Electronic Markets (2023) 33:55
https://doi.org/10.1007/s12525-023-00675-y

RESEARCH PAPER

Challenges of IT freelancers on digital labor platforms: A topic model approach

Lisa Gussek[1] · **Alex Grabbe**[1] · **Manuel Wiesche**[1]

Received: 9 May 2023 / Accepted: 15 September 2023 / Published online: 23 October 2023

Abstract
Freelancers working on digital labor platforms have to deal with many challenges. IT freelancers should be considered separately due to special characteristics such as high skill level or collaborative nature of IT work. Through a Latent Dirichlet Allocation analysis of 2804 forum posts with over 20,000 comments from IT freelancers and additional qualitative analysis, we assign themes to each identified topic, cluster them into aggregated dimensions, and illustrate the interrelationships in a model of IT freelancing. Thus, we examine the challenges of IT freelancers and synthesize them. We extend the challenges of online freelancing already outlined in the literature and identify four IT-specific challenges for IT freelancers. Therefore, we improve our understanding of how IT work is performed on digital labor platforms and which particular aspects should be considered in future research. Furthermore, we highlight implications for practitioners, i.e., IT freelancers on the one hand and platform owners on the other hand.

Keywords IT work · IT freelancing · Digital labor platforms · Challenges · Gig economy

JEL classification F66 · J4

Introduction

Online labor marketplaces are often associated with precarity and unfair working conditions (Fieseler, Bucher, & Hoffmann, 2019). Digital platforms often exploit their position of power and online freelancers are treated unfairly or they are exploited. Furthermore, online workers face enormous insecurity, for example, regarding income or insurance (Ashford, Caza, & Reid, 2018; Petriglieri, Ashford, & Wrzesniewski, 2019) or dependence on feedback and rating systems, as well as limited and purely digital communication channels with existing information asymmetries (Claussen et al., 2018; Gegenhuber, Ellmer, & Schüßler, 2021; Wong, Bunjak, Černe, & Fieseler, 2021). These conditions underline the importance of taking a social perspective on online labor market places and how digital labor platforms affect working conditions, equity, and employee satisfaction. This is reinforced by the growing importance of these markets as measured by the number of projects and tasks on these platforms (Jabagi, Croteau, Audebrand, & Marsan, 2019; Kässi & Lehdonvirta, 2018). In 2020, about 36% of the US labor force (59 million people) worked as freelancers (Upwork, 2020). The platform Upwork in particular has seen an increase in qualified freelancers, e.g., in the fields of computer programming and IT (Upwork, 2021). In addition, TopCoder CEO Mike Morris reported a spike in demand for quality engineers and software developers on their platform during the COVID-19 pandemic (Younger, 2020).

In this paper, we focus on location-independent online work, also called crowdwork (Howcroft & Bergvall-Kåreborn, 2019; Idowu & Elbanna, 2022). More specifically, we explore macro-crowdwork in digital labor markets such as Upwork, Fiverr, or Freelancer.com. These markets enable online transactions and matching between freelancers and clients who purchase the services offered through digital labor (Rai et al.,

Responsible Editor: Sunghan Ryu

✉ Manuel Wiesche
manuel.wiesche@tu-dortmund.de

Lisa Gussek
lisa.gussek@tu-dortmund.de

Alex Grabbe
alex.grabbe@tu-dortmund.de

[1] TU Dortmund Business School, Otto-Hahn-Str. 4, 44227 Dortmund, Germany

2019). They deal with single, knowledge-intensive tasks. They do not rely on collaboration and crowd intelligence in the form of competitions (e.g., Topcoder) or handle micro tasks (e.g., Mechanical Turk), nor do they work offline in the form of gig work (e.g., Uber) (Holthaus & Stock, 2017).

The necessity of taking a closer look at this form of work arises not only from the observation of its enormous growth but also from the fact that it is different from traditional forms of work, as prior research suggests, dealing with advantages and challenges of online freelancing. In contrast to traditional employment, online freelancers are self-employed and work outside of an organizational environment (Deng et al., 2016; Durward, Blohm, & Leimeister, 2020). Due to the global matching on digital labor platforms, there is a high competition and broad heterogeneity of clients and jobs (Bellesia, Mattarelli, Bertolotti, & Sobrero, 2019; Bunjak, Černe, & Popovič, 2021). Additionally, the work is temporary and purely digital (Ashford et al., 2018; Deng et al., 2016). Finally, freelancers are not managed by a traditional supervisor, but by algorithms (Duggan, Sherman, Carbery, & McDonnell, 2020; Möhlmann et al., 2021).

For the discipline of information systems (IS), this subject is particularly relevant, as a considerable share of freelancing jobs falls into the area of information technology (IT) work. Therefore, in this paper, we specifically examine IT freelancing, which can be defined as the field of IT work on digital labor platforms that includes technology and software development (app development, website design, and software testing) (Idowu & Elbanna, 2022). IT work has characteristics that can differentiate an execution of work on digital labor platforms from other areas, which makes it worth taking a closer look. IT work is particularly relevant for many companies due to the general trend toward digitization, and especially in the context of the pandemic, which is countered by a shortage of qualified workers (Alpar & Osterbrink, 2020; Dinger, Thatcher, Treadway, Stepina, & Breland, 2015; Goles et al., 2009). However, when IT work is performed by freelancers on digital labor platforms, special aspects need to be taken into account. IT freelancers differ from other online freelancers in two aspects. First, a high skill level is required for IT work, which is constantly evolving (Ang et al., 2015; Zhang, Ryan, Prybutok, & Kappelman, 2012). Second, a level of collaboration is often required on IT projects to complete them successfully. This is not the case with other freelancing activities such as simple design tasks, translations, or image editing (Kudaravalli et al., 2017).

Related research examined multiple team affiliations in software development freelancing (Watson-Manheim & Ahuja, 2019), addressed the motivations of highly skilled workers to participate in crowdsourcing platforms (Gol et al., 2018), explored the importance of enhancing professionals' non-technical skills for developing information systems in gig work environments (Frenzel-Piasentin et al., 2022), investigated the entrepreneurial behavior of IT freelancers (Sultana et al., 2019), and looked at the career trajectory of IT professionals in IT crowdsourcing (Taylor & Joshi, 2019).

