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Impact of Digital Platform Economy and Ride-Hailing Services on Urban Mobility in Pampanga

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ABSTRACT

Purpose: This study examines the impact of ride-hailing services and the digital platform economy on urban mobility in Pampanga, Philippines, focusing on the residents of Angeles City, Mabalacat City, and San Fernando City. The research aims to assess how these services affect accessibility, convenience, and commuting efficiency in the region, considering factors like transportation accessibility, demographic trends, and the increasing preference for on-demand services.

Methodology: Data was collected through an online survey targeting residents of the three cities. Statistical methods, including logistic regression, Exploratory Factor Analysis (EFA), and Confirmatory Factor Analysis (CFA), were used to analyze the data and identify key factors influencing urban mobility patterns and the impact of ride-hailing services.

Findings: The study revealed that ride-hailing services significantly improved urban mobility in terms of accessibility, convenience, and commuting efficiency. Key factors influencing these changes include enhanced transportation accessibility, demographic trends, and a growing demand for on-demand services. However, challenges persist, such as safety and privacy concerns, as well as the need for improvements in the quality of public transportation.

Unique contribution to theory, practice, and policy: The study contributes to urban mobility theory by exploring the intersection of digital platform economies and transportation systems in emerging cities. Practically, it highlights the importance of integrating ride-hailing services with public transport systems to create a more efficient and sustainable urban mobility framework. Policymakers are encouraged to address safety and privacy issues, invest in infrastructure improvements, and create policies that integrate ride-hailing services into the broader public transport ecosystem to ensure equitable access and long-term sustainability.

Keywords: *Urban Mobility, Ride-hailing Services, Digital Platform Economy, Sustainability, User Experience*

I.INTRODUCTION

1.1 Background of the Study

Urban mobility and transportation are crucial components of urban development (Upadhyay et al., 2023; Lin & Mitchell., 2023). According to Alessandretti and Szell (2022), they play critical roles in promoting economic growth, improving job accessibility, and alleviating poverty. The shift from walking to public transportation, and later to private vehicles, has transformed urban mobility worldwide. Congestion, pollution, and sustainability issues have all arisen as a result of increased private motorization (Gao & Zhu, 2022). In urban areas of today, concerns such as traffic congestion and poor space usage limit economic efficiency. Nonetheless, the integration of modern technology such as artificial intelligence, robots, and smart infrastructure is driving major change in urban transportation (Ceder, 2021). These inventions show immense potential for improving urban efficiency, sustainability, and mobility.

Gallotti et al. (2015) highlighted the importance of effective urban transportation in promoting economic growth. Urban transportation systems may boost economic output greatly by reducing travel time lost during connections, enhancing modal synchronization, and optimizing halt events per hour across all modes. Moghaddas et al. (2023) discussed this perspective, emphasizing how efficient urban transportation not only increases consumer satisfaction but also improves resource usage and service quality. These elements are critical to promoting economic, social, and environmental advancement. Similarly, Hajduk (2018) addressed the relevance of technological effectiveness in urban transportation, as well as the requirement for efficient resource allocation to drive growth in the economy. Furthermore, Narayanaswami (2017) also underscored the favorable influence of well-managed, large-scale infrastructure-intensive public transportation systems on economic performance, even during economic downturns. Such services not only improve quality of life but also promote sustainability, benefiting society as a whole.

In recent years, there has been a significant shift toward digital platforms, similar to the crucial role factories had during the Industrial Revolution, changing different aspects ranging from business operations to societal relations (Acs et al., 2021). This movement, known as "digitization," has quickly incorporated digital technology into a variety of areas, altering economies throughout the world. Central to this transformation is broad internet use, which has emerged as a primary force accelerating digitalization beyond an absolute abundance of digital data. The digital platform economy, characterized by the utilization of internet platforms to propel the digital economy, plays a fundamental role in enhancing enterprise value and fostering sustainable competitive advantages (Trachuk & Linder, 2023).

For further emphasis, the term "digital platform economy" refers to the interconnected digital systems governing online interactions (Kenney & Zysman, 2016). These platforms, composed of software, hardware, and networks, serve as pivotal hubs for user engagement, offering essential tools and interfaces for content creation and sharing. Moreover, online platforms which also exist

in the Philippines, such as Lazada, Shopee, Zalora, Google, Grab, Lalamove, Angkas, Netflix, Airbnb, CrowdFlowers, Microworkers, Zoom, and Webex, are widely utilized, facilitating various services from e-commerce to crowdwork and video conferencing (Albert, 2020).

Digital platforms, particularly in industrial sectors, serve as networks for refining consumer offers, developing partnerships, and acquiring market insights, resulting in long-term competitive advantages. Głuszak & Małkowska (2022) identified ongoing issues for small and medium-sized enterprises (SMEs), including limited financial and expertise resources despite rising digitalization. The platform economy not only boosts company value, but it also influences the formation of new models and processes, hence stimulating general economic growth and modernization.

The rise of ride-hailing services, with the aid of these digital platforms, significantly impacts transportation mode choices, leading to increased traffic congestion and changes in public transit ridership, particularly affecting urban drivers, riders, and pedestrians (Lee et al., 2022). Machine learning technologies play a pivotal role in shaping the dynamics of on-demand ride-hailing services, influencing urban traffic patterns, individual mobility behaviors, and order matching strategies, thus highlighting their disruptive effect on urban transportation (Liu et al., 2022). Bhaduri & Goswami (2023) also emphasized ride-hailing services' role in reshaping urban transportation, citing their impact on service quality and public transit integration, especially among non-car-owners in developing nations. Additionally, factors such as income, smartphone usage, and age influence the adoption of ride-hailing services, primarily utilized by the younger population on weekends. The emergence of ride-hailing services represents a transportation revolution in urban areas, influencing travel behaviors and potentially substituting for more sustainable modes of transportation (Gehrke et al., 2023).

The rapid integration of the digital platform economy and the increase of ride-hailing services have significantly altered urban mobility dynamics in the metropolitan areas of Pampanga. However, despite their growing prevalence, the specific impacts of these developments on transportation patterns, congestion levels, accessibility, and sustainability within the region remain poorly understood and understudied. Thus, there is a pressing need to investigate the multifaceted effects of the digital platform economy and ride-hailing services on urban mobility on the cities located in Pampanga to inform policy-making and urban planning initiatives due to its ongoing urbanization progress.

