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AI-Enabled Hashtag Diffusion in E-Commerce: An Information Diffusion Model Perspective

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Abstract
In this dynamic environment of e-commerce, hashtags are most essential tools that enhance customer engagement, content visibility and brand conversation. Hashtag diffusion remains underexplored still in the era of Artificial Intelligence (AI) optimization. Viral trend creation, connecting brands with customer's hashtags act as a digital connector. This study examines how AI enabled hashtags diffuse (spread) in e-commerce as well as social commerce with the help of the Information Diffusion Model. Network influence, content type, propagation probability and trust relationship as independent variables which collectively influence diffusion spread and speed as dependent variables. Based on the ideas extracted from existing literature on hashtags, the information diffusion model and AI in e-commerce, this paper shows the managerial implications and patterns for AI-enabled hashtag campaigns. AI helps in optimizing hashtag strategies in various e-commerce platforms by combining both technological and behavioural aspects, which increases wide audience reach and built strong brand-consumer relationships. The paper gives strategic takeaway for researchers and marketers seeking to leverage AI-optimized hashtag strategies.

Keywords: *Artificial Intelligence, Customer engagement, Diffusion in hashtags, E-commerce, Information Diffusion.*

1. Introduction

In this modern era, social media faces exponential growth with twitter reaching 330 million active users, Pinterest 445million and Instagram having more than 2 billion active users which produces more content (khalil et al., 2023) [1]. In the context of e-commerce and digital marketing, hashtags play a vital role in consumer engagement with brands, increasing brand visibility and communication with brand and consumers. (Xu, Yifei et al., 2025). Compared to traditional posts, hashtags act as an effective tool that connects each individual with brand across world. It helps in identifying contents, finding trending information and community discussions. Hashtags spread quickly and offer more information which used for predicting future behaviour. (Xu, Yifei et al., 2025). To manage this overloaded information and improve information diffusion hashtag came out as an important tool that recommend themes and gives influence analysis, forecast and prediction tasks (khalil et al., 2023) [2]. Hashtags are the effective categorization mechanisms for large amount of user created data and serving as the filters for quickly finding the posts as well as specific topics (Zhoa et al., 2024). The advent of AI and Natural Language Processing (NLP) helps in producing the automated hashtag. Where AI shall analyse the content in the users, extract the key contents and turns into relevant hashtags (Zhoa et al., 2024) (Khurana et al., 2017). This kind of automation reduces the technical barricades and makes a content production more attractive as well as gives more connection for the users (Zhoa et al., 2024) [3]. This ability of the hashtags becomes important for the information organization and content spread, some hashtags are getting viral due to celebrity participation, engagement in the content and relevant in some news topics (Firuzbakht et al., 2025). Instagram acting as major platform which contains more than 2 billion active users where hashtag serves as a advocacy to people and social influence, even though research

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hashtag information remains limited (Firuzbakht et al., 2025). Brand – consumer interaction and shopping experiences changed alot with the integration of the artificial intelligence in the e-commerce environment (Yan et al., 2024). In the arrival of Large Language Model like ChatGPTs, has given the attention across the marketing industries, though the AI enabled capabilities in the marketing where research attention historically limited (Ngo, 2024). The Generative AIs becomes the important role in e-commerce, providing improved solutions that enrich customer experiences through effective product positioning and personalization for the users (Ren et al., 2024). Customer Loyalty highly driven by the AI, including targeted content and personalized recommendation that influences purchasing behaviour as well as relationship with the brand (Beyari, et al., 2025) [4]. The diffusion and integration of AI innovation in the marketing based on consumer insight as well as the social system acceptance, with the social media and e-commerce platforms serve as the important place for finding consumer attachments towards AI enabled technologies (Ngo et al, 2024). This conceptual paper gives important ideologies for both academic and managerial aspects. Firstly, it gives a theoretical foundation for overall view of the hashtag diffusion in the AI era by infusing the Information diffusion theory with modern research on AI adoption in the marketing. Secondly, the paper provides a conceptual model that explains the relationships between the independent variables as well as dependent variables. Finally, this paper provides recommendation to managers in the marketing field and e-commerce leaders to effectively use their hashtag campaigns. The aim of the paper is to prepare managers with the knowledge to develop, implement and optimize AI enabled hashtag campaigns that gives meaningful results in the competitive e-commerce landscape [5]. In summary, the introduction founds that gathering of AI, social media and e-commerce have modified dynamics of the Hashtag, highlighting the importance of systematic review of how AI enabled hashtag affects diffusion patterns across multiple marketplaces Shown in Table 1.