However, IT freelancers in general and their special challenges on digital labor platforms in particular have not yet been sufficiently researched. It remains unclear whether the challenges already known from the literature in other freelancing fields also apply in the same way to IT freelancers, how they may need to be adapted, and which concrete IT-specific challenges arise from the IT characteristics described (Goles et al., 2009; Zhang et al., 2012). Furthermore, it is not yet clear how the individual challenges can be structured as well as synthesized and to which area of freelancing they should be assigned, as most studies only examine one specific challenge and do not take an overall view of the challenges and problems of online freelancing (Caza, Reid, Ashford, & Granger, 2022; Deng et al., 2016; Möhlmann et al., 2021). Moreover, previous methodological approaches are limited in that they look at single aspects based on mostly small datasets and are not able to examine a comprehensive overview and at the same time the necessary depth about the interrelated challenges of online freelancers (e.g., Claussen et al., 2018; Ludwig et al., 2022; Rahman, 2021; Tóth, Nemkova, Hizsák, & Naudé, 2022).

In this study, we address the research gaps described above for several reasons. Working in online marketplaces is steadily increasing in relevance and more and more people are using this non-traditional form of work as a serious career path alternative. Compared to traditional work, however, special circumstances prevail in the environment of digital labor platforms as described, leading to an interplay of unique new challenges to which workers, clients, and platform owners must respond. In particular, the specifics of IT work in this context, which is becoming an increasingly important area of work in the context of digitalization and globalization, need to be examined. Only by understanding these aspects better can platform work represent a sustainable, fair, and promising career alternative in the long term. For these reasons, we answer the following research question: *What are the challenges of IT freelancers on digital labor platforms, how can they be structured, and how are they interrelated?*

To answer our research question, we examine online forum posts of IT freelancers using Latent Dirichlet Allocation (LDA) (Blei, Ng, Jordan, & Lafferty, 2003) to identify relevant discussion topics. The identified topics are then qualitatively analyzed and explained in light of the original posts and synthesized into an aggregate model of IT freelancing on digital labor platforms. We thus make three main theoretical contributions to research. First, through this unique mixed methods approach (LDA and qualitative analysis) of an enormously large cross-platform dataset of online forum interactions, we gain detailed insight into how IT freelancers interact. Second, our analysis reveals several

Table 1 Challenges on digital labor platforms

Challenge	Illustrative studies
Global competition	Claussen et al., 2018; Kanat, Hong, & Raghu, 2018; Strunk, Faltermaier, Ihl, & Fiedler, 2022
High costs and time expenditure	Wood et al., 2019; Zheng et al., 2015
Algorithmic control and monitoring	Duggan et al., 2020; Jarrahi et al., 2021; Möhlmann et al., 2021; Rahman, 2021; Wang, Chen, & Xie, 2022; Wu et al., 2019
Reputation system	Graham, Hjorth, & Lehdonvirta, 2017; Kanat et al., 2018; Tóth et al., 2022; Yoganarasimhan, 2013
High personal responsibility	Caza et al., 2022; Kittur et al., 2013; Kost, Fieseler, & Wong, 2020; Petriglieri et al., 2019
Digital organization and mediation of work	Bunjak et al., 2021; Gegenhuber et al., 2021; Gol et al., 2019; Kost et al., 2020; Ludwig et al., 2022; Wong et al., 2021
Financial instability, precarity	Ashford et al., 2018; Durward et al., 2020; Petriglieri et al., 2019; Scuotto et al., 2022
Transience of work, temporary contract work	Ashford et al., 2018; Brawley & Pury, 2016; Bucher et al., 2019; Caza et al., 2022; Gol et al., 2019
Social isolation, emotional tensions	Ashford et al., 2018; Caza et al., 2022; Gussek, & Wiesche, 2023; Petriglieri et al., 2019; Silberman et al., 2010; Wood et al., 2019

challenges that have been little studied, thus we extend some challenges already identified in the literature and structure them in an IT freelancer model. We also synthesize the findings into a future research agenda that illustrates how the implications of our findings could be further explored in research. Third, we identify four emerging IT-specific issues for IT freelancers on digital labor platforms with various associated challenges. In doing so, we improve our understanding of how IT work is performed in the gig economy on digital labor platforms and what makes IT work special.

The structure of this paper is as follows. The "Literature review" section reviews the relevant definitions and describes related research to present the state of knowledge. After describing the data and the methodology in "Data and method", the "Results" section presents the identified challenges of IT freelancing, supported by quotes from the original posts. Afterwards, the results are discussed in "Discussion," and finally, limitations and issues for future research are described in "Limitations and future research."

Literature review

Challenges of freelancers on digital labor platforms

Digital labor platforms enable transactions between workers who offer their services online and clients who purchase those services through the platform (Rai et al., 2019). In this context, the service can be location-independent and online (crowd work or freelancing) or location-dependent and offline (gig work) (Duggan et al., 2020; Huang, Burtch, Hong, & Pavlou, 2020). Location-based work is also referred to as classic gig work and consists of "real-world" tasks in the offline environment (Stewart & Stanford, 2017). In contrast, freelancing through digital labor platforms, in contrast, is done purely online and location-independent (Ågerfalk & Fitzgerald, 2008; Burke & Crowling, 2015). Especially the knowledge work in skilled fields such as software engineering, digital marketing, or writing and translation, this form of work plays an important role (Blaising, Kotturi, Kulkarni, & Dabbish, 2021). In this regard, online freelancers can be characterized as independent and autonomous contractors. They do not perform traditional jobs with permanent employment and constant commitment to a company, but usually work alone under flexible arrangements. They are only loosely employed for a specific task or for a specific period of time. On the one hand, this leads to a high degree of autonomy. On the other hand, it also leads to a high degree of personal responsibility for further training, insurance, career planning, or the procurement of work equipment (Ashford et al., 2018; Friedman, 2014). In addition, too much freedom and autonomy can lead to a digital overload, which can have a negative impact on performance (Bunjak et al., 2021). Another characteristic is the coordination and completion of work online via digital labor platforms (Agrawal et al., 2015; Popiel, 2017). These platforms provide the digital infrastructure for all mechanisms such as payment, feedback, communication, or rating systems, and mediate interactions through global matching between online freelancers and clients (Rai et al., 2019). Previous research has highlighted challenges for freelancers on digital labor platforms, which are listed in Table 1 with illustrative studies.

