Exploring the diffusion of digital fashion and influencers’ social roles in the Metaverse: an analysis of Twitter hashtag networks

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Abstract

Purpose – The study aims to explore the digital fashion trend within the Metaverse, characterized by non-fungible tokens (NFTs), across Twitter networks. Integrating theories of diffusion of innovation, two-step flow of communication and self-efficacy, the authors aimed to uncover the diffusion structure and the influencer’s social roles undertaken by social entities in fostering communication and collaboration for the advancement of Metaverse fashion.

Design/methodology/approach – Social network analysis examined the critical graph metrics to profile, visualize, and cluster the unstructured network data. The authors used the NodeXL program to analyze two hashtag keyword networks, “#metaverse fashion” and “#metawear,” using Twitter API data. Cluster, semantic, and time series analyses were performed to visualize the contents and contexts of communication and collaboration in the diffusion of Metaverse fashion.

Findings – The results unraveled the “broadcast network” structure and the influencers’ social roles of opinion leaders and market mavens within Twitter’s “#metaverse fashion” diffusion. The roles of innovators and early adopters among influencers were comparable in collaborating within the competition venues, promoting awareness and participation in digital fashion diffusion during specific “fad” periods, particularly when digital fashion NFTs and cryptocurrencies became intertwined with the competition in the Metaverse.

Originality/value – The study contributed to theory building by integrating three theories, emphasizing effective communication and collaboration among influencers, organizations, and competition venues in broadcasting digital fashion within shared networks. The validation of multi-faceted Social Network Analysis was crucial for timely insights, highlighting the critical digital fashion equity in capturing consumers’ attention and driving engagement and ownership of Metaverse fashion.

Keywords Twitter, Diffusion of innovation, Social network analysis, Influencers, Metaverse, Digital fashion, Nonfungible-token (NFT)

Paper type Research paper

Introduction

Fashion and digital media have become intricately intertwined, creating a fertile ground for the emergence of digital fashion (Kalbaska et al., 2019; Noris et al., 2021). Concurrently, the Metaverse has gained prominence as a platform that spans gaming, e-commerce, and social media (Belk et al., 2022), leading innovative fashion brands to adopt digital fashion by incorporating mixed reality with the Metaverse (McDowell, 2022). Nonfungible-token (NFT) plays a crucial role in Metaverse fashion, where digital avatars and fashion products simulate human models and real-life clothing, offering an immersive consumer experience. Fashion brands have leveraged technologies like 3D Body scanning, virtual simulation, and augmented reality to promote digital fashion and capitalize on the blockchain (Sayem, 2022). Luxury fashion brands such as Ralph Lauren, Louis Vuitton, Burberry, Gucci, Dolce & Gabbana, and Balenciaga have already delved into the design of digital fashion assets, including avatars dresses, appearance-altering “skins,” shoppable virtual clothing, and physical products (McKinsey and Company, 2021). Given the significance of NFTs in the Metaverse and the growing interest in virtual reality and socializing, digital fashion in the Metaverse has emerged as a critical content vertical in contemporary times.
With its interactive dialogue function, Twitter has become a popular discussion platform. As of December 2020, Twitter had reached 192 million monetizable daily active users (Twitter, 2021), generating tweets from diverse sources (Udanor et al., 2016). Analyzing social relations in Twitter networks requires understanding the connectivity between individuals and the social units or groups that interact with them (Wasserman and Faust, 1994). Social Network Analysis (SNA) offers valuable insights into studying a network's structure and communications of hidden knowledge (Hansen et al., 2010), emphasizing relationships rather than isolated individuals or organizations in the “two-way dialogue” (Himelboim et al., 2014). Twitter data possesses latent predictivity, which has not been adequately explored in previous SNA studies on Twitter, and can help identify influencers in the adoption and diffusion of the Metaverse (Cano-Marin et al., 2023). Previous research on Twitter has not explicitly investigated the role of word-of-mouth in influencing trend diffusion (Araujo et al., 2017). In this study, we aim to address this research gap by exploring the role of word-of-mouth, in the form of tweets and retweets, in popularizing Metaverse fashion.

While several studies have examined Metaverse fashion through big data (Lim, 2023; Park and Lim, 2023) and content analysis (Tlili et al., 2023; Tunca et al., 2023), these studies lack a solid theoretical foundation for understanding the diffusion structure of Metaverse fashion influenced by social media. Our study aims to bridge this gap by integrating classic theories such as the Diffusion of Innovation theory and Two-Step Flow Communication theory, providing valuable insights into Twitter hashtag diffusion and adoptive communications about cohesive fashion-related topics in the Metaverse. Moreover, by incorporating the Digital Self-Efficacy theory, we aim to explore the social roles of influencers beyond innovators and early adopters during the diffusion process, which was not articulated in previous studies.

After identifying the relevant Twitter networks (“#metaverse fashion” and “#metawear”) for investigating Metaverse fashion in the preliminary analysis, our study explores three research questions (RQs): (1) What kind of diffusion structure characterizes the hashtag network (“#metaverse fashion”) on Twitter? (2) Within these diffusion networks, what social roles do influencers play? and (3) What topics do influencers communicate and collaborate on the hashtag network (“#metawear”) on Twitter? By exploring the variety, volume, and speed of Twitter data (Casado and Younas, 2015), the results bring the current trends in the diffusion of digital fashion within the Metaverse, identify salient clusters within game-based competition platforms, and delve into the influential social role played by opinion leaders and market mavens in the Twitter networks. To achieve these research objectives, this study utilizes the NodeXL program embedded in Microsoft Excel, enabling cluster, semantic, and time-series analysis through a data visualization approach to Social Networks. This methodological approach, combined with a solid theoretical foundation, fills gaps in knowledge and provides valuable insights into the innovation diffusion and influencers’ social roles within the Twitter networks associated with the “#metaverse fashion” and “#metawear networks”.

