Crowd inputs in reward-based and equity-based crowdfunding: a latent Dirichlet allocation approach on their potential for innovation

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Abstract

Purpose – Crowdfunding platforms are important innovations that allow nascent entrepreneurs to gain access to financial resources and crowd inputs to better refine and develop their business idea. The purpose of this paper is to investigate user-generated content (UGC) from both reward-based and equity-based crowdfunding platforms, in order to determine its implications for open and user innovation.

Design/methodology/approach – A total sample of 200 most funded technology products was extracted from four distinct crowdfunding platforms. A latent Dirichlet allocation (LDA) analysis was performed in an attempt to identify critical latent factors. The analysis was carried out through the theoretical lens of innovation literature, in an attempt to uncover the implications for open and user innovation.

Findings – The authors were able to highlight the implications of crowd inputs for open and user innovation, as backers provided nascent entrepreneurs with several types of feedback, ranging from product co-development to strategy and marketing. Furthermore, the study provided an overview of the key differences emerging between reward-based and equity-based crowdfunding platforms in terms of crowd inputs.

Research limitations/implications – The present study features intrinsic limitations of the LDA approach being adopted. More specifically, it only provides a "snapshot" in time of the current sample, rather than investigating its development over time.

Practical implications – The present study solidifies the value of UGC as a resource to mine for trends and feedback.

Originality/value – The study contributes to both the innovation literature and the crowdfunding literature. It bridges several gaps found in both literature streams, by providing empirical evidence to test and verify pre-existing exploratory research.

Keywords Innovation, Crowdfunding, Latent Dirichlet allocation, Topic modelling

Paper type Research paper

1. Introduction

Crowdfunding is a popular innovation that provides nascent entrepreneurs an alternative to traditional financing (Stefani *et al.*, 2019). These entrepreneurs get more than mere financial support through crowdfunding platforms, however, as they are also able to gather frequent feedback on the products and services being developed. Meanwhile, investors receive goods and services of various kinds as rewards for their donations (Ordanini *et al.*, 2011). As large amounts of money are often needed to fund their business ideas, nascent entrepreneurs have begun drifting towards crowdfunding websites, such as Indiegogo and Kickstarter (Belleflamme *et al.*, 2014), and academic interest has grown

in parallel to such sites' increasing popularity (Li *et al.*, 2017). While the primary purpose of crowdfunding is to provide nascent entrepreneurs the financial resources needed to fund their entrepreneurial journeys (Clauss *et al.*, 2018; Kuppuswamy and Bayus, 2017), some argue crowdfunding platforms can also act as open and user innovation tools in terms of knowledge acquisition (Troise and Tani, 2021; Di Pietro *et al.*, 2018). In fact, most online crowdfunding platforms allow users to exchange comments and feedback with entrepreneurs (Vrontis *et al.*, 2020), stimulating a knowledge-exchanging hub that helps entrepreneurs refine their products or services before release and get preliminary market validation (Junge *et al.*, 2022).

The academic literature identifies four main categories of crowdfunding—donation-based, reward-based, equity-based and lending-based crowdfunding. Donation-based crowdfunding is popular amongst non-profit and non-governmental organisations (Kim *et al.*, 2022). Supporters of donation-based crowdfunding campaigns receive no reward for their financial support. Reward-based crowdfunding is arguably the most frequently used form of crowdfunding today (Alhammad *et al.*, 2022). Supporters in reward-based crowdfunding receive tangible or intangible returns on their investment, typically products or services featured in the campaign. Both equity-based and lending-based crowdfunding feature monetary returns for the investors. In equity-based crowdfunding, investors receive financial returns on their investment if the project is profitable. In this regard, equity-based crowdfunding shares similarities with investments in the stock market, as investors have an underlying level of risk (Di Pietro *et al.*, 2018). Finally, lending-based crowdfunding sees supporters acting as lenders and receiving a defined interest rate within a specific time frame (Berns *et al.*, 2020).

In this study, we focus on online reward-based and equity-based crowdfunding for several reasons. First, the intent is to address several research gaps that have been identified in reward-based and equity-based crowdfunding literature regarding their implications for open and user innovation (Vrontis *et al.*, 2020; Madrazo-Lemarroy *et al.*, 2019). Second, while multiple types of crowdfunding exist, Prisco *et al.* (2022) suggest two main classes of crowdfunding platforms can be identified—investment-based crowdfunding platforms and reward- and donation-based crowdfunding platforms. In other words, lending and equity are seen as investment models, while rewards and donations are seen as non-investment models (Shneor and Munim, 2019), and hence our choice to focus on one type of crowdfunding platform for each of the two categories, equity-based and reward-based crowdfunding. Third, our choice was driven by the relevance that both types of crowdfunding have online. Reward-based crowdfunding features the largest number of active online platforms worldwide with minimal regulatory restrictions and low-risk participation (Banerjee and Bose, 2022). Furthermore, while equity-based crowdfunding is a relatively new concept, its popularity is growing rapidly. More specifically, a report by the Cambridge Centre for Alternative Finance (2021) ranks equity-based crowdfunding as one of the most globally used sources of finance, with a trading volume of $1,520,444,679 as of 2020. This evidence shows the significant traction equity-based crowdfunding has been gaining lately.

Several research streams have been developed around crowdfunding; some have explored crowdfunding success rates and the factors that might influence them (Ahlers *et al.*, 2015; Colombo *et al.*, 2015; Mollick, 2014), and others have analysed the motivations behind crowdfunding campaigns (St John *et al.*, 2021). While the use of Internet based crowdfunding platforms has been investigated by multiple studies (Battisti *et al.*, 2022; Vrontis *et al.*, 2020), the feedback entrepreneurs receive from investors in terms of comments and engagements is yet to be fully explored (Di Pietro *et al.*, 2018). User comments, which will be referred to as "crowd inputs" throughout the present study, is especially relevant in modern day crowdfunding platforms, as entrepreneurs use them not only to get financial support, but also and most importantly to gather feedback and validation on their projects (Junge *et al.*, 2022).

Several calls have been made to investigate the implications of crowd inputs for crowdfunding websites and how such inputs affect innovation (Vrontis *et al.*, 2020; Madrazo-Lemarroy *et al.*, 2019). Di Pietro *et al.* (2018) first attempted to categorise the inputs entrepreneurs receive from crowd investors through online equity crowdfunding, however, their qualitative study did not take reward-based platforms into account. Similarly, Jiang *et al.* (2020) called for further research into reward-based crowdfunding platforms such as Indiegogo and Kickstarter in order to determine the nature of backer-entrepreneur knowledge transfers. While their study focussed on ventures' crowdfunding descriptions, it did not consider user-generated content (UGC) in terms of comments and feedback, which is important to consider when it comes to crowdfunding and electronic commerce in general (Wang *et al.*, 2019).

To address the aforementioned research gaps, the present study provides a comprehensive understanding of online crowdfunding platforms as a source of innovation input, while highlighting the differences between reward-based and equity-based crowdfunding platforms. The goal of this research is to determine key emerging trends in crowdfunding UGC while highlighting the differences between reward-based and equity-based crowdfunding platforms in terms of crowd inputs, along with the implications for innovation, through an empirical exploration of big data. The study does this by using Bayesian statistics and latent Dirichlet allocation (LDA) topic modelling, which has been extensively employed in crowdfunding research (Jiang *et al.*, 2020; Shafqat and Byun, 2019) and is most optimally used when significant amounts of textual data need to be processed. Our research analyses data from the top 200 most funded technology-based projects on both reward-based and equity-based crowdfunding platforms in an attempt to identify and categorise the inputs entrepreneurs garner from backers on online reward-based and equity-based crowdfunding platforms, while highlighting emerging differences between the two.