The matching of clients and freelancers takes place through digital platforms and there is a wide range and high heterogeneity of clients and jobs on the platforms. Thus, global market transparency is achieved which leads to global competition on digital labor platforms (Claussen et al., 2018). In addition, freelancers are faced with high costs and time expenditure, which are often unpaid. Therefore, freelancers must pay for any equipment they might

Table 2 Methodological approaches to investigate challenges on digital labor platforms

Methodological approaches	Illustrative studies
Interview-based study	Möhlmann et al., 2021; Strunk et al., 2022; Tóth et al., 2022; Wong et al., 2021; Wood et al., 2019
Case study (e.g., interviews, social media data, archival data, platform data, platform observations)	Gegenhuber et al., 2021; Gol et al., 2019; Rahman, 2021; Scuotto et al., 2022; Silberman et al., 2010
Experimental study	Brawley & Pury, 2016; Wong et al., 2021
Survey-based study	Bucher et al., 2019; Bunjak et al., 2021; Durward et al., 2020; Kittur et al., 2013; Strunk et al., 2022; Wang et al., 2022; Wood et al., 2019
Econometrics study (platform data)	Claussen et al., 2018; Kanat et al., 2018; Ludwig et al., 2022; Zheng et al., 2015
Literature review study	Ashford et al., 2018; Duggan et al., 2020; Jarrahi et al., 2021; Kost et al., 2020

need themselves (Wood, Graham, Lehdonvirta, & Hjorth, 2019). In addition, algorithmic systems perform job matching, create freelancer rankings, and enable work monitoring, which leads to algorithmic control (Duggan et al., 2020). These rankings are additionally supplemented by a reputation system on the platform. Freelancers depend on feedback and reviews from clients to get new jobs (Tóth et al., 2022). Furthermore, freelancers are self-employed and lack the context of a fixed organization or permanent employer. They have a high personal responsibility and therefore possess a lot of freedom and a high degree of autonomy (Petriglieri et al., 2019). This also leads to high career path uncertainty (Caza et al., 2022; Taylor & Joshi, 2019). The digital organization and mediation of work through platforms can also lead to problems in interaction and communication between clients and freelancers including challenges regarding feedback (Wong et al., 2021). Another challenge is the financial instability and precarity of freelancers. Unpredictable work is leading to highly fluctuating incomes and concerns about maintaining basic incomes for freelancers (Scuotto, Le Loarne Lemaire, Magni, & Maalaoui, 2022). Moreover, freelancing work consists of short-term contracts with different clients. The freelancers therefore face a high transience of work, because they handle temporary contract work (Ashford et al., 2018). This can, for example, lead to identity and motivation challenges (Ashford et al., 2018; Chandler & Kapelner, 2013). The last challenge identified is the social isolation and the emotional tensions on digital labor platforms. Freelancers have no permanent colleagues as in traditional jobs. There is rarely any social interaction with employers or clients as freelancers organize their work via digital platforms (Silberman, Irani, & Ross, 2010).

After presenting the content issues related to the challenges of online freelancers identified in the literature, the methodological approaches used are presented in the following Table 2. These methodological approaches are mostly either qualitative and based on interview data (e.g., Rahman, 2021; Tóth et al., 2022) or survey data (e.g. Bunjak et al., 2021; Durward et al., 2020) or follow an econometric approach (e.g., Claussen et al., 2018; Ludwig et al., 2022).

IT freelancing on digital labor platforms

More and more IT professionals are working as freelancers on digital labor platforms as IT freelancers. They are working on multiple, simultaneous projects on a variety of digital labor platforms, creating a new, complex, and fragmented work environment (Watson-Manheim & Ahuja, 2019). Well-known platforms such as Upwork or Fiverr primarily offer IT project categories such as app and website development or data analytics (Wagner, Prester, & Paré, 2021). Therefore, in our paper, we investigate the special form of IT freelancing, which must be distinguished from other freelancing areas. To date, these IT freelancers have not been adequately studied to determine whether the challenges described in Table 1 also apply to IT professionals on digital labor platforms, how they need to be adapted, and what specific challenges are unique to IT freelancers.

IT professionals are increasingly indispensable due to digitization and the growing use of technologies in companies (Dinger et al., 2015). This leads to a high demand for IT professionals in various fields, which is facing a growing talent and skill shortage (Goles et al., 2009). Two main IT characteristics make IT work on digital labor platforms particularly different from traditional online freelancing.

First, IT professionals perform a wide range of IT tasks, thus requiring a high level and variety of skills (Zhang et al., 2012). In this context, the phenomenon of skill obsolescence describes the idea that outdated skills are less valuable and the person in question is less capable than individuals with newer skills. This can be particularly challenging for IT workers as technologies, and therefore the skills required, change and evolve rapidly (Fu, 2011; Guzman, Stam, & Stanton, 2008; Niederman, Ferratt, & Trauth, 2016; Riemenschneider & Armstrong, 2021). Therefore, IT professionals are forced to respond to the constant threat of obsolescence by training, learning, and updating skills (Zhang et al., 2012). On digital labor platforms, these aspects additionally pose a particular challenge for IT freelancers, as they need to further differentiate themselves from global competition by meeting high skill requirements in order to

be successful (Gandini, 2016; Jarrahi et al., 2021). Compared to tasks in other freelance fields such as design or translation tasks, IT tasks are more complex, interdependent, and constantly evolving (Gussek & Wiesche, 2022; Stol & Fitzgerald, 2014).

Second, IT work often requires working in teams (Ang & Slaughter, 2001; Kudaravalli et al., 2017) or collaborative efforts in designing architecture and integrating components are necessary (Levina, 2005; Majchrzak et al., 2005). However, freelancers on digital labor platforms usually do not work in teams but alone, e.g., translating texts or performing simple design or image editing tasks (Ashford et al., 2018). For freelancers in the IT sector, however, collaboration and teamwork can increase success and help with career advancement on the platform (Gussek & Wiesche, 2022).

Despite the described uniquness of IT freelancers, there is limited research on online IT freelancers so far. Gol et al. (2018) address the motivations of highly skilled workers to participate in crowdsourcing platforms. Stol and Fitzgerald (2014) show that crowdsourcing in IT works better for specific software development tasks that are less complex and without dependencies. In addition, Watson-Manheim and Ahuja (2019) study software development teams in the gig economy. Furthermore, Alpar and Osterbrink (2020) show the shift from permanent to temporary employment in IT as a change due to the COVID-19 pandemic. Furthermore, Frenzel-Piasentin et al. (2022) examine the importance of improving the non-technical skills of professionals for the development of information systems in the gig economy. Kanat et al. (2018) address survival in global online labor markets for IT services. Finally, Taylor and Joshi (2019) address the career trajectories of IT professionals in IT crowdsourcing, and Sison and Lavilles (2018) examine the practices of freelancers in software development in the Philippines.

