Autonomous Delivery: A Vehicle for Assisting the Elderly and Disabled
(Technical Project)
Data Privacy in Food Delivery Services: A Sociotechnical Analysis of Stakeholders and Ethical Implications
(STS Project)

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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

In modern society, technological convenience and assistance has become increasingly accessible. Many individuals, especially the elderly and disabled, face challenges in their daily lives that technology has the potential to address. Simultaneously, these technologies have the capabilities to harness countless amounts of data. Keeping track of data is not inherently a harmful act as data is needed for a smooth user experience. Though these conveniences come with a cost: data privacy. Concerns about data privacy and security loom large as the world becomes more digital, even ordering food can be done in a matter of pressing one button. Through the exponential growth in online food delivery system (OFDS) scholars and researchers have shown concerns on the data privacy aspect. This topics on this paper addresses on how technologies can be extremely beneficial to people, but simultaneously different stakeholders can take advantage of it for their own benefit if society ignores a healthy discussion on it.

The technical project endeavors to develop an autonomous vehicle that can deliver object to the user, explicitly designed to cater to the unique needs of the elderly and disabled. This autonomous vehicle aims to provide support by enabling individuals with limited mobility to seamlessly perform daily tasks. Through autonomous object delivery, obstacle avoidance, and user-friendly voice control, this vehicle seeks to offer its user an improved quality of life. Under the guidance of our faculty advisor and a dedicated team of computer engineer students, our project will span several phases, including hardware development, software integration, and extensive testing to ensure the utmost safety and reliability of the vehicle.

The STS (Science, Technology, and Society) research project delves into a concern surrounding data privacy in the realm of online food delivery services (OFDS) and its sociotechnical relations between various stakes holders. With the increasing prevalence of online

food ordering platforms, users' personal data, including food ordering histories and preferences, have become valuable assets for companies and many other stake holders. This research aims to analyze the sociotechnical aspect of online food delivery systems and privacy implications of its data collection. Creating a discussion on how third-party entities, such as insurance providers, could potentially exploit this data for personal gain. Additionally, this research discusses the increasingly prominent risks of data breaches in the food delivery systems and the subsequent targeting of consumers by local restaurants for targeted advertising, potentially violating their privacy.

The STS research paper delves into the data privacy concerns associated with devices that track personal data, such as location, a theme closely tied to our technical project on autonomous delivery vehicles. While our vehicle relies on user data for its functionality, these parallels broader data privacy challenges explored in the STS project. The research highlights the risks in collecting sensitive information, such as user location in the case of OFDS and the technical project, emphasizing the potential for misuse by entities prioritizing profit over privacy.

The STS research project will utilize the Social Construction of Technology (SCOT) framework, developed by Trevor Pinch and Wiebe Bijker, to analyze the complex interplay of stakeholders involved. SCOT enables us to understand how technology adoption and policy regulation are shaped by various user groups, their interests, and the power dynamics that influence technological change. Together, the technical and STS topics discuss the beneficial aspects of technology to society as well as its conflict of interests.

Autonomous Delivery: A Vehicle for Assisting the Elderly and Disabled

In a world where robotics have advanced exponentially and provided solutions to various societal challenges, our computer engineering project aims to apply this technology for a helpful purpose: autonomous delivery. The main objective of our technical project is to design and develop an autonomous vehicle specifically tailored for delivering small objects, possibly food items, within a confined environment. Unlike traditional autonomous vehicles, our vehicle's design tailored to assisting elderly and disabled individuals in their daily lives.

Under the guidance of Professor Adam Barnes, a team of six computer engineering students, Ky Nguyen, Pranav Ramkumar, Dylan Lewis, and along with three other potential classmates, will spend a semester building a robust autonomous vehicle capable of delivering small food items and objects. The vehicle will autonomously navigate the chosen location, have the ability to hold objects, recognize obstacles, and be user-friendly. Our design incorporates a multifaceted set of functionalities, each designed to meet the unique requirements of our intended users. Central to its capabilities is autonomous navigation, enabling the vehicle to move around the environment without direct human control. This autonomy extends to obstacle avoidance, a crucial feature that ensures the vehicle avoids collisions and traffic. To achieve this, each team member will contribute to developing the Printed Circuit Board (PCB) that connects the given microcontroller to the remote controlled (RC) car's circuit board. The PCB will act as an interface between the microcontroller and the rest of the RC car. Additionally, team members will develop software that provides instructions to the microcontroller on how to integrate all the sub-parts into a cohesive system, including the car's main circuit board, cameras, power supplies, sensors, and user interface screen. Team members will also be responsible for training the machine learning model from scratch, which will send signals to the microcontroller to control