In 2017, there were an estimated 2.4 million Filipinos who downloaded at least one ride-hailing application, and this significantly increased to 4.1 million in 2018. A consistent uptrend in the adoption rate is expected coupled with increased active users (Serafica & Oren, 2021). According to Department Order No. 2015-011 issued by the Land Transportation Franchising and Regulatory Board (LTFRB), a Transportation Network Company (TNC) is described as an organization—whether it be a corporation, partnership, or sole proprietorship—that offers pre-arranged transportation services for a fee using internet-based technology applications or digital platforms.

Mirandilla & Regidor (2019) claimed that this definition identifies TNCs as providers of public transportation, utilizing privately owned vehicles operated by drivers connected through these digital platforms like Grab. The legalization of app-based shared mobility services in the Philippines in August 2015 marked a significant milestone, making it the first country in Asia to formalize its longstanding tradition of shared transportation (Schechtner & Hanson, 2017).

The Philippines was ranked 7th place among other Asian countries to have the worst traffic congestion based on its traffic index which is around 187.3 (Numbeo, 2023). As Metropolitan Manila undergoes rapid urbanization and expansive growth in both size and population, attention has turned to urban regions beyond the National Capital Region (NCR) as potential hubs for emerging metropolitan areas in the Philippines. Decentralization initiatives led by national, regional, and local governments aim to alleviate congestion in Metro Manila by fostering socio-economic growth in other areas, such as the cities in Pampanga, identified as key urban centers under the National Framework for Physical Planning: 2001-2030 (Beltran et al., 2015). Despite being situated outside the metropolitan hub, the province of Pampanga has experienced substantial growth in recent years, fueled by various infrastructure initiatives within the province and neighboring regions. Recognizing the pivotal role of connectivity in fostering business activities within the region, the national government has embarked on a series of infrastructure projects poised to elevate Pampanga into the next major economic corridor of the Philippines.

Pampanga, home to the cities of Angeles, San Fernando, and Mabalacat, maintains a substantial population and service-driven economy due to its strategic location outside the metro. Managing significant traffic flows within and between cities underscores the critical importance of prioritizing accessibility and mobility in Pampanga (Pascual et al., 2023). Public utility jeepneys (PUJs) and tricycles are the primary transportation options in the city, valued for their convenience and affordability. Four transport terminals serve outside city routes: SM Clark Terminal/Bayanihan Clark for northbound destinations, Jao Ville Pandan Terminal for the east, Nepo Mart Terminal for the west, and Essel Park Common Terminal for the south. Additionally, Marquee Mall hosts a bus terminal for provincial routes, while ride-hailing apps are also available in the area (Beltran et. al, 2015). Nevertheless, it is imperative for Pampanga to learn from the transportation challenges faced by Metro Manila, where commuters endure lengthy hours of traffic congestion daily.

The objective of this study is to explore the use of digital platform economy through ride-hailing services around urban areas and how it affects consumer preferences regarding transportation.

Specifically, this study aims to;

I. Assess the extent to which the digital platform economy and ride-hailing services have influenced commuting patterns and modal choices in Pampanga;
II. Investigate how digital platforms and ride-hailing services impact accessibility in urban areas of Pampanga;

III. Examine how the mobility of both people and goods via public and private transportation in Pampanga shifts because of digital platforms and ride-hailing services that aid future transportation policies.

This research investigates the influence of ride-hailing services and the digital platform economy on urban mobility indicators, providing crucial insights for informed policy-making, sustainable urban development planning, and the enhancement of transportation efficiency and accessibility in Pampanga, while addressing transportation challenges and meeting the needs of its residents and commuters.

1.2 Theoretical Framework

There are several frameworks for guiding the innovation diffusion studies: like Technology Acceptance Model (TAM), the Technology-Organisation Environment (TOE) Framework, and the Unified Theory of Acceptance and Use of Technology (UTAUT), and most of them are derived from The Innovation Diffusion Theory proposed by Everett Rogers in 1958. This theory is termed the "Paradigm of Innovation Decision Process." It is differently known as the Classical Innovation Theory, the Diffusion of Innovations, and the Diffusion Theory (Kelleher & Sweetser, 2012), among others. The IDT connects the three classifications of correlates: the characteristics of the individual potential adopter, how the adopter perceives the innovation, and the characteristics of the social system or organization where the potential adopter is to the innovation diffusion. Rogers specifies that an individual's propensity to adopt any innovation depends on the characteristics of the individual (Bakkabulindi, 2014).

Rogers defines adoption as the diffusion of an innovation, where "diffusion" is defined as a "process in which an innovation is communicated over time." The digital economy has various innovations, including mobile applications, digital platforms, and technologies that facilitate economic activities. With Rogers' definition of diffusion, understanding how these digital innovations are spread across channels and eventually adopted by various urban population segments is made easier with Innovation Diffusion Theory.

This theory has been applied in various fields, including urban transportation and the digital platform economy. The researchers shall investigate the factors influencing continued usage of ride-hailing services, blending theories on innovation diffusion and technology advancement.. Studies conducted in major Southeast Asian cities like Manila have compared traditional transportation methods with ride-hailing apps, revealing user preferences (Ferreira et al., 2022). These studies highlight the significance of the Innovation Diffusion Theory in shaping urban mobility and the digital platform economy, particularly concerning ride-hailing services in the Philippines.