In summary, it remains unclear in existing research how the individual challenges can be structured and synthesized and to which area of freelancing work they can be assigned because most research examines only a specific challenge and fails to take an overall view on the challenges and problems of freelancing. In addition, the methodological approaches used so far are limited to the extent that they look at individual aspects based on mostly small data sets and cannot examine a comprehensive overview and simultaneously a necessary depth of the interrelated challenges of online freelancers. Moreover, it is clear that IT freelancers in general and specifically their particular challenges have not been sufficiently researched to date. Whether the freelancing challenges identified in previous literature also apply to IT freelancers on digital labor platforms, how they need to be adapted, and which concrete IT-specific challenges arise from the two IT characteristics described above have not yet been researched.

Data and method

Data

The underlying dataset consists of postings in the forum r/Upwork on Reddit[1]. Reddit is ranked the 14th most popular website in the world (Alexa Internet, 2022), even higher in some countries like the USA (6th), the UK (7th), and Germany (10th), and offers users to create sub-forums (subreddits) that others can join. The Upwork subreddit alone has more than 29,000 users as of April 2022. One advantage of online forum data as a research source over survey or interview data is what is referred to as naturally occurring and unobtrusive data. Participants were not influenced or guided by a predefined discussion framework or the researcher's own categories or expectations (Guo & Yu, 2020; Silverman, 2010).

Since we wanted to analyze only discussed topics from IT freelancers, we had to filter the data to include only posts from the IT field. We therefore filtered the data with appropriate keywords. We filtered the posts in this forum for 100 IT-specific terms, like skills, software, or tasks. These search terms include terms that clearly indicate IT freelancing (e.g., C++, full stack development), but also terms that are less clear and are used in related freelancing activities as well (agile, admin support). This selection was made to get a comprehensive picture of the topics discussed by IT freelancers. A detailed list of the terms can be provided on request by the authors. To verify that our filtering process includes only IT-specific posts, we manually reviewed a sample of posts (Jiang et al., 2021). The final dataset contains 2804 posts with more than 20,000 comments released on r/Upwork over 3 years until January 2022, the time was limited to ensure that the topics discussed are highly contemporary. All used posts and comments together comprise 1.43 million words.

Freelancers predominantly use social media platforms, such as Reddit, to discuss about problems and challenges, because the freelancing platforms themselves offer few opportunities to do so. For Upwork, there is an official community platform (https://community.upwork.com/), but in the perception of many freelancers, it is moderated too much, particularly when criticizing Upwork, and thus does not offer the possibility for free exchange. Moreover, this forum is used by comparatively few freelancers, which illustrates the low number of postings. The sub-forums for IT freelancers and admin support include, without time restriction, about 500 posts. For this reason, while we use this forum for a cross-check, we focus on the larger, more active, and freer Reddit forum.

[1] https://www.reddit.com/r/Upwork/

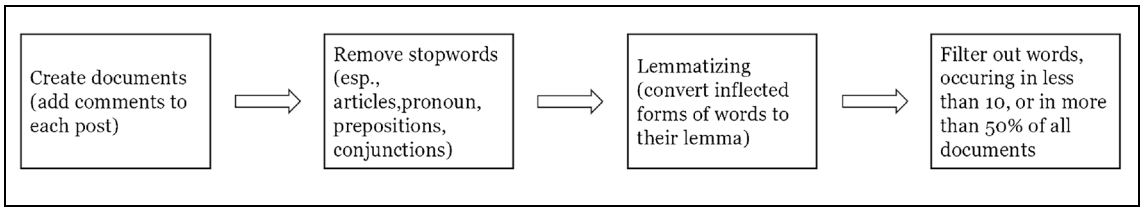

Fig. 1 LDA preprocessing steps

Analysis

We proceeded in two steps in our analysis. First, to analyze the forum posts, we applied the Latent Dirichlet Allocation (LDA), a machine learning algorithm, widely used in the research field of IS (e.g., (Caron et al., 2021; Geva, Oestreicher-Singer, & Saar-Tsechansky, 2019) that aims to identify a predetermined number of topics in a text corpus. We first performed some preprocessing steps and then applied LDA to our collected data, which is based on some hyperparameters and the number of topics. The details of the LDA analysis are provided in the Appendix.

Once the algorithm has identified the topics, their meaning must be interpreted based on grounded theory principles (Croidieu & Kim, 2018; Gioia, Corley, & Hamilton, 2013). Therefore, second, we followed an established process for interpreting the generated topics (e.g., Karanović, Berends, & Engel, 2021) to add depth to our results.

Topic modeling overview and procedures

To address our research question, we first apply the LDA analysis, which aims to identify a predetermined number of topics in a text corpus. The text corpus consists of unordered documents, in our case each individual post including the related comments is a document, and a document in turn consists of a set of unordered words. In order for the documents to be processed by the algorithm as input, some preprocessing steps must be applied, as shown in Fig. 1. The idea behind the algorithm is that each document can be represented as a mixture of topics, and each topic as a mixture of words. Hyperparameters for the algorithm are α and β. The α affects the distribution of topics to a given document, so that a lower α leads to a more unique assignment of documents to fewer topics. The β is an assumption about the size of the topics, which means a smaller β leads to topics consisting of fewer words (Blei et al., 2003).

LDA furthermore requires a predetermined number of topics T. To find the optimal number of topics, we need a measure to evaluate the results of the model. A widely used measure for evaluating topic models, and also originally used by Blei et al. (2003), is perplexity. This measures how well a trained LDA model can predict a sample of held-out documents, regarding their topic distribution. However, measures such as perplexity, while suitable for measuring model performance, lack in determining the meaningfulness of the computed topics from a human perspective (Chang et al., 2009). For this reason, coherence measures were proposed that directly evaluate the topics found, based on their semantic coherence. Within the area of coherence measures, the Cv measure shows the highest correlation with human topic-ranking (Röder et al., 2015; Syed & Spruit, 2017). We ran the algorithm for T=[5,10,…,95,100], and evaluated the emerged topics using, whose scores are shown in Fig. 2.

Because LDA uses random numbers in the training steps and statistical inference, the mean of the score from 10 runs, as well as the standard deviation, is presented. The highest coherence value is scored for a topic number of 15. Further hyperparameters are set to values of α=50/T and b=0.1 (Griffiths & Steyvers, 2004). The final 15 topics are output as collections of words, and they must be manually evaluated according to the representing content.