By understanding the dynamic diffusion structure and influential roles played by opinion leaders and market mavens, industry professionals can leverage these insights to enhance their engagement with the Metaverse and capitalize on its potential for innovative digital fashion experiences. The interplay between the concept of the Metaverse and the novel business ideas such as NFTs, cryptocurrencies, gaming, and virtual fashion collectibles presents exciting opportunities. We propose creative game-based competition strategies for fashion brands, marketers, and social media practitioners, intending to expand the scope of the Metaverse.

Literature review

Digital fashion in the Metaverse (Metaverse fashion)

The Metaverse serves as a platform that digitally replicates our real-world interactions and activities (Hollensen et al., 2022). Belk et al. (2022) described that “the users can come together
via avatars that resemble them and mimic their movements so that they can interact with each other and the surroundings, which also replicates the physical world in the 3D digital space”. Within this context, digital fashion emerges as a crucial element of the Metaverse, as evidenced by luxury fashion brands offering branded avatars garments, customizable skins, and shoppable virtual clothing. In our study, we define Metaverse Fashion as the immersive experience of engaging with digital fashion products through gaming platforms and NFTs where avatars resembling real individuals can interact, communicate and collaborate within the Metaverse environment. This immersive experience has the potential to influence the adoption of digital fashion innovativeness among the population. Notably, in 2019, the digital fashion brand “Fabricant” introduced Iridescence, the world’s first digital blockchain dress, which sold for $9,500 (Särnäkari, 2021), highlighting future economic opportunities associated with digital fashion. Furthermore, fashion brands often collaborate with celebrities to create virtual avatars in the form of Computer-Generated Imagery (CGI), enhancing the realism and immersive experience of the Metaverse by incorporating the personality and preferences of these celebrities.

NFTs play a critical role in the realm of digital fashion as they provide a means to verify the authenticity and ownership of products on blockchain platforms. Notably, NFTs have gained prominence in various domains, including profile pictures like CryptoPunks, gaming objects, virtual lands in the Metaverse, and collectibles, which have emerged as lucrative investment opportunities (Belk et al., 2022). Luxury fashion brands such as Gucci and Nike have recognized the potential of Metaverse fashion within the luxury segment, leveraging it to create gaming skins that replicate users’ appearances and overlay product imagery onto them (Joy et al., 2022). These digital fashion products enhance the immersive experience of the product trial. For example, avatars representing LVMH brands donning Dior sneakers and carrying Rimowa suitcases (Joy et al., 2022) can promote the brands’ NFTs within the same platform. Nike has even established a Metaverse called Nikeland in collaboration with Roblox, an online gaming platform, allowing consumers to interact with the brand’s products within a 3D interactive digital space (Hollensen et al., 2022). In Nikeland, users can virtually wear Nike products and engage in simulated real-life movements. These instances underscore the growing significance of NFTs in the Metaverses, presenting new opportunities for digital fashion in this virtual environment.

Social roles of influencers
In social media, influencers hold significant sway over individuals’ adoption of innovations, akin to the influence exerted by celebrities (Ahn et al., 2022). For example, influencers are willing to invest in NFTs and digital collections, seeking to immerse themselves in alternate lives within the Metaverse (Williams, 2021). Influencers on social media garner attention from both the business and academic spheres because they are perceived as personal, authentic, credible, and down-to-earth sources of information, coupled with the advantage of their extensive network (De Veirman et al., 2017; Djafarova and Rushworth, 2017; Schouten et al., 2020). These influencers can be considered opinion leaders who communicate with a vast network of followers (De Veirman et al., 2017). The Two-Step Flow Communication (TSFC) theory supports the role of opinion leaders in information diffusion through word-of-mouth communication on a web of social interactions (Katz et al., 2017). According to the TSFC theory, individuals acquire information through mass media and interpersonal communication networks. Opinion leaders serve as intermediaries between the media and communication network, with their impact exceeding that of mass media (Zhang and Dong, 2008). They filter and interpret the content of messages as they communicate and interact with others (Harrigan et al., 2021; Jiménez-Castillo and Sánchez-Fernández, 2019). In the traditional TSFC theory, information flows from mass media (e.g. radio or print) to opinion
leaders, who then disseminate the information to the broader public in the second step (Lazarsfeld, 1940). Opinion leaders exert their influence on others or are sought after due to their expertise in specific domains (Bostian, 1970). In the context of Twitter, the initiation of a new or popular hashtag can be seen as the introduction of an innovation, analogous to the role played by traditional mass media in the first step, influencing other imitators or followers to popularize and validate the content associated with the hashtag in the second step (Chang, 2010). Thus, if tech-savvy influencers on Twitter act as opinion leaders, they can spearhead the diffusion of Metaverse fashion among the masses. Consequently, the interpersonal relationships between opinion leaders and their followers play a crucial role in effectively disseminating information (Bostian, 1970). These relationships shape the communication networks and serve as sources of social pressure or support (Katz, 1957). Followers of innovation (i.e. early adopters, early majority, late majority, and laggards) may look up to these tech-savvy opinion leaders for their domain-specific knowledge of Metaverse fashion while exploring the new technology. Indeed, opinion leaders play a vital role as key influencers in the initial adoption of a product or idea, subsequently popularizing it through mass media in the second step (Bostian, 1970; Katz, 1957).

The social role of an influencer can be likened to that of opinion leaders (Brancaleone and Gountas, 2007). Opinion leaders possess specialized knowledge and expertise in a particular field, acquired through diverse channels, frequent interactions with innovation agencies, life experiences, social activities, and an innovative mindset (Roger, 1995). Their motivation primarily revolves around sharing information rather than seeking it (Bostian, 1970; Katz, 1957), indicating a unidirectional flow of information from opinion leaders to followers. Initial dissemination of information about innovations by opinion leaders creates a reservoir of new information, which, when shared by enthusiastic advocates, gives rise to new opinion leaders (Bostian, 1970).

