of knowledge about how the construction industry functions and can be optimized. Combined with our passion for this area, this makes us very confident in being able to lead the creation of this new platform.

Worthiness: *Why do you feel this is unique or award worthy?*

The path that our team has taken to arrive at this service has been unique and unlike the typical project experience WPI intends students to have. Our entrepreneurial journey has seen us pivot between many different project ideas that we have individually tested for feasibility and market opportunity. By conducting numerous interviews with industry professionals (a total of 24 to date), we heard firsthand the host of pain points and struggles that the construction industry deals with on a daily basis. From all the data we collected, we recognized the potential the industry had for growth, but still struggled to find the right project we thought could make a true impact on people. But after long hours working as a team and getting help from many people much smarter than us, we identified this service as a project that is both feasible and greatly beneficial to the construction industry.

Through this project journey, we have built an incredibly strong team of eight members and multiple advisors across many disciplines, all passionate to make this idea come to fruition. Our team is highly motivated to bring the construction industry something truly innovative, with many members working on the project for no academic credit and others putting in countless hours of additional work. Through avenues such as I-Corps and Enactus, we are continually becoming a stronger team with not only the passion to succeed, but the know how to do so as well. For these reasons, we humbly ask for the Strage Innovation Award's support in bringing us one step closer to success.

Appendix J

New Coded Challenges



New Coded Challenges

Coded Categories	Missing Materials	Material Delivery	Technology	Would Use Pallyt	Other
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Materials are short or missing	Very Tech driven	Everyone on site has a computer	What's the benefit for a business to join when they can just deliver themselves	Personally, thinks that most consultants would not be interested	Very Tech driven	Good for small material delivery, not efficient for large quantities	Great idea, can be used a lot on site by super and subs.
Material Delays push project deadlines	Want to try new tech	Interviewee is very willing to test new technologies	Some may not trust that the application would guarantee that the correct material is delivered	Target would be hardware stores	Biggest issue facing the industry today is digitizing the construction process	Saving time will help people greatly	Most materials are the sub-contractor's responsibility
Willing to test if there is a need	DPR has a tech investing team	Sub-contractors would use Pallyt more than a general contractor	If there are minimal risks, the idea is very solid and would help companies and homeowners greatly.	Contractors may be a little more hesitant	There is a big need for quick material deliveries		
Most materials are delivered on a schedule	A delivery service would greatly help the construction projects they do	Interviewee is unsure if there is a need for Pallyt because Home Depot or lumber store always near and can just use a runner		Thinks it would be very beneficial to connect to this type of platform.	A delivery service would work but they would have to make sure the products are correct. Would use it though		

Note: Each Column represents a different company
(For privacy reasons company names were removed)

Appendix K

Pallyt Functionalities



Delivery and Locator Tool

Functionalities

- Locate tools and materials in the Central Massachusetts Area
- Stores can join, price based on need of store (How many Deliveries, how fast)
- Various sized cars/vans/trucks for delivery
- Deliver anything from a box of screw to drywall/lumber
- Have materials and tools delivered to a jobsite in a fast amount of time
- Real time tracking of delivery through app
- Purchase items through the app
- Various delivery options (same day, within hours, few days in advance...etc.)
- Allow customers to save jobs and locations on app for faster checkout
- Allow the customer the option for pickup if that is better than delivery for them
- Shop a variety of stores through one app
- Have a website for the suppliers to fulfil and identify orders

Ideas for Stores/Suppliers

- Connect with their inventory
- Have stores/supplies get the orders ready for the driver
- Take phone orders

Ideas for drivers

- Hire gig drivers, like Uber or Lyft drivers
- Require safety training and explanation of some products (We could make a video)
- Require pants and closed toed shoes
- Provide Branded safety equipment
 - Hardhat, vest, glasses

Appendix L

Weekly Reports Format



BPS

Bidding/ Procurement/ Scope *A revolution in construction pricing* Weekly Report #4

Week Dates:11/9-11/13

Report Date:11/15/20

Weekly Overview:

- The project topic was determined to be focused on bidding and scope based on interview feedback, as well as faculty input.
- Updated project name going forward is BPS
 - Name may be changed to reflect software, but this is it for now
- Met with students and faculty to discuss the project and get their POV
- Foisie Business School approved the project idea and explained the next steps for getting the MQP built.
- Recruiting process is ongoing

Meetings Occurred Last Week:

- Meeting #6 - Weekly Meeting
- IMGD Meeting
- FBS Meeting
- Math Meeting
- Meetings with potential students
- ___ Construction Interview
- ___ National Construction Interview

Meetings Scheduled This Week:

- Meeting #7 - Weekly Meeting 11/16/20
- Student meetings
- Tentative Faculty meetings if possible

Last Weeks Schedule:

Task	Notes	Status
Conducted RD 2 Interviews	-3 interviews allowed us to pose new questions and help solidify the topic	Completed
Project Overview sheet	-Established a preliminary project statement	Completed

Compiling list of contacts	-Looking for Industry and WPI Contacts	Ongoing
Work from Task To Do sheet	-A Sheet was made to track items that need to be worked on	Ongoing
Recruiting Students and Faculty	-Actively working to find top students in each department	Ongoing

This Weeks Schedule:

Task	Notes
Recruiting	-Big focus on speaking with Wally Towner, Wilson Wong, and Finding CE and ME professor. Finding students in IE and CS, Math is on hold
Analyze feedback from interviews	-Detailed analysis of the first 2 rounds of interviews
Project Design	-Begin research into similar softwares -Come up with ideas for the software we hope to design
Company Follow ups/ New contacts	-Speak with RD 1 and 2 contacts and look at talking with new contacts
Continue Reading/ Researching	-Read startup materials