Topic modeling interpretation

Since the LDA algorithm does not label the topics, the researcher must interpret the topics. Therefore, to elicit the meaning of the topics, we used a qualitative approach to code the topics and followed a process that similar studies have also followed (Jiang et al., 2021; Karanović et al.,

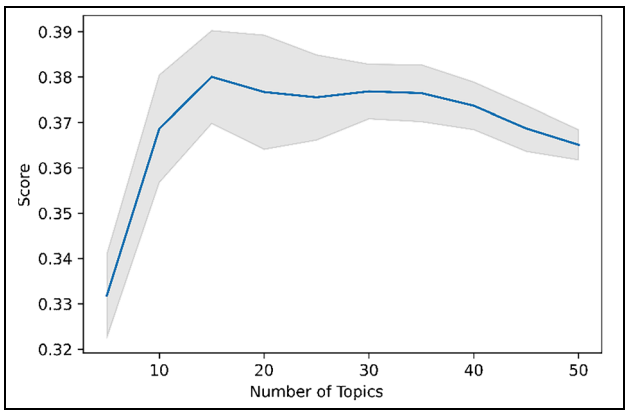

Fig. 2 LDA topic scores

2021). Applying grounded theory to interpret the topics generated by the LDA analysis enables the identification of relevant mechanisms and their interactions among them, as it aggregates the topics into higher-order dimensions, thus enabling an understanding of the essential components of the underlying data (Croidieu & Kim, 2018; Gioia et al., 2013).

The first step was to examine raw-generated topics, which we interpreted based on the best-fitting and associated words that generated each topic. All three authors independently labelled all topics and discussed discrepancies to reach a consensus on topic themes (see Table 3). The themes should be (1) specific enough to provide the clearest possible distinction from other topics and (2) general enough to encompass as many words from the word collection as possible. We look at two different word lists for each topic. First, the list with the 30 most frequent words in the respective topic, and second, the list with the 30 words whose frequency of occurrence in this topic has the highest share of the frequency of occurrence in all posts. The first list, on the one hand, partly consists of rather generic words that occur frequently throughout the corpus and thus inevitably also in individual topics, but which have limited specific reference to a particular topic. On the other hand, the second partly consists of words that occur almost exclusively in the selected topic, but which may occur only very rarely overall, so that they are already very specific even for the selected topic. The theoretically optimal word, for the representation of a topic, would therefore appear in both lists, since it occurs very often in posts to this topic, measured in absolute number, and furthermore even occurs exclusively in this topic. Since these theoretically optimal words occur rarely (highlighted in bold in Table 3), we argue that a selected mixture of the frequent, but partly generic (normal), and the very specific words (italic), is a reasonable indicator of the underlying topic.

When identifying the topics from the word lists, one topic turned out not to be suitable for further analysis (Karanović et al., 2021). The words, and accordingly the posts, in which this topic was given a high weighting, dealt with the freelancing area of writing and translation. The occurrence of this topic is due to the deliberately broad choice of terms for the selection of Reddit posts to be used, as explained above. This topic will not be further considered due to its lack of IT relevance.

In the second step, we grouped the themes into aggregate dimensions by applying a qualitative interpretation. The first and second authors interpreted the most representative forum posts of each generated topic for underlying challenges discussed by the IT freelancers and then grouped them into aggregate dimensions (see Table 3). These are explained and illustrated with quotes in the "Results" section. In addition, 800 posts and their associated comments, representing approximately 30% of the dataset, were qualitatively coded by a third independent person from the research team who was unaware of the LDA topics. In this process, the qualitative coding matched the LDA topic assignment per post in most cases.

Based on the analysis outcomes and the qualitative analysis of the forum posts, we have developed Table 3, which provides a detailed overview of the data structure of topics, assigned words, themes, and aggregated dimensions.

Results

In the following, we present the results of the analysis in detail and describe the individual aggregated dimensions with their assigned themes and their corresponding challenges. For this purpose, we use exemplary quotes, which have been assigned to the respective topic, from our dataset to clarify the descriptions and contexts. Furthermore, we structure the results in an aggregated model of IT freelancing on digital labor platforms (Fig. 3), which shows where and when the challenges occur.

As described in the "Data and method" section, the 14 topics from the quantitative LDA analysis were additionally analyzed in detail by a qualitative analysis of the forum posts. On this basis, we clustered the topics into aggregated dimensions (Table 3). To illustrate the interrelationships of these dimensions and the IT specifics, we develop an aggregated model of IT freelancing on digital labor platforms in Fig. 3.

The 5 aggregated dimensions, regarding the overall online freelancing, are shown in bold. The four IT-specific topics of the 6th aggregated dimension "Topics unique to freelancing in the IT profession" are clarified in the model by the oval frames: Starting in IT and Support, Rights and Property, IT Teams and Collaboration, and IT Skills. Thus, the start in the platform environment is clear, followed by a cycle of gig acquisition and gig execution on the platform. This is influenced by the relationship between the IT freelancer, the digital labor platform, and the clients. The four IT-specific topics can thus be assigned to the individual parts of the model depending on whether they relate to the IT freelancer, the work process, or the platform start. The individual parts of the model are described in more detail in the following.

Platform start

Topic 1: Platform onboarding and platform switch

A big issue for IT freelancers is the onboarding on the platform. The initial profile creation and the following profile design is the first step of a platform activity. This process poses many challenges. Without projects and thus without