the vehicle and process signals from the 3 surrounding cameras attached to the car. The data for this learning model will be extracted solely from the vehicle's 3 cameras. Team members will feed the data to the machine learning model and train its autonomous navigation feature. Our vehicle's design focuses on robustness, ensuring its ability to securely transport small objects and withstand moderate collisions if that happens. Team members will research durable, affordable, and functional chassis options for the design. In terms of the user interface, user-friendliness is a priority. Team members will create comprehensive user interface software to communicate the car's functionality through a liquid-crystal display (LCD) screen. Lastly, members will develop a cohesive testing plan to test each sub-part of the vehicle, ensure that it functions properly, and meets safety regulations.

Data Privacy in Food Delivery Services: A Sociotechnical Analysis of Stakeholders and

Ethical Implications

The exponential growth of food delivery systems, exemplified by the Covid-19 pandemic, has led to a shift in how we procure goods and services in recent years. These "cloud kitchens" deliver food to customers with a simple tap of a button. In 2021, the online food delivery system (OFDS) accounted for an estimated 26.5 percent of the global e-commerce user market, generating 111.32 billion in revenue (Su, 2022). However, the surge in user popularity also comes with a growing amount of user data. Every action within OFDS application is tracked, including the user's location, eating habits, food ordered, and credit card information, among others. Despite the convenience, the OFDS industry raises concerns about data privacy. The exponential growth in users brings an intricate web of data flows and exchanges, posing significant risks of security breaches and privacy infringements. Therefore, safeguarding user data becomes essential and requires responsible data practices within OFDS. It is crucial to explore the landscape of data privacy in the OFDS, as its data privacy issues are unique compared to other technology systems. This research aims to dive into OFDS unique issues by analyzing the complex interplay between its stakeholders, their motivations, the ethical and non-ethical use of customer data using the Social Construction of Technology framework as theorized by Trevor Pinch and Wiebe Bijker.

The Social Construction of Technology (SCOT)

The concept of Social Construction of Technology provides a comprehensive lens through which we can understand how technology evolves and interacts with society. At its core, SCOT challenges the traditional notion that technology is a mere product, also referred to as an "artifact." Instead, it claims that technology is a result of a dynamic and complex interplay between four tenants, which are relevant social groups, interpretive flexibility, closure, and stabilization (Bijker, 2015). An example that Bijker mentioned in his paper "Technology, Social Construction of" is a bicycle. In its general purpose, a bicycle is a revolutionary affordable tool to help people travel across distances. Though, its goal can be interpreted differently amongst different social groups. Back in the 1870s, the bicycle was viewed as "unsafe machines" by women because it often made their "skirt entangled and... frequently made [them] fall" (Bijker, 2015). On the other hand, riding a bicycle is interpreted as a "means to impress people (including young ladies)" by young men (Bijker, 2015). The different interpretation of the same artifact between different social groups is called Interpretive flexibility. These different meanings that each group attributed to a particular artifact "shapes the artifact's development" (Bijker, 2015.

By elaborating on these stakeholders and their interpretive flexibilities, we gain valuable insights into the sociotechnical dynamics within the online food delivery ecosystem. The stakeholders that will discuss include Restaurant owners, OFDS providers, Users, and Investors.

Restaurant Owners

Restaurant owners are integral stakeholders within the online food delivery technology ecosystem. Their primary motivation is to ensure the profitability and survival of their businesses, especially in the face of evolving consumer preferences and challenges such as the

COVID-19 pandemic. To remain competitive, many restaurant owners have "found it essential to adapt to recent changes... and offer online food delivery services for their survival" (Meena, 2022). A substantial percentage of their take-out orders now flow through these platforms, making them heavily dependent on the success of OFDS. Their engagement with OFDS lies in optimizing their menus, pricing, and promotions to attract more customers, which shapes the development of the OFDS as well because these aspects directly translate to the OFDS.

Online Food Delivery Services (OFDS) Providers

OFDS providers, including platforms such as GrubHub, DoorDash, Uber Eat, Zomato, are primarily motivated by profit generation and user engagement. These platforms "collect information or data of users and therefore offer personalization features to increase customers' experiences" (Su, 2022). The ability to recommend food choices tailored to individual preferences is a key aspect of their engagement strategy. More engagement means the platform can benefit more from advertisers, "build customer loyalty — and, in turn, drive revenue" (Fertik, 2019). While personalization can enhance the user experience, it also raises concerns about data privacy, as these platforms use personal data for other profit-driven purposes (Su, 2022). The same data that enhances user experience is often used for other profit-driven purposes, including sharing data with third-party advertisers (Daniels, 2023). This underscores the complex ethical considerations within the OFDS ecosystem.

