

Design of a Prioritization Methodology for Equitable Infrastructure Planning
(Technical Paper)

Examining the Ethical, Practical, and Societal Implications of Data Monetization
(STS Paper)

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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
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Introduction

The City of Charlottesville, facing a labor shortage of school bus drivers due to COVID-19 related layoffs, is looking to increase the number of children with safe routes to walk or bike to school. This is not only a response to the unexpected bus driver shortage due to COVID-19, but is also part of a city-wide school mobility reconfiguration project intended to upgrade outdated facilities and bring fifth graders back to their respective elementary school as opposed to Bufford Middle School to build community and equity in neighborhood schools (Katherine, 2021) (Xuemei Zhu, 2009) (Richard J. Lee, 2017). As stated in the City's 2015 Bicycle and Pedestrian Master Plan, "walking and biking will be practical, convenient, safe, and pleasant ways to travel to destinations within and adjacent to the City" (Charlottesville City, 2015). The vision of the technical topic is in alignment with the vision of the City's pedestrian and bicycle development. The challenge is to breakdown the impact of infrastructure projects and organize key information in a way that allows urban planners, stakeholders, and the public to make a well-informed and data-driven decision for a greater equitable access so that students within their respective school-walking zones have the ability to walk or bike to school. Therefore, the technical topic for the Department of Systems and Information Engineering is designing a prioritization tool to address the infrastructure planning challenges of the City of Charlottesville.

Content recommendation algorithms (CRAs) are used to sort and filter user-generated content based on relevancy to prioritize which content a user sees first based on the likelihood that they will actually engage with such content. The algorithms that popular social media platforms use is responsible for the spread of culture as well as a new front for e-commerce and influencer marketing (Demadis, 2021) (Michael Haenlein, 2020). Social media analytics expert, Nick Cicero, found significant trend in social media marketing in the past few years is the

growth of video-based content on social media platforms (Hutchinson, 2021). Like any new technology, there are unintended consequences and negative implications of poor algorithmic designs, such as systematic data bias that reduce the algorithm's accuracy (Krishnamurthy, 2019) (Reuben Binns, 2017) and groupthink-induced hysteria (Alexander Haslam, 2014). A constant battle exists between the companies and its users over how users' personal data are stored. This research will explore how TikTok utilize their algorithms to monetize their consumers, particularly 18 to 24 years old, and its societal, ethical, and practical impacts.

The technical subject of the STS prospectus and the technical topics for the Department of Systems and Information Engineering are not related in a structural point of view as the STS topic is about the design of an ethical content-recommendation algorithm. However, both topics are related in technical operation as they both explore the societal impact; the technical topic of the Department seek to understand how to provide equitable pedestrian and bicycle access to lower socioeconomic neighborhoods within school-walking zones, and the STS technical topic to understand the impact of content-recommended social media on young adults individually and collectively. Both topics heavily utilize data analysis to draw insight and create data-driven recommendations.

Technical Topic: The Charlottesville School Mobility Prioritization Project

The goal of the technical topic for the Department of Systems and Information Engineering is to design a prioritization methodology that will enable the City's planners and stakeholders to address the ongoing expansion in an equitable, transparent, and objective manner. The vision for the technical topic is as follows: A network of pedestrian and bicycle

paths in neighborhoods adjacent to the school will greatly enhance the walkability for daily commuters, promote active transportation, and improve quality of life. The scope of the topic is limited to understanding the grant proposal process that initiates an infrastructure project, creating a network of stakeholders and subject experts to explore design concepts and understand the needs of the key stakeholders, conducting field research to understand the values of daily school active commuters. The prioritization methodology has two parts. The first part is analyzing the current walkability of each school neighborhood by considering the metrics that represent walkability. Once the necessary information is organized, the second part utilizes the walkability score to prioritize the most impactful infrastructure project and communicate to decision-makers what data and rationale is used.