Table 3 Overview of the data structure

Topic	Best-fitting and associated words	Theme	Aggregate dimension
1	**new,** try, platform, project, thanks, hire, gig, best, guy, start, help, chance, requirement, hope, **fiverr,** *toptal*, *freelancercom*, *browse*, *inconvenience*, *unverified*, *navigate*, *whine*, *selection*, *overlook*, *disadvantage*, *belong*, *awhile*, *skim*	Platform Onboarding and Platform Switch	Platform start
2	**proposal,** *attachment*, *introduction*, *customize*, post, apply, *applicant*, application, **description,** land, hire, write, cover, letter, bid, response	Job Application	Gig acquisition
3	**invite, invitation, talent, badge, rise, profile, search,** *visibility*, view, history, **feed,** plus, *hide*	Platform Visibility	
4	contract, project, **scope, escrow,** pay, **milestone,** dispute, change, **revision,** complete, submit, **deadline**	Gig Project Management	Gig execution
5	**screen,** *desktop*, *laptop*, *monitor*, *keyboard*, *timer*, *mouse*, phone, **tracker, manual, screenshots,** *billing*, **app,** *diary*, *clock*, *pause*, *timer*, *speed*, *browser*, hour, week, minute, *log*, contract, **protection, record**	Platform Labor Monitoring	
6	**feedback, star, leave, rating, score, negative, review,** *satisfaction*, bad, poor, contract, **private, affect,** *jss*, honest, ask, *hurt*, **remove, close**	Feedback and Rating	
7	**rate, raise,** *pricing*, hour, price, **charge,** hourly, high, budget, day, offer, bid, *discount*, *gradually,* increase*, flat, bargain,* cheap, value	Gig Project Finances	Finances
8	**tax,** *boost*, *expense*, *profit*, *insurance*, *vacation*, *covid*, **pay,** money, business, fee, **income,** cost, spend, *revenue*, *net*, saving, *stable*	Entire Finances of Freelancing	
9	*asshole*, *unpaid*, **scam,** fuck, **test,** *difficult*, *caution*, *clueless*, nda, free, pay, red, flag, ask, outside, report, accept, rule, platform, *zoom*, *agreement*, *interact*, *officially*, *middleman*, *ethical*, *forbid*	Client Management	Platform and client relationship
10	**bank,** check, receive, money, address, **verification,** payment, **paypal, card,** *deposit*, **account,** contact, support, **ban, suspend,** reason, issue, fake, scam, forum	Platform Rules and Sanctions	
11	*certificate*, *python*, *backend*, *frontend*, *aws*, *nodejs*, *django*, professional, *devops*, start, help, advice, learn, *collaborate*, *affiliate*, *guidance*, experience, idea, build, helpful	Starting in IT and Support	Topics unique to freelancing in the IT profession
12	ask, right, **availability,** share, send, let, file, share, provide, *github*, *asset*, *eligible*, *property*, *intellectual*, *commercial*, *ownership*, *specification*, *accurately*, *technically*, *forbidden*, information	Rights and Property	
13	hire, **agency,** software, developer, people, offer, **code,** person, build, team, create, lead, manage, solution, individual, *outsource*, *role*, *api*, *consult*, *viable*, *integration*, *organization*, linkedin, *crm*, *devs*, *coder*, *implementation*	IT Teams and Collaboration	
14	**wordpress,** *excel*, *javascript*, *virtua*l, *php*, *adobe*, *java*, medium, *photoshop*, *animation*, *html*, website, create, development	IT Skills	

Frequent but partly generic words are shown in normal font, very specific words are shown in italics and theoretically optimal words are shown in bold font

customer reviews that can be proven, finding jobs on the platform is extremely difficult. Especially getting the first job is a big challenge for IT freelancers, as they cannot prove any expertise yet and therefore it is difficult for customers to build trust to book the IT freelancer.

In addition, many IT freelancers try out different platforms in the beginning to find the most suitable one. After all, once a certain reputation has been built on one platform, switching to an alternative platform is fraught with challenges. Reviews on one platform cannot be easily ported to

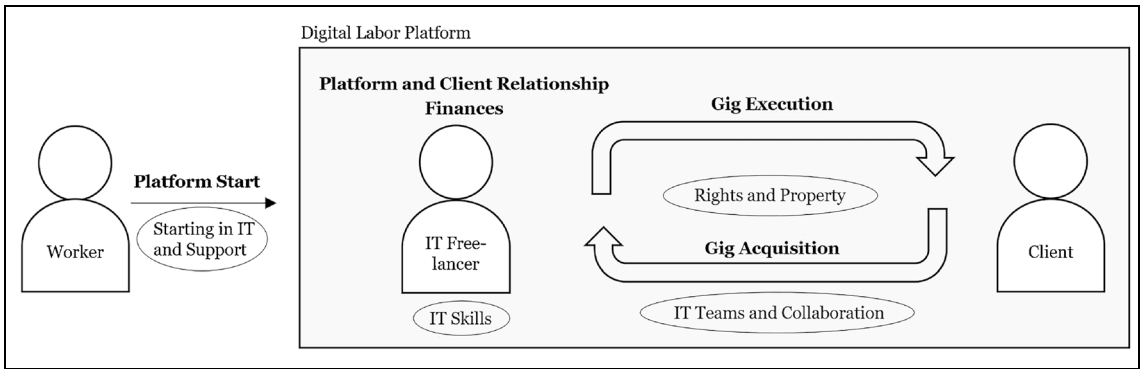

Fig. 3 Aggregated model of IT freelancing on digital labor platforms

another. The IT freelancer would therefore again have no experience to show and would start again with getting jobs. Consequently, the dependency on a platform increases the more successful an IT freelancer is on a platform.

> *Hi everyone, i'm 28 years old web developer who started doing freelance 6 months ago, i've been working on fiverr, i got some good projects and clients who also left a nice review + 5 Starts rating. Now i want to switch to upwork so i can work based on hourly rate and increase my earnings, cause prices at fiverr as we all know is pretty low […]*

Gig acquisition

Topic 2: Job application

Regarding the application process for jobs on the platform, convincing the customer is especially challenging for IT freelancers. The writing of proposals and the cover letter must accordingly be so good that the IT freelancer is selected over the very large competition on the platform. This often requires a very large number of requests or proposals, which are often ignored or rejected, in order to get a job.

> *I have recently started working on Upwork, […] and I have secured four small jobs […]. So far all my clients loved my work […] most of them particularly noted that my proposal was "very good" and "amongst the best they had received". Yet most of my proposals get no reply from the clients, I have submitted 30 proposals, so far six replied one ghosted and five secured, the rest never replied. […]*

Topic 3: Platform visibility

Another challenge is the uncertainty or lack of clarity about the visibility and display order of IT freelancers for customers. The influence that the platform has on matching is particularly unclear here. There are also concerns about various sanctions, such as being less visible. These sanctions can result in an IT freelancer receiving fewer job invitations and so-called interviews with potential clients. In addition, it is often not clear how and when an IT freelancer receives a profile badge to attract customers' attention.

> *If we decline an interview with reason "Too busy on other projects" will our visibility in clients' future searches decrease? Will, in some way, Upwork consider that we are generally busy and put us in a more "hidden" mode?*

Gig execution

Topic 4: Gig project management

Once a project has been acquired, successful execution of that project poses further challenges. There are different project phases to manage: the contracting, payment arrangements, execution and the associated choice of whether to work on an hourly or milestone basis, and the final completion and closure of the project. Along this process of work execution, different challenges arise. For example, customers often request a large number of revisions that were not previously agreed upon. However, due to the power of the client, IT freelancers can do little about it for fear of receiving a bad review. Other clients rarely respond and unnecessarily delay project completion. In addition, IT freelancers often face the problem that clients suddenly stop responding or cancel the project without explanations. Furthermore, agreements regarding time off, for example, for vacation, can be problematic.