Users

Users are undoubtedly central stakeholders in the online food delivery services (OFDS), and their influence extends beyond financials. Their vision of ODFS revolves around

convenience and personalization, emphasizing the seamless and efficient ordering of their favorite meals. This emphasis on user experience is critical, as it directly impacts the success of OFDS. The success of OFDS hinges on its ability to meet user expectations. When a platform excels at recommending great dining options, providing swift and cost-effective deliveries, and ensuring user satisfaction, users will surely return to the platform (Meena, 2022). Users are not just customers; they are financial contributors to the OFDS ecosystem. Their spending habits and preferences shape the platform's revenue streams as well as the local restaurants that use the platform (Solutions, 2023). Users also cause indirect influence for the OFDS platforms to adapt and evolve. These platforms actively collect and analyze user data, allowing them to identify patterns and trends in each user. If certain operational changes lead to a significant revenue increase, driven by user behavior and preferences, the platform is inclined to incorporate these changes. For instance, Zomato, the most popular ODFS in India, started to heavily improve its artificial intelligent capabilities for their platform, specifically a chat bot called "Zomato AI". By collecting a wealth of user-tracked data, including past purchases, expenditure patterns, and location, Zomato AI can optimize food recommendations and recommend users their next favorite meal (Tech, 2023). In essence, the OFDS application adapts to the user's evolving preferences, effectively also reflecting how users are actively reshaping the platform. In this symbiotic relationship between users and OFDS providers, users serve as dynamic agents of change. Their preferences, behaviors, and feedback continually inform the platform's design and features. Therefore, it is evident that users are actively shaping and redefining the online food delivery system, highlighting the intricate sociotechnical interplay within this ecosystem.

Investors

Investors constitute a pivotal group of stakeholders, and their primary vision centers on achieving financial success. Their involvement is driven by the expectation of substantial returns on their investments, which exerts an influence on the technical development of OFDS. Financially, investors provide the essential capital required for OFDS platform to expand into new markets, launch extensive marketing campaigns, and invest in technological innovations. This financial backing directly impacts the platform's reach and competitiveness (Global, 2023). Furthermore, investors closely monitor financial metrics and key performance indicators, pressuring OFDS providers to prioritize profit generation and strategic growth. Their focus on profitability influences decisions related to pricing models, advertising strategies, and service quality enhancements. Beyond financial contributions, investors hold sway over strategic choices, such as mergers, partnerships, and diversification efforts, significantly shaping the OFDS's economic future. Investors steer the evolution of OFDS to align with their financial interests and expectations, while also contributing to the platform's growth and competitiveness.

After the discussion about the significant influence of investors on OFDS, it is equally important to explore how interpretive flexibility, the second tenet of SCOT, among various stakeholders further shapes the ethical and operational dynamics of these platforms.

Interpretive Flexibility Among OFDS Providers

The concept of interpretive flexibility becomes prominent when examining the viewpoints of Online Food Delivery Service (OFDS) providers. For these entities, platforms like GrubHub, Uber Eats, and Zomato are not just service facilitators; they are intricate ecosystems driven by data analytics to maximize profitability. OFDS providers interpret their platforms as

tools for revenue generation, leveraging user data to refine user experiences and user boost

engagement. This data-driven approach, while enhancing operational efficiency and customer

satisfaction, often extends to practices that raise ethical concerns. For instance, the aggregation

and analysis of user data such as eating habits, location, and transaction history are frequently

used for targeted advertising and, in some instances, sold to third parties like insurance

companies. These practices, rooted in the providers' profit-oriented interpretation of the

technology, can lead to the commodification of personal data, often without explicit user consent

or awareness.

User Perspectives and Data Privacy Concerns in OFDS

      Contrastingly, the user perspective on OFDS is centered around convenience and instant

gratification. Most users engage with these platforms with the goal of satisfying their food

cravings easily and efficiently, valuing the diverse choices, ease of ordering, and quick delivery

that OFDS offer. This user-centric interpretation tends to overlook the implications of data

sharing, as the immediate benefits of convenience overshadow concerns about personal data

privacy. However, this lack of emphasis on data privacy from the users' end inadvertently

empowers OFDS providers to continue their data-centric operations with minimal resistance. The

OFDS providers are encouraged to do so because it is free money for them. Users often

unknowingly agree to these practices due to a lack of awareness or concern about how their data

is being used, which can create ethical problems. For instance, when OFDS providers share user

data with insurance companies, these entities gain access to intimate details about individuals'

eating habits and lifestyles, which can be used to tailor insurance plans in ways that are more

profitable for the insurers, possibly to the detriment of the users. This highlights a major ethical

problem in the OFDS world: interpretive flexibility between providers and users could lead to

using user data for profit.

