Delivering Tomorrow: Analyzing Automated Delivery Vehicle Narratives through Media Mining

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ABSTRACT

Amid the COVID-19 pandemic, automated delivery vehicles (ADVs) have gained even more significance due to their touchless capabilities, aligning perfectly with the need for contactless delivery services to safeguard public health. This study collected and conducted quantitative analysis on the most relevant 86 news articles focused on ADVs by employing sophisticated text network and collocation analyses to extract valuable insights. The findings indicated a noteworthy trend: express delivery services have forged partnerships with various ADV companies, leveraging their capabilities to tackle the challenging "last mile" delivery stage. Furthermore, the study revealed a growing integration of ADVs into diverse delivery sectors, particularly in food, grocery, and other on-demand services. Overall, this study provides invaluable insights into the current state of ADVs and their widespread adoption across various delivery sectors.

INTRODUCTION

E-commerce has sparked a transformation in the retail industry, resulting in a surge in demand for efficient delivery services. This surge has paved the way for the development of Automated Delivery Vehicles (ADVs) tailored to meet these delivery demands. ADVs have captured significant attention due to their potential to revolutionize the delivery of goods, offering numerous advantages over conventional delivery methods.

A crucial milestone advancing ADV technology was reached with the National Highway Traffic Safety Administration's (NHTSA) approval of ADV deployment at low-speed thresholds. This approval enables the use of ADVs in specific controlled environments, such as college campuses, business parks, and other restricted areas, where they can operate safely and effectively according to AASHTO (2010). Unlike traditional automated vehicles (AVs), ADVs are exclusively designed for delivery purposes and have no human occupants. This design grants them several key advantages over conventional delivery methods. Firstly, ADVs are projected to significantly reduce delivery costs by eliminating the need for human drivers. Secondly, their operations are optimized for efficiency, as they can plan and execute delivery routes without requiring breaks or rest periods. Finally, ADVs boast eco-friendliness by releasing fewer harmful emissions than traditional delivery vehicles.

An essential advantage of ADVs is their potential to address the issue of crashes caused by human error. The Highway Safety Manual (HSM) reveals that 93% of crashes result from human errors. By eliminating the need for human drivers, ADVs remove this risk factor, contributing to safer roads and enhancing overall road safety. During the COVID-19 pandemic, ADVs have become even more critical due to their touchless capability. Online shopping has increased significantly, with people avoiding public places to maintain social distancing. ADVs allow

packages to be delivered without human interaction, reducing the risk of virus transmission. This has increased the demand for ADVs and highlighted their importance in maintaining a safe and healthy environment.

As a relatively new technology, there are still many uncertainties and doubts regarding ADVs. While there are significant benefits to using ADVs for delivery services, there needs to be a greater understanding of the current state of research and development in this field. Very few studies have focused on ADVs, instead typically focusing on general AVs without accounting for the unique aspects and challenges that emerge with ADV adoption. Berendt (2017) mentioned that news media plays a crucial role in communicating further developments on emerging technologies, including ADVs, and is a beneficial tool for learning more about the state of development of significant research areas.

However, analyzing news articles is challenging due to the vast amount of information available online and the lack of structured data such as topic labels and semantic structure. This study conducted a comprehensive literature review and text mining of news media to collect relevant articles on ADVs, and text network and collocation analyses were employed to identify current trends and topics surrounding ADVs.

LITERATURE REVIEW

ADVs have garnered significant attention for their potential to revolutionize the logistics industry. Flämig (2016) conducted a comprehensive study outlining strategies to integrate AVs into road freight transportation systems within public facilities. The research aimed to determine the feasibility of employing AVs in logistic systems and provided historical insights into in-house logistics, shedding light on companies' reasons for adopting AVs. Additionally, the study addressed essential aspects such as navigation, safety, and control requirements for ADVs. On the other hand, Paddeu and Parkhurst (2020) investigated the developments surrounding ADVs and presented an extensive review focusing on their current and future state of development. They identified research gaps concerning assessing ADVs' economic benefits and development costs. Furthermore, practice and policy barriers were highlighted as significant challenges that still need to be addressed. Both studies contribute valuable information to the ongoing exploration of ADVs' potential impact on the logistics sector.

