2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023
The Harbor of Engineering Education for 130 Years
ASEE
Paper ID #38753

Community Perceptions of Procedural and Distributive Justice in Engineered Systems: A Case Study of Community-Engaged Vehicular Electrification

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Dr. Ivonne Santiago is a wife, mother, Environmental Engineer, and teacher. She is an Associate Professor of the Civil Engineering (CE) Department at the University of Texas at El Paso (UTEP). Dr. Santiago has a combined experience of over 20 years in the areas of community engagement, water quality, water treatment and wastewater treatment in Puerto Rico (PR), New Mexico and Texas. Currently, she is Chair of the El Paso Water Public Service Board (PSB), where she is a member of Engineering Selection and the Communications subcommittees, and the ad-hoc committee for storm water priorities. She has been a member of the Environmental Protection Agency National Advisory Committee (NAC), that advises the Administrator of the EPA on environmental policy issues related to the implementation of the former North American Agreement on Environmental Cooperation and was a member of the Good Neighbor Environmental Board (GNEB) that advises the President and Congress of the United States on good neighbor practices along the U.S. border with Mexico. Dr. Santiago's history of service started in Puerto Rico as Director of the Water Quality Area of the PR Environmental Quality Board, in charge of Compliance, Permit, and Planning Bureau, that included Industrial and Non-Industrial permits, Leaking Underground Storage Tanks (LUSTs), and watershed restoration activities. As Director, she implemented the first Beach Monitoring program in coordination with the PR Tourism Office and the Blue Flag program (A world renowned eco-label) and implemented the first Total Maximum Daily Load Program in PR. Professionally Dr. Santiago has been recognized with the 2019 El Paso Engineer of the Year by the Texas Society of Professional Engineers. This is the first time in more than 30 years that a UTEP faculty wins this prestigious award and the 2018 American Society of Civil Engineers' Texas Section "Service to the People" award. This award honors civil engineers who have distinguished themselves with special service to the people and bring credit to their profession through community activities that are visible to the public. As Associate Professor her mantra has been to connect education to professional practice inside and outside the classroom as demonstrated by the local and state awards she has won: 2014 UTEP's CETaL Giraffe Award (for sticking her neck out); 2014 College of Engineering Instruction Award; 2014 The University of Texas System Regents' Outstanding Teaching Award; the 2012 NCEES Award for students' design of a Fire Station. In her work, Dr. Santiago helps to find innovative engineering solutions through an understanding of the balance between sustainability, social equity, entrepreneurship, community engagement, innovation, and leadership to improve the well-being of people. A few examples include: interdisciplinary projects that provide safe drinking water to underserved communities in El Paso, Ciudad Juárez, Puerto Rico, and Haiti; a bridge that connected communities in Puerto Rico; a solar charging station for natural disasters in Puerto Rico; innovation and entrepreneurship activities on water quality sensors and phyto-remediation; remote sensing applications using Hyperspectral cameras on UAVs for water quality and agricultural applications; and study abroad opportunities that advance the emerging field of Peace Engineering in Curitiba, Brazil; native communities in the Amazon in Villavicencio, Colombia; and underserved communities in Piura, Perú. Dr. Santiago is passionate about providing experiential learning opportunities to both undergraduate and graduate students with a focus on Hispanic and female students. She is currently Co-PI of UTEP's NSF-AGEP program focusing on fostering Hispanic doctoral students for academic careers; the Department of Education's (DoE) STEMGROW Program to encourage students Latino(a) students and students with disabilities to pursue STEM careers;

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Community Perceptions of Procedural and Distributive Justice in Engineered Systems: A Case Study of Community-Engaged Vehicular Electrification

Engineered systems often reproduce injustices via infrastructures that result in harm to the health and economic well-being of historically minoritized groups.[1] As examples, ports of many kinds—including seaports, airports, and inland ports—are usually sited by Communities of Color or low-income communities, and they contribute to environmental injustices related to toxic emissions from diesel equipment.[2]