II. REVIEW OF RELATED LITERATURE

2.1 Urban Mobility

Both the research and academic communities, along with numerous research and development projects, have explored urban mobility from diverse perspectives. Urban mobility, as defined by Vidović et al. (2019), involves accessing desired destinations through the utilization of different transport modes, aimed at ensuring accessibility and movement within the urban environment. According to Gillis et al. (2015), mobility encompasses the transportation of passengers and goods within urban agglomerations, incorporating all modes of transportation pertinent to urban travel, including motorized and non-motorized, public, and private modes. Additionally, Amaral et al. (2018) characterizes mobility by its impact on economic prosperity, emphasizing factors such as travel duration, expenses, and congestion, underscoring the importance of improving urban mobility for sustainable city growth. Rashidy & Muller (2014) identify two dimensions of urban mobility. The first pertains to the user perspective, focusing on the ability to move from one point (origin) to another (destination) using suitable transport modes. The second dimension examines mobility from an infrastructural standpoint, defining it as the transport system's capacity to provide access to work, education, health services, commerce, etc., ensuring users can reach their destinations using appropriate transport modes and with satisfactory service levels.

Urban mobility poses one of the most daunting challenges for cities today, with existing systems nearing breakdown (Cheba & Saniuk, 2016). One of the central challenges for future urban mobility lies in achieving a harmonious balance between economic sustainability, environmental regulations, and the satisfaction of travelers (Miskolczi et al., 2021). Additionally, Paiva et al. (2021) claimed that the challenges of urban mobility extend beyond the movement of people and private vehicles to encompass the mobility of goods, commercial transport, and urban logistics, all of which are crucial for achieving sustainable and environmentally friendly mobility, necessitating consideration of the impact of commercial fleets on traffic congestion alongside private vehicles. The complexity of urban mobility, encompassing technical, morphological, social, and political dimensions as mentioned by Acheampong et al. (2021), poses formidable challenges to implementing sustainability measures.

In the context of a city, urban mobility encompasses all facets of the urban transport system, necessitating effective management through the use of indicators to identify adequate subsystems and areas requiring greater investments (Braga et al., 2019). Furthermore, it serves as a cornerstone of smart city initiatives, closely intertwined with cross-border decision-making on routing, digital transformation systems, and car traffic forecasts, with municipal policies leveraging data and communication tools and innovations to shape smart mobility initiatives (Tomaszewska & Florea, 2018 ; Allam & Sharifi, 2022). Prakash (2021) asserts that smart mobility solutions are integral to bolstering urban mobility in component cities. These solutions aim to enhance public transport, offer guidance to commuters, and effectively manage traffic. Cagney (2020) disclosed that the diverse location data sources mentioned earlier enable the mapping of individuals' daily activity

areas and movement patterns within urban areas. Nonetheless, as previously mentioned, sociological investigation moves beyond merely tracking people's locations to encompass analyzing the social structures, significance, and consequences of the places they frequent or travel through. Moreover, Cohen & Kietzmann (2014) also claimed that shared mobility solutions offer potential for alleviating urban traffic congestion and pollution, yet their business models encounter inherent complexities. The interplay between service providers and local governments seeks to determine effective strategies for realizing sustainable urban mobility. Cities' economic growth objectives are linked to the endeavor for sustainable urban mobility, leading policymakers and planners to explore strategies from different areas. These attempts to transfer policies, whether willingly or through coercion, affect the procedures and approaches to policy implementation (Canitez, 2020).

In the context of the Philippines, community quarantines proved effective in curbing urban mobility in the Philippines amidst the peak of the COVID-19 pandemic, with mobility showing significant responsiveness to varying degrees of lockdown stringency. However, it was noted that lockdown measures were less successful in constraining mobility in cities reliant on manufacturing industries (Furceri et al., 2021 ; Gaspay, 2021). In light of this, the researchers aimed to assess Pampanga to understand how residents navigate their daily destinations and the common transportation challenges they face. The objective is to propose improvements and solutions that could effectively address the community's needs and enhance urban mobility (Lapid et al., 2023).

The future of urban mobility could undergo significant transformation, driven by advancements such as new propulsion methods, vehicle control systems, evolving ownership models, and empowering mobile technologies. It seeks to bridge the gap between smart and sustainable objectives, acknowledging the pivotal role of technology while emphasizing the importance of sustainability considerations (Lyons, 2018). Estacio (2019) proposes that the future of urban mobility in the Philippines entails the adoption of innovative, locally-produced, and environmentally sustainable transportation alternatives, such as automated guide-way transit, hybrid electric road trains, and hybrid electric train prototypes. In Metro Manila, ridesharing services like Uber and GrabCar are favored over traditional taxis due to their enhanced reliability, safety features, and service quality, thereby influencing the trajectory of urban mobility (Regidor & Napalang, 2018). The introduction of Uber and similar services has implications for the taxi industry in the Philippines, potentially fostering increased competition and delivering benefits to commuters, thus indicating a promising outlook for urban mobility with the integration of ride-hailing services (Mendoza et al., 2015).

2.2 Ride-Hailing Services on Urban Mobility

According to Liu et al. (2019), Urban mobility is being disrupted by the rapid expansion of Mobility-on-Demand (MoD) services like Uber and Lyft. However, according to Zhong et al. (2020), the rapid growth of internet-based ride-hailing services has improved city transportation and, at the same time, has significantly impacted the current city transportation modes. In urban

areas, on-demand platform mobility services are becoming more prevalent. These services have grown in recent years through innovation in Information and Communication Technology (ICT) because Transportation Network Companies (TNCs) provide adaptable and convenient mobility options. In addition, internet-based on-demand mobility services or ride-hailing are spreading globally, influencing travel behaviors and the emergence of urban mobility patterns. People also prefer ride-hailing services because they are convenient and affordable to use since travel time can be shorter, and some individuals do not have to use a personal car in an urban center with limited parking and congested areas and avoid driving while intoxicated (Acheampong et al., 2020).

In developing countries, ride-hailing services are being used by people on a daily basis. Some providers are well-known global companies such as Uber, Didi, or Lyft. These services use applications on smartphones to link drivers and passengers. They have various effects on travel behavior, for instance, by giving travelers more alternatives, lowering uncertainty about transportation and parking, or substituting alternative modes. According to the study result, respondents reported using ride-hailing services because it is faster and more comfortable than public transportation (Lesteven, 2021). Although ride-hailing services have gained popularity and have succeeded in capturing a segment of the urban transport market share and are competing with other modes of transportation in a shorter period, it is a different case for other cities and countries because the popularity and acceptance may differ based on various countries. Ride-hailing services may have the same provider in multiple countries, but it still varies on what range and level of services they offer. It is a different case for developing countries since they survive and grow rapidly. Moreover, there are three factors in the mode choice of individuals: individual characteristics, trip characteristics, and the level of service provided by the transport service (Raj et al., 2023).