A market maven can represent another influencer’s social role, particularly applicable to the Metaverse. Market mavens are highly sociable individuals with substantial influence due to their ability to gather and disseminate critical market information (Clark and Goldsmith, 2005). They serve as hubs for potential growth (Aljukhadar et al., 2020) and often act as intermediaries between brands and consumers, collecting and sharing relevant product and market-related information (Ki and Kim, 2019; Uzunoglu and Kip, 2014). Their intrinsic motivation to help others by sharing information positions them as vital agents in the diffusion process within extensive networks (Laughlin and Macdonald, 2010; Walsh and Elsner, 2012). Therefore, market mavens can be considered influencers, especially when they occupy central positions in dense relationship networks (Aljukhadar et al., 2020; Kietzmann et al., 2011). Therefore, in the context of the Metaverse, we regard the influencers’ social roles as encompassing both opinion leaders and market mavens.

Diffusion of innovation in social networks

Diffusion of Innovation (DoI) theory (Rogers, 1995) can support explaining the adoption of digital fashion in the Metaverse. Chen et al. (2008) specified four crucial elements of the adoption process of DoI, which are Innovation, Communication Channel, Time, and Social System. “Innovation” can be conceptualized as new goods, services, creations, and ideas. For example, a newly created topic of digital fashion with hashtag use on Twitter (i.e. #metaverse fashion and #metawear) based on innovators’ credibility and investments could be considered an innovation. In that case, it can be adopted and disseminated voluntarily through social networks (Chang, 2010). The diffusion has continued via mass media and interpersonal “Communication channels” (Morris and Ogan, 1996).

Furthermore, the smartphone’s mobility and functionality have renovated the conventional DoI cycle to unprecedented volume, velocity, and variety (Harrigan et al.,
Thus the “Time” factor has accelerated the DoI employing the innovation-decision and adoption process and the rate of adoption (Rogers, 1995). Specific time series analysis might be meaningful in illustrating these time factors in the DoI cycle. “Social systems” were viewed with the adoption rate or volume. Roger (1995) has structured innovation diffusion with a typical distribution system in which only 2.5% of the population acts as change agents or gatekeepers, and 13.5% of the people are early adopters who work as opinion leaders, trendsetters, and risk takers. Most early (34%) and late (34%) majorities accept innovations when the trends are popularized with low-risk associations. Recently, Workman and Lee (2017) found that the distribution for fashion adoption does not follow this typical diffusion system as in the earlier DoI model. The distribution was skewed where the change agents (i.e. the innovators), early adopters, late adopters, and reluctants (i.e. laggards) constituted 17%, 36.6%, 28.3%, and 18.1% of the population, respectively.

Indeed, the innovation-decision process is an intellectual process in which a person or community transfers, adopts, or rejects new knowledge while shaping an attitude toward innovation (Rogers, 1995). For example, a tech-savvy majority might be willing to adopt digital fashion NFTs that early adopters have already tried and recommended. On the other hand, price-sensitive laggards may follow majorities for recommendations through vicarious experience and verbal persuasion. Thus, we postulate that the number of innovators will be significantly different from that of the followers because innovators exhibit a greater need for variety in terms of higher tendencies for sensation-seeking and mental stimulation (Workman and Johnson, 1993).

Drawing upon the DoI theory and the Two-Step Flow Communication theory, we adopt a social network perspective to conceptualize the diffusion of the Metaverse fashion. Hunt and Gruszczynski (2023) have proposed that social media messages circulated within a large user base, particularly among individuals with higher degrees of centrality, tend to generate more retweets. Social media has brought about significant transformations in social diffusion, allowing people to establish interactive relationships and cultivate relational benefits such as trust, satisfaction, commitment, and loyalty (Aral et al., 2013; Hollebeek et al., 2014). Consequently, social networks emerge as structured systems when connections are established between individuals and organizations (Wasserman and Faust, 1994). These networks represent social structures that elucidate the pattern of interaction and conversations on specific topics within social media.

Through their extensive studies, scholars (Bruns and Stieglitz, 2013; Himelboim et al., 2014) studied the structural topologies of social diffusion to elucidate the influencer’s role and relational characteristics within the broader network. They have identified six distinct social structures of diffusion, including (1) a “polarized crowd” characterized by two densely connected groups with limited interaction between them, (2) a “tight crowd” exhibiting high interconnectedness among entities, (3) “brand clusters” consisting of numerous disconnected users, (4) “community clusters” encompassing multiple smaller groups along with their respective audiences, influencers, and information sources, (5) a “broadcast network” featuring a single, prominent hub that is well connected to the information source but disconnected from other participants, and (6) a “support network” where a hub engages in replies with multiple disconnected participants, creating outward spokes (Smith et al., 2014). These structural typologies provide insights into the dynamics of social diffusion and the various configurations that may exist within a network.

**Digital self-efficacy in collaboration and communication on social networks**

Consumers in the Metaverse have the opportunity to purchase digital fashion artifacts that blend elements of reality and imagination, disrupting traditional market interactions and collaborations. Network research indicates that social influencers are not independent entities.
but influence one another. When two social actors connect as friends on social media, they are more likely to interact and exchange ideas and information (Stefano and Martin, 2018). However, the nature of the relationship between social actors is not always symmetrical but driven by authenticity, particularly in the case of social influencers such as opinion leaders or market mavens influencing adopters (Audrezet et al., 2020). In their study, Flynn et al. (2016) identified a positive correlation between market mavens and the personality trait of extraversion. These individuals maintained their influential social position and were characterized by their assertiveness compared to the majority of adopters (Goldsmith et al., 2003). Additionally, market mavens tended to prioritize their self-esteem, which is defined as an individual’s positive self-perception (Rosenberg, 1979).

The self-efficacy theory provides an explanation for why influencers and adopters in innovation diffusion exhibit perceived self-efficacy to achieve their goals (Bandura et al., 1999). Perceived self-efficacy is influenced positively by enactive attainment (i.e. successfully carrying out a goal), vicarious experience (i.e. observing others accomplishing the goal), and verbal encouragements (i.e. receiving positive feedback to reinforce confidence) (Bandura et al., 1999). For example, in the context of the novel ideas or innovations transmitted through social interactions, perceived self-efficacy in trying innovative technologies (such as Metaverse fashion) can be fostered through positive enactment (e.g. innovators successfully engaging in Metaverse fashion), persuasive communication (e.g. praises in the social media comments, likes, and retweets) and observing others’ vicarious experiences (e.g. video posts of innovators and early adopters engaging in Metaverse experience).