Drawing on Di Pietro *et al.*'s (2018) theoretical framework for equity funding, this research strives to identify several key factors that emerge from online crowdfunding discourse and map them around their theoretical constructs as a means of providing an updated reference for reward-based crowdfunding platforms. In doing so, it offers several contributions to both theory and practice. From a theoretical perspective, the study contributes to the reward-based and equity-based crowdfunding literature streams (Liu *et al.*, 2022; Battisti *et al.*, 2022) by offering empirical insights into how the online crowdfunding discourse is being carried out by both backers and entrepreneurs (Di Pietro *et al.*, 2018). From a practical perspective, our study demonstrates that, while time-consuming to manage, entrepreneurs should consider online crowds to be a valid source of knowledge to exploit in terms of user innovation potential.

The article is structured as follows: The current section provides an overview of the study, with a brief introduction. The next section features a literature review on crowdfunding, as well as user innovation and online UGC in crowdfunding. The third section provides an in-depth analysis of the methodology that was implemented in our research design. The fourth section illustrates the results and highlights the several dimensions of online crowdfunding discourse. The fifth section discusses the results and compares them with that of previous literature on crowdfunding. The final section contains a discussion of the study's managerial and theoretical implications, as well as limitations and directions for future research.

2. Literature review and theoretical background
2.1 Reward-based and equity-based crowdfunding
We mentioned earlier that primary crowdfunding models include lending, equity, reward and donation, yet they can be classified in two major and distinct categories. Whereas lending and equity are viewed as investment models, reward and donation are regarded as

non-investment models (Shneor and Munim, 2019). Reward-based crowdfunding is generally regarded as the most commonly used type of crowdfunding (Chan *et al.*, 2020). To get a better understanding of its scope, in 2016, reward-based crowdfunding volumes were estimated at EUR 191 million in Europe and have been growing since (Ziegler *et al.*, 2018).

Rewards are varied in their shapes and forms, though they predominantly include, but are not limited to, physical copies of the product, discounts (Cappa *et al.*, 2022), gadgets and special editions of products (Bi *et al.*, 2017), creative collaborations and experience (e.g. backers being featured as secondary characters in a video game or comic book) and creative mementos from the producers (Kuppuswamy and Bayus, 2017). Direct communication between backers and innovating entrepreneurs plays an important role in reward-based crowdfunding, as backers actively engage in crowdfunding platforms through messages and comments as a means of monitoring the development of the product they are backing (Agrawal *et al.*, 2014), making them a sufficient source of knowledge (Cholakova and Clarysse, 2015; Gerber and Hui, 2013).

Data from equity-based crowdfunding platforms was included in the study in an attempt to address several calls for future research that have been made over the years (Di Pietro *et al.*, 2018). Vrontis *et al.* (2020), for instance, suggested that literature would benefit from statistical analyses on information crowdfunding users exchange over the Internet. Additionally, while equity-based crowdfunding is still relatively new, it is gradually gaining momentum in Europe and particularly in the UK (Wachira and Wachira, 2022), and getting attention from both entrepreneurs and academics (Troise *et al.*, 2022b). Equity-based crowdfunding features unique and specific peculiarities that sets it apart from reward-based crowdfunding (Lukkarinen *et al.*, 2016). Research shows that equity investors are generally more careful, as they would rather wait for an advanced product development stage before investing. They also value credible signals and disclosure from entrepreneurs more highly (Ahlers *et al.*, 2015).

While crowdfunding research is quickly becoming a vast, lively stream (Estrin *et al.*, 2018), its connection to innovation as a whole requires further exploration, with several calls for future research having been made. For instance, Belleflamme *et al.* (2014) stress the importance of future research on crowdfunding platforms as devices for user-based innovation. This sentiment is echoed by Ahlers *et al.* (2015), who highlight the importance of input exchange between users and entrepreneurs on crowdfunding platforms. Several studies have also called for research on the differences between reward-based crowdfunding and equity-based crowdfunding (Troise *et al.*, 2022a), also in terms of user–entrepreneur interactions (Stanko and Henard, 2017; Cholakova and Clarysse, 2015), with some suggesting that big data-powered research could prove to be a means of analysing a wide range of empirical content from multiple crowdfunding platforms at once (Bi *et al.*, 2017).

Because of the different nature of reward-based and equity-based platforms, users approach projects and novel entrepreneurs differently. In equity-based crowdfunding, investors receive an ownership stake in exchange for their investment in the nascent enterprise (Battisti *et al.*, 2022), in contrast to the physical reward that is given to pledgers in reward-based crowdfunding. This leads to divergences in the interactions between users and entrepreneurs, as different expectations and stakes come into play (Lukkarinen *et al.*, 2016). These arguments lead to Hypothesis 1 (H1).

H1. The intrinsic differences between reward-based crowdfunding and equity-based crowdfunding are reflected in the different inputs received from users of each platform type.

2.2 User-generated content in crowdfunding platforms
Crowdfunding platforms can connect investors to entrepreneurs, fostering an exchange of knowledge in the form of UGC (Troise and Tani, 2021; Di Pietro *et al.*, 2018). While it cannot be

considered a core foundation of crowdfunding, the social network aspect of modern crowdfunding platforms is not secondary either, as it attracts users willing to interact with entrepreneurs throughout their developmental journey appealing (Junge *et al.*, 2022; Estrin *et al.*, 2018). In return, those entrepreneurs can gather new inputs from their backers as a means of improving their products or services (Troise and Tani, 2021; Wald *et al.*, 2019; Di Pietro *et al.*, 2018). This factor has several implications for innovation, including changes to business models (Mollick, 2014) and crowdsourced research and development (Callaghan, 2014). Generally speaking, the proliferation of new technologies has allowed for the generation of enormous amounts of customer data available in nearly real time. In fact, Belleflamme *et al.* (2014) refer to crowdfunding platforms as an open call via the internet, fuelling the exponential growth of crowdfunding as an important funding source for entrepreneurial businesses. Similarly to reward-based crowdfunding platforms, equity crowdfunding platforms provide investors the opportunity to engage with entrepreneurs and each other through online discussion boards (Iurchenko *et al.*, 2022), thus allowing equity investors to take part in an information exchange process with nascent entrepreneurs via Internet UGC.

UGC itself has been investigated through the lens of innovation over the past decade, especially in correlation with the new technological advancements powered by Internet 2.0 (Dong and Wu, 2015). Researchers agree that UGC can actively aid in product-development activities, in terms of both user innovation and open innovation (Fidel *et al.*, 2015; Poetz and Schreier, 2012). This practice is not new, as companies have been gathering information from their user bases for decades (Franke *et al.*, 2014) since companies claim that users can provide innovative information on the development of products and services. Nowadays, companies no longer have to limit their scope to a specific group of customers willing to offer feedback on their product and services, as they can now rely on modern technology to enable users to engage in online communities; this leads to many more inputs from them (Dong and Wu, 2015).

Agrawal *et al.* (2014) highlight the intrinsic difficulties of online communication and the need for entrepreneurs to carefully manage information flow from offline to online networks. Difficulties aside, Stanko and Henard (2017) stress the importance of crowdfunding UGC in terms of open search, which includes all tactics intended to uncover new ideas and knowledge from external entities, since companies are not meant to "innovate in isolation" (Dahlander and Gann, 2010). In this regard, crowdfunding platforms are considered prime opportunities for companies to receive high-quality ideas from their backers (Poetz and Schreier, 2012), and for users to actively participate in the development of product or services (Ho-Dac, 2020). While literature on open innovation and UGC has been extensively developed, the value of crowd investors as a source of innovation knowledge has received little attention in the crowdfunding literature (Di Pietro *et al.*, 2018). In fact, while crowdfunding UGC has been investigated mostly in terms of its implications for the future success of crowdfunded ventures (Zhang *et al.*, 2021; Wang *et al.*, 2019), Ho-Dac (2020) stresses the importance of future research on the value of crowdfunding UGC in the product development process. Sentiments on the need for further research on the topic are echoed by other researchers as well (Zhang *et al.*, 2021; Di Pietro *et al.*, 2018).