The state-of-the-art methodology for prioritizing infrastructure project used by the City is ActiveTrans Priority Tool (APT). Developed by the National Cooperative Highway Research Program, APT is a step-by-step methodology that evaluates and prioritizes bicycle and pedestrian improvement along existing roadways and was designed to help local communities establish a flexible and transparent project prioritization process that accounts for community values (ActiveTrans Priority Tool, n.d.). The methodology includes a spreadsheet that guides users through the process of identifying and scaling factors and variables, collecting the appropriate data, calculating a prioritization score for each project and finally creating a ranked list of projects based on the score (Charlottesville City, 2015). It was determined by the research team that APT is an inaccurate prioritization tool as it is fundamentally flawed in the way it calculates the prioritization score. More specifically, the tool implicitly sets trade-off values based on the user-input scaling method. This is flawed decision theory as the decision is not based on a single objective. A multi-objective problem requires making trade-offs. An example that came up in a

research team discussion about making trade-offs is: “How much decision makers would be willing to sacrifice in safety factors for greater equitability?”. APT does not address trade-offs in this manner. Instead, it implicitly set a trade-off value based on the scaling factor set by the user, meaning that the tool encourages user to set values for each variable based on its importance to the project. For example, a decision maker can set safety factors to weigh twice as much as equitable factors, and they are implicitly setting their trade-offs without multi-attribute decision theory merit. The research team concluded that it was done in this manner for simplicity reasons.

The technical topic is advised by Professor Reid Bailey of the Department of Systems and Information Engineering. The research team consists of four undergraduate systems engineer Claire Miller, Rahul Dhansinghani, Aditya Kannothe, and myself; as well as two graduate civil engineers Lena Nguyen and Ayman Ibrahim. Sponsoring the project is Amanda Poncy, the Bicycle and Pedestrian Coordinator and Kyle Rodland, the Safe Routes to School Coordinator of the City. Additionally, Professor Andrew Mondschein of the Department of Urban and Environmental Planning provided support and mentorship throughout the project. Principal Mark Marini and Assistant Principal Juanita Eddy of Clark Elementary School, Chairman of Clark Elementary School’s Parent-Teacher Organization, Joey Conover and the Outreach Coordinator of Friendship Court Advisory Committee, Claudette Grant, provided insight throughout the duration of the project.

STS Topic: Examining the ethical, practical, and societal implications of CRA employed by TikTok to target 18 to 24 year old users

Content-recommendation algorithms (CRAs) are to sort user-generated content based on relevancy to prioritize which content a user sees first based on the likelihood that they will engage with such content. Adopted by social media platforms like TikTok, CRAs are drivers of popular culture and enable social media networks to break new grounds in e-commerce. Social media networks like TikTok created its CRA for economic purposes by profiling users and delivering tailored advertisements. Therefore, the research question of the STS technical topic is as follows: What are the ethical, practical, and societal implications of CRA employed by TikTok to target 18-24 year old users?

As with any new technology in its early stages, a lack of regulation and accountability enable unethical CRAs designs for monetization as they input user's app usage data and output performance measurements that are then used to modify user behavior (Jose Ramon Saura, 2021). The inherited risk in the process of collecting and monetizing user data is data leaks and cyberattacks that puts users' personal data in the hands of cybercriminals. The opportunity in for CRAs is network security as well as establish governance for ethical design. The design of CRAs for users' online safety is a socio-technical problem and must be understood both from a social, practical and technical viewpoint.

There exists a push-pull relationship between the users and the organizations and creators of the digital environment. The users' motivation for using social media is to pass time, find social information, escape from the world and more while the software creator and data analytics firm is motivated by driving profits through user monetization (Johannes Ahlse, 2020). The ethical perspective of this relationship deals with the design of the social media network, more

specifically, it is purposefully designed to retain users for staying on the app for as long as possible and target certain demographics that are ignorant of monetization in order to drive the highest profit (Jose Ramon Saura, 2021).

The social identity theory state that people tend to categorize others they interact with based on self-recognition, and by doing so they implicitly create motivation behind in-group bias and confers self-esteem (Mou, 2020). In *Ethical design in social media: Assessing the main performance measurements of user online behavior modification*, Jose Ramon Saura introduces to the reader the concept of “Surveillance Capitalism, whereby access to data management using new technologies that can help some groups manipulate the society or users to make decisions based on economic and business factors, rather than on social ones” (Jose Ramon Saura, 2021). The study sets out to answer the following questions. The first question is: “What are the main performance measurements to measure user activity in social media?” (Jose Ramon Saura, 2021). The study identified “10 performance measurements and 4 ethical design measurements to increase user engagement” (Jose Ramon Saura, 2021). The second question is “How can the lack of ethical design increase user engagement in social media?” (Jose Ramon Saura, 2021). The study found that “in order to increase profitability, companies show users personalized content based on the analysis of their data (for ad personalization) and let users search social networks for content related to the purchase of products and service” (Jose Ramon Saura, 2021). The third and final research question is “What is the role of surveillance capitalism in the ethical design of social media platforms that would lead to user online behavior modification?” (Jose Ramon Saura, 2021). The study found “that the 14 elements related to user online actions suffice to make users think that they are performing their own decisions online; however, from the perspective of surveillance capitalism and ethical design backgrounds, these actions are the result