2. Literature Review

Table 1 Comparative Review of Information Diffusion and Hashtag Studies

S. No.	Title and Author	What have done?	What is missing?
1	The Role of Network and Identity in the Diffusion of Hashtags(Ananthasubramaniam et al., 2025)	This study explains that joint modelling of network and identity exhibit accurate hashtag diffusion rather than single-factor model.	The study did not evaluate AI enabled hashtag diffusion in e-commerce.
2	Product information diffusion in a social network (Zhang, Luo, & Boncella, 2018)	This paper analysed independent cascade model on Twitter data (i.e from product launch) to measure nodes and paths.	It narrowed the study only to production information diffusion and it not considered any AI based suggestions and e-commerce.
3	State-of-art review of information diffusion models and their impact on social network vulnerabilities (Razaque et al., 2019)	In this study, they reviewed both classical and modern diffusion models and they discussed the advantages, disadvantages of each model.	This study does not address about AI integration and hashtags in e-commerce.
4	Behavioural Analyses of Information Diffusion Model by Observed Data of Social Network (Saito et al., 2010)	The paper compared independent cascades, linear threshold and other models and they recommended the model based on the real network data.	This study focused on information model and it missed to target hashtags and e-commerce.

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5	A survey on fairness of large language models in e-commerce: progress, application, and challenge (Ren et al., 2024)	This study reviewed the use Large Language Model and transparency in e-commerce platforms. It analysed product recommendations, reviews and explains the future research demand.	The study focused on fairness of LLM but it does not study about diffusion of hashtags.
6	Promoting Research, Awareness, and Discussion on AI in Medicine Using MedTwitterAI (Nawaz et al., 2022)	In this study, they examined longitudinal twitter hashtag campaign by content, NLP and reach. And they highlighted how hashtags enhance the medical outreach.	It focused on analysing twitter hashtags but this study does not considered e-commerce.
7	Framework for Social Media Analysis Based on Hashtag Research (Pilar et al., 2021)	The study used network science for proposing seven-phrase framework for hashtag based social media.	The study does not experiment about AI driven, diffusion models.
8	Popular Tag Recommendation by Neural Network in social media (Xiao et al., 2020)	In this paper they developed neural system that recommends hashtags and tags on social media and increase the content visibility.	This study limits its study to developing neural network system and it does not connect to any e-commerce platform and AI enabled hashtags.
9	Assessing information diffusion models for influence maximization in signed social networks (Hosseini-Pozveh et al., 2018)	The study examined the different diffusion models to know which maximises the influence and it focus on trust and distrust in social networks.	This study does not examine about e-commerce, hashtags and does not included AI.
10	Selecting Information Diffusion Models over Social Networks for Behavioural Analysis (Saito et al., 2010)	The study used automated diffusion model and they selected based on hold-out validation and analysed how it fits.	In this is study it lacks in practical usage of hashtags in e-commerce.
11	What motivates users to hashtag on social media? (Rauschnabel et al., 2019)	This study identified 10 key motivations for hashtag usage and established measurement scale.	This study only conveyed about hashtag usage but it does not study about AI, suggestions and e-commerce results.
12	The Effect of Social Network Size on Hashtag Adoption on Twitter (Monster & Lev-Ari, 2018)	The study investigated how size of social network influence hashtag usage and found that smaller network adopts variety of hashtags.	This study has not address about hashtag diffusion on e-commerce.
13	Social-media engagement of hashtag users in the context of local events: A mixed-method approach (Stepanov et al., 2019)	This study explored engagement of hashtag in context of local events by using surveys and digital trace analysis.	This study focused on events and it does not examine e-commerce and AI diffusion.

2.1. Research gap

The previous literature disclosed that there is a significant research gap in AI- enabled hashtag diffusion in e-commerce. The prior study explains about network and identity factors in hashtag diffusion but they did not examine about AI enabled techniques in the context of e-commerce (Ananthasubramaniam et.al., 2025) [6 - 10]. The

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study concentrated about product information diffusion using independent cascade and it lacks AI-based recommendation and e-commerce platforms (Zhang, Luo & Boncella.,2018). Similarly, Review of information diffusion model and Behavioural analysis these two papers excluded hashtags, AI integration and e- commerce in their studies (Razaque et al., 2019) (Saito et al., 2010). The study analysed large language models in e-commerce and about their fairness did not examine about diffusion of hashtag (Ren et.al 2024). The existing studies focused hashtag campaigns and development of framework, ignored to study about e-commerce and AI-enabled diffusion models (Nawaz et al., 2022) (Pilar et al., 2021). This study addresses the identified literature gap by examining AI-enabled hashtags in e-commerce by applying information diffusion models as a theory. By studying this, it helps to know how hashtags spread in an e-commerce environment. Therefore, founded research gap clearly tells that a critical need to analyse the AI enabled hashtag diffusion pattern within e marketplace, as earlier studies less integrate AI capabilities with diffusion process.

