Digital innovation in the United States: Spatial determinants of transformation as exemplified by Kickstarter campaigns

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Abstract

Digital transformation is reshaping innovation processes and capital allocation models, fostering the emergence of alternative financing mechanisms such as crowdfunding platforms. This study investigates the spatial determinants of digital innovation development using Kickstarter campaigns in the United States as a case study. Empirical data were preprocessed and classified into digital and traditional categories. Advanced AI methods, including Deep Autoencoders and Self-Organizing Maps (SOM), revealed spatial clusters of digital innovation in crowdfunding. Cluster visualizations exposed geographic concentration patterns and links to local infrastructure. AI uncovered latent ties between campaign structure and regional context, underscoring the role of AI and crowdfunding in decentralized, localized digital transformation.

Keywords: digital transformation, crowdfunding, artificial intelligence, spatial analysis, deep autoencoders

1. Introduction

The growing role, regional disparities in crowdfunding and their connection to digital transformation remain understudied [11]. Few analyses apply AI to uncover latent spatial patterns. Crowdfunding platforms like Kickstarter [13], [22] facilitate capital access without intermediaries, advancing idea commercialization and supporting digital ecosystems [2], [18]. This study addresses that gap by analyzing over 145,000 Kickstarter campaigns (2010–2025) in the U.S., using economic and AI-based methods, Deep Autoencoders and Self-Organizing Maps (SOM), to assess activity intensity, campaign typology, clustering, and spatial dynamics.

2. State of research based on a literature review

Crowdfunding platforms like Kickstarter and Indiegogo play a central role in digital transformation by supporting decentralized innovation, capital access, and community formation [3, 4], [6, 7, 8, 9, 10], [14], [16], [18]. Regional disparities reflect infrastructure and network differences [10], [12]. While AI tools such as neural networks and SOMs reveal investment patterns [1], [5], spatial applications remain limited. SOM analysis of Kickstarter data reveals digital activity clusters in states like California and New York [15].

3. Research methodology

This study analyzes over 145,000 U.S. Kickstarter campaigns (2010–2025) [13], [22] to explore spatial determinants of digital transformation. Crowdfunding is examined as a driver of digital change in capital flow and regional ecosystems. Using AI methods, campaigns were classified (digital/traditional), key features extracted via deep autoencoders, clustered with Self-Organizing Maps (SOM), and analyzed for success prediction using models like XGBoost. The framework highlights AI's role in mapping digital innovation dynamics.

4. Research results

From over 240,000 Kickstarter campaigns (2010–2025), approximately 145,000 with complete geolocation data were retained and assigned to U.S. states. Campaigns were classified as *digital* (e.g., technology, apps) or *traditional* (e.g., art, music), enabling spatial analysis in relation to digital infrastructure.

Kickstarter data from 2010–2025 reveal strong spatial variation in crowdfunding activity across U.S. states (Fig. 1). Darker shades indicate higher campaign counts, with cumulative data reflecting long-term trends. While time-based analysis is deferred, this study focuses on spatial clustering as a proxy for digital ecosystem maturity.

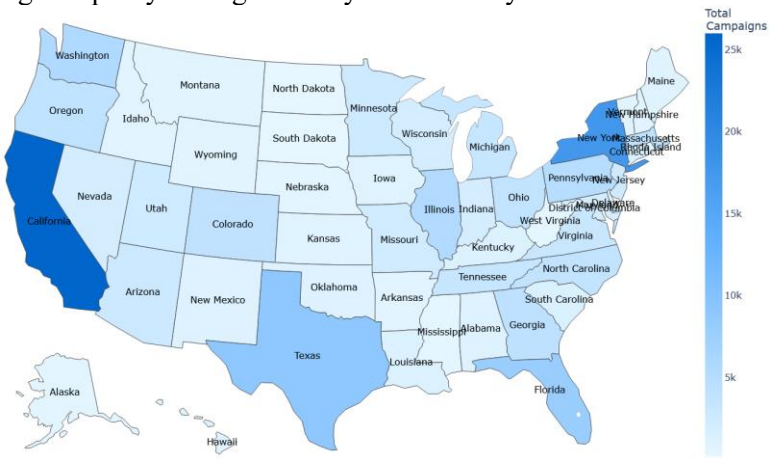

Fig.1. Spatial analysis of the number of crowdfunding campaigns in the United States
Source: Created by the authors