We mentioned how crowdfunding platforms could attract entrepreneurs willing to test and develop their products or services (Junge *et al.*, 2022; Estrin *et al.*, 2018). Similarly, we have seen how companies find value in UGC online (Fidel *et al.*, 2015; Poetz and Schreier, 2012) to receive high-quality ideas from their user base. What is missing, however, is empirical proof of how valuable crowdfunding UGC can be, since backers somewhat differ from customers in nature (Zhang *et al.*, 2021; Wang *et al.*, 2019). Additionally, research shows differences in terms of user base between reward-based and equity-based platforms. Equity-based models are generally deemed more appropriate for early-stage ventures due to their uncertain nature

(Ferreira and Pereira, 2018) and investors' motivations (Cholakova and Clarysse, 2015). In other words, reward-based platforms are more likely to attract individuals who invest because they like and support a project (Schwienbacher and Larralde, 2010), to the point that they feel psychological ownership over it and want it to succeed (St John *et al.*, 2021). In contrast, equity-based platforms attract people looking for a return on their initial investment (Ferreira and Pereira, 2018). Thus, considering previous research on inputs collected from end customers (Fidel *et al.*, 2015; Poetz and Schreier, 2012), theoretical advancements on crowd backers as psychological owners and quasi-customers (Cappa, 2022; St John *et al.*, 2021), and the overall difference between the users found amongst the two types of crowdfunding platforms, we hypothesise the following:

H2. UGC from equity-based crowdfunding platforms enables the exchange of valuable information between investors and nascent entrepreneurs.

H3. UGC from reward-based crowdfunding platforms enables the exchange of valuable information between investors and nascent entrepreneurs.

2.3 Open and user innovation in crowdfunding

It is generally agreed that users carry significant knowledge regarding product use, which is often driven by their needs and expectations in terms of user experience (Chatterji and Fabrizio, 2014). The idea that innovation can happen outside of companies—in this case, through user input—sparked the creation of the distributed innovation paradigm and later the development of two distinct literature streams, one focussed on user innovation and the other on open innovation (Gambardella *et al.*, 2017). While these streams have similarities, sharing the theoretical underpinnings tied to the distributed innovation paradigm, they developed independently throughout the years (Bogers and West, 2012). Additionally, at the core of open and user innovation, we find two different mindsets. Open innovation sees innovation being undertaken as a collaborative cultural approach as opposed to it being a process. In other words, innovation is open to all aspects of an organisation where contributions from various sources are acceptable (Wald *et al.*, 2019; Di Pietro *et al.*, 2018). On the other hand, user innovation is a more aggressive approach that emphasises a company's competitive advantages in the marketplace (Bradonjic *et al.*, 2019). This approach involves the end users in suggesting how products or services can be improved according to their desires. User innovation is, as a process, more explicit and direct compared to open innovation, as it directly involves end users in an attempt to add value to the product or service in question (Ho-Dac, 2020).

Despite mixed results, user innovation has proven to be a significant asset for companies that want to refine their product and service offerings and shape them around their customers' needs (Bradonjic *et al.*, 2019). Notably, Baldwin and von Hippel (2011) go as far as to say users can actively contribute to product development and can sometimes even contribute to the increased innovativeness of entire industries. However, when it comes to user innovation in crowdfunding, the existing literature remains somewhat scant. Brem *et al.* (2019) highlight that crowdfunding platforms can effectively foster not only user innovation, as users share consumer feedback in the form of comments, but also market acceptance in terms of the overall funding volume achieved by the ventures.

Open innovation, on the other hand, focusses on firms' point of view as they expand their boundaries to promote innovation through various external sources (Chu *et al.*, 2019). In other words, open innovation refers to leveraging external information from multiple sources in an effort to accelerate internal innovation (Stanko and Henard, 2017). The final user is one of the most studied of these sources (Piller *et al.*, 2009), as companies actively look for user input on online platforms to facilitate their product development (Palacios *et al.*, 2016).

Open innovation is well known across larger companies, yet little is known about its implication for startups and crowdfunded ventures (Di Pietro *et al.*, 2018). By engaging in open innovation practices, companies interact with many actors, enabling them to collect large amounts of data from various sources (Bogers and Jensen, 2017). More specifically, crowd-based phenomena arise from open innovation, which postulates the need for the inflow and outflow of information amongst several entities in order to advance knowledge and value creation. Through digital transformation and thanks to the increased digital literacy of society, the exchange of information described above can now easily be expanded to involve significant amounts of individuals. Their involvement can potentially lead to the collection of ideas, data, and, in the case of crowdfunding platforms, funds (Cappa, 2022).

Amid the scant literature on open innovation in crowdfunding, authors agree on platforms' potential in terms of open innovation (Bogers and Jensen, 2017)—innovation that is mostly connected to the role played by end users and their interaction with companies (Bogers *et al.*, 2018). In addition, several calls for future research on open innovation in crowdfunding have been made (Bogers *et al.*, 2018), with early research showing how crowdfunding platforms can be seen as open innovation tools (Troise and Tani, 2021; Wald *et al.*, 2019; Estrin *et al.*, 2018).

Overall, it is understood that users hold potential for innovation. Their feedback is shaped around their expectations (Chatterji and Fabrizio, 2014), and helps companies better understand their market and develop their offer accordingly (Bradonjic *et al.*, 2019). Since backers of technology projects ultimately end up being consumers of the products or services they invest on (Banerjee and Bose, 2022), the following two hypotheses can be formulated.

H4. Crowd inputs from equity-based crowdfunding platforms have potential for open and user innovation.

H5. Crowd inputs from reward-based crowdfunding platforms have potential for open and user innovation.

3. Methodology
3.1 Research design
This study took an exploratory approach to address the research gaps illustrated in the previous section. While exploratory studies are not meant strictly to develop theory, they can use theoretical lenses to guide the analysis of empirical data (Franklin, 2005). Several theoretical frameworks have been implemented in crowdfunding and UGC research. For instance, social presence theory was used in an attempt to investigate the relation between crowdfunding UGC volumes and social network integration (Huang *et al.*, 2019). Moreover, social exchange theory was used to determine the factors that influence backers' motivations in crowdfunding (St John *et al.*, 2021). However, after a careful review of the literature, the authors concluded that the most fitting theoretical lenses were the ones formulated by Di Pietro *et al.* (2018) and Ahsan *et al.* (2018), as they specifically address crowd inputs as a source of information.

3.2 Data sample
Several studies have applied an LDA approach to UGC research, as LDA allows for the analysis of large amounts of text in an automated (Tirunillai and Tellis, 2014), replicable and transparent manner, thus helping researchers go beyond the qualitative approach and look for latent dimensions that may have not emerged from previous exploratory research (Blei, 2012). LDA was deemed fitting for the current research design, as it answers the call for large-scale, big data-powered research echoed by previous studies on crowdfunding UGC (Bi *et al.*, 2017; Cholakova and Clarysse, 2015).