The study by Chalermpong et al. (2023) underscores the rapid motorization and widespread informal transport in Southeast Asian countries grappling with high population growth, increased income, and urbanization. However, the pace of urban expansion has outstripped public investment in urban infrastructure, necessitating a catch-up. This underscores the need for transportation infrastructure investments to accommodate the growth in most Southeast Asian cities. The concept of mobility as a Service or MaaS, which integrates public and private transportation services from various operators, is emerging as a new transport solution. MaaS, focusing on integrated transport, incorporates new mobility services (NMS) like ride-hailing and car- and bike-sharing, ensuring on-demand access to transportation through a single payment channel and offering curated mobility packages (Hasselwander et al., 2022). Furthermore, allowing travelers to choose the best mode for all trips is fundamental to mobility as a Service (MaaS). The results of the first field trials of MaaS systems showed that test subjects made better decisions in such a setup, saving money and lowering carbon emissions (Becker et al., 2020).

According to Tirachini (2019), the distinctive attributes of ride-hailing are one of the mitigating factors influencing ride-hailing services. Other factors such as fare transparency, driver

identification, and behavior of the drivers, like their friendliness and initiative of carrying things, based on the survey, are also relevant for ride-hailing choice. On the other hand, the study by Sadowsky & Nelson (2017) mentioned that the ride-hailing service entry affected bus riders' behavior and never became a substitute for bus use. Based on the result of their study, they complement each other since the average bus rider has less money than the average rail user, and ride-hailing service reservations still cost far more than the average bus rider's. On the other hand, the cost of a ride-hailing service reservation is significantly greater for wealthy rail customers. Therefore, price competition between the average train passenger is far more likely than the average bus user to utilize a ride-hailing service.

Transportation Network Companies (TNC) have become a new form of transportation that has considerably impacted urban mobility in the last ten years. Current research suggests that there may be several ways that TNCs impact people's mobility decisions and the efficiency of the transportation network, which has varying effects on the sustainability of metropolitan areas (Diao et al., 2021). In addition, pricing, thus, offers an essential management tool that may impact customers' decisions or choices about personal ride-hailing journeys, shared rides, and other means of transportation (Naumov & Keith, 2020).

Ride-hailing services affect urban mobility in diverse ways, potentially alleviating traffic congestion through increased capacity utilization while also contributing to congestion by displacing other modes of transportation (Agarwal, 2019). Additionally, they reveal reproducible demand patterns, implement surge pricing during peak times, and lead to longer passenger wait times in residential areas, affecting urban mobility dynamics (Oh et al., 2022). Despite showing a positive association with public transit use, ride-hailing services do not significantly affect transit ridership odds, indicating a complex relationship between the two modes (Osakwe et al., 2022). In the Philippines, ride-hailing services like Uber provide valuable insights into traffic patterns and city structure, as observed in Metro Manila through Uber trip data (Carcellar III, 2019). These services impact urban mobility by enhancing accessibility, creating job opportunities, and reducing car ownership, albeit facing challenges such as unfair competition and environmental concerns (Khavarian-Garmsir et al., 2021).

2.3 Digital Platform Economy on Urban Mobility

Garud et al. (2022) and Bauriedl & Strüver (2020) highlight the pivotal role of digital platforms in fostering innovative community engagement within the sharing economy. Yuana et al. (2019) likewise emphasize the rise of the sharing economy, propelled by digitalization and collaborative sharing, marking a critical convergence of two major technological shifts. Creutzig (2021) argues that urban transportation is undergoing a significant shift characterized by the emergence of smart and shared mobility options, such as food delivery and ride-pooling, heavily influenced by the presence and impact of the digital platform economy. Moreover, there are observations that urban mobility is evolving through digital innovations like real-time data analysis, autonomous vehicles, and shared mobility services, which enhance travel experiences and reduce infrastructure

dependence (Dia, 2017). Conversely, Dunn (2020) suggests that digital platforms reshape urban mobility, influencing city politics, user participation, and conflict resolution, thereby altering urban interactions and governance dynamics.

The digital platform economy further enhances urban mobility by integrating service modules and data sources, facilitating the co-creation of innovative services and enhancing transportation efficiency within cities (Schreieck et al., 2018). Ganapathy (2018) elaborates on how the sharing economy positively impacts urban mobility through smartphone app-based ridesourcing services, offering convenience, lower prices, and income stability for driver-partners, thereby benefiting both riders and service providers. Additionally, Acs et al. (2022) and Fauzi (2022) underscore the capacity of digital platforms to leverage data for economic gain and promise sustainability through enhanced resource efficiency. Sutherland & Jarrahi (2018) remark on the diverse attention garnered by the ideology of the sharing economy, particularly from researchers in marketing and environmental studies.

The growth of peer-to-peer (P2P) transportation platforms like Uber & Lyft influences urban consumer patterns, reducing movement frictions, impacting local consumption behaviors, and altering the economic performance of businesses (Zhang & Li, 2017). Cruz & Paulino (2020) and Frosio (2020) further emphasize the evolving nature of urban mobility with complex patterns and sustainability demands, as Mobility-as-a-Service (MaaS) platforms leverage the digital platform economy to provide flexible, low-emission transportation solutions. Hodson et al. (2024) discuss the significance of social norms and perceived benefits in shaping the adoption and ongoing usage of ride-hailing apps, exemplified by transportation platforms like Grab that provide matching services without owning goods or services.

Garau (2016) also asserted that the digital platform economy is reshaping urban mobility in Africa through app-based services, impacting travel behavior, safety, and sustainability. Truong et al. (2021) adds that the digital platform economy, particularly ride-hailing services, significantly influences urban mobility in Hanoi's city center by shaping mode-shifting behaviors for various trip purposes. Riemens et al. (2021) highlight how digital platforms impact urban mobility through governance challenges and negative effects, emphasizing the need to safeguard public values in platform design for sustainable and efficient travel. Krasteva et al. (2021) notes that digitization introduces new automated and networked vehicle systems, reshaping the entire mobility system with enhanced flexibility, reliability, cost-effectiveness, and energy efficiency. Moreover, urban digital platforms enhance citizen participation in sustainable urban planning, fostering innovation for more inclusive and democratic urban development (Katmada et al., 2023).