Digital self-efficacy expands the self-efficacy concept to an individual’s perceived ability and confidence in adopting recent technologies using digital skills (Malodia et al., 2023). Self-efficacy in digital transformation involves leveraging technologies for business innovations to create value for consumers. This digital literacy in self-efficacy encompasses knowledge of using various technologies (Malodia et al., 2023). Thus, the perceived digital self-efficacy of opinion leaders and market mavens motivates them to communicate, collaborate, create, and share knowledge within their social community (Jiao et al., 2022), influencing early adopters and further popularizing the trend among the majority in the social diffusion hierarchy. By integrating the theories of diffusion of innovation (Rogers, 1995), two-step flow communication (Katz et al., 2017), and self-efficacy (Bandura et al., 1999), we propose that the influencers who have adopted and posted tweets using “#metaverse fashion” or “#metawear” can generate a buzz on Twitter and in social media. Early adopters who follow these influencers can then disseminate the trends to the early majority, late majority, and laggards through retweets of the “#metaverse fashion” or “#metawear” posts. This dissemination process can eventually lead to a cascading effect of diffusion, increasing the popularity of digital fashion in the Metaverse as the trends are retweeted by the early and late majority, thereby encouraging the late majority and laggards to follow the trends. Based on the discussions above, we aim to explore the diffusion of digital fashion and the social roles of influencers in interaction, communication, and collaboration within the Twitter hashtags networks (#metaverse fashion and #metawear).

In the forthcoming methods section, we provide a rationale for choosing Twitter networks as the platform for data collection and SNA as the research method. Subsequently, we explain the procedure for collecting data and visualizing networks using the “NodeXL” program for the Twitter network associated with the “#metaverse fashion” hashtag. Finally, we outline the semantic and time series analysis for the “#metawear” Twitter network.

### Methods

**SNA for understanding the DoI in Twitter networks**

Social Network Analysis (SNA) was used in studying the diffusion of Metaverse fashion in Twitter hashtag networks. SNA within unstructured data mining can reveal the relational
network structure among Twitter users participating in public communications (Himelboim et al., 2014). Due to the advantage of interactive dialogue features, we chose the data platform from Twitter, which has been given much attention over the last decade in academia. For example, identification of information diffusion (Naveed et al., 2011), popularity prediction (Hong et al., 2011), fake news detection (Buntain and Golbeck, 2017), hashtag classification and prediction, recommendations (Rui et al., 2013) and the virality of content (Cano-Marin et al., 2023) are essential, which could be utilized in predicting social trend and identifying influencers. Employing SNA techniques grounded in graph theory to identify distinct communities on Twitter provide insights into the trajectory of innovation diffusion (Cano-Marin et al., 2023).

Data collections and analysis using the NodeXL program

The NodeXL program was employed as a plug-in SNA tool within Microsoft Excel for non-programmers. NodeXL enables content analysis and data visualization after calculating a network’s key metrics by filtering, clustering, mapping vertices and edges, and customizable visual attributes and tags (Hansen et al., 2010). The topic discovery on Twitter began by exploring topical cohesion and the influencers-followers relationship in applying graph algorithms in the SNA approach (Araujo et al., 2017). By running a preliminary search in Google Trend analysis (https://trends.google.com/trends/explore) and several iterations of keyword search in the NodeXL import function, we identified two hashtag keywords, “#metavers fashion” and “#metawear” depicting the resourceful data size for exploring Metaverse fashion networks.

Data was collected using the keywords search function, and the hyperlinked API (application programming interfaces) addresses were exported to the “vertices” and “edges” worksheets in the NodeXL program. Generally, vertices (i.e. nodes, entities, or actors) refer to an individual, event, physical or virtual location, content, or social structure, such as an organization, country, institution, or team (Hansen et al., 2010). Edge refers to ties, links, relations, or connections which occur when two vertices collaborate or exchange information (NodeXL, 2022). Calculating the graph metrics about vertices and edges based on “degree” and “centrality” describes the network’s size, connectivity, and attributes to distinguish influencers and show their popularity on social networks (Yang et al., 2018). The recent graph visualization algorithms techniques in SNA show a two-dimensional graph using network density and centrality graph metrics, the strength and direction of relational ties, and actors’ in/out-degrees (Emirbayer and Goodwin, 1994).

Cluster analysis was used to examine the network characteristics (i.e. often referred to as the structural signature) in relating RQ1 and RQ2 by grouping the vertices using the Clauset-Newman-Moore (CNM) algorithm set in NodeXL (Clauset et al., 2004). The CNM is a heuristic method suitable for quickly finding communities for large-scale networks (Clauset et al., 2004). The CNM assumes all vertices as separate clusters, then compares all vertices pair by pair to see which two vertices can be merged as a cluster (Yum, 2020). After clustering, the Harel-Koren Fast Multiscale layout algorithm generated the graph visualization. This method enables both multiscale graph representation and a locally comprehensible layout. Furthermore, it visualizes directed and large graphs in multiple dimensions with a navigational ability (Harel and Koren, 2006; Jayaraman and Abirami, 2020).

Embedded in the NodeXL program, we performed a semantic analysis relating to RQ3 to explore the communication flow on Twitter based on sharing of words, themes, or concepts. A semantic network is composed of words linked to other words (NodeXL, 2023) when words often appear next to one another in a text collection of Twitter data. To convey the communication network, we selected the keyword “#metawear” because salient groups in the “#metaverse fashion” network frequently tagged and shared the hashtag keyword “#metawear” in the preliminary Initial Data Profiles.
Lastly, we implement the time series analysis for RQ3 to identify whether local and bounded popularity in a specific social network is prompt and particular to a selected topic or issue (NodeXL, 2022). Time-series data is a sequence of data points collected over time intervals, allowing us to track referring keywords over time. Time-series data can track changes over milliseconds, days, or even years, but we analyzed the word frequencies of “#metawear” daily that appeared in tweets.