Crash prevention and safety

Crash prevention is a critical concern for ADVs, as it is necessary to consider the importance of safety when introducing new technology. Operating primarily in densely populated neighborhoods, ADVs must prioritize safety, particularly in ensuring smooth interactions with pedestrians. Strauss et al. (2021) underscored in the safety report their focus on minimizing physical harm in case of ADV-pedestrian collisions. In this pursuit, NHTSA has identified 12 safety elements for autonomous driving systems, and Nuro's safety report addresses their approach to these elements. ADVs offer a significant advantage in reducing fatalities and injuries related to vehicle occupants, primarily due to their occupant-less nature. Note that Strauss et al. (2021) specializes in robotics and is at the forefront of developing ADVs. It also is the first company to be granted an autonomous exemption by the NHTSA. Witcher et al. (2021) conducted a study demonstrating that full market penetration of occupant-less ADVs could potentially reduce fatalities by 58.2% and injuries by 61.8%. Based on current safety data, Dorr

and Seba (2020) predicted a 90% decrease in crashes involving AVs compared to conventional vehicles. Additionally, Hawkins (2017) wrote that Tesla's introduction of autopilot in 2015 resulted in a 40% drop in crash rates. However, some critics doubt the feasibility of a 90% crash reduction and raise concerns about potential risks AVs might introduce to traffic safety. Mueller et al. (2020) suggested that AVs could reduce up to 34% of traffic crashes, with even more significant improvements if technology could eliminate all traffic violations.

Though direct studies on ADV safety impact are limited, safety features of ADVs bear similarities to those of general AVs. Morando et al. (2018) utilized a simulation-based surrogate safety measure approach to study AV safety impacts, revealing substantial overall safety improvements at high market penetration rates, despite AVs operating with smaller headway to enhance roadway capacity. Ye and Yamamoto (2019) used a heterogeneous flow model to explore the impact of connected autonomous vehicles (CAVs) on traffic safety, finding that higher market penetration rates yielded additional benefits for traffic safety, especially when employing a more cautious car-following strategy. Papadoulis et al. (2019) developed a decision-making CAV control algorithm and implemented the Surrogate Safety Assessment Model (SSAM) to evaluate its safety effects. The results indicated that even at low market penetration rates, CAVs could significantly reduce traffic conflicts. Katrakazas et al. (2019) developed a novel risk assessment approach using interaction-aware motion models and Dynamic Bayesian Networks (DBN), which showed an up to 10% improvement in the interaction-conscious model, particularly in collision-prone traffic conditions.

Public Acceptance of ADV

Public acceptance of ADVs is crucial as this emerging technology still faces skepticism and uncertainties among consumers. Understanding the factors influencing public acceptance is essential to effectively deploy ADV services, allowing companies to address concerns and tailor their approach accordingly. Pani et al. (2020) conducted a comprehensive analysis of public feedback from 483 Portland customers, examining desires, attitudes, and willingness to pay (WTP) for ADVs. Their study provides practical insights to promote the mass adoption of eco-friendly delivery vehicles by identifying latent class WTP determinants. On the other hand, Kapser and Abdelrahman (2020) highlighted that ADVs may only reach their full potential if they are not widely embraced as a viable alternative. Additionally, Kapser et al. (2021) investigated the gender differences in ADV acceptance during the COVID-19 pandemic, incorporating gender as a moderator within the Unified Theory of Acceptance and Use of Technology (UTAUT2) framework. Employing structural equation modeling on questionnaire data, they concluded that price sensitivity is a significant factor influencing ADV acceptance among consumers in Germany, while perceived risk plays a decisive role in the acceptance of ADVs among female consumers in the country.

Despite their increasing significance in the delivery industry, ADVs have yet to receive substantial research attention. As the potential for mass deployment of ADVs becomes more imminent, researchers are increasingly invested in developing efficient and safe ADV networks and operation systems. However, a critical aspect that requires attention is the lack of studies on public perception of ADVs. Understanding how the public perceives this emerging technology is essential for its successful integration into society. Public perception plays a pivotal role in shaping the acceptance and adoption of new technologies. By examining the public perception of ADVs, this study aims to identify potential barriers, concerns, and misconceptions that might

hinder their widespread adoption. Additionally, understanding the factors contributing to positive or negative perceptions of ADVs can aid in developing targeted strategies to foster public trust and confidence in this technology.

As ADVs promise to transform the delivery landscape and significantly impact daily life, studying public perception is vital to ensure their successful and harmonious integration into our communities. Such research can contribute to developing effective communication strategies, policy frameworks, and educational initiatives that address public concerns and facilitate the responsible deployment of ADVs. Ultimately, a well-informed and positive public perception of ADVs can maximize their benefits while minimizing potential challenges during their implementation and deployment.