This case study occurred in a near-port community experiencing numerous health and economic impacts associated with excessive port emissions. For example, one local study found that air pollution levels in the near-port community were associated with increased school absences, and estimated that reducing pollution by 50% would save $426,000 per year in a school district that was already under-resourced.[3] This estimate did not account for the economic impacts on working caregivers who took time off to watch children, or who incurred medical costs from pollution-related illnesses themselves. Additionally, excessive exposure to PM2.5 has been repeatedly linked with adverse consequences in children's brain development.[4,5]

Given the substantial injustices caused by engineered sociotechnical systems, such as this inland port, the field of engineering educational research must develop better approaches that more fully prepare future engineers to collaborate with communities to address and redress injustices through the realization of new infrastructures that result in equitable and just outcomes, and which are the result of equitable and just decision-making processes.

Accordingly, the purpose of this case study was to highlight ways in which engineers and other stakeholders might foreground procedural justice, or the rights of historically minoritized people to participate actively in decision-making,[6] and distributive justice, or the rights of historically minoritized people to benefit from the decisions that are made.[7]

This study was conducted in the context of a near-port community in which vehicular electrification efforts were occurring. Electric vehicles (EVs) and their associated infrastructures—including charging stations and wirelessly charging roads—may redress environmental injustices near inland ports because they significantly reduce vehicular emissions that harm human health. However, if the sociotechnical infrastructures associated with EVs are not intentionally planned to bring benefits to historically minoritized communities, they run the risk of reproducing interrelated transportation, economic, and environmental injustices. Thus, this study sought to answer the following overarching research question: ***What factors contribute to, or hinder, procedural and distributive justice relative to electrification for the near-port community?*** Because most research on electrification has been conducted with a consumerist orientation,[8] we sought to expand this research base to better understand how engineers can advocate for community-driven plans for electrification. At the same time, we also sought to develop broader implications for other engineers (including those who work outside of fields associated with vehicular electrification) who seek to actualize sociotechnical systems that fundamentally respect people's rights.

Context of the Study

We conducted this study in a near-port community that ranks above the 95th percentile in the EPA's Environmental Justice Index in terms of places in the country that face the worst exposure to toxic pollutants. These pollutants primarily stem from emissions from freight trucks and trains entering and existing the nearby inland port. These trucks and trains contribute to transportation injustices because the train tracks and freight routes make it more challenging for residents to travel to particular areas within their communities, such as a local grocery store blocked by the rails. The near-port community is comprised of geographically and politically-bounded neighborhood councils that have banded together to form the Southside Coalition (pseudonym) based on a shared history of economic and environmental minoritization. Despite this shared history, the community is also characterized by distinct linguistic and cultural histories. It includes many families who immigrated from Central and South America, East Africa, and the Pacific Islands. The majority of residents identify as Hispanic.

We are a racially, ethnically, and linguistically diverse team of researchers and practitioners, including several members who grew up in neighborhoods near the Southside Coalition. We conducted this study as part of our work in an NSF-funded Engineering Research Center focused on equitable vehicular electrification. Our approach was initially based on Pahl-Wostl et al.'s[9, 10] model of social learning, which addresses how multiple stakeholders can learn together to advance justice and community governance relative to resource and infrastructural management, ultimately resulting in systemic changes in equitable participation of historically minoritized communities. Under this framework, we sought to foster equitable connections among different groups (community-based organizations, schools, industries, legislators, transit authorities, the port authority) with the ultimate intention that community members and organizations would have greater sovereignty and decision-making power relative to the actualization of cleaner transportation infrastructures.

Research Design

To explore the community's definitions of justice, as well the factors that promoted or hindered movement toward justice, we conducted a case study of the near-port community. The case was bounded by port electrification efforts in the geographic area near the Southside Coalition, consistent with the assertion that case studies can be at a city or community level.[11]