Initial Data Profiles using graph metrics analysis
We imported data from the Twitter Search Network between November 2021 through March 2022. The “#metaverse fashion” network data yielded 13,353 vertices (the total number of unique Twitter accounts) and 21,135 edges (the total number of mentions, mentions-in-retweets, replies, retweets, and tweets) in the initial dataset (refer to Table 1). Group 1 had the most considerable number of vertices (74.3%) and edges (64.9%), meaning it dominated any other groups.

The Graph Metrics analysis calculated in- and out-degree, betweenness centrality (BC), and numbers of followed, followers, tweets, and favorites of the top ten vertices. We identified the ten salient vertices based on the highest value of “betweenness”, a sociological proxy for “influence”. BC differs from other “social media reputations” in finding a valuable vertex within a particular topic during a specific time (Hansen, 2010) (Table 2).

The vertex of “spacerunnersnft” was the broadcast hub with the highest BC and in-degree. The vertex of “meroorapp” was the next highest BC, followed by the vertices “breakingpanda2”, “thesandboxgame” and “hypebeast”, “genwealth0”, “decentraland”, “altavagroup”, and “seedifyfund” respectfully in the “#metaverse fashion” network.

Results

RQ1. What Kind of Diffusion Structure Characterizes the “#metaverse fashion” on Twitter?

The CNM algorithm clustered 154 groups of the “#metaverse fashion” network, and then the Harel-Koren Fast Multiscale layout algorithm visualized the group networks as identifiable. Each graph’s group was laid out in its box (Group-In-a-Box, GIB) to make the layout more readable (Figure 1). Upon sorting based on the group metrics of BC, we found the interaction and communication structure of “#metavers fashion” as the “broadcast networks”. Characterized by the high degree of centralization, these topical networks formed a “hub-and-spoke” topology (Park and Thelwall, 2008).

Group 1 had a significant number of vertices, with the salient hub of “spacerunnersnft” reaching more than 74% of all vertices on the “#metaverse fashion” network. As shown in Table 1, group 1 was prominent in its volume of vertices and the density edges, surrounded by spokes of people (e.g. groups 2, 3, and 4) who repeat the messages generated by the news.
Individual vertex in group 1 connected to a single or a small number of actors for most of the flow of information, resulting in a concentration of power in the vertex “spacerunnersnft” as evidenced in Table 2. Typically, the “broadcast” network is centered around well-known media outlets, experts, and organizations, and the non-hub members of the broadcast network are the “audience” who are constantly connected only to the hub without any connections to one another (Smith et al., 2014).

In Figures 1 and 2, the vertex “spacerunnersnft” spread the NFTs and the Metaverse information to its 141,520 followers and 274 tweets with the top nine vertices from groups 2, 3, 4, 6, 7, and 8 (Table 2). The NFT competition-based group led by the vertex “spacerunnersnft” drew considerable attention to Yahoo’s news (i.e. “NBA Champions Kyle Kuzma and Nick Young to Launch Fashion NFTs for the Metaverse”). Group 2 consisted of participants in the spacerunnersnft competition (e.g. breakingpanda2), and group 3 mainly included the fashion brands relating to NFT and “#metawear”. Luxury brands such as merоорapp (Vertex id# 4), gucci (Vertex id# 17), burberry (Vertex id# 28), voguemagazin (Vertex id# 13188), Gartner Inc, nike, tencent global, balenciaga, and adidas, were noted to be used as hashtags. Group 4 had a virtual game platform (i.e. thesandboxgame, vertex id# 86), new meta-related media

organization or dominant characters (Smith et al., 2014).
(e.g. metanews-com, and metaprints), and crypto-related influencers (e.g. cryptodinamite and cryptorobertk) to diffuse the information or interest to a broad audience.

**RQ2.** Within These Diffusion Networks, What Social Roles Do Influencers Play? Beginning from the salient ten vertices (Table 2), we examined their social roles as influencers for interacting and communicating in the “#metaverse fashion” network. To enhance the readability, we reduced the size of the data set by filtering the salient eight groups (group 1 through group 8) and the hundred salient vertices having higher BC than 10,679.23. Figure 2

**Figure 1.** The broadcast network of the “#metaverse fashion” network

**Source(s):** Authors own creation

**Figure 2.** The salient influencers of the “#metaverse fashion” network

**Source(s):** Authors own creation
illustrates the updated visualization employing prominent BC, accentuating group interactions and communications.

The vertex “spacerunnersnft” diffused its broadcast network by sending information and promotions of its first NFT collection to individual influencers and entrepreneurs of the Metaverse fashion and NFT marketplace. It was evident by the considerable attention of In-Degree \( (n = 10,433) \) and followers \( (n = 141,520) \) and directly interacted with other salient groups’ influencers, such as “merooapp, hypebeast, and forbes” (G3), “singhdiggi, ankit31308171, and ayushkumar501” (G5), and “genwealth0” (G6). The vertex “spacerunnersnft” served the role of an opinion leader as the key influencer in the entire network.

The vertex of “merooapp” was the next high BC, which was essential to reaching other vertices in group 3 (such as eniley, gucci, burberry, and fronné) and subgroups (groups 4 and 6) that otherwise would not receive network communication information. Although “merooapp” had a zero vertex in-degree, the vertex out-degree \( (n = 53) \) was the highest amongst all the other lifestyle brands, with impressive numbers of 2,397 tweets and 2,234 favorites. The vertex “merooapp” was the website of “#metawear” that virtualized real-world clothes, and fashion shops used this digital mirroring app. The founders of this group analyzed facial features from people’s pictures and behavioral traits through artificial intelligence to find psychologically similar people.

The vertex “breakingpanda2” from group 2 was the third-highest BC. The impressive attention was evident with the vertex in-degree \( (n = 1,078) \), followed by 664 users, followers to 15,362 users, 382 tweets, and 1,927 favorites. This vertex was brought into this Metaverse in 2021 when the physical and digital worlds blended by creating a new Metaverse NFT. The creators of this NFT were crypto artists, trendy art and fashion brands (virtual reality brands and physical lifestyle brands), immersive social augmented reality (AR) experiences, generative music, urban sculptures via interactive design, and NFT gallery experience.