METHODOLOGY

Data Collection

In this study, data was collected using Google News Alert and entering relevant keywords related to ADVs to gather pertinent Uniform Resource Locators (URLs) pointing to webpages with related information. To automate the web scraping process, the popular R package Quicknews (https://github.com/jaytimm/quicknews) was utilized. Through this approach, 86 articles were extracted and chosen for subsequent analysis. Table 1 presents the selected news articles chronologically, covering the period from January 30, 2018, to July 1, 2021. The most recent articles are listed at the bottom of the table. To ensure the accuracy and relevance of the collected data, all news articles were manually inspected to verify their connection to ADVs. The headlines of these articles encompass a wide range of topics, providing insights into various aspects of ADV development and implementation. Some highlighted subjects include the progress made by companies like Nuro and Google in creating self-driving delivery vehicles, collaborative efforts between retailers and AV startups, and regulatory changes aimed at facilitating the operation of AVs on public roads.

Table 1. Sample Headlines of News Articles

No.	date	News Headlines
1	01/30/18	Ex-Google Engineers Raise $92 Million To Roll Out Robot Delivery Vehicles This Year
2	01/30/18	Nuro raises $92 million to develop autonomous delivery vehicle
3	01/04/19	DoorDash eyes driverless vehicles for grocery delivery
4	01/07/19	udelv to begin autonomous last-mile delivery pilot in Houston
5	02/06/20	U.S. lets autonomous vehicle bypass human-driver safety rules
6	02/06/20	Nuro's R2 autonomous delivery vehicle gets official OK to ditch steering wheel
7	03/12/20	Delivery robot firm Neolix closes RMB 200 million Series A+
8	07/06/21	Yandex Self-Driving Group partners with GrubHub to bring robotic delivery to college campuses
9	10/07/22	Amazon shelves pilot of robotic delivery vehicle
10	11/09/22	Waymo can now charge for fully driverless services in San Francisco

Text Network Analysis

Text mining, a popular technique in data mining and a branch of natural language processing (NLP), permits exploratory analysis of unstructured datasets. It can be extended to complex statistical analysis based on specific research questions. A powerful tool by (Hunter, 2014; Kwayu et al. 2021) that was used within text mining is text network analysis (TNA), which uncovers hidden trends in unstructured text data. TNA has been used across several fields, including literature and linguistics, traffic safety and operations, and the bibliometrics of transportation studies by (Paranyushkin, 2011; Kutela et al. 2021; Kutela et al., 2022). TNA uses nodes and edges to establish relationships between keywords within a corpus (a large, structured body of text).

Several steps are undertaken to process the data during TNA. Normalization is the first step, in which unstructured data is converted into a structured format, symbols are removed, and all text is converted to lowercase. Then, this processed data is used to develop a matrix representing keywords and their respective frequencies of occurrence. Next, the matrix is visualized, with node sizes representing the keywords' frequency. Two common metrics for comparative analysis are employed: document frequency, which measures the number of documents containing the keyword, and keyword frequency, which counts how often the keyword appears in the documents. Collocation frequency is another important metric that assesses the proximity between two keywords in the corpus. This metric is crucial in forming text clusters or communities of keywords.

These communities represent groups of clustered keywords in the text network, and a single network can have several of these communities. Barnier and Privé (2023) implemented a simple Reinert textual clustering method which was employed to further assess the key clusters for each source in the introduction section. This method utilizes the same data preparation approach as TNA but results in several clusters, each representing a specific theme. The following section presents the results and discussions of this analysis.

RESULTS AND DISCUSSIONS

Qualitative Data Analysis

This study used Taguette, a free and open-source tool designed for qualitative research, for quantitative data analysis. Rampin and Rampin (2021) allows users to import and tag a variety of formats, including text, images, and PDF documents. Several major steps were conducted during the qualitative data analysis. The first step was identifying key themes or topics that need to be explored in the news media reports and creating tags to represent these themes. Some of the developed tags were: 'ADV Development,' 'Partnerships,' 'Safety Concerns,' 'Regulatory Changes,' and 'Public Perception.' The second step was reading the news media reports, identifying text segments corresponding to each tag, and highlighting and applying the relevant tags to each segment by selecting the appropriate tag from the Taguette interface. The third step was annotating the tagged segments and adding notes in Taguette if additional context or insights needed to be provided. Annotations and notes can aid in the later stages of analysis and reporting. The final step was analyzing the tagged data to identify trends, patterns, and insights related to ADVs. Some of the main themes identified from the analysis are discussed below.