The UGC data were collected from several crowdfunding platforms, including both reward-based and equity-based crowdfunding websites. The reward-based crowdfunding UGC was collected from Kickstarter and Indiegogo, while the equity-based one was collected from Rentberry and Wefunder. Sites were picked based on a careful evaluation of available platforms meant to highlight those that featured the most relevancy and transparency regarding UGC. The data were collected between January 2021 and January 2022, a time frame that was deemed sufficient in terms of data saturation (Debortoli *et al.*, 2016). Drawing on previous research (St John *et al.*, 2021; Debortoli *et al.*, 2016), we collected 130,981 words from 50 companies from each crowdfunding platform, for a total of 200 companies across four platforms. We specifically looked for technology projects and sorted them by "most funded" using the sorting tools provided by each platform. We followed the example set by Mollick (2014) by limiting our study to successful projects in the technology category, which has been echoed in recent scientific literature as well (St John *et al.*, 2021). Aside from the increasing popularity of technology projects, evidenced by the over $1.8bn raised by Kickstarter for new technology projects as of July 2019, the choice was driven by the fact technology projects tend to deliver concrete products as rewards (Mollick, 2014), thus making them the ideal choice for investigation under the lens of open innovation and user innovation (Palacios *et al.*, 2016; Fidel *et al.*, 2015; Poetz and Schreier, 2012). We then selected the 50 most funded projects from each platform and consequently proceeded to extract the data. The decision was driven by our theoretical background and literature review, as researchers have found a connection between the use of crowdfunding inputs from backers and the success rate of the nascent venture (Wald *et al.*, 2019; Estrin *et al.*, 2018; Di Pietro *et al.*, 2018). We did not analyse images or videos published with the ventures' landing pages, as we focussed our attention on the comment section, in which the vast majority of UGC is created by both entrepreneurs and backers.

3.3 Latent Dirichlet allocation

Several topic modelling algorithms have been developed recently, as text mining research has risen in popularity due to the increased availability of textual data and UGC from social media platforms (Liu *et al.*, 2017). LDA uses Bayesian statistics as its foundation (Blei, 2012). LDA is an unsupervised topic modelling approach that requires researchers to first gather enough data divided in distinct sets of words, commonly known as "documents," and then extract several common themes, known as "topics." LDA is based on the assumption that each document has its own topic distribution, and it is meant to extract the topic distribution for each document and the word distribution of each topic through an iterative process until the most fitting set of topics and word distribution is found. With regard to model fitness, several tests can be conducted to assume the correct number of topics to extract from the sample. We conducted multiple tests, detailed results of which can be found in Appendix.

Regarding topic mapping, the number of topics extracted inevitably affects the interpretation of the results. While, as previously mentioned, it is possible to determine the ideal amount of topics to be extracted via fitness score tests, researchers recommend that the number be chosen *ad hoc* and kept as small as possible for more easily interpretable results (Savin *et al.*, 2022; Debortoli *et al.*, 2016). Thus, drawing on previous research, we gathered an expert panel to aid in the interpretation of the results. This panel, which included two of the current study's authors, was selected on the basis of each member's expertise in crowdfunding and knowledge of crowdfunding literature. It identified a total of five topics for inputs from reward-based crowdfunding platforms and four topics for inputs from equity-based crowdfunding platforms. The number was kept low in order to follow the guidelines set by Debortoli *et al.* (2016), which stressed the importance of keeping the number of extracted topics low in an effort to guarantee a satisfactory degree of interpretability.

3.4 Data pre-processing

After the research design was addressed and the expert panel meant to support the analysis was established, several steps were taken to pre-process the data before performing the LDA topic modelling extraction. The first was to lemmatise the sample. Here, the authors manually reviewed the dataset and transformed the inflected words to their dictionary form (Tirunillai and Tellis, 2014). WordNet Lemmatiser from the Natural Language Toolkit (NLTK) in the Python programming language was used in this process, as suggested by previous LDA research (Savin *et al.*, 2022; Debortoli *et al.*, 2016). Following the lemmatisation, the authors made sure to address and replace acronyms in their original notations. While acronyms and abbreviations are more commonly used in other forms of textual data—patents, for instance—they are still present in UGC and need to be replaced with their intended form. Both of these steps are crucial in LDA research, as they allow the research to make the dataset homogeneous and avoid several interpretation issues, such as the risk of considering a word and its acronyms or abbreviations as distinct when, in reality, they have the same meaning and need to be analysed accordingly (St John *et al.*, 2021). Then, all the characters were transformed to lowercase letters, and stopwords (e.g. "and," "or," or "the") were removed from the sample. In addition, we chose three as the cut-off point for the minimum word length so that meaningless words would be excluded from the dataset (Grün and Hornik, 2011). This step was taken after replacing acronyms and lemmatising words so that no word would be mistakenly removed from the sample due to the cut-off.

3.5 LDA topic modelling

Through LDA topic modelling, it is possible to highlight the latent factors being investigated across a selected corpus. These factors are referred to as "topics." Topics are distributions over terms or, alternatively speaking, the observable words featured in the corpus. What differentiates LDA from other topic modelling techniques is that the former assumes that each document has a specific distribution over topics. In other words, each topic has a set probability percentage of being featured in a set document, based on its frequency in the dataset (Hagen, 2018; Park and Oh, 2017). In the present study, LDA was applied to each of the two databases divided between reward-based crowdfunding and equity-based crowdfunding to obtain topics related to the inputs garnered from backers. Guided by the theoretical framework highlighted in the study and the theoretical lenses provided by the expert panel, we used the 10 most relevant words for each topic to determine its content. If these words were not enough to gain a proper understanding of the topic, we extended the analysis to include the top 20 most relevant words instead, as suggested by previous research (Hagen, 2018). The topics, along with their most relevant words, will be discussed in detail throughout the sections that follow. Figure 1 summarises the data-processing steps (Buenano-Fernandez *et al.*, 2020). In the figure, α represents the Dirichlet prior weight of the topic by document; θ displays the document-topic distribution, Z represents the assignment of a word to a given topic, W represents the observed word in document M, and N stands for the number of words in the given document.

3.6 Validation

LDA features its own set of validation measurements that we have calculated and provided in the Appendix. To further validate the results of topic modelling, we conducted a separate, independent semantic analysis of the same set of data. Leximancer software was used to perform the semantic analysis. The tool uses a quantitative approach and a blend of Bayesian measurements that record the event of a word and associates it with the event of a progression of different words (Manthiou *et al.*, 2022). The Bayesian learning algorithm used by Leximancer allows researchers to perform semantic analysis and investigate the

Source(s): Buenano-Fernandez *et al.* (2020)
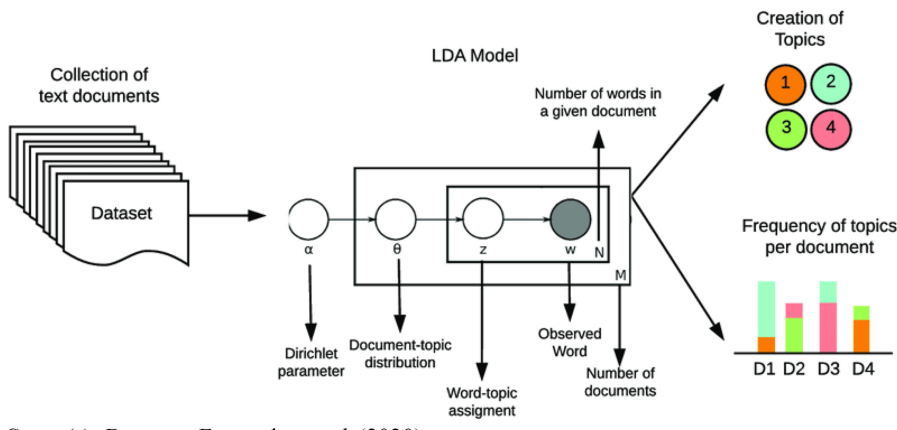
Figure 1.
Latent
Dirichlet allocation
approach

connections between keywords featured in a specific dataset (Moses and Hopper, 2022). The relationships between the identified concepts are then featured in a network diagram generated by Leximancer, in which commonly related concepts are linked and appear geographically closer than the rest. Using this methodology it was possible to gain a comprehensive semantic distribution of both the reward-based and the equity-based crowdfunding corpora.