Crowdfunding campaigns concentrate in digitally advanced states, California, New York, Texas, and Florida, reflecting ecosystem strength. California leads due to Silicon Valley; lower activity in states like Wyoming stems from limited access and low population density. These patterns underscore spatial drivers of digital growth. The following section assesses digital campaign shares as indicators of regional innovation.

The relative share of digital campaigns, visualized in Fig. 2 offers sharper insight into regional specialization than absolute counts. States like Colorado, Delaware, and Wyoming show a high proportion of tech-focused projects (Software, Hardware, AI) despite lower overall volume, indicating concentrated innovation activity in smaller but digitally dynamic regions.

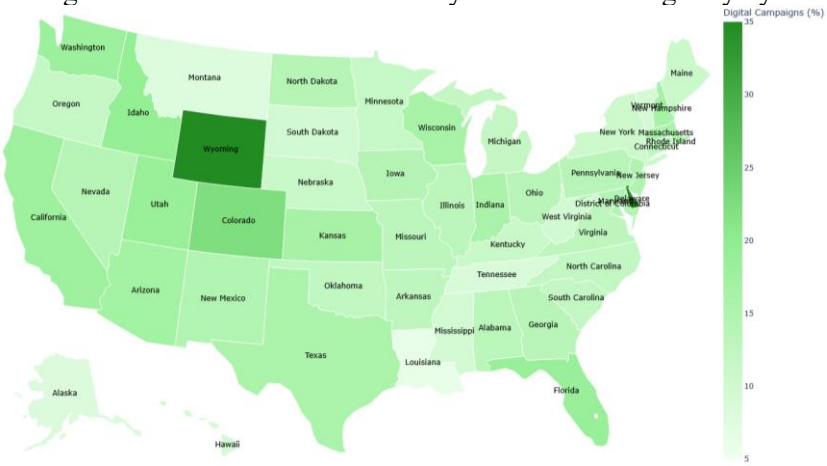

Fig.2. Spatial analysis of the share of digital campaigns in total crowdfunding activity in the United States
Source: Created by the authors

In contrast, high-volume states such as California and New York display moderate digital shares due to creative-sector dominance (e.g., film, music), indicating thematic diversity. States with weak digital infrastructure, like Mississippi and Alabama, show minimal digital engagement. These spatial patterns suggest that digital crowdfunding concentration reflects local tech ecosystems, knowledge transfer, and innovation policies.

The findings support the use of crowdfunding data as an indicator of regional digital transformation, supplementing traditional economic measures.

In addition to spatial mapping, a statistical analysis assessed the link between total crowdfunding volume and the share of digital projects. Statistical significance ($p = 0.6117$) indicated no meaningful relationship, implying that digital engagement is shaped by other factors, further explored through AI-based methods.

Deep autoencoders reduced dimensionality in crowdfunding data by encoding project variables into latent space, supporting clustering and SOM analysis. Low reconstruction error (MSE ≈ 0.0059) confirmed model reliability. This AI-based method revealed spatial-economic patterns, enhancing the analysis of regional digital transformation.

To examine structural patterns in over 145,000 Kickstarter campaigns, 166 project-level variables were compressed into an eight-dimensional latent space using a deep autoencoder. PCA and t-SNE aided visualization, revealing key variance axes, clusters, and nonlinear structures linked to innovation niches. Based on silhouette scores and elbow plots, five clusters were selected, balancing detail and interpretability. Clustering in latent space avoided t-SNE distortions. These AI-driven methods improved segmentation and strategic insight, highlighting AI's value in analyzing digital innovation finance.

Based on crowdfunding campaign data from the United States, market segmentation was performed using the K-Means algorithm applied to the latent representations generated by an autoencoder. The clustering results, visualized in the PCA-transformed space, revealed five clearly differentiated groups of campaigns, distinguished by the structure of their latent features, such as thematic category, funding goal, and level of community engagement (Fig. 3).