Several news articles reported on COVID-19 and delivery services made by ADVs. Amidst COVID-19 restrictions and limited entertainment options, there has been a notable surge in

online shopping, leading to reduced driving activity and increased reliance on delivery services. As a result, delivery vans have been covering unprecedented distances. The landscape of autonomous or self-driving cars is transforming due to the COVID-19 crisis. Several companies are now exploring the utilization of these vehicles for delivery purposes. Among them, Nuro is a well-known company developing its autonomous delivery vehicles (ADVs). The autonomous mobile robot industry is experiencing significant growth, with the e-commerce sector witnessing a surge, particularly during the pandemic. Despite the recession, the market is expected to continue expanding due to the increasing demand for automated delivery solutions. Several news articles reported on food delivery services made by ADVs. ADVs have emerged as an innovative solution for food delivery, offering efficient and timely transportation from restaurants to customers' doorsteps without the need for human drivers. By programming these vehicles, they can take the most optimized routes to avoid traffic congestion, ultimately reducing delivery times. The reports reveal the significant interest in ADVs within the food delivery industry. Companies like Domino's Pizza, DoorDash, and Uber Eats have been actively testing and implementing ADV systems to enhance delivery services. The ADV companies are being targeted for the last-mile delivery of local goods and services in collaboration with major grocery or wholesale firms. For instance, Nuro, a company specializing in local deliveries, has joined forces with the long-established grocery retailer Kroger to offer convenient same-day delivery services.

Text Network Analysis

Content of the News Headlines

The contents of the news headlines of ADVs were evaluated, and the text network of news headlines is presented in Figure 1, while Table 2 presents the metrics of the text networks' top frequent words and collocations. The text network of news headlines is heavily centered on the keywords *nuro*, *grocery*, *robot*, *walmart*, and *kroger*. This is because all of the news collected in this paper was ADV-related. In addition, some keywords of news headlines with a relatively low representation are presented, like *amazon*, *launch*, *udelv*, *partner*, and *pizza*, which indicates other industries involving ADVs. Observing the text network, some linked keywords include *startup* and *nuro*, *pizza* and *robot*, *dominos* and *pizza*, *cars* and *delivering*, and *coronavirus* and *tests*.

Although Figure 1 shows the text networks, a comparative analysis of the networks can be performed using the keyword and collocation frequencies. According to the results in Table 2, among the top 20 keywords, the most frequent word in this metric is *nuro* (an American robotics company), appearing 15 times. The top 5 most frequent words include *robot*, *grocery*, *pizza*, and *first*, which appeared 12, 7, 6, and 6 times, respectively. There are also some less frequent words like *walmart*, *amazon*, *kroger*, *udelv*, and some companies with ADVs.

In addition to the individual keywords, the collocated keywords' results can be presented in the metrics. Among the top 20 linked keywords, the most frequent collocation in this metric is *startup nuro*, appearing 4 times. The top 5 most frequent collocations also have *pizza robot*, *domino's pizza*, *cars delivering*, and *coronavirus tests*, which appeared 3, 2,1, and 1 times, respectively. There are also some less frequent collocations like *cars groceries*, *expands program*, *food program*, *gatik expands*, and *delivering food*, among others.