4. Results
While LDA relies heavily on Bayesian statistics, its nature is ultimately interpretative. In other words, the labelling and the interpretation of the results is up to the researchers themselves and it can be highly subjective. In an effort to minimise interpretative bias, Asmussen and Møller (2019) suggest a combination of reviewing the most frequent words for each topic and triangulating the data with the theoretical framework needed to interpret them. Drawing from previous research (St John *et al.*, 2021), the authors labelled and interpreted the results of the LDA analysis by triangulating their own interpretation and the theoretical lenses applied to the dataset (Ahsan *et al.*, 2018; Di Pietro *et al.*, 2018). They did this because LDA generates topics based on co-occurrences, rather than emphasising individual items. To better guide this step of the process, model fit statistics were obtained and are included in Appendix. In this section, word frequencies and topic distributions are used to describe the inputs from backers in reward-based crowdfunding platforms as well as equity-based crowdfunding platforms. Tables 1 and 2 show the word frequencies, illustrating the most common word stems for each topic. Each word contributed to the overall topic with a specific degree of intensity, as per the LDA algorithm; words with a higher intensity—or, in better terms, words that occurred more often—showed up higher on each list.

4.1 Reward-based crowdfunding inputs
4.1.1 Customer experience. Reward-based crowdfunding users share a lot of traits with generic consumers. They want their product or service to feature the characteristics that have been advertised on the crowdfunding platform, and the delivery time being within the expected range. In other words, they are interested in the utilitarian and hedonic value of the product or service they back, as they expect it to be worth the price they paid for it

(Davis *et al.*, 2017). Ahsan *et al.* (2018) point out that backers often carefully review the product or service, on which they plan to invest in terms of its desirability and uniqueness, much like consumers would do when shopping for online goodies (Courtney *et al.*, 2017; Stanko and Henard, 2017).

This factor emerged in our LDA analysis, as we identified a topic labelled "customer experience," which features all the elements that backers share with customers. "Questions," "update" and "email" are keywords that effectively represent this sentiment, as backers look for proper customer care throughout their crowdfunding experience. This includes constant updates on the status of their product or service, as well as prompt replies to their emails and questions.

4.1.2 Co-development and feedback. Reward-based backers value the product development implications of their funding experience, as they willingly choose to take part in the entirety of the product development process (Agrawal *et al.*, 2014) while frequently sharing their feedback and opinions with the innovating entrepreneurs in the hope that their inputs will actively affect the development of the products and services (Agrawal *et al.*, 2014; Gerber and Hui, 2013). In line with the theoretical framework used to interpret the data (Ahsan *et al.*, 2018), our empirical findings suggest that reward-based backers enjoy the process of developing their own personalised products and participate in co-creating value activities.

More specifically, this LDA topic features keywords such as "need," "ability" and "feature," which suggests that backers actively share inputs with innovating entrepreneurs in the hope that the product or service they are backing will better suit their needs as the development progresses. Further, words like "possible" and "adjustment" offer a better sense of the nature of said inputs, which are often delivered through the realm of ideas and possibilities rather than commands.

Logistics	Co-creation	Support	Noise	Customer
Backers	Need	Project	Refund	Update
Good	Ability	People	When	Questions
Shipping	Feature	Money	Money	Pictures
Battery	Possible	Hope	Kickstarter	Address
Received	Adjustment	Update	System	Delivery
Delivery	Display	Support	Survey	Month
Work	Setup	Best	Devices	Email
Purchase	Manual	Campaign	Cost	Number
Pledge	Accurate	Future	Change	Week
Question	Great	Business	Network	Product

Table 1.
LDA analysis topics for reward-based crowdfunding platforms

Strategy	Development	Market	Ambassadors
Company	Application	Market	Product
Questions	Customers	Competitors	Impressed
Investments	Experience	Sell	Media
Price	Problem	Product	Input
Business	Campaign	Competition	Sales
Investors	Feature	Hope	Public
Work	Things	Years	Presentation
Future	Inspiration	Repay	Demand
Key	Technical	Commercialising	Individual
Technology	Planning	Margin	Reason

Table 2.
LDA analysis topics for equity-based crowdfunding platforms

4.1.3 Noise. Like any other source of UGC, crowdfunding platforms are not exempt from vengeful, non-constructive feedback from unsatisfied users (Manes and Tchetchik, 2018). We labelled this topic "noise," in accordance with previous literature on UGC (Kavanaugh *et al.*, 2012). Noise is a significant component of UGC and has to be carefully considered by entrepreneurs in order to be distinguished from constructive feedback, especially with regard to innovation (Diamantini *et al.*, 2019). The model proposed by Ahsan *et al.* (2018) suggests that crowdfunding campaigns can strategically use noise by presenting the arguments in favour of their product and considering opposing arguments. They draw from research on two-sided messages, in which the communicator takes into account both positive and negative aspects of an issue or product but favours one side.

Within "noise" are several significant keywords that reflect the dissatisfaction of backers. "Refund" and "money" suggest the intent of backers to get their money back in response to their dissatisfaction. "Kickstarter" refers to the platform, on which backers interact. Reward-based backers often mention it as a means of complaining about the terms and services of the platform, or to call for specific action from the platform's owners.

4.1.4 Logistics and delivery. This topic has several points in common with "customer experience"; however, after much deliberation, we opted to separate the two since they provided different perspectives on the same issue. Generally speaking, researchers agree on how reward-based backers value the credibility of the ventures they back. Projects with little to no credibility have less success than more professional projects (Lewis-Kraus, 2015), which typically have an established reputation prior to the crowdfunding campaign. Ahsan *et al.* (2018) translate this aspect in terms of delays in delivery or failure to deliver products after successful funding, as reward-based backers are still able to fund projects after the funding goal is reached, as well as withdraw their support any time before the funding period expires. Logistics is an important element of the crowdfunding experience, as backers put value in products and services that ship on time and work as advertised.

On closer examination of the results, we discovered the importance of logistics in reward-based crowdfunding comments. In this topic, we included anything that was connected to the actual physical delivery of the goods or services the backers paid for. More specifically, "shipping," "delivery," and "received" are keywords that clearly describe this sentiment, as users actively engage in online discourse related to the status of their shipping, and promptly request explanations on how and why their product or service was not delivered properly or on time.

4.1.5 Support for innovation. In reward-based crowdfunding, backers willingly pledge to use innovative products, thus changing the perspective and making previous findings not fully applicable in the crowdfunding context. Notably, in crowdfunding contexts, the level of uncertainty is rather high, which makes for considerable differences between experienced crowdfunders, who possess expertise on specific products or services and are able to evaluate them accordingly, and those with less experience who are more likely to be driven by their intuition, hope and others' opinions (Ahsan *et al.*, 2018).

"Support," "hope" and "future" all refer to the general evaluations backers perform in relation to the products or services they are funding. Some share their previous experiences and offer valuable insights based on them, and others simply believe in the innovative projects of their own perceptions. Regardless of the nature of said inputs, crowd support for innovativeness comprises a significant portion of the inputs that reward-based crowdfunding ventures get, as illustrated by the quote below.

4.2 Equity-based crowdfunding inputs
4.2.1 Market advice. Equity-based crowdfunding inputs are considerably different from reward-based ones, as equity backers feel more engaged with the long-term success of their

backed entrepreneurship. This leads to them sharing several inputs and suggestions on multiple topics in an effort to steer the entrepreneurial development process in the direction they deem most profitable. In this regard, our empirical analysis showed a significant number of inputs connected to the strategic and marketing direction of the backed company. More specifically, equity backers actively confront innovative entrepreneurs in terms of their market competitors, the strategies they intend to implement to carve their own market share, and even more technical aspects, such as price points and returns.

Inputs from equity backers mostly feature terms such as "market," "competition" and "competitors," as they share information about the fine-tuning of the product or service being developed while stressing the importance of the expansion and development of the company through existing and potential new markets. Competitors are also mentioned fairly often, which further illustrates the concern of equity investors towards the future prosperity of the company they are backing, as they try to give them advice on how to stand out from the competition and carve themselves a significant enough market share.