To answer the question, ***What factors contribute to, or hinder, procedural and distributive justice relative to electrification for the near-port community?***, we generated or collected four sources of data. First, we conducted semi-structured interviews (90 minutes each) with community leaders, such as leaders of neighborhood organizations or appointed justice leaders for the Coalition. During these interviews, the leaders shared their views of justice, as well as characteristics of partnerships that have contributed to justice-oriented goals (e.g., to ascertain factors of egalitarian partnerships that are characterized by procedural justice) as well as characteristics of partnerships that did not contribute to those goals (to ascertain factors that hindered procedural justice). We also conducted interviews with liaisons within other organizations that were relevant to vehicular electrification, even if they were not necessarily

community-based, to better understand how they envisioned and enacted partnerships and goals related to vehicular electrification. Second, we attended public community meetings during which vehicular electrification was addressed, and we took non-identifiable field notes on people's comments during the meeting. Third, we read public forums, such as comments on opinion pieces in the local newspaper, to better understand community members' definitions of just outcomes and their desired processes for realizing those outcomes. Finally, we attended several community events at local parks and centers, and collected surveys (in English and Spanish) regarding people's perceptions of EV infrastructures, the ways in which they perceived they might be harmed by them or benefit from them. All participants received remuneration for their participation. We used constant comparative analytic methods to identify common themes across these data sources.[12] We report on these themes as headings in the findings section.

Findings and Implications

Below we use quotes from the interviews to introduce core themes, and then we describe how these themes related to procedural and distributive justice in engineered systems. For each theme, we describe possible implications for engineering educational settings in which engineers are better prepared to realize sociotechnical systems that advance justice.

Theme One: *It's so interwoven. It's hard to even know where to start picking it apart. It's all intertwined.*

One primary finding was that participants believed that engineers, legislators, and other decision-makers and stakeholders must contextualize current efforts at vehicular electrification within deeper histories of injustice, minoritization, and harm, under belief that "justice is again, one of those all-encompassing, tangled up situations" in which one action could not be understood apart from another action. As examples, one city council member explained that the Southside Coalition neighborhoods had experienced a deep history in which affluent residents on the Northside side of the city "dumped" things on them. He mentioned in the early days of the city, brothels were placed in the Southside against the residents' wishes. As noted previously, the inland port was placed there, despite community efforts to organize and petition against it.

Another resident pointed out that other structures, such as homeless shelters, were placed in their community even though elected leaders of these districts voted against them. In her words:

> *Whether that's people in Arby's that are parked (sleeping in their cars) predominantly on the Southside, whether it's shelters and halfway houses being predominantly on the Southside, whether it's manufacturing and a lack of housing availability on the Southside. I think that that's all of those things are things that the community feels has happened and they're worried about. I think there's a lot of opportunities in focusing on the southside of the valley to make things better, but I think people are also equally worried that they will then be displaced because of that… it's a community that feels like it has had a lot of the negative parts of society pushed to it.*

At the time of the study, a local highway was being expanded, and the expansion was planned to be placed in the Southside, requiring residential structures to be removed. In the words of one participant:

> *Even if, again, it feels like with the [highway] corridor, it's one of those times where again, people are just going to get screwed. Because landlords will be able to get some sort of money for the land, but the people renting those houses will then just be displaced and there's now less cheap housing for them to then get into…Even if you're compensating people who own homes or whatever, you're still really displacing a lot of renters, which is who lives next to freeways already.*

The community members' concerns underscored that, from their perspective, people had been repeatedly "crapping all over us," and the installation new EV infrastructures must not follow in that trend. In their view, the installation of new infrastructures was more than an issue of meeting technical specifications for safety, and even more than an issue of improving air quality and children's health. Instead, new infrastructures were issues of justice that were contextualized within larger histories of injustices that manifested themselves in numerous ways. Electric vehicles were not just about cleaning the air (promoting one form of environmental justice), but instead ran the risk of being yet another thing done *to* the community without their consent. Their experiences highlighted the need for community members to "be heard" and involved at all levels of decision-making. This experience of "being heard" would allow community members to share multiple forms of harm they feared or had experienced in the past, including displacement; the installation of unattractive infrastructures that brought down property values; sites falling into disrepair and becoming ugly "eyesores"; and freight truck drivers (EV or otherwise) using their neighborhoods as training sites and providing less safe roads for their children.

Their interviews underscored that one requirement for procedural justice for vehicular electrification was the need for engineers and other stakeholders to deeply understand the connections between residents' current and past experiences related to area development, in order to avoid the mistakes of the past.