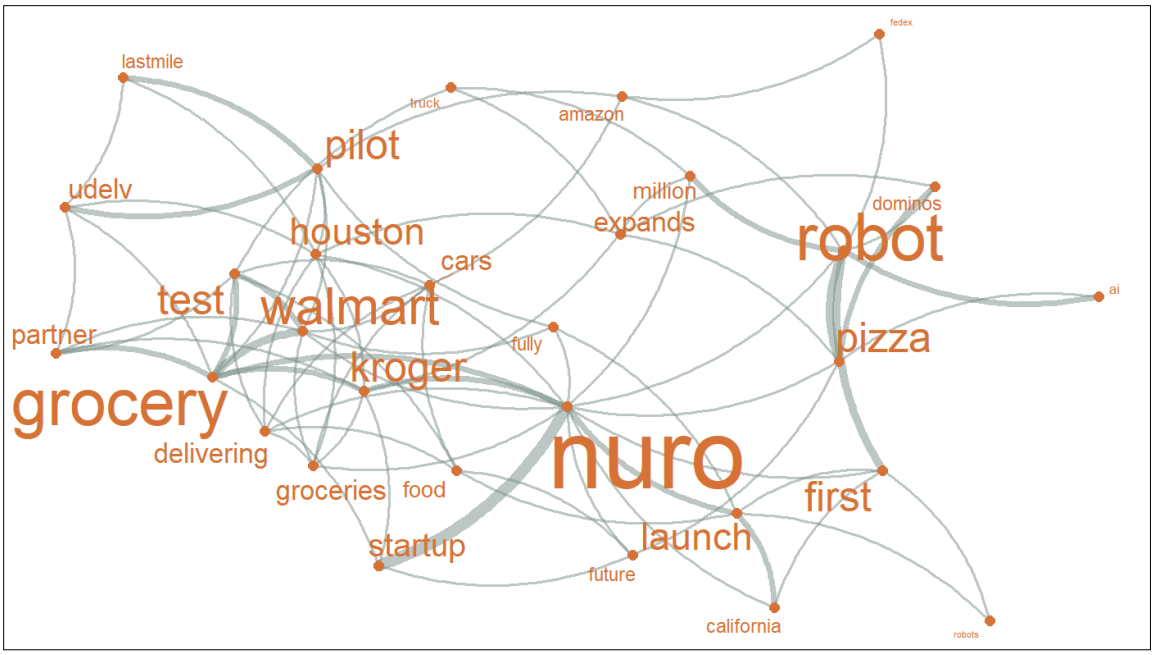

Figure 1. Text networks from News Headlines

Table 2. Top frequent words and collocations in the news headlines.

Word	Count	Collocation	count	lambda	z
nuro	15	startup nuro	4	6.0918	5.3602
robot	12	pizza robot	3	4.6030	4.4441
grocery	7	dominos pizza	2	4.9162	4.3258
pizza	6	cars delivering	1	5.5148	3.8969
first	6	coronavirus tests	1	5.5148	3.8969
walmart	5	groceries arizona	1	5.5148	3.8969
startup	5	industry chain	1	5.5148	3.8969
kroger	5	roll robots	1	5.5148	3.8969
amazon	5	service safety	1	5.5148	3.8969
pilot	5	bring robotic	1	5.0013	3.7958
launch	5	cars groceries	1	5.0013	3.7958
million	4	expands program	1	5.0013	3.7958
future	4	food program	1	5.0013	3.7958
food	4	gatik expands	1	5.0013	3.7958
partner	4	groceries houston	1	5.0013	3.7958
california	4	middlemile truck	1	5.0013	3.7958
udelv	4	truck begins	1	5.0013	3.7958
truck	4	delivering food	1	4.4877	3.7022
test	4	delivering groceries	1	4.4877	3.7022
cars	3	expands houston	1	4.4877	3.7022

Content of the News Reports

Figure 3 presents the four clusters based on various statistical methods, including chi-square, likelihood, frequency, and document proportion. According to the clusters for chi-square (Figure 3(a)), the first cluster contains keywords such as *zerooccupant*, *windshield*, *mirrors*, *Prius*, and *nuro*, which are associated with the automobile topic. For the second cluster in Figure 3(a), the keywords mainly cover the field of business and economy, including the keywords *facilities*, *Nevada*, *track*, *jobs*, *manufacturing*, and *facility*. Some retail companies are mentioned by Cluster 3, such as *Walmart*, *Kroger*, *grocery*, *Domino's*, and *food*. The last cluster in this figure, Cluster 4, includes the keywords: *drone*, *robots*, *cameras*, *lidar*, and *autonomy*, which are associated with the technology and innovation of ADVs.

Figure 2(b) presents clusters derived from likelihood. From the figure, these keywords may be related to automobiles in ADV, which is like cluster 1 in Figure 3(a); such keywords are *zerooccupant*, *windshield*, *Prius*, *cameras*, *mirrors*, and *seat*. On the other hand, the second cluster contains keywords such as *facility*, *facilities*, *Nevada*, *tax*, *manufacturing*, and *million*. These keywords are linked to business and economy. Keywords relating to some companies with delivery services can be observed in the third cluster: *walmart*, *kroger*, *doordash*, *domino's*, and *fedex*. The fourth cluster includes keywords such as *lidar*, *robots*, *cameras*, *drone*, *truck*, and *areas*, explaining the technology and innovation in the delivery services.

Figure 2(c) presents clusters showing the frequency of keywords in these news media. The figure shows some keywords in the first cluster, like *Nuro*, *zerooccupant*, *pilot*, *road*, *testing*, and *mirrors*, which are related to technology and innovation of new mobility services such as Nuro. In the second cluster, the keywords are associated with the analysis of business and economy, with *facility*, *track*, *tax*, *manufacturing*, *capital*, *build*, and *plans* included in this cluster. Keywords in the third cluster, like *walmart*, *amazon*, *waymo*, *nuro*, *pilot*, and *Kroger* show that this cluster is mainly about the industry of grocery and delivery services. The last cluster includes *ai*, *robots*, *robot*, *technology*, and *industry*, which show the cluster is associated with technology in the field of ADVs.