4.2.2 Strategic advice. This study's expert panel agreed on the significant number of inputs that could be labelled strategic advice under the guidance of the theoretical framework (Di Pietro *et al.*, 2018). They identified strategic inputs as those aimed to provide advice in terms of how markets operate, the services available in those areas, and insights on potential strategies. The empirical analysis highlighted several attempts from equity backers to review their backed business strategies and steer the strategic direction of their respective companies in the direction they deemed most successful, in line with previous research on equity financing (Bertoni *et al.*, 2011).

The words "business," "price" and "investors" highlighted the crowd inputs in terms of market positioning and price points. Equity backers offer their insights on current market trends and.

Future expansion of their respective companies, stimulating the discussion in terms of price point and overall business strategy. The word "future" further strengthens the projected perspective of the topic of LDA, with equity backers asking themselves and their companies about their plans for the future and how best to implement them.

4.2.3 Product co-development. Much like reward-based crowdfunding initiatives, the product or service being backed takes centre stage in the UGC on equity-based crowdfunding platforms (Ho-Dac, 2020). Equity backers use their words and inputs to add their own value to the product or service co-creation process (Palacios *et al.*, 2016). In line with user innovation literature, the equity backers featured in our sample stimulated the discussion with innovative entrepreneurs, as they suggested new ideas, highlighted their needs and desires and provided several inputs meant to assist in the developmental phase (Brem *et al.*, 2019).

The expert panel deemed terms such as "application," "problem," and "feature" explicative of the correlation between user innovation and crowdfunding (Chatterji and Fabrizio, 2014), as equity backers use their needs as reasons to provide feedback and ideas to crowdfunded entrepreneurs. This finding elaborates on the correlation between user innovation and crowdfunding (Brem *et al.*, 2019) and acts as common ground between equity- and reward-based crowdfunding platforms.

4.2.4 Equity backers as ambassadors. Equity investors are known to play a mediating role between innovative entrepreneurs and the industry, in which they compete. This role does not simply revolve around electronic word of mouth, but can be broadly defined as the process of establishing new partnerships across the industry through promotion and growth. Several studies have stressed the importance of influential individuals in finding and nurturing key industry connections that novel entrepreneurs can exploit to access assets, partners and know-how (Brown *et al.*, 2019). Moreover, Di Pietro *et al.* (2018) claim that equity investors are ambassadors of the business promoting the product and the business through social media and friends.

The words "public," "media" and "presentation" all revolve around the promotion phase of the crowdfunded entrepreneurial project, as the expert panel pointed out the transition of equity backers from investors to ambassadors of the project. As the empirical data suggested, equity backers are often driven by firm beliefs in the product or service they are currently backing. As such, their funding goes beyond the simple hedonistic nature of the crowdfunding experience, as they feel compelled to promote the company further through their own network.

5. Discussion
While rapidly evolving, the crowdfunding literature continues to reveal significant research gaps, particularly in terms of the implications for innovation and comparisons between more popular crowdfunding platforms, such as rewards-based ones, and less popular ones (Troise *et al.*, 2022b). Our LDA approach aimed to provide empirical evidence for this discussion by highlighting emerging trends in crowd inputs from both perspectives, reviewing them through the theoretical lens of innovation literature and shedding light on the core differences between them (Ahsan *et al.*, 2018; Di Pietro *et al.*, 2018). By analysing the top 200 most funded technology projects from both rewards-based and equity-based crowdfunding platforms (Troise *et al.*, 2022a), we strive to highlight the differences in terms of crowd inputs and their potential for open and user innovation.

The results suggest equity and rewards-based crowds provide different sets of inputs. This finding is in line with previous research suggesting that platform types have significant differences in terms of user base, mostly regarding motivation (Ordanini *et al.*, 2011) and overall attitude towards the project (Stanko and Henard, 2017; Cholakova and Clarysse, 2015). Additionally, this result expands upon the literature on differences between rewards- and equity-based crowdfunding platforms by providing an ulterior perspective of analysis (Troise *et al.*, 2022b). The LDA findings show that user–entrepreneur interactions varied significantly between the two samples, despite both being significant sources of knowledge in their own way (Agrawal *et al.*, 2014; Gerber and Hui, 2013). Most notably, our data revealed rewards-based users to be more attracted to the utilitaristic side of the crowdfunding experience (Ahsan *et al.*, 2018), while equity-based users put more emphasis on their beliefs regarding the project they are backing, to the point where some act as voluntary ambassadors of the crowdfunded company (Brown *et al.*, 2019). The study demonstrates the emerging differences between rewards- and equity-based crowdfunding platforms that previous research proposed be investigated (Cholakova and Clarysse, 2015), thus proving H1.

Furthermore, our study advances current knowledge on UGC in crowdfunding platforms. Overall, our efforts confirm the importance of UGC and, more generally, Internet platforms as hubs for information exchange between investors and entrepreneurs (Prisco *et al.*, 2022). Our findings verify that crowdfunding platforms hold potential for entrepreneurs to acquire new knowledge from crowdfunding users about products and services and to incorporate said knowledge into their planned business models (Troise *et al.*, 2022a; Wald *et al.*, 2019; Estrin *et al.*, 2018). Therefore, our study contributes to the investigation of instant messaging and online platforms as hubs for fast-paced, extensive and intense collaboration between crowdfunding platform users (Burger-Helmchen *et al.*, 2020; Busse and Siebert, 2018). However, several distinctions must be made between rewards- and equity-based crowdfunding platforms.

Regarding rewards-based crowdfunding, our empirical dataset suggests it features a more customer-like experience (Stanko and Henard, 2017), as backers pay for goods or services and, in return, expect them to work properly and be shipped on time (Courtney *et al.*, 2017). When these conditions are not met, rewards-based crowdfunding platforms get inundated with "noise" comments from angry customers (Manes and Tchetchik, 2018). Therefore, we contribute to the literature on rewards-based crowdfunding by addressing the diverse nature

of crowds, responding to calls for further research on the matter (Alhammad *et al.*, 2022). Furthermore, our results agree with those of Chan *et al.* (2020), as they show our rewards-based crowdfunding users tend to be more instinctive and to look for instant gratification rather than prioritising the long-term vision of the entrepreneur they are backing.

This is relevant in terms of open innovation, as it forces nascent enterprises to be mindful of the knowledge inflows obtained by said sources and to well understand the ways backers "talk" about them (Diamantini *et al.*, 2019). By stating the above, we highlight how important it is for entrepreneurs to learn how to engage with crowds through rewards-based crowdfunding platforms to effectively manage negative interactions and make the most of the proactive ones, thus partially addressing Shneor and Muni's (2019) call for research. With the above in mind, we can only partially support H3, as the usefulness of rewards-based crowd inputs come with several caveats due to users' sense of customer-like entitlement.

Further, the findings suggest rewards-based crowdfunding features strong potential for innovation, effectively expanding upon previous research on the matter (Troise and Tani, 2021; Wald *et al.*, 2019; Estrin *et al.*, 2018). More specifically, we found that rewards-based crowd inputs revolve around product or service development, mostly as a means of satisfying specific needs. However, as previous user innovation literature has shown, innovative entrepreneurs must be careful when analysing them, and determining which feedback is constructive, and which should be labelled "noise" created by unsatisfied and vengeful users (Manes and Tchetchik, 2018). In conclusion, despite the more consumer-like experience of rewards-based platforms compared to equity-based crowdfunding, the potential for open and user innovation is sustained by the significant presence of feedback on products and services (Boutillier, 2019), requests for future features to better answer specific market demands and valuable information from experienced backers (Chatterji and Fabrizio, 2014). Overall, we find H5 to be partially supported with the same caveats as H3. Regardless, our empirical findings address several calls for future research by going beyond the analysis of project descriptions or social networks and instead focussing on the dynamic interactions between entrepreneurs and investors on the crowdfunding platform.