Method and Plans:

To comprehensively analyze data privacy concerns within online food delivery services

(OFDS), this research utilizes a methodology that incorporates primary and secondary data

collection methods. Primary data will be collected through interviews, surveys, and observations

involving key stakeholders such as users, restaurant owners, and OFDS providers. The collection

of primary data will adhere to rigorous ethical considerations, ensuring informed consent,

participant anonymity, and data security. Simultaneously, secondary data consisting of legal

documents, industry reports, and scholarly articles will be accessed and examined. This

combined approach will provide a comprehensive understanding of the current state of food

delivery policies and privacy laws. Data analysis will be conducted using qualitative and

quantitative methods, with the assistance of software for robust pattern recognition and trend

identification. Moreover, this research will adhere to established legal and ethical frameworks

governing data privacy, incorporating industry-specific regulations and guidelines. Additionally,

ethical review processes will be carried out to validate the research approach. As part of the

analysis, this research aims to identify areas for improvement in food delivery data privacy

policies, while establishing criteria and benchmarks for evaluation.

Conclusion:

In summary, this prospectus consists of two interconnected topics. The first topic is a

technical project that focuses on designing an autonomous delivery vehicle to assist elderly and

disabled individuals. The second topic is an STS research project that addresses data privacy

concerns in online food delivery services (OFDS). Both projects explore the complex

relationship between technology and society, with a particular emphasis on the role of

stakeholders in shaping these sociotechnical landscapes. Using the Social Construction of

Technology (SCOT) framework, the research aims to understand how OFDS technology impacts

society and identify potential improvements in technology adoption, and data privacy practices.

By undertaking these efforts, the research aims to bridge the gap between technology and

society, fostering a more equitable and ethically conscious future.

References

1. Bijker, W. E. (2015). Technology, social construction of. In *International Encyclopedia of the Social & Behavioral Sciences* (pp. 135–140). https://doi.org/10.1016/b978-0-08-097086-8.85038-2
2. Buettner, S. A., Pasch, K. E., & Poulos, N. S. (2023). Factors Associated with Food Delivery App use Among Young Adults. *Journal of community health, 48*(5), 840–846. https://doi.org/10.1007/s10900-023-01229-1
3. Daniels, N. (2023, August 22). How secure are food delivery apps? which apps are safe?. VPNOverview.com. https://vpnoverview.com/privacy/apps/food-delivery-apps/
4. Fertik, M. (2019, December 16). Why customer engagement should be every business's top priority in 2020. *Forbes*. https://www.forbes.com/sites/michaelfertik/2019/12/16/why-customer-engagement-should-be-every-businesss-top-priority-in-2020/?sh=641a0846214a
5. Meena, P., & Kumar, G. (2022). Online food delivery companies' performance and consumers expectations during Covid-19: An investigation using machine learning approach. *Journal of Retailing and Consumer Services, 68*, 103052. https://doi.org/10.1016/j.jretconser.2022.103052
6. Morgan Stanley. (2023, July 7). Global food delivery to expand in 2024. https://www.morganstanley.com/ideas/food-delivery-platforms-growth
7. Solutions, A. I. (2023, March 28). Online food delivery business model: A comprehensive guide. *LinkedIn*. https://www.linkedin.com/pulse/online-food-delivery-business-model-comprehensive-guide-solutions/
8. Su, D. N., Nguyen, N. A. N., Nguyen, L. N. T., Luu, T. T., & Nguyen-Phuoc, D. Q. (2022). Modeling consumers' trust in mobile food delivery apps: perspectives of technology acceptance model, mobile service quality and personalization-privacy theory. *Journal of Hospitality Marketing & Management, 31*(5), 535-569.
9. Tech Desk. (2023, September 4). Zomato AI can help gold users choose their next meal. *The Indian Express*. https://indianexpress.com/article/technology/artificial-intelligence/zomato-ai-can-help-gold-users-choose-their-next-meal-8923982/

10. Uber. (n.d.). Privacy notice. https://www.uber.com/legal/en/document/?name=privacy-notice&country=united-states&lang=en