Capital One Agile Maturity Assessment Tool

Future of Lithium Ion Battery Standardization

A Thesis Prospectus
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Bachelor of Science in Computer Science

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

For my technical topic, I will be discussing my past work experience as a Software Engineer Intern at Capital One in the summer of 2021. I will discuss the work I accomplished as a team, how it was done, and most importantly how it will benefit Capital One in the future. A final point I will discuss is how my learnings at the University of Virginia Computer Science Department have helped me and any changes I would add to the curriculum.

For my STS topic I intend to research methods of standardizing electric vehicle batteries in order to better recycle them. Electric Vehicle usage has increased dramatically in recent years. With 0.3 million EVs in the United states in 2015 to 1.1 million in 2020 (IEA 2021), the shift to a potentially more sustainable form of transportation is a great trend for the environment. This relatively new form of transportation has been found to have superior energy efficiency compared to gas vehicles in the long term, despite the waste produced from the disposal of the large lithium ion batteries. With an estimated 12 million tons of lithium-ion batteries expected to retire by 2030, absurd amounts of raw materials such as lithium, nickel, and cobalt threaten to enter into landfills (Lim 2021). As the automobile industry continues to progress, now is the time to plan for what will happen to these batteries in order to expand upon the green effects of electric vehicles.

Technical Topic

ABSTRACT

During my internship as a Software Engineer Intern at Capital One, I built an agile maturity assessment tool to standardize agile methods across different lines of businesses and Capital One as a whole. Standardization of the agile methods across Capital One enabled the company to bring even more cutting-edge technology and forward-thinking solutions to the Financial Tech sector. The programs used in developing the agile maturity assessment tool included Java Spring Boot for the server side, Angular for the client side, and Amazon Web Services for deployment to production. The outcome of the project was a number of teams picking up the assessment to use in the future after the final summer presentation. The project fulfilled its original purpose by creating a simple yet elegant user interface to standardize agile maturity across a company. Some future work to be completed are to incorporate other user stories into the application, some of the most important being Google integration or JIRA board integration so teams can easily track their progress.

Nature and Purpose of Project

The nature of the project was creating an agile maturity assessment to be distributed to Agile Development Leads throughout Capital One. The final vision was to have all Agile Development Leads at the entire company taking these assessments for their software development teams to gather data on teams and their agile maturity, with the agile maturity relating to the efficiency of the teams and the quality/speed of product delivered. The purpose of the project was to standardize the workflow of software teams at Capital One in order to maximize efficiency and to create a widely used tool in house rather than outsource the product.

Work Accomplished

A wide variety of features were added to the application. The first feature added was creating server-side code to add table entries in the PostgreSQL database which contained important team details such as team IDs, time of submission, etc. when a team submitted an assessment.

Another feature added was the ability to have an admin user lock assessment on a certain date, meaning all the teams in their sub-line-of-business were required to take the assessment by the given date. This ensured all teams completed the assessment by the certain date so that analysis could be performed and teams who needed to increase their performance would be notified immediately.

An important feature for users was the ability to add comments on assessments so that future assessment questions and answers could be molded to better match the agile methodologies of teams at Capital One. To accomplish this, a comment box feature was added on the client side using an Angular component which stored the text from the user, then this comment was saved to a new column in the PostgreSQL table through adding another field in the Java Spring Boot classes.

In order to easily perform data analysis on team assessment data by admin users, an export CSV file was created. This allowed admin users such as Agile Development Leads, Vice Presidents, and others to export all their team(s) data and the scores each team received on each assessment area. The data was organized by team, then sub-line-of-business, then line-of-business. This organization of data allowed the admin teams to group their data by divisions, as well as create figures for presentations using the values of the scoring.

Arguably the most important feature of all added was the redesign of the client-side web pages. The redesign incorporated bar graphs, line charts, and a more colorful presentation of data to the user. This more eye-appealing redesign was a key factor in spreading the usage of the application by creating a more user-friendly website as well as one which showed only the necessary data without extra clutter.