Regarding equity-based crowdfunding, the findings of our empirical research provide an extensive overview of crowd inputs from equity backers, as requested by several calls for research. These results are consistent with the theoretical framework used to interpret the data (Di Pietro *et al.*, 2018) and illustrate the significant implications of UGC in equity-based crowdfunding platforms for open (Troise and Tani, 2021; Estrin *et al.*, 2018) and user innovation. We find equity-based crowdfunding platforms to be as valuable as social media in terms of information exchange via UGC; thus, we are in line with Battisti *et al.* (2022), albeit from a different perspective. Additionally—and particularly in the case of equity crowd inputs—our results strengthen those of Junge *et al.* (2022) by highlighting how the value of crowd inputs could potentially go beyond mere financial support. While Shneor and Munim (2019) found the above to be true for rewards-based crowdfunding platforms, our evidence suggests the same can be said about equity-based crowdfunding. Therefore, considering all the information above, we consider H2 to be validated.

Concerning open innovation, the findings highlight the role of investors in knowledge inflows, as they provide input on several aspects of the crowdfunded venture's development, including its business strategy, marketing and product development. Regarding user innovation specifically, we found equity-based crowdfunding platforms to be a significant opportunity for validation in terms of market acceptance and consumer feedback; this validates previous exploratory research (Brem *et al.*, 2019). We mentioned "noise" being present in rewards-based crowd inputs. This phenomenon was far less frequent in the equity-based crowdfunding portion of our dataset, in which backers seemed to be more concerned about the long-term profitability of the company rather than the short-term returns on their investment (Ahlers *et al.*, 2015). Equity-based crowdfunding platforms feature a plethora of

crowd inputs to be leveraged in the open innovation strategy of the nascent enterprise (Di Pietro *et al.*, 2018). Much like in the case of rewards-based crowdfunding platforms, equity backers provide suggestions for new products, services and features inspired by their own needs and visions (Davis *et al.*, 2017; Chatterji and Fabrizio, 2014). However, as opposed to rewards-based backers, in equity crowdfunding emphasis is placed on the strategic direction of the company (Bertoni *et al.*, 2011), including its market positioning (Gerber and Hui, 2013), price points and returns (Ahlers *et al.*, 2015). Therefore, we can validate H4.

6. Practical and theoretical implications

Despite being in its infancy, the crowdfunding literature indicates several promising directions, particularly regarding implications for innovation (Mochkabadi and Volkmann, 2020; Drover *et al.*, 2017). Meanwhile, interactions with backers via crowdfunding platforms have proven to be a realisable source of information for both companies interested in obtaining new knowledge from their user base and researchers seeking validation of existing exploratory theories through empirical data. The present study combines both perspectives as a means of exploring the worlds of equity- and rewards-based crowdfunding through the theoretical lens of innovation.

This study makes several unique contributions to both theory and practice. From a theoretical perspective, our research addresses multiple research gaps in the crowdfunding literature stream (Zhang *et al.*, 2021; Di Pietro *et al.*, 2018) and the innovation literature stream (Vrontis *et al.*, 2020; Madrazo-Lemarroy *et al.*, 2019). Our empirical findings validate existing theoretical frameworks for both open (Chu *et al.*, 2019) and user innovation (Brem *et al.*, 2019), while uncovering unique perspectives on the differences between equity- and rewards-based platforms regarding innovation. Of special interest is the support found for open innovation inputs in equity-based crowdfunding platforms (Diamantini *et al.*, 2019) and the strong presence of noise in rewards-based crowdfunding platforms (Manes and Tchetchik, 2018), which affect such inputs' contribution to innovation (Diamantini *et al.*, 2019). Additionally, our findings advance the theoretical understanding of equity-based crowdfunding platforms by providing evidence of the usefulness of crowd inputs as a source of valuable information for product or service development, effectively bridging a gap that thus far only rewards-based crowdfunding has been investigated in that light (Shneor and Munim, 2019).

From a practical perspective, the research shows practitioners, entrepreneurs and professionals alike that crowd inputs are an excellent data source to mine for value and meaning (Troise and Tani, 2021; Di Pietro *et al.*, 2018). The study strives to provide a clear, transparent and replicable protocol to use to extract and interpret data from crowdfunding platforms (Hagen, 2018; Park and Oh, 2017). This contribution both strengthens previous research on UGC as a source of valuable inputs for entrepreneurs by once more proving its reliability (Zhang *et al.*, 2021; Wang *et al.*, 2019) and illustrates the various crowd inputs that can be extracted from crowdfunding platforms (Di Pietro *et al.*, 2018). Additionally, our study shows the importance of adequate training for entrepreneurs interested in crowdfunding, as successful interactions with backers could prove to be critical for their venture's success (Ahsan *et al.*, 2018). In light of our results, practitioners should consider educating themselves on how crowdfunding platforms work and how to efficiently manage their interactions with users. Furthermore, the comparison examined in this study can provide practical insights for entrepreneurs, possibly facilitating their choice of platform for their nascent enterprise (Cholakova and Clarysse, 2015).

7. Limitations and future research

This study has several limitations. The first set of limitations is tied to the sampling choices. For instance, the dataset included fully funded enterprises operating in the technology sector.

While this choice was deemed necessary in terms of the research design (Wald *et al.*, 2019; Estrin *et al.*, 2018; Di Pietro *et al.*, 2018), it left the door open for future studies that could explore other types of crowdfunding projects and highlight possible differences in the results. Additionally, we focus on the most funded projects, as suggested by previous research, and thus do not consider projects that have received little to no funding from users. Finally, our study focusses on rewards- and equity-based crowdfunding platforms specifically. While we explain in detail the reasons for this (Stanko and Henard, 2017; Cholakova and Clarysse, 2015), additional data from other types of crowdfunding platforms is needed to be able to effectively generalise the findings.

A second set of limitations is intrinsic to the methodology used. In fact, while LDA has proven to be a reliable choice in business and social science research over the past few years (Liu *et al.*, 2017), it features several methodological caveats. Most notably, LDA offers a "snapshot" of the current crowdfunding landscape, the way in which it was implemented in the current study. In other words, a longitudinal perspective on how crowdfunding input topics have evolved over time is missing from the results of this study. Further, the interpretative nature of the results leaves room for human error in labelling topics. While we did our best to implement a strict and rigorous research protocol drawn from previous research, this limitation must be considered. Finally, LDA forced us to compile every input in the same corpus, making it impossible to compare inputs from high- and low-sum contributors. This is worth investigating further in future studies.

In fact, the exploratory nature of our research also leaves room for several questions to be answered by future research. First, it would be interesting to analyse entrepreneurs' viewpoints in an attempt to determine how and why they are willing to manage the crowd inputs received on crowdfunding platforms. In fact, while backers' viewpoints have been extensively investigated in crowdfunding research, the entrepreneurial side is yet to be fully explored. Additionally, our study focusses solely on equity-based and rewards-based crowdfunding platforms. A study of other forms of crowdfunding, such as donation-based crowdfunding, could potentially reveal diverging sets of crowd inputs compared to the ones identified in the present study. Furthermore, several comparative studies could be performed by gathering data from different sets of crowdfunding platforms. Future studies could compare crowd inputs from projects of different kinds (i.e. technology, health, food and beverage) or crowdfunding success (i.e. fully funded, partially funded and barely funded). Additionally, future research could also compare the impact of crowd inputs with other methods of open innovation knowledge gathering to attempt to understand the differences between the two approaches to innovation.

Finally, while we contribute to the line of research identified by Ahsan *et al.* (2018), there is still significant room for future contributions. For instance, the ways in which entrepreneurs interact and manage inputs from crowdfunding users require substantial further investigation. Similarly, as noted by Shneor and Munim (2019), comparisons between inputs from low and high contributors could be worth investigating, as there might be differences in their information-sharing intentions.