III. RESEARCH METHOD

3.1. Methodology

The researchers analyzed the urban mobility in the cities of Pampanga and examined how the integration of the digital platform economy and ride-hailing services affect all of the movements

that occur within the areas. This study focused on the three component cities in Pampanga, namely, San Fernando, Mabalacat, and Angeles.

This study utilized a cross-sectional research design, collecting data from a population at a single point in time to provide a snapshot of how the digital platform economy and ride-hailing services affect urban mobility in Pampanga. This design enables the analysis of relationships between factors such as ride-hailing usage, traffic congestion, and demographic variables within a single study period. It is an efficient and cost-effective approach, allowing for gathering real-time data without the need for long-term tracking.

To ensure a representative sample, a stratified random sampling design was employed. This method ensures the inclusion of key subgroups within the population of Pampanga, such as frequent and occasional users of ride-hailing services, individuals from varying income levels, and residents from both urban and suburban areas within Angeles, Mabalacat, and San Fernando. By using this approach, the study captures a comprehensive picture of the impact of digital platform economies on urban mobility across diverse demographic groups. Three hundred eighty-five (385) participants were surveyed to ensure sufficient representation from each subgroup.

Utilizing multivariate analysis, the researchers used Principal Component Analysis (PCA), initially introduced by Karl Pearson and Charles Spearman in the early 1900s. This method aims to reduce the dimensionality of the collected data, assuming a linear relationship among digital platform economy, ride-hailing services, and urban mobility. PCA, a statistical technique, encompasses two main types of factor analysis: Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). Both EFA and CFA were utilized in developing the survey tool.

During the pilot testing phase, EFA was employed to determine the number of factors by scrutinizing PCA output. Additionally, EFA aids in summarizing the data into a smaller set of variables, facilitating the identification of the relationship structure between variables and respondents. This process further enables the assessment of the underlying constructs or latent factors, such as ride-hailing services, digital platform adoption, and urban mobility patterns in Pampanga.

3.2. Data Analysis Plan

The data collected from primary sources were analyzed using quantitative methods to assess the impact of digital platform economies and ride-hailing services on urban mobility in Pampanga. The analysis used descriptive and inferential statistical techniques to explore the relationships between key variables such as ride-hailing usage, traffic patterns, and demographic characteristics.

Initially, descriptive statistics was employed to summarize the demographic profile of participants and provide an overview of their experiences with ride-hailing services. Measures such as frequencies, percentages, means, and standard deviations were used to describe the distribution of

responses to key survey questions. This will help identify trends in ride-hailing usage, mobility patterns, and perceptions of urban mobility issues.

The data were analyzed using statistical software, such as SPSS, for Validity through pilot testing and Principal Component Analysis (PCA) to summarize data. Before analysis, researchers cleaned the data to check for any missing values, outliers, or inconsistencies. Any missing data was handled through appropriate imputation methods, and outliers were identified and addressed. The analysis results were presented using tables, charts, and graphs to facilitate interpretation and provide a clear visual representation of key findings. These analyses helped answer the research questions and provide insights into the influence of digital platforms on urban mobility in Pampanga.

3.3. Scope and Limitation

The research only covers how the digital platform economy and ride-hailing services shape urban mobility in Pampanga, Philippines. The introduction outlined specific research objectives, including examining the growth of ride-hailing usage and its effects on urban mobility, considering available data and research resources online. The literature review prioritized exploring studies on the socio-economic impacts of ride-hailing services. At the same time, the theoretical framework was aligned with the research goals, drawing from established theories in the field. The methodology involved utilizing surveys or focus groups to collect data and adapting to resource constraints and respondent accessibility. Analysis and findings employ appropriate quantitative or qualitative methods, offering insights relevant to policymakers and transportation experts. The discussion placed the findings in the context of urban mobility planning, identifying knowledge gaps and suggesting practical recommendations for stakeholders. The conclusion summarizes the main findings, recognizes research limitations, and underscores the study's significance in improving urban mobility in Pampanga.

The inclusion criteria for this study are individuals aged 18 years old until 59 years old only, both regular and non-users of ride-hailing services, residents of the selected areas within Pampanga, specifically Angeles, Mabalacat, and San Fernando, and those who have access to a smartphone and are familiar with digital ride-hailing platforms. The exclusion criteria consist of individuals under the age of 18 years and above 59 years old or senior citizens, those who do not reside in the aforementioned specified areas, and participants who either lack access to a smartphone or are unfamiliar with digital ride-hailing services. These criteria ensure that the sample selected is appropriate for examining the impact of digital platforms on urban mobility in Pampanga.

3.4. Ethical Considerations

By providing participants with an informed consent form, researchers uphold principles of autonomy, respect, and beneficence, all of which are central to ethical research practices. The participants have the right to know that the researchers will collect their personal data, which were only used for research purposes, and ensure that researchers are committed and accountable to protecting participants' information, ensuring that data is anonymized or kept confidential, and will

respond appropriately to any potential data breaches. The researchers implemented strict protocols to protect participants' identities, ensuring confidentiality, privacy, and anonymity throughout the research process in compliance with the Data Privacy Act of 2012.

All survey data were anonymized, with only relevant information being collected. Access to data was restricted to authorized personnel only, and all collected information was stored securely using encryption and anonymization techniques. Thus, personal identifiers were removed from the findings and securely stored with password encryption, limiting access to sensitive information to authorized research team members only. The researchers ensured that the participants were fully informed about the purpose, procedures, potential risks, and benefits of the study in a transparent manner, and consent was obtained prior to any data collection or participation in the survey, ensuring participants had ample time to review the information and ask questions. This process ensures that participants voluntarily agree, fully understanding their involvement without coercion. Consent was obtained clearly and transparently without pressure, allowing participants to make an informed, voluntary decision. Researchers are committed to protecting participants' information and will respond appropriately to potential data breaches.

