Week 3: Constructive Research Problems

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# Constructive Research Problems

For this assignment, examine three constructive research studies published in peer-reviewed journals to evaluate the alignment of the research questions to the research problem and purpose.

Table 1: Outline of Constructive Research Papers

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| --- | --- | --- | --- |
|  | E-Cig (2021) | Electric Distr. (2021) | Power People (2018) |
| Problem | Regulating electronic cigarettes – 29% of Indonesia smokes | Forecasting failures in electric power grids | Indian Villagers have low adoption rates of Prepaid electric |
| Questions | 1. Are people for/against regulation? 2. What reasons | 1. How can we use NoSQL stores to centralize data from heterogeneous sensors 2. Can we build a forecasting model to predict reliability issues | 1. Why aren’t they using the service 2. Are there design changes to promote engagement |
| Design | 1. Collect Tweets 2. Apply clustering algorithms 3. Compare the performance | 1. Collect and simulate different usage requirements. 2. Build a forecasting model 3. Assess performance using historical data | 1. Build disposable prototype 2. Iterate with rural Indians 3. Assess the suitability of the system |
| Study Purpose | Understand the impact of increased taxes and marketing | Improve efficiencies in the spot market and reduce customer costs | Prepaid electric business models require “enough” customers to be sustainable |
| Conclusions | 1. The classifier reliably detects e-cig preferences. 2. Improvements exist across demographic tags, resampling, only uses Twitter | 1. The discharge model saves 2.5% daily ($10k on 375k) 2. Deploying more broadly would be desirable | 1. Technical details were confusing 2. Most rural people cannot read English 3. Including the balance on the home screen was most useful |

# Analyzing E-Cigarette Conversations on Twitter (2021)

## Problem

Indonesia has one of the highest smoking populations (28.9%). Regulators and lobbyists have concerns that e-cigarettes (e-cigs) will increase this value and create burdens on its public health care system. They need to understand the population’s perspective on the safety, taxation, and regulation of e-cigs.

## Approach

Kaunag et al. (2021) approach this problem by training classification models with 8079 tweets discussing vaping (e.g., Favor or Against smoking). Each tweet goes through a pre-processing pipeline to remove punctuation, duplicate words, and common keywords (e.g., lol). After cleaning, the messages are tagged and clustered. Finally, they tease out the user’s decision rationale using topic modeling (e.g., NMF and LDA).

## Conclusion

The authors deliver a process for analyzing e-cig sentiment and rationale from a corpus of tweets. These insights enable regulators to track changes in public opinion and design more effective marketing campaigns. For instance, when Muhammadiyah fatwa approved e-cigs usage, an enormous supporters spike occurred. Future efforts could also consider demographic information or consider additional social media sources.

# CPS Applications with Case Study of Intelligent Dispatch of PV (2021)

## Problem

Distributed energy grids encounter intermittent failures, causing service disruptions in the availability of electricity for customers. Smart grids mitigate these issues with battery backup systems that collect and discharge energy as necessary. Like other commodities, electricity has a variable spot price that reacts to supply and demand changes. Power companies need to forecast these disruptions and charge their batteries before the prices jump. It is challenging to build these predictive capabilities due to the limited standardization of sensor data.

## Approach

Riggs et al. (2021) construct an ingestion pipeline that pushes sensor data into a NoSQL database. This approach simplifies data centralization by relaxing schema at write requirements. Next, an Extract-Transform-Load (ETL) process normalizes the instrument readings for multiple machine learning algorithms. The authors compare the performance and accuracy of Markov models, Genetic algorithms, and Support Vector Machines (SVM). This step requires simulating traffic and replaying historical data.

## Conclusion

The author’s system can more gracefully handle disruptions and more accurately decide when to charge the batteries. Administrators that deploy this solution would save 2.7% ($10k daily savings assuming $370k expenses). Deploying the system more broadly would further reduce costs and volatility for all participants within the swarm.

# Power to The People (2018)

## Problem

Villages in rural India can use prepaid electricity services to power their home. These

businesses typically use solar energy to deliver a more economical solution than natural gas and kerosene. Solar farms have a high initial cost and require sufficient customer adoption to justify the investment. However, customers are not onboarding into the program at a fast enough pace. These challenges risk the sustainability of local providers. Simmonds (2021) wonders what prevents people from using cheaper and renewable electricity? Are these defects in the service offering or superficial usability issues?

## Approach

Simmonds (2021) traveled from Finland to rural India. After arriving, she interviewed several villagers and observed their service interactions. She noticed that most neighborhoods would recruit a child to update the system. This decision stems from the control panel using English, a foreign language to many. The panel also contains too many irrelevant technical details. Meanwhile, the most common action, checking the remaining balance, was hidden.

The author built a prototype replacement using a mobile phone and a discarded cereal box. She revised the display to show the remaining balance by default and moved the technical details into an advanced menu. Next, she translated all instructions into Hindi.

## Conclusion

Simmonds re-assessed the usability of her control panel. The villagers welcomed the design changes and found onboarding into the prepaid electric services easier. She states that these updates were discoverable only after monitoring the customers. This strategy represents a stark difference from previous designers, who built for their local norms.

# Alignment Evaluation

Design science research (DSR) is a framework for improving knowledge generation within constructive research projects (van Rensburg & Goede, 2019). It outlines a formal process from first awareness of the problem through suggestions, development, evaluation, and conclusions. Following this process ensures that the research problem, questions, and study purpose are in alignment. Both “Power to the People” and “Intelligent Dispatch of Photovoltaic” papers explicitly implement DSR. Meanwhile, “Analyzing E-Cigs” does not mention DSR but does start with the business case and the regulators’ needs.

All three articles begin with a clear business case and a clear set of questions to address. For instance, the solar farm needs to increase adoption rates or go out of business. That problem statement naturally transitions to asking, why are adoption rates low? Simmonds (2021) rules out costing in her opening statements, leaving the reader to wonder about the service’s usability. A similar structure exists within the other two articles, drawing a straight line across problems, questions, and purpose.

# References

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