Figure 2(d) presents clusters on keywords proportion in the document. The figure shows that some keywords in the first cluster are mainly related to technology used in ADVs, like *generation*, *pilot*, *mirrors*, *nuro*, and *zerooccupant*. In the second cluster, the keywords are associated with the development of business in the field of industry, as *goed*, *million*, *manufacturing*, *capital*, *plans*, and *track* are included in this cluster. Keywords in the third cluster like *kroger*, *customers*, *services*, *food*, and *goods* show that this cluster is mainly about the services in the grocery company. The fourth cluster contains keywords like *technology*, *robots*, *robot*, *safety*, and *drivers*, related to the technology used in the delivery services.

The content of the keywords in news media was evaluated. Figure 3 presents the text network of the keywords section in the four clusters, while Table 2 and Table 3 present the performance metrics of the text networks. The text network of keywords in cluster 1 (Figure 3(a)) is heavily centered on the words *nuro*, *technology*, *zerooccupant*, *first*, and *pilot*, which are associated with the advanced technology in ADVs. Further, the title sections constitute keywords such as *mountain*, *mirrors*, *permit*, and *commercial*, indicating the news also covers some information about business and the economy. Some other keywords have a relatively low representation, including *testing*, *generation*, *eleven*, and *road*.

Figure 3(b) presents the text network for cluster 2. The text network is heavily centered on the words *nuro*, *testing*, *track*, and *facility*, indicating this cluster is mainly related to business

and economy in ADVs. Observing the text network (Figure 4(b)), some words are linked, such as *get* and *permit*, *first* and *generation*, *permit*, and *test*, and *mountain* and *view*. Figure 3(c) presents the text network for cluster 3, which indicates the keywords in the field of delivery services in some companies, especially grocery companies. The text network is heavily centered on *grocery*, *amazon*, and *service*. Some words are significantly linked, including *nuro* and *service*, *pilot* and *program*, and *electric* and *technology*. These linked keywords show the core of the research. *Fig*ure 4(d) presents the text network for cluster 4. The text network is heavily centered on the keywords *technology*, *robots*, *drivers*, *like*, and *amazon*. These words are associated with innovation in the delivery services of ADVs. There are also some words with low presentations, like *road*, *drone*, *robotics*, and *truck*.

Although Figure 3 shows that the four networks share different aspects in news media about ADVs, a comparative analysis of the four networks can be performed using the keyword frequencies. According to the results in Figure 3, among the top 20 keywords there are some common for different sides, like *nuro*, which is ranked first in Clusters 1, 2, & 3. There are also other common keywords with various ranks. For instance, the keyword *technology*, ranked 13th in cluster 1, appearing 13 times, is ranked fourth in cluster 3, appearing 67 times, and is ranked second in cluster 4, appearing 76 times. Keywords often appear in multiple clusters, including *pilot* in clusters 1 & 3, *like* in clusters 1 & 4, *testing* in clusters 1, 2, & 3, and *road* in clusters 1 & 4. There are several common words in clusters 3 & 4, such as *service*, *first*, *amazon*, *food*, and *goods*.

Table 3. Top frequent words in news report contents by clusters.

Word	Cluster 1 (count)	Word	Cluster 2 (count)	Word	Cluster 3 (count)	Word	Cluster 4 (count)
nuro	48	nuro	26	nuro	113	robots	93
mountain	29	nevada	19	customers	79	technology	76
view	26	las	11	service	75	robot	58
zerooccupant	23	vegas	11	technology	67	people	55
thats	22	fully	10	walmart	60	amazon	54
make	20	testing	10	pilot	59	first	50
nuros	18	goed	10	safety	57	food	49
like	15	jobs	10	first	53	many	46
way	15	facility	8	amazon	51	like	44
pilot	15	track	8	test	46	ai	44
permit	15	press	8	grocery	45	around	41
see	13	include	8	gatik	43	human	40
technology	13	tax	8	food	41	business	39
testing	13	abatements	8	kroger	40	goods	38
eleven	13	according	8	goods	39	industry	36
generation	12	wage	8	waymo	39	road	35
mirrors	12	application	8	trucks	38	last	33
road	12	test	6	program	37	need	33
really	12	southern	6	testing	37	robotics	33
get	11	state	6	cruise	37	service	32