Respondents under 18 and over 60 were excluded to protect vulnerable groups. In the absence of special populations such as minors, legally incompetent individuals who cannot give consent, or indigenous groups, the consent process is straightforward. Still, it remains essential to maintain the principles of autonomy and voluntariness. Participants were informed that their participation decision was entirely their own, free from coercion or undue influence.

Furthermore, participants were informed that they had the right to withdraw from the study at any point without facing penalties or consequences. They can choose to do so if they feel uncomfortable sharing their information, opinions, or experiences or no longer wish to participate for any reason. In addition to this, the researchers did not receive funding or sponsorship from external organizations, ensuring the study remains independent and free from biases. This absence of financial sponsors strengthens the study's objectivity, as no vested interests are involved. The researchers are committed to maintaining transparency and adhering to ethical standards throughout the study, free from conflicts of interest.

The potential risks to participants are minimal, primarily involving slight discomfort when answering sensitive questions about their use of ride-hailing services or urban mobility habits. These risks are mitigated by ensuring participants' anonymity and confidentiality of personal information. On the other hand, the benefits of participation include contributing valuable insights into the impact of digital platform economies on urban mobility in Pampanga, which could inform policies and services. While no direct monetary rewards exist, the research may lead to improved mobility strategies, benefiting the wider community.

3.5. Research Instrument

The researchers distributed an online survey for the respondents made through Google forms, who are using ride-hailing service applications. The respondents currently reside in one of the municipalities in Pampanga, including Angeles City, Mabalacat City, and San Fernando City.

The questionnaire encompasses demographic profiles such as gender, monthly salary/ allowance, age, place of residency, selection of ride-hailing app, and car ownership/use. In addition, Part 2 of the paper encompasses a Likert scale ranging from 1-4, with 1 representing "strongly disagree," 2 representing "disagree," 3 representing "agree," and 4 representing "strongly agree". These questions are designed to understand ride-hailing services' and application users' experiences and preferences. The survey questions for the first table are about Urban mobility, the second table is about the Digital Platform Economy, and the third table is about ride-hailing services.

The survey was available for two weeks, and participants were invited to complete the questionnaire through posts and links shared on social media, specifically in groups with residents from the said municipalities. The collected data was analyzed to identify patterns and relationships between digital platforms and regional urban mobility.

3.6. Model

UM = 0+1 RHS + 2 DPE +e

Eq. 1. The effect of Ride-Hailing Services and Digital Platform economy on Urban Mobility in the three component cities in Pampanga: San Fernando, Mabalacat, and Angeles.

wherein:

UM = Urban Mobility,

RHS = Ride-Hailing Services,

DPE = Digital Platform Economy.

3.7. Diagnostic Test

The diagnostic used was logistic regression to find the relationship between two data factors to predict the value of one factor based on the other. The researchers used Exploratory factor analysis (EFA) and Confirmatory Factor Analysis (CFA) for the Principal Component Analysis.

Exploratory Factor Analysis plays a pivotal role in this study. It grouped the questions from the survey questionnaire into clusters, allowing the researchers to identify and remove irrelevant questions, thereby enhancing the accuracy and relevance of findings.

Confirmatory Factor Analysis deals with the measurement models, such as the relationship between variables or indicators and latent variables or factors (Brown & Moore, 2012).

IV. RESULTS AND DISCUSSION

Table 1

Descriptive Statistics of the Respondents (n = 385)

Characteristic	Category	N	%
Age	18 - 24	178	46.23%
	25 - 31	86	22.34%
	32 - 38	61	15.84%
	39 - 45	24	6.23%
	46 - 52	23	5.97%
	53 - 59	13	3.38%
Sex	Male	136	35.3%
	Female	167	43.4%
	Non-binary	64	16.6%
	Prefer not to say	18	4.7%
Place of Residency	Angeles City	138	35.8%
	Mabalacat City	104	27%
	San Fernando City	143	37.1%
Monthly Salary/ Allowance	₱ 15, 000 and below	111	28.8%
	₱ 15, 001 - ₱ 30, 000	97	25.2%
	₱ 30, 001 - ₱ 45, 000	102	26.5%
	Above ₱ 45, 000	75	19.5%
Ride-Hailing App Usage	Grab	242	63.9%
	Joyride	197	51.2%
	Angkas	195	50.6%
	Other	99	25.7%
Car Ownership/ Use	I have a car	87	22.6%
	I don't have my own car, but there is at least one car in my household that I can use if available.	156	40.5%
	I don't have my own car, and we don't have any car/s in my household.	142	36.9%

Out of the 385 respondents in the survey, the majority were aged between 18 and 24 years, making up 178 respondents (46.23%). A further 86 respondents (22.34%) were aged 25 to 31 years, while 61 respondents (15.84%) were aged between 32 and 38 years. Additionally, 24 respondents (6.23%) were in the 39 to 45-year age group, and the remaining 13 respondents (3.38%) were aged between 53 and 59 years. Regarding sex, 136 respondents (35.3%) identified as male, while 167

respondents (43.4%) identified as female. Furthermore, 64 respondents (16.6%) identified as non-binary, and 18 respondents (4.7%) preferred not to disclose their sex. In terms of place of residency, 138 respondents (35.8%) were from Angeles City, 104 respondents (27%) were from Mabalacat City, and 143 respondents (35.7%) were from San Fernando City. With respect to monthly income, 111 respondents (28.8%) reported earning ₱15,000 or below, 97 respondents (25.2%) indicated their monthly income ranged from ₱15,001 to ₱30,000, 102 respondents (26.5%) earned between ₱30,001 to ₱45,000, and 75 respondents (19.5%) reported earning above than ₱45,000. When asked about their preferred ride-hailing apps, respondents were allowed to choose multiple options. Grab was the most popular, used by 242 respondents (63.9%). Joyride was selected by 197 respondents (51.2%), while 195 respondents (50.6%) used Angkas. Additionally, 99 respondents (25.7%) selected "Other," specifying a ride-hailing app not listed among the choices. Finally, regarding car ownership and use, 87 respondents (22.6%) reported owning a car. In contrast, 156 respondents (40.5%) did not own a car but had access to at least one car in their household. The remaining 142 respondents (36.9%) indicated that neither they nor their households owned a car.