3. Conceptual and theoretical framework

3.1. Information Diffusion Model

Research on information diffusion has focused on forecasting the scale and popularity of information flows across various platforms, from posts in social media to e-commerce product advertisements and citations in scientific papers. Previous approaches depend on hand-crafted statistical features such as Recurrent Neutral Networks were used to picture the evolution of cascade patterns, however, these methods have been substituted by graph-based models, which effectively show structural and temporal dependencies within and across the information cascades (Peng et al., 2025) [11- 15]. Spread of information with buyer behaviour and their purchase decisions is linked with the help of modern diffusion framework. The study about Taobao platform shows that sharing of product information increases the spread of product interest, which creates an interconnection with actual buying behaviour. Both the structural and temporal dynamics of diffusion network play essential role in this relationship (Huang et al., 2021). The advances in diffusion model have hands on application in spotting out fake information which goes viral, optimizing social media marketing strategies and enriching e-commerce suggestions by understanding how information diffusion develops and influence user actions (Peng et al., 2025) [16 - 20]. Collectively, this framework strengthened that information diffusion theory makes a strong foundation for developing how the structural, technological factors and behavioural elements forms AI driven hashtag distributed Shown in Figure 1.

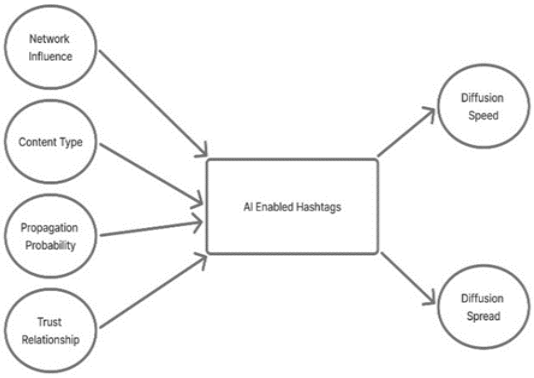

Figure 1 AI-Enabled Hashtag Diffusion Framework in Social Networks

3.2. Network Influence

Network influence shows that the capacity of some participants behaviour which affects others, that obtained from Information Diffusion Theory (Guille et al., 2013). In hashtag diffusion, multiple mechanism demonstrated through Network Influence. User with large number of followers with higher popularity and extensive connection can connect network clusters- This enhances flow of hashtag, that reach the wider audiences (Chan et al., 2023). Network influence grow as an important determinant in hashtag distribution, focusly, how the user engaging and social structures enhances the diffusion across platforms.

3.3. Content type

The existing research shows that content types such as image, news, videos and petitions in which petitions is one which becomes viral than other contents types. These content types differ sustainably in how many people shared, how many level it

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reached and how the content spreads (Goel et al. 2015). This statement acts evidence for content type as independent variable [21 - 25].

3.4. Propagation Probability

Propagation probability shows that how hashtag will transmit from one person to another. To find the flow size and velocity in the information diffusion theory is done by propagation probability (Hosseini-Pozveh et al., 2019). The strength of the relationship between users, relevance in the content, platform utility and algorithmic enhancement were determined by the propagation probability (Guille et al., 2013).

3.5. Trust Relationship

In the E commerce and social networks, trust consider as a critical element to estimating the information spreads. Trust has been vastly studied for consumer behaviour and intentions especially in e commerce studies (Dwidienawati et al., 2020). In the AI enabled hashtag diffusion context, trust relationship becomes crucial for finding how user propagate and assess information through e-commerce platform.

3.6. Diffusion Spread

Hashtag diffusion uses patterns like outbreak where behaviour converts into specific spreads in hashtag from one user to other users through social media network, with users can post content including that hashtag (Lehmann et al., 2011) (Lin et al., 2013). This function act as a flow where another user also adopts that hashtag. However, research shows that epidemic playing minor role in hashtag spread. But is majorly done by external factors like disaster, events and elections etc., (Crane et al., 2008) [26 - 30].

3.7. Diffusion speed

The rate at which the topic prefixed with symbol "#" spread through the social networks is called Hashtag diffusion speed. The diffusion process is specified by fast spread of information (Wang et al., 2014). Investing the viral spread of hashtag has been attracted by significant attention as in today's social network (Kim et al., 2020). The hashtag diffusion by many factors like content features, users' popularity etc., The unpredicting level are also influenced by the interplay of identity of user and network topology, where adoption happens through the identity-based signalling and social connections.