Significance

Previously there had been no way to measure the metrics of agile maturity at Capital One. This application will help to standardize agile maturity across teams, lines of businesses, and Capital One as a whole. The standardization of agile maturity at Capital One will lead to more streamlined release dates and a higher quality of products at Capital One.

Program of Study and Preparation

The classes which most helped me to prepare for my technical applications were Advanced Software Development (CS 3240) and Program and Data Representation (CS 2150). Advanced Software Development taught me the concepts of web development, more specifically the best practices to use when working with POST and GET requests, as well as how data is transferred between the server and client side. Program and Data Representation taught me the nuances of the command line and how to optimize my programs by choosing the correct data structures.

Some things in the Computer Science curriculum I would like to add are a requirement to learn more about the usages of Integrated Development Environments (IDEs) as well as Version Control. With Version control being the backbone of any software development team, Git and other version control tools should be taught in order to be comfortable with branching, reverting, and commit history (Gehman 2019). Finally, an ability all managers and software engineers at Capital One had was knowing how to navigate as well as the tricks of IDEs. This simple ability allows me to complete time consuming tasks such as tracing method calls or following debuggers with ease.

STS Topic

Introduction

The current infrastructure of recycling lithium-ion batteries from electric vehicles is very poor and could use much advancement. The present-day substandard process recycles less than 5% of all lithium-ion batteries globally (Wollacott 2021). In addition, a variety of pollutants such as lithium, nickel, cobalt, and others enter water sources or landfills when incorrectly recycled. My research will focus on the possible methods to recycle these large bundles of energy in an efficient and environmentally friendly manner through the standardization of these battery packs. Specifically, I will seek answers to the following: Who are the most active stakeholders in building lithium-ion battery standardization? From these stakeholders, what are the best practices they are performing as well as next steps in lithium-ion battery standardization?

Literature Review

According to an article from Dan Race from UNCTAD, lithium mining requires vast amounts of groundwater, an estimated 2 million liters of which to pump out brines from drilled wells all to create a single ton of lithium. This lithium mining accounts for 65% of the water usage in the Andean region which causes “groundwater depletion, soil contamination, and other forms of environmental degradation, forcing local communities to abandon their homes” (Race 2020).

There are currently a handful of basic methods of recycling lithium-ion batteries. The majority of batteries undergo pyrometallurgy, a high-temperature melting-and-extraction, or smelting process similar to ones used in the mining industry. The issue with this technique is that the work is done in large, costly commercial facilities which are energy intensive. Despite the high costs and high energy usage from the smelting process, not all of the lithium is recovered (Jacoby 2019).

Another more advanced form of recycling lithium-ion batteries is one called direct-recycling. This process recovers battery materials by “reinsert[ing] into the battery supply chain with little or no additional processing" (Gaines 2014). Direct recycling of lithium-ion batteries is advantageous over other methods because almost all battery components are recovered and can be *reused* after processing. The emphasis on the word reuse is important here because the components can be put into new batteries, rather than just stripped of materials and used in other electronic devices like *recycling* would do. For direct-recycling to excel, standardization in battery packs would need to be incorporated into the manufacturing process so that the largest amount of material can be recovered.

There are questions on whether the recovered materials would perform and last as well as "virgin" materials, causing some manufacturers to be wary of purchasing the materials recovered from direct recycling. Some developments that could facilitate the reduction of the downsides of direct recycling would be standardization of battery materials and designs. This way more automakers would know how battery packs were designed even if they were not the ones who produced them. In addition, the performance concerns of the reusable materials would be alleviated since all lithium-ion batteries would need to meet certain requirements, thus the recovered materials from direct recycling would be more likely to perform as well as "virgin" material.

