Background

One of the main objectives of Edison Cars AG is to promote sustainability and reduce their carbon footprint. In line with this, the company has integrated battery recycling as a part of their value chain. This move has helped to massively expand the use of secondary materials, which reduces the need for raw materials. Additionally, it prevents hazardous materials from escaping and causing environmental damage. Despite these efforts, the current processes of battery recycling are not fully understood. However, it is assumed that there is still some potential for optimization in the processes. As such, Edison Cars AG continues to research and develop better ways to optimize their battery recycling methods.

To support the tracking and improvement of the recycling processes, the recycling department at Edison Cars AG has turned to the in-house consulting team for assistance. The consulting team recognizes the importance of having accurate data and documentation of the actual process of battery recycling. Therefore, they request process logs documenting the process, including the data collected either automatically or by manual entry into the ERP system. In addition, they conduct interviews with people involved in the process, including those with different roles, to gather their perceptions of the process. This approach enables the consulting team to have a more comprehensive understanding of the battery recycling process, which will help them identify areas of improvement and optimize the recycling process further. The task of recording and documentation of the actual process of battery recycling is crucial in helping Edison Cars AG achieve its sustainability goals and reduce its carbon footprint.

Interview 1 – Stan (Management)

“Hello, my name is Stan and I am a manager at the Edison Car AG. As a member of the company's leadership team, I am responsible for overseeing various aspects of the business, including operations, production, and strategic planning. I have to say that I'm not entirely satisfied with our current battery recycling process. While we've made significant progress in recent years, I believe there is still a lot of room for improvement. Why am I not happy with the process? Well, for one thing, there are still some inefficiencies in the way we handle certain steps of the process, and I believe we could be doing more to reduce waste and increase our recycling rates. Additionally, I think we need to be more proactive about identifying potential hazards and mitigating any risks associated with the process.

But beyond these specific issues, I think it's important to recognize that improving our recycling process is critical to our overall sustainability goals. As a company, we have a responsibility to reduce our environmental impact and operate in a way that's mindful of the resources we use. By improving our recycling process, we can reduce our reliance on raw materials, cut down on waste, and ensure that we're doing our part to create a more sustainable future.

Now, I want to be clear that when we're looking at improving our recycling process, we should focus only on the steps that Edison Car AG is responsible for. While it's important to understand what happens to the materials we recycle after they leave our facility, we can't control that part of the process. What we can control is how we handle the materials while they're in our possession, and that's where we need to focus our efforts.

So, to my team: I want to motivate you to really dig deep and explore the battery recycling process. Let's work together to identify areas for improvement, come up with creative solutions to the challenges we face, and ultimately create a process that we can all be proud of. Remember, every little bit counts, and by improving our recycling process, we're not just doing the right thing for the environment - we're also setting ourselves up for long-term success as a company.”

Interview 2 – John (Process Operator)

“Hi, my name is John and I'm part of the recycling process at Edison Car AG. I'm not 100% sure how the entire process works, but I can describe what I know. So, the process starts with the battery cell completely discharging and we check the battery cell for damage. Damaged cells are a risk because they can cause leaks and release hazardous chemicals. For example, I remember one time we found a battery with a cracked cell, and we had to put it in a safety box, which is a secure place for damaged batteries.

If the battery is not damaged, then comes the delicate path to open the battery. I don't like this step because it requires a lot of caution and attention to detail. One small mistake can cause the release of dangerous chemicals, which is a risk to our health and the environment.

Then, we collect the electrolyte, which is a liquid that conducts electricity, and it will be evaporated while the electrodes get cleaned. After cleaning, they get shredded, and the residues of the electrolyte and the shredded electrodes get melted down. Then, we collect the recyclable materials, which are sent to another company for reprocessing.

The rest of the battery parts that cannot be recycled are disposed of. It's a pretty complex process, but it's necessary because batteries contain hazardous materials that can cause significant harm to the environment and human health. We must finish the process because it's too dangerous to stop and leave battery parts everywhere. So, either way, the battery ends up in the box, or the separated parts are sent away.”

Interview 3 – Sarah (IT Department)

“Hi there, my name is Sarah, and I'm a programmer in the IT department at Edison Car AG. n addition to being a programmer, I'm also an avid gamer and enjoy playing video games in my free time. I'm particularly into RPGs and strategy games. I'm also a big fan of science fiction and fantasy, and I love reading books and watching movies in those genres. When I'm not working or gaming, I like to stay active and enjoy going for hikes or taking fitness classes.
While I'm not part of the actual recycling process, I do work with the IT system that collects log data for the process. I have to admit that the system can be quite complex, and it can be a challenge to navigate at times. However, I think that the system logs cover the process pretty well, and I don't expect there to be too many blind spots. Of course, you never know with these things.

That being said, there are some bugs in the IT system that we're currently working to fix. One issue we've encountered is that sometimes the log files get corrupted, and the last collected steps are lost. It's frustrating because it means that we don't have a complete record of the recycling process, and it can make it challenging to identify areas for improvement.

To address this problem, I created a CSV export that should help our team to better analyze the log data and identify any patterns or issues that may have been missed. I'm hoping that this will be a helpful tool in addressing some of the bugs in the IT system and ensuring that we have accurate and complete data on the recycling process.”

Task

Use the provided process logs and interviews to model the battery recycling process in Edison Car AG. Use the BPM notation that was introduced in the lecture.

Input

For this task, you will be provided with the following:

- Process logs from the recycling process as a csv file
- Further information for process mining and process discovery. These are possible approaches that have different advantages and disadvantages. In particular, the information on BPM Modeling is more extensive than in the lecture. However, only the constructs presented in the lecture are required. Of course, you can also use other approaches and resources:
    - BPM Modeling (More detailed than in the lecture): process.st
    - Analysis of Process Logs: pm4py.fit.fraunhofer.de or Celonis (Academic Edition)
    - Visualization Tool: Drawio

Submission

The following documents must be emailed to s3g@fim-rc.de as one zip folder by 09:00 AM on 14.06.2023:

- Code file(s) to reproduce the results. Should the setup of a special environment or packages be necessary, a step by step guide is also needed
- Complete process model with tasks, gateways, descriptions and probabilities
- A PowerPoint presentation explaining your approach. You should be able to present your approach in the next lecture

Keep in mind

The content provided here serves only as a starting point. Feel free to use your own approaches and algorithms to get the best possible prediction.

Use only the pricing data provided.

The following aspects are important for the assessment of your submission:

- Code quality: The code must be executable, readable, commented, and adhere to the output format
- Process Model: The process model should follow the presented BPM notation and contain all existing information
- Explanation of the approach should be understandable