4.2. Validity Results

4.2.1. Pilot-testing the Research Instrument

Table 2 *Result of Cronbach Alpha*

Reliability Statistics		
Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
.908	.912	30

The researchers conducted a pilot test to examine the validity of each question. Cronbach's Alpha is significant in ensuring the reliability of measurement instruments and assessing the degree of interrelatedness among items in a questionnaire (Izah et al., 2023). In this study, forty (40) residents from one of the three municipalities in Pampanga (Angeles, Mabalacat, or San Fernando) that use ride-hailing apps/services for transportation/commuting participated in the pilot testing. The Cronbach's Alpha of 0.908 indicates excellent reliability, which allows the researchers to proceed with data collection (Hazzi & Maldaon, 2015).

4.2.2. Data Cleaning

Table 3 *Principal Component Analysis extracted from the SPSS*

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.840
Bartlett's Test of Sphericity	Approx. Chi-Square	1625.818
	df	300
	Sig.	.000

Table 4 *Principal Component Analysis extracted from the SPSS*

Pattern Matrix

	Component		
	1	2	3
RH 6	.606		
RH 4	.596		
RH 3	.564		
RH 8	.545		
RH 10	.538		
RH 1	.519		
RH 9	.517		
RH 2	.511		
RH 5	.501		
RH 7	.477		
DPE 5		.683	
DPE 6		.669	
DPE 7		.632	
DPE 4		.566	
DPE 9		.535	
DPE 2		.529	
DPE 8		.422	
UM 5			.626
UM 6			.626
UM 3			.612
UM 9			.564
UM 2			.553
UM 7			.476
UM 4			.451
UM 10			.428

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

The Kaiser-Meyer-Olkin (KMO) test is intended to measure the suitability of data for factor analysis in which the KMO values between 0.8 to 1.0, such as in table 3, 0.840, indicating that the sampling is adequate, which also showed that factor analysis is helpful for the variables, while between 0.7 to 0.79 are middling, 0.6 to 0.69 are mediocre, and less than 0.6 indicate that sampling is not acceptable. Moreover, a significant value of 0.000 in Bartlett's Test of Sphericity, which is less than 0.05, indicates that factor analysis may be beneficial for the data set (Shrestha, 2021).

According to Samuels (2016), Tabachnick and Fidell (2014) suggest ignoring factor loadings with an absolute value of less than 0.32, in which table 4 shows no UM 1, 8, DPE 1, 3, and 10 to suppress factor loadings less than 0.3 while retaining with loading greater than 0.4. Coefficient value less than 0.4 was extracted in the final scale and regarded as insignificant. In contrast, the absolute value retained in table 4 was considered sufficiently high to assume a strong relationship between variables (Agustin & Valdez, 2020). According to Shrestha (2021), a suppressed coefficient value of less than 0.4 will suppress the presentation of any factor loadings using values below 0.4. The study could continue with regression because of the changes and recent acceptable results.