> *I'd like some advice on creating milestones when submitting a proposal for jobs with vague descriptions. […] How do you break a job into milestones when the client hasn't given enough information for you to accurately do so? […] I've only done hourly jobs on Upwork so far and welcome any advice on taking fixed price jobs.*

Topic 5: Platform labor monitoring

Since clients cannot directly supervise work on digital work platforms as they can in traditional jobs, labor monitoring on platforms is different. IT freelancers need to record their work hours in different ways, for example, in an app, in order to provide proof of hours worked. Major challenges are the technical aspect on the one hand and the critical aspect of data protection on the other, which is often ignored. For example, automatic screenshots are taken at random times so that the customer can monitor what exactly the IT freelancer is doing at work. Privacy is thus often violated. Example situations where such a screenshot can be misunderstood are when the IT freelancer is listening to music while working and just changes the song or when an aspect of the work is googled, which might make the client think that the IT freelancer does not sufficiently master the required skills of the project.

> *Sometimes I'd like to search for someone as simple as linking a js file maybe because I forgot, I wouldn't be able to do so because I'm unsure if the app will take a screenshot of that and the client might think that I'm incompetent because I searched for something as basic as that.*

Topic 6: Feedback and rating

The already mentioned importance of (star) ratings for success on digital labor platforms leads to a number of further challenges. Negative reviews can consequently set IT freelancers back in their success and weigh more heavily than a positive review. Many IT freelancers also actively ask for feedback from clients and try to understand the formation of the job success score (JSS) formed from the reviews. However, this score is not fully transparent and therefore not controllable.

> *I recently got a bad client. I made the mistake of accepting this work with a low budget but for something that had to be done in days. The client went on and on with new changes. […] The work was completed. And she then changed the website herself. She ruined it […]. She then came to me to express that the work was not done as she wanted and that it had issues (which she created). I' ve even corrected the issues and asked to release the milestone. She didn't respond […]. I submitted the work for payment and got paid by Upwork after 14 days. A month after, she sent me a quick message to express how disappointed she is. It's like I killed her son. The work had no issues. I'm not a beginner and I know what I'm doing. […] And I know that I will get a bad feedback which will probably affect my good profile. […]*

Finances

Topic 7: Gig project finances

Another challenge relates to finances regarding individual gig projects. It is particularly difficult to determine the optimal price for a project. If this is too low, the IT freelancer sells himself short and misses out on income. However, if it is set too high, the contract may not be signed because the competition on the platform is very high and clients will choose a cheaper freelancer. Especially at the beginning, the price can not be set high but only increased over time.

> *So I recently started freelancing on UpWork and I started at a really low hourly rate and then when I went to raise my rate for one of my customer she decided to drop me. […] Is there anything I could have done differently? I'm still underpricing myself for my specific web dev niche.*

Topic 8: Entire finances of freelancing

Generally, challenges exist at the level of the entire online freelancing activity. Significant issues are mainly ambiguities or uncertainties about tax issues, insurances regarding the activity, or the high fees that the platform requires. For the quasi self-employed IT freelancers, these aspects are particularly challenging, because they are responsible and have to take care of everything themselves.

> *I started freelancing at the beginning of the pandemic and I've made a bit of money from Upwork […]. I haven't done my own taxes before so I am a bit lost and overwhelmed. Any advice would be really appreciated […].*

Platform and client relationship

Topic 9: Client management

The management of clients or the relationship with clients is also a challenging issue in IT freelancing. There are numerous complaints about clients for many reasons. For example, clients often do not pay, post scam projects online, or demand services without paying for them.

> *Some asshole hired me for a small edit. It was maybe a page, so I did what I always do and fired up Word and delivered with tracked changes. […] He immediately says it's crap and wants to negotiate. We all know he meant refund, but if you don't like a test edit, you don't get your money back. You pay and move on. That's what most people do, but this guy was on a mission.*

He proceeds to snapshot a post on here from a couple weeks ago where I said I don't even try (in regards to bidding on contracts) and tells Upwork that I'm scamming people. […]

In addition, challenges arise when customers want to break the rules of the platform. However, this potentially leads to sanctions by the platform for the IT freelancer (see Topic 14). For example, customers ask if the projects, the communication, or payment can be handled outside the platform. As described, this increases the risk for IT freelancers on the one hand, because they work without the protection of the platform. On the other hand, there are advantages for both sides. For example, costs can be saved because the platform would retain a share of the profit when the project is completed via the platform, which would then be retained by the other two parties.

[…] the client sends me an external link for the job application, suggesting I apply through there. Then she sends me her personal email for future contact, and just for good measure she also suggests we get on a Skype call together. I guess this leads to a natural conclusion of also wanting to pay me through their own payment funnel and not on Upwork. […] it puts freelancers in a horrible situation. We are forced to then explain the rules of the platform, which some clients take the wrong way, and put the job in jeopardy […].

Topic 10: Platform rules and sanctions

Finally, the already mentioned rules of the platform are an important topic as well as the associated sanctions for rule violations. There are many complaints from IT freelancers about the platform, whose often quick sanctions are perceived as unfair and can hinder the success of IT freelancers. The most common sanction is the blocking of the IT freelancer's account. The reasons for this blocking are manifold. For example, time off due to vacation, project completion or communication outside the platform, customer complaints, payment problems, failed ID verifications, or a change in work or home location can lead to the account being blocked.

I've been working with Upwork since like forever, but recently I've been noticing dodgy things with them […]. They blocked my bank accounts with a Payment method verification in progress, as allegedly the beneficiary name is mismatched. (it's not) […]. Now I have $4k stuck with them. Waiting for the support team to follow-up. […] they blocked my account entirely pending a Verrification (ID and face) + photo on profile. […].

The consequences of such account suspensions are severe for the IT freelancer, as they may have to recreate their profile, lose their reputation and access to their clients, and suffer damage to their image and trust. The following specific example also shows that the widely discussed great advantage of online freelancing, that work can be done from anywhere, does not always apply. The platform and its rules make this freedom aspect of IT freelancing much more difficult.

I have been on Upwork for about 5 months […]. I traveled to Thailand and continued working on Upwork from there. When I came back to the US, my account was suspended and they wanted me to verify my identity and location. I was able to verify my identity easily but had an issue with my location […]. Is it possible to make a new account and start over? Wouldn't be ideal to lose my reputation I had started to build from that account but better then nothing […].