Theme Two: *I think justice is going to be individualized as much as possible because it would be different for everyone.*

Several community members noted that, although they formed a Coalition based on shared interests and histories of injustice, engineers and other stakeholders who sought to facilitate new technical and human infrastructures should not minimize their differences or assume that any one person spoke for any one group.

One participant asserted that different people would have different opinions about different EV infrastructures. In her words:

> *It doesn't mean that just because a few of them say no (to bus routes using electric vehicles), probably more people will be using it. The people that actually use the transportation might be happy to be having more accessibility to electrified*

> *transportation compared to the people that might not even know how to use the public transportation.*

Community members' comments underscored the need to talk to many different people, as well as community-based organizations that served different constituents, as possible, in order to develop overall solutions that considered the perspectives of many different residents, including those who used public transport, those who did not, and those from different geographic regions of the area relative to any proposed infrastructural developments.

Although definitions and enactments of justice varied by person, several residents underscored that definitions of justice and environmental justice did not necessarily involve air quality. Even with the understanding that bad air quality harms human health, numerous residents mentioned that they have more pressing immediate needs. In the words of one community leader who described her constituents' concerns:

> *It is always, where am I going to get food, and how am I going to make my rent? Those are the two biggest concerns for people. Air was always at the very bottom* [of the priority list].

Another leader of a community organization similarly stated:

> *And I'd love our families to get involved in causes that are meaningful to them, whether that's the environment, whether that's support of electric vehicles, whether it's air quality, whatever. I would love to see that, but I don't know how they would with the fact that they're working two to three jobs.*

Multiple comments such as these underscored that engineers' initial definitions of justice, such as those pertaining to better human health through cleaner air, were not necessarily the topics that were most pressing to residents. To address this finding, we sought to develop approaches that addressed residents' concerns, such as addressing concerns about employment through connecting local residents to local jobs created through electrification. Overall, this finding underscores that engineers and other stakeholders can learn to understand community priorities and determine whether electrification can advance their priorities, even if it seems outside of the traditional purview of understanding and meeting technical specifications.

Theme three: *not just a one-time thing.*

Several community members noted fatigue with researchers coming into the community, holding listening groups or collecting data, and then leaving without bringing benefit back to their community. In one person's words:

> *I think that that's another thing that people in the Southside feel like is that they get, again, these grants where if something is done and something is put in with great fanfare and then it is just kind of left to disintegrate and become an eyesore. And so whatever is done has to be a real commitment for the future, not just a one time kind of thing.*

Another person similarly stated that engineers should constantly be

> *making sure that your lenses are open to more ideas and not only have this idea of basically being the savior of the community and then forgetting that there is other problems that may happen throughout this creation of electric vehicles.*

Numerous data sources indicated that community members believed procedural justice should entail a plan for sustainability, in the sense that ongoing conversations and evaluations, as well as benefits from the proposed project, should continue over an extended period of time, including beyond the project's initial funding period. Numerous community leaders and liaisons noted that the primary characteristic of a good partnership is that it lasts over time. In one person's words:

> *I think that that makes a real difference and it shows how committed the people working for those organizations are to this particular neighborhood. I think that makes a huge difference. I think that that's the biggest thing is just that there's a continuity of who is doing the work and who is showing up every day.*

These quotes and others indicated that engineers and other stakeholders can consider how to institutionalize benefits to historically minoritized communities, for example, through obtaining commitments to maintaining physical infrastructures, or through commitments to fund long-term job positions whose function is to build and maintain relationships and partnerships across organizations. As noted by the second participant's quote, this long-term institutionalization of systemic changes should include ongoingly evaluating whether the proposed sociotechnical solutions, such as new partnerships or new physical infrastructures, are inadvertently causing different types of harms or new problems, and ongoingly developing plans to mitigate and redress those harms.

Conclusion

Engineers of the future must be prepared to evaluate whether and how their proposed solutions contribute to justice or injustice in society. This study offers concrete implications for how engineers can partner with others to actualize their proposed designs in ways that promote procedural and distributive justice for communities that have historically been harmed by sociotechnical systems.

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