4.3. Discussion

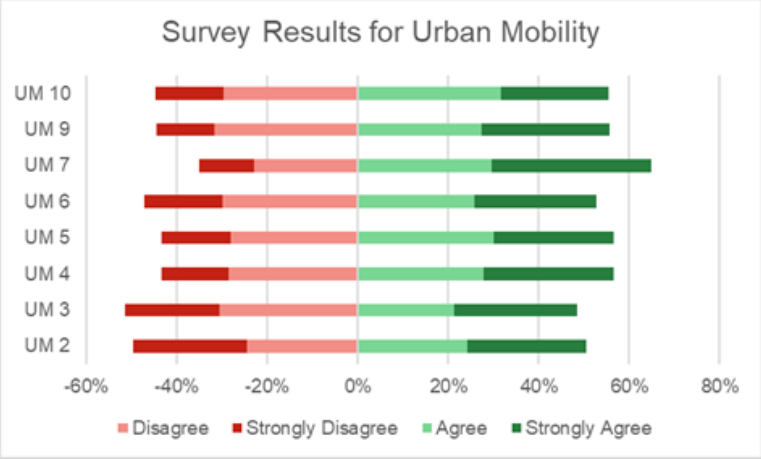

Figure 1. *4-point Likert scale Chart of Urban Mobility*

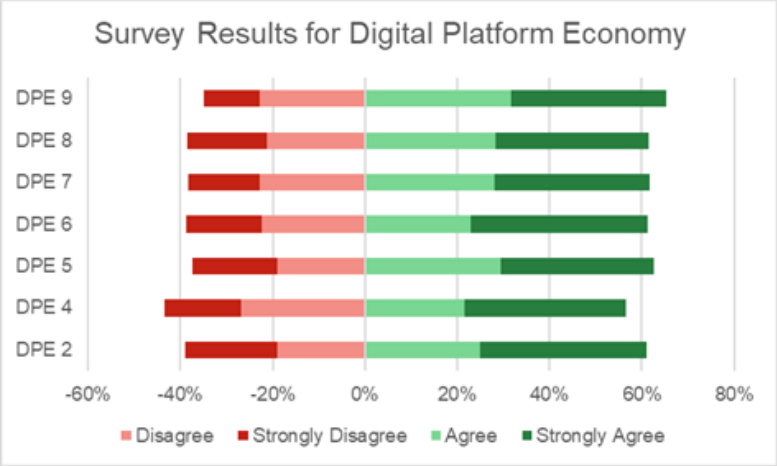

Figure 2. *4-point Likert scale Chart of Digital Platform Economy*

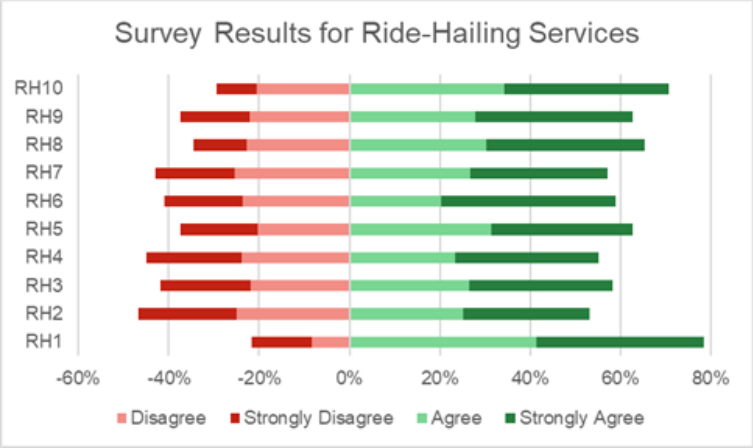

Figure 3. *4-point Likert scale Ride-Hailing Services*

The researchers utilized a survey instrument to systematically explore the use of digital platform economy through ride-hailing services around urban areas and examine the impact of digital platform economy and ride-hailing services on urban mobility in one of the three municipalities of Pampanga. Moreover, the UST Commerce Ethics Review Committee (COMMREC) reviewed and approved the survey instrument.

With the survey results shown in figure 1, UM 10 has the most agreed rate, with 31.7%, which indicates that most respondents agree that they are satisfied with the quality of public transportation in Pampanga. In comparison, 35.3% strongly agree in UM 7 that there is always an available mode of transportation in Pampanga. On the other hand, UM 9 has the most disagreed rate, with 31.7% showing that users of ride-hailing services and apps disagree that they prefer public transport in Pampanga, and 25.2% of respondents of UM 2 strongly disagree that they are comfortable traveling on public transport. Hence, figure 2 shows that DPE 6 has the highest rate of strongly agree, with 38.4% indicating that they think technological advancement is generally a

positive thing, and DPE 9, with 31.7%, has the highest rate of agree, which tells that participating in the ride-sharing apps will be fun showing its influence in commuting patterns and modal choices. DPE 2 has a 20% rate of strongly disagree, which means ride-hailing apps are not easy to use for some users, and DPE 4 has the highest disagreed rate of 26.8%, indicating that the majority of ride-hailing app users were not satisfied with the privacy and security of the app offers.

In Figure 3, RH 6 has the highest rate of strongly agree with 38.7%, saying that respondents prefer ride-hailing services for nonwork trips like going to the mall, while 41.3% agree in RH 1 that they are comfortable using ride-hailing services. In contrast, RH 2 has the highest rate of strongly disagree, which is 21.8%, showing that most of the users of ride-hailing services do not feel safe using it, and RH 7 had a 25.5% disagree rate, so most of them do not use ride-hailing services when going to work or school.

4.3.1 Regression Results

The researchers utilized a multiple regression for the three variables: Urban Mobility, Digital Platform Economy, and Ride-Hailing Services shown in Table 5. The p-value of the Digital Platform Economy, which is 0.004712698, has a statistically significant impact on Urban Mobility. In addition, Ride-Hailing Services with 3.16991E-06 or 0.00000316991433075291, which is also less than 0.05, has a significant relationship with the dependent variable. A coefficient of 0.244, on the other hand, has the most substantial positive impact on Urban Mobility, which means as the number of users of Ride-Hailing Services increases, there is also a significant increase in Urban Mobility. The Digital Platform Economy also positively influenced the UM with a coefficient of 0.135 (Sarstedt & Mooi, 2018).

Table 5 *Multiple Regression*

	Coefficients	Standard Error	t Stat	P-value
Intercept	1.605834271	0.14757882	10.8812	3.34544E-24
DPE (IV)	0.134759612	0.047404592	2.842754	0.004712698
RH (IV)	0.243836156	0.051554741	4.729655	3.16991E-06

Table 6*Summary of Hypotheses*

	Hypotheses	Interpretation
H1	There is a significant relationship between Digital Platform Economy and Urban Mobility	Significant
H2	There is a significant relationship between Ride-Hailing Services and Urban Mobility	Significant

The table above shows the summary of hypotheses that are aligned with the findings of this research. For H1, there is a significant relationship between digital platform economy and urban mobility. Likewise for H2, which shows significance between the relationship of ride-hailing services and urban mobility. Although the models and methodologies employed in these studies differ, their outcomes consistently highlight the transformative role of digital platform economies and ride-hailing services in improving urban mobility. There were similar studies found that reinforce the validity of this research by demonstrating that ride-hailing services contribute to reducing travel times, increasing access to public transit, and mitigating traffic congestion. Collectively, these findings suggest that integrating ride-hailing services into urban transportation systems can significantly enhance overall efficiency, accessibility, and sustainability in urban mobility.

V. Conclusion

5.1. Summary of Key Findings and Conclusion

The study highlights several key factors shaping urban mobility in Pampanga, particularly the integration of ride-hailing services and the digital platform economy. While public transportation is generally accessible, concerns about its comfort and quality drive many individuals to prefer ride-hailing. Demographic factors, such as age and income, also influence mobility choices, with younger people and those with lower incomes relying more on ride-hailing, especially affordable options. Additionally, social preferences for convenience, time savings, and comfort contribute to the popularity of ride-hailing. Technological innovations, like real-time ride matching and seamless payment systems, have improved accessibility and efficiency, making ride-hailing a preferred option for many, especially for non-work-related trips. However, safety and privacy concerns remain barriers to wider adoption, alongside ongoing dissatisfaction with the quality of public transport. To optimize urban mobility, addressing these challenges and better integrating ride-hailing with public transport is essential.

5.2. Policy Implications

The study on urban mobility in Pampanga emphasizes the need for a comprehensive approach to tackle the region's transportation issues. Key strategies for improving public transit include investing in infrastructure upgrades, modernizing fleets, increasing service frequency, and making fares more affordable. Addressing safety and privacy concerns with ride-hailing services requires stronger regulations, better in-app safety features, and clear data privacy policies, alongside the creation of a dedicated regulatory body. Enhancing the transportation system also involves improving integration between different modes of transport through partnerships between ride-hailing companies and public transport providers, as well as exploring demand-responsive options. To address socioeconomic disparities, subsidies for public transportation, affordable ride-hailing options, and better access to technology for low-income communities are necessary. By implementing these measures, Pampanga can build a more sustainable, inclusive, and efficient transportation system that benefits all residents.

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