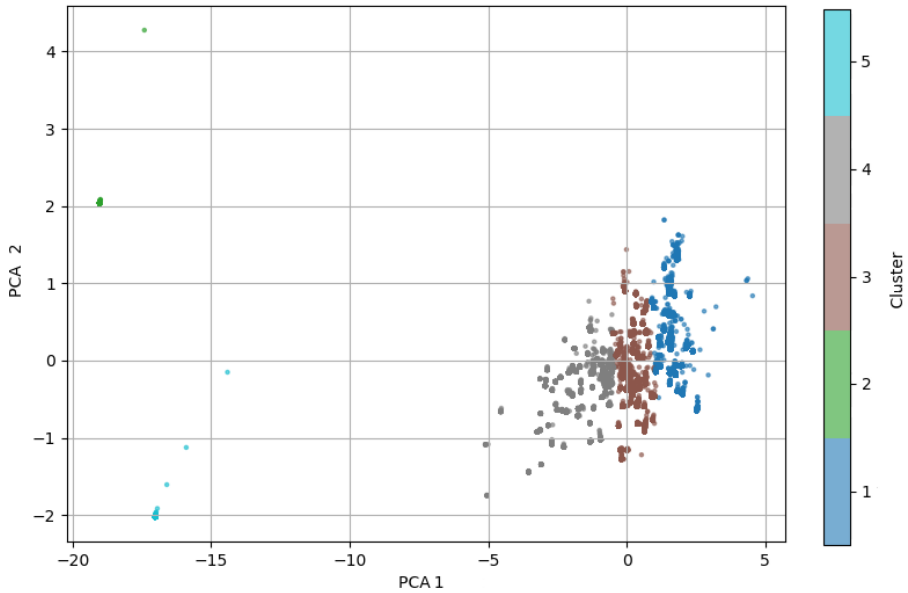

Fig.3. Clustering of campaigns using the K-Means method
Source: Created by the authors

AI-based segmentation identified five distinct crowdfunding clusters (Tab. 1), including two dominant groups (Clusters 1 and 3, comprising over 100,000 campaigns), a technology-oriented cluster (Cluster 5) focused on artificial intelligence and emerging innovations, and two smaller clusters (2 and 4) representing niche and experimental initiatives. This structural diversity is illustrated by representative campaigns: Cluster 1 includes artistic projects such as indie comics (The Transformers Compendium Set [6]) and experimental design; Cluster 3 encompasses mainstream content including board games (Tiny Epic Quest [19], Nemesis: Alien Kings Set [20]), films, and music. Cluster 5 reflects tech-driven initiatives, such as AI writing tools, educational robotics kits, and

modular smartwatches (UNA Watch [21]). Clusters 2 and 4 include inclusive technology projects, such as OpenFarm [17]. Table 1 also highlights the hybrid nature of content within Cluster 5 and the broader strategic diversity across all clusters, supporting the application of SOM-based spatial segmentation in analyzing regional crowdfunding dynamics.

Table 1. Characterization of crowdfunding projects method

Cluster	No. of camp.	Cluster characterization based on latent feature	Interpretation
1	46694	Moderate average values, with a slight emphasis on project-related features	Artistic campaigns, creative projects (e.g. publishing, design, fashion)
2	2148	Distinct feature values, with high variance	Niche, innovative campaigns (e.g. experimental technologies, startups)
3	54068	High feature consistency, with stable means	Typical, high-volume campaigns in popular categories (e.g. film, music)
4	1498	Strongly divergent features, marking deviation	Unconventional, experimental projects, niche or unique themes
5	40792	Slightly shifted features toward technology and applications	Technology-oriented campaigns, often overlapping with creative formats such as games and digital media

Source: Created by the authors

This latent feature-driven structure highlights the strategic and thematic diversity within the crowdfunding landscape, confirming the utility of AI in identifying innovation patterns and enabling the development of personalized platform functionalities.