The vertex of “thesandboxgame” in group 4 had one of the least vertices out-degree \( (n = 2) \) but was followed by 1,152 users, followers to 836,874 users, 10,907 tweets, and 7,385 favorites. “thesandboxgame” interacted with “stratorob, hypebeast, and chboursinin” in group 3. Twitter interactions of “thesandboxgame” were driven by exchanges related to creating different Metaverse gaming scenarios where users created and owned their imaginary world and played on it free of cost.

**RQ3. What Topics Do Influencers Communicate and Collaborate on the “#metawear” network on Twitter?**

Semantic network analysis examined the “#metawear” network, which attributed to the communication and collaboration context of the “#metaverse fashion” network. Due to the large data set, the semantic network was visualized using the Harel-Koren Fast Multiscale layout algorithm in the GIB Layout. The entire “#metawear” network had 2,134 individual vertices with 10,028 total edges, including 3,416 retweets, 4,813 of mentions-in-retweets, 725 replies to, 162 tweets, and 912 mentions. The most salient vertex of “metaweartoken” in group 1 activated the communication pathways among 47 sub-clusters (Figure 3). The top keywords of each group are shown on the top left of each box in Figure 3.

The result from Figure 3 revealed that group 1 has mainly interacted with most 47 subclusters directly or indirectly through two words, “#metawear” (a total of 4,296-word counts) and “trustpad” (a total of 2,167-word counts), in collaborating to opening the competition “TrustPad x MetaWear Whitelist” (https://gleam.io/hDhGZ/trustpad-x-metawear-100-x-winners-guaranteed-ido-allocation). Figure 4 filtered Figure 3 semantic network to convey this competition-based communication context. Choosing 100-word pairs (edge counts from 140 to 817 and salience value greater than 0.003) illustrated how the web of words and hashtags was transmitted across the clusters.
Figure 3.
The semantic network of the “#metawear”

Source(s): Authors own creation

Figure 4.
The filtered semantic network of #metawear

Source(s): Authors own creation
Classified by in-degree of 1,739 and BC of 2,977,739.07, the crucial communication launched from “metaweartoken”. Tweet’s salient hashtags were “metawear, ido, igo, nft, fashion, metaverse, nfts, coinborsafamily, trustpad, wear” (Table 3 and in the red boxes Figure 4). The subsequent communication generated “trustpad,” which had an in-degree of 1,115 and BC of 635,747.56. The vertex “#trustpad” collaborated with “#metawear” in the competition venue. The top word pairs in the entire tweets in Table 3 (i.e. #metawear, #nft, wear, igo, price, #igo, metaweartoken, x, trustpad, giveaway, giving, away, and guaranteed) are marked in the blue boxes in Figure 4, which explicit the participation of the Twitters’

![Table 3. Top domains, hashtags, and word pairs of the “#metawear” semantic network](image-url)
competition and two companies’ collaboration. Group 2’s top word pairs (i.e. #nft, #metawear, #metaverse, seedifyfund, trustpad, polkafoundry, paid_network, gate_io, partners, four, aces, #ido, and #listings) marked in the green boxes in Figure 4 supported these two companies’ cross-collaboration to launch an innovative NFTs competition. The vertex “trustpad” is a leading company of multi-chain launchpads for high-quality projects on the blockchain (https://trustpad.io/). The vertex “#metawear” has developed a Cross-Platform Metaverse Creator Ecosystem to transform the fashion industry’s textile manufacturing and marketing methods into the Metaverse, which has a three trillion-dollar value (www.Metaversewear.io).

The time series analysis using a search network was visualized in Figure 5. While tweets related to #metawear initially emerged on November 15, 2021, it was during the “trustpad x metawear” competition period from March 19 to March 27, 2022, that the large volume of tweets containing the “#metawear” was observed (refer to Table 4). This surge informed the driving interactive and collaborative responses among users to illustrate the value of the competition.

Discussions
The surge in popularity of luxury digital fashion NFTs in the Metaverse, mainly through social media platforms, has garnered significant attention from both business and academia. Through our analysis of Twitter networks data pertaining to the “#metaverse fashion” and “#metawear” hashtags, we have uncovered valuable insights into the communication and

![Figure 5. Time series analysis of the “#metawear” search network](image)

**Source(s):** Authors own creation

<table>
<thead>
<tr>
<th>Tweet date</th>
<th>Tweet counts</th>
<th>Tweet date</th>
<th>Tweet counts</th>
<th>Tweet date</th>
<th>Tweet counts</th>
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<td>18-Mar</td>
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<td>Nov</td>
<td>1</td>
<td>2-Mar</td>
<td>1</td>
<td>19-Mar</td>
<td>399</td>
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<tr>
<td>15-Nov</td>
<td>1</td>
<td>5-Mar</td>
<td>2</td>
<td>20-Mar</td>
<td>1,266</td>
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<td>2</td>
<td>21-Mar</td>
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</tr>
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<td>2</td>
<td>11-Mar</td>
<td>2</td>
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<td>24-Mar</td>
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<tr>
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<td>14-Mar</td>
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<td>18-Mar</td>
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</tr>
</tbody>
</table>

**Total Counts of Tweets 4,239**

**Source(s):** Authors own creation
collaboration patterns among individuals, organizations, and venues. These findings shed light on the diffusion of innovation within shared networks (Saheb and Saheb, 2019), providing a deeper understanding of how individuals perceive and adopt digital fashion innovations within the context of Metaverse. Moreover, our analysis highlights the dynamic social roles of influencers as both opinion leaders and market mavens, playing a pivotal role in fostering digital self-efficacy and driving innovation in Metaverse fashion. This immersive experience, marketed by game-based competition, further enhances the adoption and acceptance of innovative digital fashion trends within the Metaverse.