Research Updates:

- Began finding similar companies to the product/business we aim to make.
 - Web based/ app based?
 - Tackle all levels of computer knowledge
- Read *Talking to Humans* and other startup books
- Research construction scope and bidding software

New Developments:

- IQP product will be designing forms/paperwork, product design, Preliminary marketing materials
- MQP product will be actual software

Business Plan/ Project Plan Updates:

- Detailed Problem Statement

- Detailed Project overview/ Major requirements

Roles/ Responsibilities:

David Hinckley Jr: Leading interviews, Leading Recruiting, Research

Ryan Menard: Note taking for interviews, Research, Leading data compiling

Term Look ahead:

C term:

- Develop plans for MQP
- Form MQP Team with advisors
- Begin construction scope analysis

D Term:

- Final Paper
- Forms and procedures for MQP
 - Meeting templates, additional forms
- Marketing materials

Action Items/ Next Steps:

- Recruiting team members and advisors
- Paper format
- Possible additional interviews discussing BPS
- Obtain Scope sheets if possible

Appendix:

Project Overview

Objective: To innovate within the construction industry by creating a tool that can be universally used throughout the bid process allowing general contractors to request pricing from subcontractors in an easy and efficient way.

Problem Statement: Through our many interviews with various companies some of the most commonly cited problems in the construction industry had to do with the pre construction phases in the bidding, procurement and scope areas. Through these interviews we discovered that there are not any softwares which effectively tackle all areas of the bidding/procurement/scope steps in the construction industry. The goal of our project is to fill the holes which many of the pre existing bidding softwares have and produce an effective bidding/procurement/scope software.

Solution: To create a tool that will allow companies to define the scope of a project from options that are within the tool or custom options that are inputted by the company. The goal is to make

the bidding/procurement/Scope part of the process as easy and seamless as possible. This can compliment the construction documents while also allowing all bids to come back in the same format. BPS will be a software that a general contractor purchases to have all divisions of the project labeled with customizable scope choices, areas for notes, and costs associated with each part of the scope. The general contractor would then send a template to the subcontractor that includes the scope of work, areas for notes and costs, for the company to fill in. After everything is filled in by the sub contractors, the general contractor can now level the bids because they are all in the same format. This will allow for a faster estimate process because the estimator can go line by line comparing each item and clearly see what is missing. This will not replace bidding from the drawings, rather it will assist in the process and ensure that all contractors are carrying the same items. This tool can be used with design build or plan and spec estimates as there will be areas for quantities or lengths. BPS will save time, money and effort while also limiting mistakes and missed items in the scope of work that a contractor may not have carried. We aim to make the software efficient, user friendly and allow for collaboration between general contractors and subcontractors.

Appendix M

Revised Weekly Reports Format



Construction Innovation

Weekly Report #20

Report Dates: 4/17/21-4/24/21

Report Date: 4/25/2021

Weekly Summary

This week was a very productive week, the team finished I-Corps, met and discussed the MQP structure and officially got our first partner store! I-Corps was helpful for us to understand the problem and identify the customers who will be our main focus. The scope of the MQP will need to be established to ensure that we have minimal scope creep. Any work that exceeds the scope of the MQP will be for the Business side of Pallyt. Lastly, Saturday marked a key milestone for Pallyt with our first official partner; _____ Hardware. _____ Hardware will be working with the team to design, build and test our application. We are excited and eager to continue moving forward with the project.

Interviews to Date:	46	Interviews Scheduled:	0	Interview Focus:	Stores/Homeowners
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Task Items

Date Scheduled	What/Who	Date Completed	Risk Level	Notes
18-Apr	Split Team Meeting	18-Apr	Completed	Business Operations and Dev team met
19-Apr	Management Meeting	19-Apr	Completed	Discussed MQP format
20-Apr	IQP Advisor Meeting	20-Apr	Completed	Discussed IQP Paper
20-Apr	Dev Team Meeting	20-Apr	Completed	Pallyt Mockups
21-Apr	Full Team Meeting	21-Apr	Completed	Marketing, Weekly Recap, Project Future
22-Apr	MQP Structure Meeting	22-Apr	Completed	Established how the MQP will flow and identified any major concerns.
22-Apr	Management Meeting	23-Apr	Completed	Finalized brochure for _____ Hardware
23-Apr	Management Meeting	23-Apr	Completed	Pitch prep for _____ Hardware
24-Apr	Hardware	24-Apr	Completed	Pitched Pallyt to _____ Hardware
25-Apr	Split Team Meeting	-	Low	Work on projects for Business/operations Team and Dev Team
26-Apr	Management Meeting	-	Low	Plan for _____ and Pallyt Partnership
27-Apr	IQP Advisor Meeting	-	Low	Discuss IQP progress
27-Apr	Dev Team Meeting	-	Low	Mockups
28-Apr	Full Team Meeting	-	Low	Provide updates, discuss hot items
29-Apr	Management Meeting	-	Low	Future Planning & Go over hot items
2-May	Split Team Meeting	-	Low	Work on projects for Business/operations Team and Dev Team
10-May	IQP Final Paper	-	High	Submit Final IQP Paper
No Date	OTC Meeting	-	High	Discuss Trademark, Idea disclosure, Etc.
No Date	Register MQP's	-	High	Register with registrar