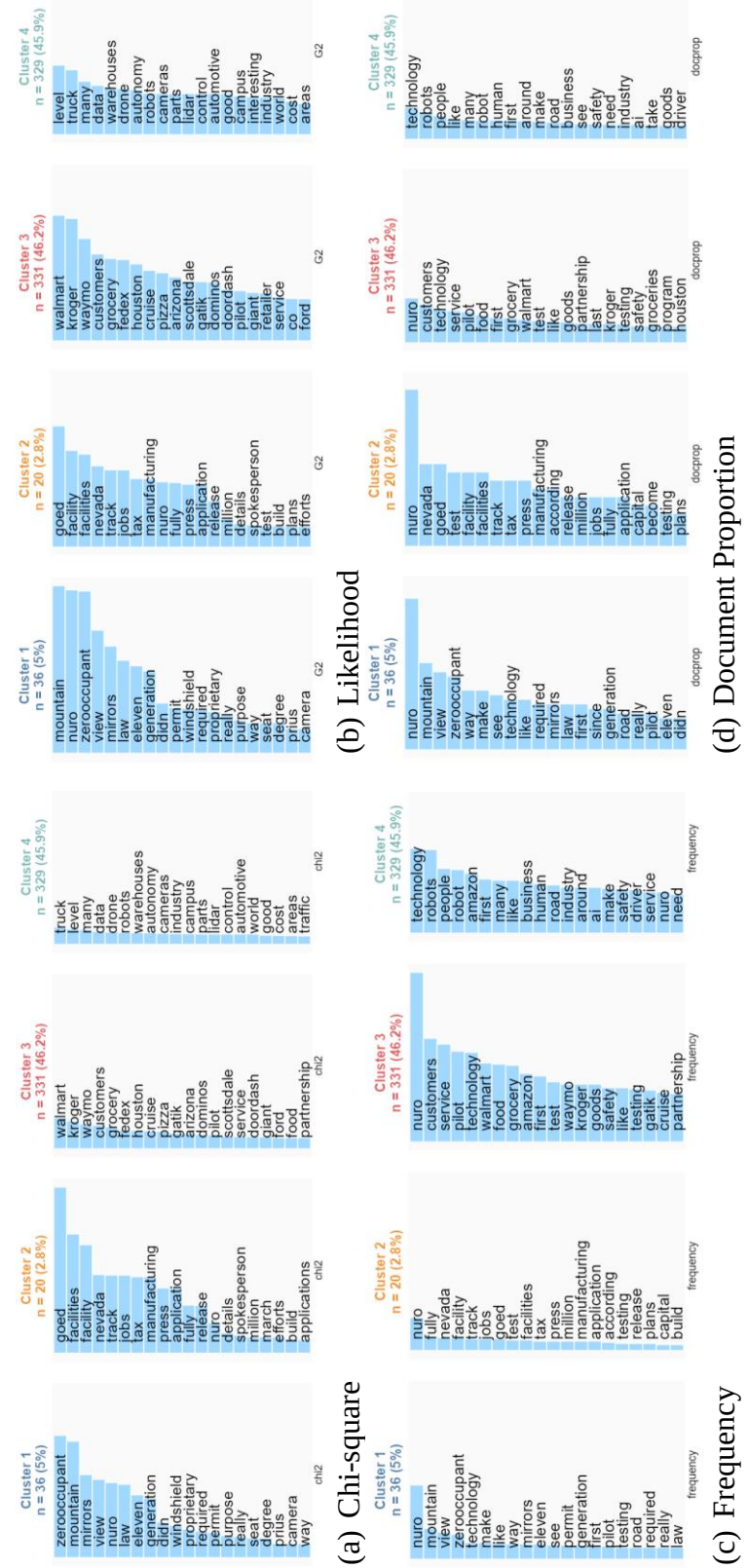

Figure 2. Clusters generated from the news reporting contents.