The use of Self-Organizing Maps (SOM) grouped states by campaign traits, revealing digital disparities. Clusters like West Virginia and South Dakota reflected limited infrastructure, while Massachusetts and Illinois showed strong fintech activity. While the number of states per SOM node is discrete, a continuous color scale was used in Figure 4 to improve visual clarity.

SOM enables the identification of differences in the adoption of digital crowdfunding models. States such as California, New York, and Florida, which occupy distinct positions on the map, may represent digital transformation leaders, where crowdfunding has evolved into highly digitized forms, such as equity-based or blockchain-based platforms.

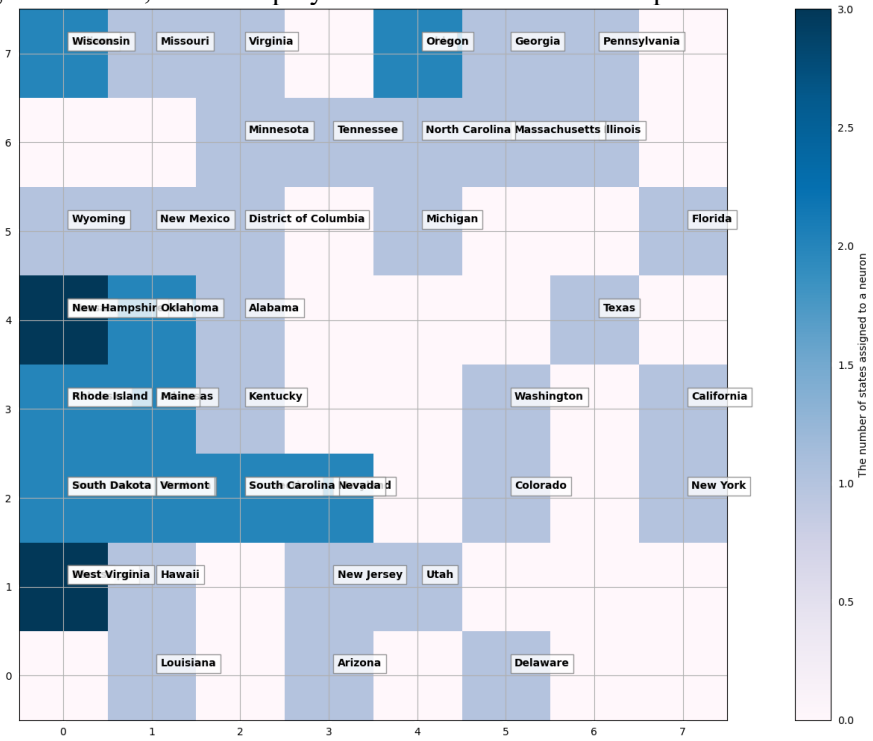

Fig.4. Self-Organizing Maps for the analysis of crowdfunding patterns.
Source: Created by the authors

Conversely, states grouped within denser clusters (darker areas) may demonstrate a stronger reliance on traditional forms of crowdfunding, oriented around local campaigns and physical channels of distribution.

5. Conclusions and summary

This study confirms the role of crowdfunding, analyzed via over 145,000 Kickstarter campaigns (2010–2025), as a key driver of digital transformation in contemporary economic models. Using AI techniques (Autoencoders, K-Means, SOM), the analysis uncovered latent market structures and regional disparities in crowdfunding adoption.

Digital and traditional campaigns showed distinct spatial and structural patterns. States like California and Massachusetts led in digital activity, while regions such as Wyoming and Alabama favored traditional formats. Clustering revealed five campaign segments, from entertainment-focused and commercially mature projects to tech-driven and niche initiatives, reflecting diverse user strategies and capital flows.

These findings have practical relevance for information system development, including intelligent recommendation tools and spatially informed policy design. SOM analysis emphasized the impact of local infrastructure on digital engagement. The study suggests that AI-driven diagnostics can inform regional innovation policies and enhance inclusivity in digital ecosystems.

In conclusion, the study demonstrates AI's effectiveness in modeling crowdfunding behavior and highlights crowdfunding's potential as an indicator of regional digital maturity and innovation capacity.

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