of companies' implementation of strategies of user online behavior modification that aim to increase the profitability of their business models" (Jose Ramon Saura, 2021).

The design process of an ethical CRA requires an understanding and application of theoretical frameworks. The following concepts will serve as a foundation for the analysis: principal-agent problem, perceived vs. actual system states (Greg Hennessy, n.d.), and technology adoption curve.

Principal-agent problem occurs when someone acts as an "agent" on behalf of another (i.e. the "principal") and make decisions on behalf of the principal. "This dilemma exists in circumstances where agents are motivated to act in their own best interest, which are contrary to those of their principals, and is an example of moral hazard" (Principal-Agent Problem, 2021). Applying the framework to the research question, the agent is the social media networks and the data analytic firms and they act in their own interest of driving profits. On the other hand, the users are the principal whose interest in social media network is purely entertainment. The moral hazard is the risk of user data exposure in which the principal has little to no control as the data is managed internally by the social media networks.

Perceived vs. actual system state can be thought of as the cognitive dissonance between what is true and what is thought of as the truth. For example, there is a difference between actual, perceived, and desired user satisfaction and these factors should be treated as three distinct variables as opposed to grouping into one ambiguous variable. In *Ethical design in social media: Assessing the main performance measurements of user online behavior modification*, one of the 10 performance measurements to increase user engagement is the user sentiments that predict how users feel at any given moment in time (Jose Ramon Saura, 2021). Applying perceived vs.

actual system state to this scenario would differentiate the actual self-reported user sentiment, and the perceived user sentiment calculated by the algorithm.

Technology adoption curve is a model that “describes the adoption of new product according to the demographic and psychological characteristics of defined adopter groups” (Technology adoption life cycle, 2021). There are five demographics of the adoption curve: Innovators, early adopters, early majority, late majority, and laggards. The research question is specifically on young adult TikTok users that are typically the early adopters and early majority as they are more open to new ideas than the older, and more conservative users who are the late majority and laggards adopters.

Research Question and Methodology

The research question of the technical topic is as follows: How can the City of Charlottesville prioritize equitable active transportation infrastructure? The research team applies a systems approach in answering the research question starting with determining the goals of the system, then establishing criteria for ranking alternatives, then developing, and lastly ranking the alternatives. This process is used iteratively throughout the duration of the research.

The research question of the STS topic is as follows: What are the ethical, practical, and societal implications of content-recommendation algorithms employed by TikTok on 18 to 24 year old users? In order to answer the STS research question, the researcher will send out survey to a random sample of TikTok users of the age 18 to 24. The survey will ask technical data like how often an individual uses TikTok, the motivation for the usage, and the types of content that appears on the user screen. The survey will also collect the socio-cultural data of the user to understand if CRA explicitly target vulnerable demographics.

Conclusion

The goal of the Department's technical topic is to review the current active transportation planning methodology of the City and design an equitable methodology that generate an optimized combination of infrastructure projects for the greatest return on investment in social value. A better strategy is a better grant proposal process that allows the City planners to secure not only more funding, but also a greater approval certainty for a large-scale street renovation project. Better public policies complement infrastructure projects as a large-scale walking school-bus program would greatly increase the number of students walking or biking to school, especially for students in lower socioeconomic households that have limited access to alternative school transportation methods as opposed to students in upper socioeconomic households. Once completed, the prioritization of Charlottesville school mobility infrastructure has the potential to provide greater equity in active school transportation.

The STS topic goal is to manifest design requirements and ethics policies to regulate the design of CRAs. A better understanding of content-recommendation algorithm has the potential to regulate social media networks so that there is a greater emphasize on user's wellbeing as well as data security.

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