**Diffusion structure: broadcast network in the “#metaverse fashion” network**

We identified the structure of the “#metaverse fashion” network as the “broadcast network”, which was dominated by the innovation hub (i.e. group 1) and surrounded by spokes of users (e.g. groups 2, 3, and 4). Drawing from the DoI theory (Rogers, 1995), we suggest that group 1 is the origin of diffusion for the “#metaverse fashion” trend due to adopting it in its formative stage. Furthermore, based on the self-efficacy theory (Bandura et al., 1999), a higher degree of digital literacy with confidence, skills, and awareness about digital fashion gives this group social influence on the early adopters, early majorities, late majorities, and laggards in the diffusion stages.

The tweets from “spacerunnersnft” in group 1 diffused the topics to groups 2 and 3, consisting of major luxury brands and gaming platforms, respectively. Both groups can contribute to further diffusing the Metaverse-related topic among these luxury brands and gaming platforms. Based on the DoI theory (Rogers, 1995), it could be implied that groups 2 and 3 played early adopters’ roles. Since gamers might have a higher digital literacy and digital self-efficacy, group 2 users’ experience of the Metaverse fashion may encourage early majorities to adopt this trend due to vicarious experience.

Group 4 had a new digital medium (e.g. metanews-com, and metaprints) and crypto-related influencers (e.g. cryptodinamite and cryptorobertk) to diffuse the innovation to a broad audience. Based on the DoI theory (Rogers, 1995), we suggest that group 4 played the role of the early majority. Indeed, collaborating NFTs-based competition with emerging promotional media and celebrities or equitable fashion brands diffused the innovation of Metaverse fashion.

**Social role of influencers: opinion leaders/market mavens vs innovators/early adopters**

Twitter users who influence followers are often characterized as influentials (their ability to influence others to retweet their tweets) and information brokers (their position connecting groups of users and having solid ties with the influenced follower) (Araujo et al., 2017). Influentials and information brokers are associated with more retweets for brand content. Although information brokers have a more considerable influence on retweeting, they are more prone to do so when influencers are mentioned in the brand tweet, supporting the strategy to associate the brand with influential users (Araujo et al., 2017). Valente and Davis (1999) proposed the opinion leaders model to measure how quickly diffusion occurs when opinion leaders activate interpersonal communications within a community. The credibility and trustworthiness of opinion leaders can speed up the diffusion process by allowing the entire community to select opinion leaders. Opinion leadership in social media depends on the ability to supply information and impact others through the transmission of information (Weimann et al., 2007). We referred to opinion leaders and market mavens as influencers in the context of innovation diffusion. If we apply these influencers’ social roles to the “#metaverse fashion” broadcast network, the innovator, the source of opinion leadership, was “spacerunnersnft” (group 1); opinion leaders were “breakingpanda2” (group 2), “meroorapp” and “forbes” (group 3); and early adopters were “hypebeast” (group 3), “thesandboxgame” (group 4), “genwealth0” (group 6), “altavagroup”/“seedifyfund” (group 7), and “decentraland” (group 8).
The salient influencer as an opinion leader because of its highest in-degree, “breakingpanda2” could help popularize the Metaverse fashion through its gaming in the Metaverse. The vertex “forbes” had the highest number of followers and tweets, followed by the early adopters of “hypebeast” and “thesandboxgame”. They could be instrumental as information brokers (Araujo et al., 2017) in the diffusion of the Metaverse fashion. Considering their high BC Centrality and robust interactions (frequencies of in/out-degrees), the Metaverse fashion adoption might be active among gamers due to their prior digital literacy associated with Metaverse. The vertex “forbes” might have a competitive advantage due to its brand value and credibility. The information from “forbes” helped lessen the perceived risks associated with exploring the Metaverse fashion among first-time users. The early adopter “hypebeast” caters to the need for men’s contemporary fashion streetwear and popularizes the Metaverse fashion among male consumers, especially those engaged in Metaverse gaming or with a positive attitude toward exploring such experiences. Other early adopters, “decentraland” and “seedifyfund” might be market mavens who explore the opportunity for a customized Metaverse model in which consumers could have an immersive experience through technology-mediated symbols and digital games. This idea is supported by the self-efficacy theory (Bandura et al., 1999) because their communications and collaborations about digital fashion and Metaverse technology may simulate the perceived superiority among gamers in the Metaverse.

We noticed that “genwealth0” “altavagroup” and “meroorapp” were influenced by each opinion leader to target their niche markets. For example, “meroorapp” might target consumers who use fashion for self-expression. Since “altavagroup” offered Metaverse-related solutions to various brands, it could help target consumers from different fashion brands interested in exploring Metaverse fashion.

Communication and collaboration in the “#metawear” network
In the “#metaverse fashion” broadcast network, the competition-based collaborations accelerated the diffusion of innovation through celebrity participation and luxury fashion NFTs in the form of computer-generated imagery (CGI). CGI influencer was created for Instagram with over 3 million followers in 2016 (Ahn et al., 2022). Fashion brands develop CGI NFTs that imbue the traits and attributes of celebrities, designed to engage in extensive conversations with consumers on social media, simulating interaction with a real celebrity.

The collaborations in the network intensified immersive participation from mass crowds with diverse avatars or NFTs. In the semantic analysis of the “#metawear” network, we found a creative collaboration between two influencers of the “#metaweartoken” and “trustpad.” Metawear®, a leading fashion Metaverse company, implemented innovative ideas and practices in the sector’s strategic purchasing, design, production quality control, marketing, and sales branches (www.Metaversewear.io). Most recently, “#metawear” and “trustpad” collaborated to run the NFT competitions in 2022 to promote their Metaverse fashion business and enhance consumers’ awareness of this competition. Specifically, the time series analysis confirmed how this competition promoted consumer traffic during a specific period. With the embodied avatars, individuals in the Metaverse can collaborate, communicate about their desired digital identities, and socialize in different scenarios. The “#metawear” network is related to brand and consumer identity and digital ownership through the innovative competition of NFTs.