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Appendix

Several LDA fit statistics have been checked to determine the ideal number of topics to extract from each dataset. Figures A1 and A2 illustrate the coherence scores for each tentative model. In other words, we tested the coherence scores of models with 1–12 distinct topics. The higher the coherence score, the better the topic distribution is within the sample, as there are fewer words co-occurring in multiple topics.
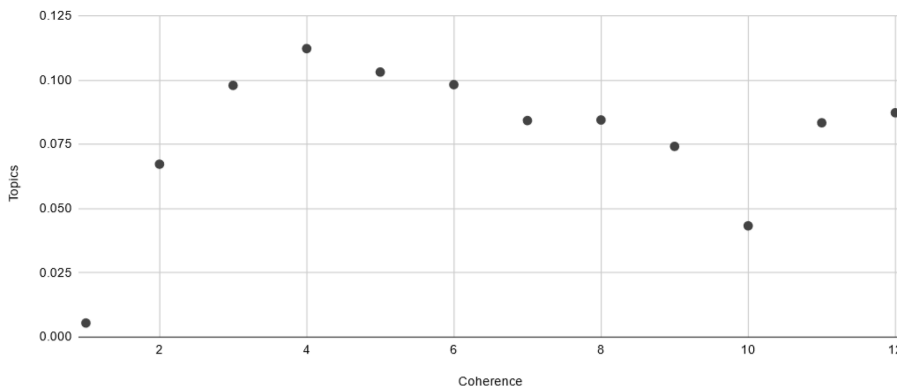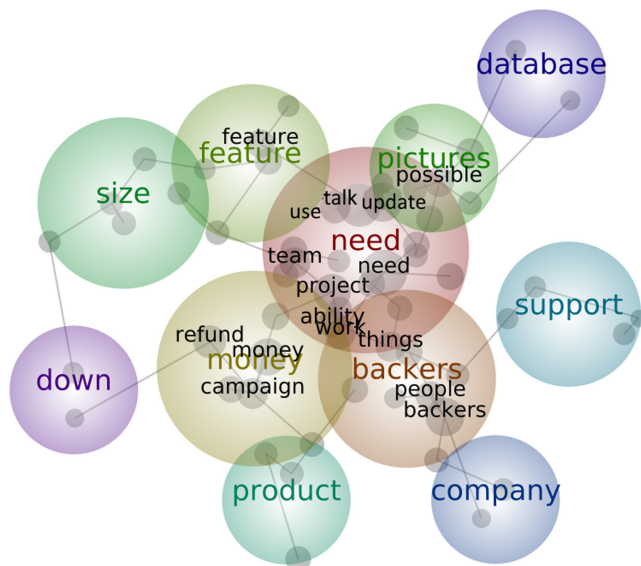

Figure A1.
Coherence score for
equity-based crowd
inputs

Figure A2.
Coherence score for rewards-based crowd inputs
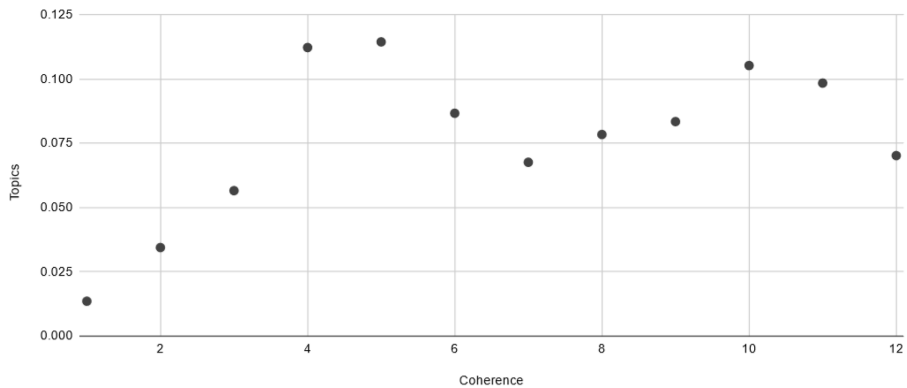
 The results of the semantic analysis carried out via Leximancer are shown below. Figure A3 features the results related to the rewards-based crowdfunding corpus. From the results we can see the topics that have emerged via LDA, albeit with a different distribution due to the nature of the software being used. In the middle, we find the "co-creation" topic, here labelled "need". We notice the word "need" is amongst the most used ones, and it is strictly connected to words like "feature", "possible" and "ability". These results, which agree with those found via LDA, suggest the strong influence of rewards-based crowdfunding users' needs in co-developing ideas along with the entrepreneurs. Their inputs stem from their needs as customers, which then translate into requesting specific features in the products they are backing. Furthermore, we find both the "support" and the "noise" topics. What is interesting about them is the distance between the two. This is due to how poorly correlated they are in terms of co-occurrence. In other words, Leximancer has unveiled the distinct nature of inputs from satisfied backers, who proactively show their support of the project, and those from unsatisfied backers, who instead create so-called "noise" or give vengeful, non-constructive feedback. Finally, Leximancer seemingly grouped the labels "logistics" and "customers" into a single one called "backers". The most related concepts under the "backers" theme are "shipping", "good", "people" and "things", as the label mixes words from both topics. We interpret this as an attempt to group under a single label everything that has to do with the

Figure A3.
Leximancer analysis of the rewards-based crowdfunding corpora

customer experience of backers. While we have acknowledged the similarities in our findings, we ultimately decided to separate the two topics due to how consistent the validation measurements for LDA were.

Figure A4 illustrates the Leximancer analysis of the equity-based crowdfunding corpora. While the clustering is slightly different from that we obtained using the LDA approach, we can still clearly highlight the two main topics. Originally labelled "strategy" and "market", Leximancer labelled them "company" and "market". Our interpretation of this result is the distinction between the internal and external perspective of equity-based crowdfunding. On one hand, backers are compelled to see the company grow with innovative ideas and product development. On the other hand, they are concerned with the external context, as the market in which companies operate features several competitors and overall risks connected to competition. The label "possible" loosely coincides with the topic "development", as they both refer to the realm of future possibilities made available to entrepreneurs via crowdfunding. Here, we find keywords such as "planning", "experience" and "application", suggesting the proactive nature of the inputs being exchanged, as equity investors share their thoughts with entrepreneurs based on their personal experiences with the products or services provided or with close alternatives. Finally, the "ambassador" does not seem to emerge from the Leximancer analysis. The words that refer to it are scattered throughout the graphic, without a clear distribution. However, we believe it was worth treating them as distinct in an effort to highlight a specific pattern in equity-based crowdfunding users' behaviour that has been explored at length in previous research.
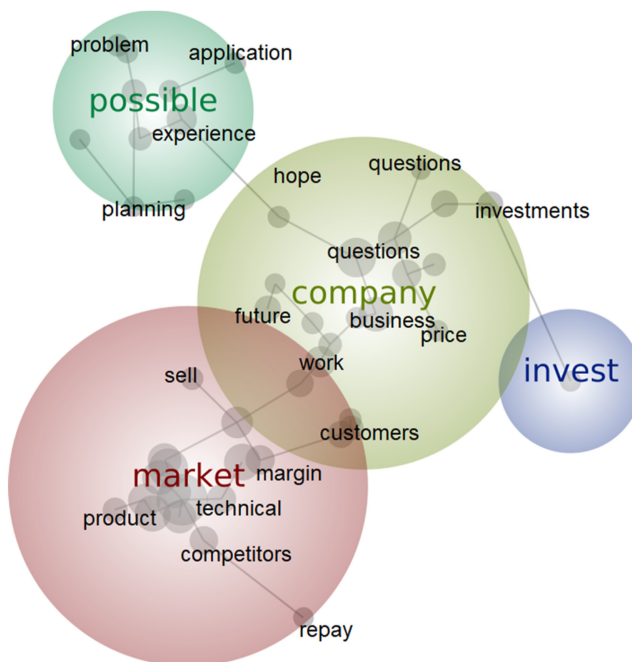
Figure A4.
Leximancer analysis of
the equity-based
crowdfunding corpora

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