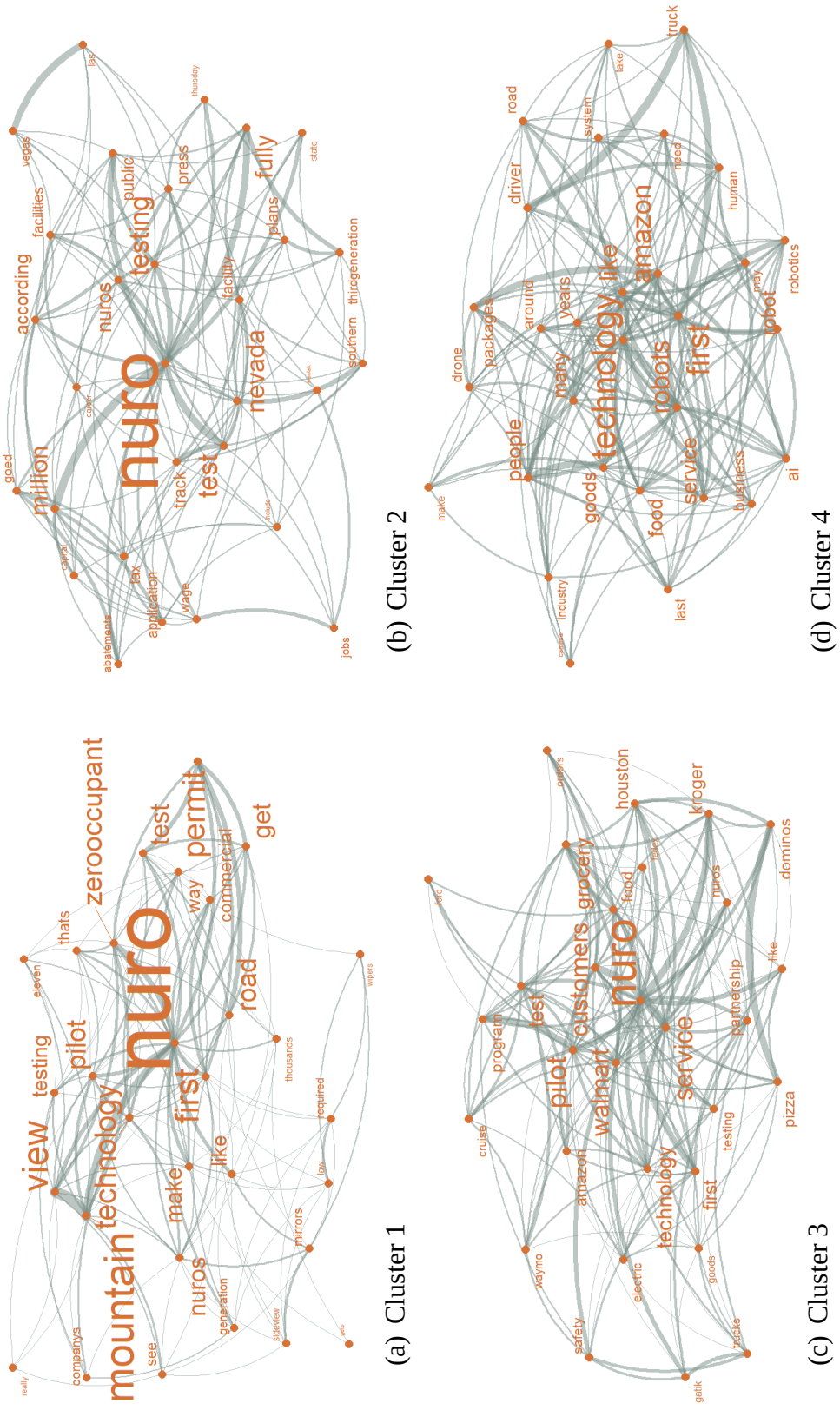

Figure 3. Text networks from the news reporting contents.

CONCLUSIONS

ADVs are gaining significant attention and are expected to revolutionize how goods are delivered. The analysis of news media indicated that there are some specific topics mainly discussed regarding ADVs, including express delivery service, Nuro and other ADV companies, robot delivery, and food delivery. The emerging companies developing ADVs, such as Nuro, Waymo, Udelv, Quadrobot, Einride, REV-1, and Kar-go, offer tremendous potential to revolutionize the delivery industry. The results show that express delivery services have begun cooperating with various ADV companies to complete the last mile, including DHL Express, FedEx, and the U.S. Postal Service. ADVs are increasingly being used in food, grocery, and other delivery services, with companies like Domino's Pizza, DoorDash, and Walmart partnering with ADV companies to offer same-day deliveries. The use of ADVs can result in reduced vehicle use, emissions, and traffic, owing to increased efficiency for vehicle use. Overall, ADVs are becoming an increasingly popular option for delivery services, providing a more efficient and convenient way to deliver goods while reducing costs and improving road safety.

This study's unique contributions lie in its innovative use of TNA to better understand ADVs' current trends, adoption, and impact as portrayed in news media reports. By employing TNA, the study presents valuable insights that can guide further research, policymaking, and industry developments in autonomous delivery vehicles. The study's policy implications highlight the need for clear regulations and safety standards for ADVs, incentives for sustainable ADV adoption, and public-private partnerships to facilitate responsible deployment. Policymakers should also address employment challenges, promote accessibility and equity, ensure data privacy and security, and invest in public awareness and education to support the successful integration of ADVs into transportation systems.

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