Conclusions
Theoretical contributions
The study’s findings indicate that the diffusion of Metaverse fashion primarily occurs through the “broadcast network”, which exhibits a higher in-degree than out-degree.
centralization within the “#metaverse fashion” network. This structure pattern implies the dissemination of information from influential hubs to fragmented users, leading to the replication or spread of content across the network. The hub-and-spoke broadcast network’s structure revolves around digital fashion artists, virtual gaming platforms, blockchain developers for NFTs, and luxury/premium fashion brands collaborating to promote Metaverse fashion. Influencers, particularly luxury digital fashion opinion leaders and market mavens of Metaverse NFTs and virtual gaming platforms, play crucial roles in driving the diffusion of digital fashion in the Metaverse. Moreover, competition within the digital fashion space contributes to the widespread adoption of Metaverse fashion.

These findings address critical gaps in the literature and extend theories of diffusion of innovation (Rogers, 1995), two-step flow communication (Katz et al., 2017), and self-efficacy (Bandura et al., 1999). Firstly, we contribute to understanding how communication and collaborations among different users in the Twitter network contribute to the diffusion of Metaverse fashion trends, expanding the traditional scope of the DoI theory by exploring and visualizing the social network of 13,353 Twitter users. Contrary to the assumption of DoI theory (Rogers, 1995), which suggested a normal distribution of adoption rates over time among innovators, early adopters, early majorities, and late majorities, our study reveals that innovators comprise the largest group (group 1, 74.3%), followed by early adopters and the early majority. This skewed distribution may be attributed to our relatively shorter data collection period in the “#metaverse fashion” Twitter network. Nonetheless, applying the DoI theory to current social media contexts potentially offers a theoretical foundation for understanding “fads” as intensely shared enthusiasms but short-lived trends in the broadcast network.

Secondly, we shift the scope of influencer research from consumer-to-consumer communication to the context of two-step flow communication, revealing a prominent hub account of tweets where many users repeat influential tweets. Through the analysis of graph metrics such as in/out-degrees, BC, and the number of followers, we identify the social roles of opinion leaders and market mavens based on their Twitter account profiles and detect their positions in the diffusion process as innovators, early adopters, and early majorities.

Finally, our findings support the transferability of influence within the Twitter network, highlighting the role of digital self-efficacy among users. While earlier studies on self-efficacy theory focused on consumers’ responses in terms of perceived satisfaction (Ellen et al., 1991), attitude toward the technology (Esch et al., 2021), acceptance of technology (Hsu and Chiu, 2004; Zhang et al., 2017) and purchase intention for the technology (Esch et al., 2021), we identify the structural pattern of social network in Twitter that guide the diffusion of Metaverse fashion, catering to diverse user categories such as innovators, early adopters, and the majority.

Managerial implications

Metaverse presents exciting opportunities for buyers and sellers connections, facilitated by cryptocurrencies and NFTs, as we examined in the “#metawear” Twitter network. In the digital realm, users can purchase and trade digital fashion artifacts anytime and anywhere. To capitalize on these opportunities, we propose several recommendations. Firstly, fashion brands should consider investing in Metaverse fashion NFTs to generate revenues. Given the high development costs of Metaverse fashion NFTs during this formative stage, targeting the luxury segment through market skimming strategies could be a viable approach. In the Metaverse, individuals have the opportunity to collaborate with fashion designers, software engineers, and hardware specialists to conceive future fashion innovations by merging AR and imagination. Analyzing market mavens within the Metaverse, especially in game-based competitions, can yield valuable insights into the substantial development of digital fashion equity.

Secondly, millennials and Generation Z consumers, known for their tech-savviness, are potential target cohorts for Metaverse fashion. Their digital self-efficacy enhances digital literacy
(Malodia et al., 2023) and reduces risk perception through interaction and communication with market mavens in the broadcast network. Motivating them to showcase their expertise using Metaverse fashion through competition calls can attract their market mavens. Thirdly, marketers can enhance the immersive experience by exploring collaborations between virtual gaming platforms and haptic technologies, simulating real-life touch sensations of digital fashion products. Lastly, recognizing the instrumental role of social media interactions in spreading awareness of new products, marketers should focus on creating buzz around Metaverse fashion and accelerating the diffusion of Metaverse trends by building communicative social networks. Using hashtags that reflect users’ high self-efficacy in accepting Metaverse fashion, such as “#ITriedMetaverseFashion,” can encourage the majority and laggards to explore this technology.

**Limitations**

Recognized digital fashion assets, particularly in “#metaverse fashion” and “#metawear” Twitter networks, capture consumers’ attention and generate intentions to engage with and own Metaverse fashion. The study found that communication and collaborations among influencers, organizations, and competition venues foster the broadcast-type diffusion of digital fashion within shared networks. With extended theoretical support from the multifaceted Social Network Analysis, we conclude that Metaverse fashion can accelerate its diffusion of innovation during the early adoption stage.

However, several limitations should be considered when generalizing these findings. Firstly, data collection restrictions on Twitter limit the generalizability of the results. Selecting specific two-hashtag keyword networks may introduce biases in SNA results. Future studies should employ diverse data sources to mitigate potential biases when examining hashtag networks. Secondly, the data reduction procedure that enhances readability may lead to subjective analysis and interpretations. While metrics thresholds alleviate concerns about differences in result robustness, conducting longitudinal studies enables the observation of diverse phases in the diffusion of Metaverse fashion and its impact on consumers’ adoption of these innovations. Thirdly, this study used actual tweets to analyze diffusion structure and identify influencers and their roles. However, it was not possible to ascertain the extent to which influencers, information brokers, or strong ties influenced their retweet decisions. Future studies should employ experiments or surveys to investigate these dynamics further. Lastly, non-luxury brands often derive inspiration from trends set by luxury brands or innovators to cater to price-sensitive target markets. This study did not investigate the diffusion of trends from the secondary vertices (e.g. vertices from groups 2, 3, and 4) during the early diffusion stage. Subsequent studies can explore these aspects through the secondary and tertiary vertices in the Metaverse fashion network in social media.

**References**


Further reading


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