3.8. Managerial Implications

This model gives a strategic suggestion for marketers, e-commerce managers as well as digital strategist trying to leverage the AI enabled hashtag strategies. Collectively the below managerial implications show that AI enabled hashtag tactics can improve the engagement, personalization and decision-making skills in the modern e-market place.

4. Implications for E Commerce Managers

The managers in the E commerce sectors prioritize to implement AI enable hashtags to meet growing consumer demands for enhancing the consumer shopping experiences, as analysing in advanced AI enabled things that analyse the consumer data that enhance the experience, loyalty and repeat purchases (Dai et al., 2024). The arrangement of AI enabled hashtags will handle highest numbers of users, provide real-time AI enabled hashtag recommendations. There by we will increase the customer satisfaction as well as customer engagement. E- Commerce managers should use predictive analytics to forecast consumer needs and identify the emerging trends (Dai et al., 2024). In addition to that AI enabled social network engagement act as key element for retail suggestions, using AI things to analyse the consumer engagement in social networks, to increase the purchase frequency and enhance the spending patterns [31 - 35].

5. Implications for Marketers

The marketers should enhance the customer engagement and it's done through visual content analysis and AI enabled hashtags. Companies should highlight the visual demonstration of the customer engagement as part of social network listening strategies, use tools like cloud vision API to analyse the content (Azer et al., 2023). The amalgamation of digital marketing tools is prime thing for consumer engagement understanding. Marketers must identify and emphasize the various points like social networks, search engine and email marketing, which AI enhances the customer engagement (Masfer et al., 2025). This type of unified approach helps in digital marketing strategies that influences the purchasing decisions across the multiple platforms.

6. Implications for Digital strategist

While implementing AI-enabled hashtag techniques

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digital strategies should switch from reactive to predictive approaches. Predictive analysis based on AI and big data act as a vital tool for cost, time and managing the customer databases interactively. It enables the digital strategists will wisely use the digital technologies in marketing analysis and decision making (Varzaru et al., 2022). Brands can move beyond the consistent audience segmentation by integrating AI advanced analytics, forecasts behaviour of users in advance instead of reacting. (Shaheen, 2025). Digital strategist must ensure whether artificial intelligence will influence the marketing ability of influencers, acts as a communicator, before AI implementation research sued to understand its pros and cons (Bansal et al., 2024) [36 - 38].

7. Limitations and Future directions

This paper exhibits a conceptual model by using Information Diffusion theory by analysing existing literature, but this study did not undergo any empirical attempting. Future researcher can examine real-time usage of hashtag data from e-commerce platforms, they can test independent variables such as network influence, content type, propagation probability, trust relationship which influences diffusion spread and speed rather than theoretical foundation. Various social media network having different peculiar characteristics, different algorithms and different user behaviour patterns that moderating the proposed relationships. Comparable studies between different platforms should scrutinize how platform affects the hashtag diffusions. To increase the practical applicability, we need to develop platform specific models. AI enabled technologies are growing rapidly. Future research must explore how the emerging capabilities including AI agents, LLMs and Gen AI which help to transform hashtag strategies. This Model mainly focuses on optimization of hashtags without considering ethical aspects, manipulation, privacy and authenticity. The future research should focus on ethical dimensions of AI enabled hashtag diffusion, that includes consumer perceptions of privacy concerns and manipulation.

Conclusion

This paper has analysed AI enabled hashtag diffusion in e-commerce platforms via theoretical lens of information diffusion theory. By including the vision from hashtag research, AI applications, network analysis and digital commerce literature, this study developed a complete conceptual model that interprets how network influence, propagation probability, content type and trust relationship jointly impact diffusion speed as well as diffusion spread. This theoretical contribution by founding information diffusion theory as a strong framework for finding hashtag behaviour, including different dimension of diffusion into a unique model, differentiate between diffusion spread and speed as different outcomes, and locating AI enabled as fundamental thing that amplifies the diffusion relationships. Identification, content optimization, algorithmic implications and trust building are done through optimization of hashtags, that will give strategic recommendations and evidence-based guidance. In the Modern era, E-commerce is continuously evolving and AI technologies are become more enlightened, the importance of hashtag will surely increase. That brand which excels in AI enabled hashtag strategies including data driven optimization with creative thoughts and genuine customer engagement- will accomplish competitive advantage in reaching the audiences and building the communities. This conceptual framework gives a good foundation for this familiarity, providing theoretical insights, conceptual framework and effective recommendations that jointly gives advance understanding of AI enabled hashtag diffusion in the e-commerce environment as well as social media networks.

Overall, this study tells a strong theoretical foundation of how AI enabled hashtag diffusion in e-marketplace, offering a through model that gives academic insights and supports e-commerce practices.

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