According to the Gaines article, the primary stakeholders driving standardization of lithium-ion batteries "[are] being addressed in the United States by the Society of Automotive Engineers and in Europe by EUROBAT. Both groups have active working groups attempting to better define and find solutions to the problems of cross-contamination of battery types in recycling streams" (Gaines 2014). The best practices according to Gaines in standardization are "label[ing] battery components by means of bar codes, RFID chips, or delegated paint color or type (e.g., visible under black light)." These standards would allow recyclers to more easily separate lithium-ion batteries from acid-based batteries and extract lithium-ion components in a more straightforward manner.

Framework

To demonstrate the importance of the advancement of reuse and recycling of lithium-ion batteries in EVs, I will use the Risks and Standards of Waste framework. This framework helps me to examine which actors are aiming for the minimization of waste and standardization of lithium-ion batteries, how the waste minimization technology is valid, and any counterclaims involved with the technology.

The primary groups that are pushing for advancements in lithium-ion battery standardizations and recycling are environmentalists and government agencies who care to see the full benefits of EVs. For example, Jeff Spangeber from the U.S. Department of Energy states that to expand on lithium-ion recycling we must "make it cost effective, so that people have an incentive to bring their batteries back" (Kumagai 2021). In other words, to make lithium-ion battery reuse/recycling a typical matter, we must not only make battery recycling cleaner, but also reliably profitable. This way recycling companies have reason to act on lithium-ion recycling.

One specific study from the Journal of Cleaner Production looks at the adoption of "ISO 15118, a communication standard for V2G capable EV charging in four countries" (Kester, Noel, Lin, Rubens, Sovacool 2018). This study explains the bidirectional electricity flows and the ability for electricity grids to utilize EV batteries as a result of a single standard of vehicle to grid (V2G) mobility. The study's conclusion states that ISO 15118 is a crossover between technical and political achievements, as the "interoperability between two industries and a subsequent potential scalability of EVs that is required for a further transition of our transport system away from fossil fuels". This early study on EV standardization will act as a benchmark for standards and technological developments to come.

Another extremely present organization in lithium-ion battery standardization is UL, formerly known as Underwriters Laboratories. UL frequently publishes standards for different electric appliances and a plethora of battery types. Their most applicable publication being "UL 1642: Lithium Batteries". The entire publication has vast amounts of standards and tests to be performed on lithium batteries in order to ensure both their validity and reliability. For example, "User-replaceable lithium cells or batteries are to be tested...complying with the Crush Test" (Prusko Section 5.2, 1999). While this article is relatively older it shows that lithium battery reuse standardization has been around for over two decades and can be expanded into the designs of large EV battery packs.

While standardization of the battery packs would lead to many environmental benefits in lithium-ion recycling, too much standardization is unwelcome in any industry as it stifles innovation. According to Roger Brereton from Pailton Engineering, "[EV] is not yet a mature technology and progress is being driven by competition" (Brereton 2020). Many counter criticisms to battery standardization will come from the EV companies themselves as they have spent years designing their batteries to perfection. According to an article by John Voelcker, "incorporating a battery pack developed by someone else would impose significant constraints on how they could arrange their components, crash structures, and the like" (Voelcker 2014). This article shows the risks of standardizing battery packs as well as the fact that the biggest actors posing as barriers to standardizing battery packs are the manufacturers themselves.

Methods

For the remaining information necessary to complete the project, I plan to analyze policies from organizations like UL and the United States by the Society of Automotive Engineers as well as governmental laws in place for standardizing lithium-ion batteries. It will be critical to emphasize the benefits of lithium-ion recycling, as well as the heavy part standardization plays in said recycling.

Next Steps

In my efforts to minimize waste and standardize battery pack reuse, I intend to review actions from actors aiming to provide a reliable method of standardizing lithium-ion battery packs in an effort to bring profitable recycling throughout the EV world as we transition to a fossil-fuelless world.

Action	Timeline
Research groups involved in EV battery	November-December 2021

standardization similar to (Prusko 1999) and (Gaines 2014).	
Pinpoint and summarize best practices used by groups involved	December 2021
Research Governmental Policies in EV Batteries similar to (Kumagai 2021)	January 2021
Find the correlation between the governmental policies and groups involved in EV battery standardization	February 2021

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