Topics unique to freelancing in the IT profession

Topic 11: Starting in IT and support

When freelancers start on the platform in the IT sector, additional challenges exist. At the beginning, it must be decided whether the IT freelancer wants to specialize and offer a single service, or whether he or she wants to serve several skill areas and thus operate more as a generalist. This choice can be difficult if it is unclear how high the demand is in certain areas. Also, choosing a set of technologies and skills that the IT freelancer will focus on to complete projects professionally in that area is usually difficult.

Should I move to Full stack dev or stay? […] Mostly my job doing an academic writing that publishable into journals or conference […]. I was thinking to move to other niche such as web app development might be using Django or node.js. How is the niche?

In addition, challenges arise regarding individual IT skills or other IT-specific issues such as loneliness or lack of IT expertise of the client for which the IT freelancers seek support and help. For example, sometimes the client does not have enough technical knowledge to actually use the results of an IT project, such as a programmed code, without help.

I've been taking on some Python Development odd jobs here and there for some extra cash. For whatever reason, I have been most successful with clients who aren't necessarily very good with technology, but have an idea they would like to see through to fruition […]. The problem comes when it's time to hand off the script, which I created on Linux inside a Virtual Environment, for them to run on their outdated Windows PC […]. I can usually get the script working on their

computer. But I sort of feel like I'm sending a kid off into the woods with a flashlight and a pat on the back. "Good luck and thanks for the money!" […]

Topic 12: IT Teams and collaboration

Especially in IT the projects are extensive and require a high skill level. To solve this challenge, many IT freelancers use teams or collaborations with other IT freelancers. On the one hand, the critical aspect of time can be overcome by dividing the work in the project and thus successfully completing more projects in the same time to increase reputation. On the other hand, the team members can complement each other in terms of the required skills and it is not necessary that one IT freelancer can handle all the tasks. This help in the team is therefore especially important for IT freelancers. In addition to the private formation of such teams, the platform offers the possibility to create so-called agency profiles. However, there is a lot of confusion among IT freelancers about this, for example, whether it is worthwhile to create an official agency or what exactly the creation of such a shared profile looks like.

Is it a good idea to gather a team of developers to get jobs on upwork? I'm from the IT field […]. The reason to gather a team is that so we can help each other. I just got one job at upwork and I got a bad review. The client wanted me to complete the tasks fast. The tasks were kind of simple but the problem was that I didn't get the project from scratch so I had many problems with it. […] Also the project was not organized and they didnt use best coding pratices what made more difficult to understand the application. […] So what's your opinion on gather a team to find jobs so we can help each other? […]

Topic 13: Rights and property

Another aspect of platform IT work is the rules regarding the rights and property of developed products. Especially in IT projects, the content and data of the clients are often private and confidential, so certain agreements have to be signed by the IT freelancer at the start of the project, so-called non-disclosure agreements (NDA). Due to this fact, it is difficult for IT freelancers to show their successfully completed projects to potential new clients for self-promotion purposes. So-called portfolios or work samples can often not be easily shown to new clients. In this regard, however, there are many uncertainties regarding the rights to the work results and the property.

[…] I'm aware the default Contract Terms we agree on when accepting a contract say that now client owns all rights related to the work, including intellectual property (also taking away the freelancer's right to use that work for self-promotion). Most of my clients tell me over the chat that they are ok with me using the work in my professional portfolio. […] I know it doesn't matter, but in my country (Spain) it's not allowed to sell intellectual property, and I'm culturally uncomfortable with that.

Topic 14: IT skills

Lastly, it can be challenging to keep up to date with the latest skills in demand in the IT area. The market demand has to be constantly monitored and the skills have to be adapted accordingly to stay up to date on the platform. In addition, skills that were once in demand can quickly become outdated, which requires continuous training and updating of IT freelancers to be and remain successful. Finally, customer requirements in the IT sector are particularly high and sometimes very specific, which is why simply mastering many skills is often not enough to get a job.

[…] While waiting on my next data-related Upwork gig and also to figure out what new skills I might be looking into, I've been collecting jobs data from the official Upwork RSS feed since 1st October 2020. […] I've gotten 302427 unique job postings out of the data. Here are the overall top 20 skills as included by the clients in the job postings: …"
"Why are almost all the jobs related to WordPress? Reason: I'm freelancer who want to work on some freelance jobs as a Frontend Developer using HTML, CSS (SASS), JavaScript (Reactjs), Bootstrap, etc., but mostly jobs are related to WordPress with which I have no experience.

Discussion

Our study makes several theoretical contributions to research. First, we investigate challenges on online labor platforms through a unique mixed method approach (LDA and qualitative analysis) of an enormously large cross-platform dataset on online forum interactions. We study unique dynamics and thus gain a detailed and comprehensive insight into the interactions of IT freelancers.

Second, we shed light on the various issues and resulting challenges of IT freelancers and bundle them into aggregate dimensions and a model of IT freelancing (Fig. 3). In doing so, we structure and extend the challenges of online freelancing already identified in the literature and synthesize the findings into a future research agenda (Table 5) that clarifies how the implications of our findings might be further explored in research.

Third, we identify four new IT-specific topics for IT freelancers on digital labor platforms with the described associated challenges. Thereby, we improve our understanding of how IT work is performed in the gig economy on digital labor platforms by IT freelancers and which particular aspects should be considered in future research. Our results contribute to the discussion of what makes IT work special and challenge already studied IT characteristics in a new context, the digital labor platforms. Furthermore, we highlight implications for practitioners, i.e., IT freelancers on the one hand and platform owners on the other.

Implications of the unique mixed method approach and large cross-platform dataset

The first theoretical contribution of our study lies in the unique methodology used and the large cross-platform dataset on online forum interactions investigated. We thus examine unique dynamics through LDA analysis and gain a detailed and comprehensive insight into the online interactions of IT freelancers through the subsequent qualitative analysis. Comparing the most commonly used methodological approaches in previous research on challenges on digital labor platforms highlights our contribution, as only small or single case datasets have been mostly explored through qualitative (e.g., Rahman, 2021; Tóth et al., 2022) or econometric methodologies (e.g., Claussen et al., 2018; Ludwig et al., 2022). However, our data source and the LDA methodology used are particularly relevant to the online freelancing space under consideration, as freelancers often use communication channels that are not allowed by digital labor platforms (such as Upwork). They help and learn from each other as a kind of team or colleague, even though they are actually competitors in the global platform market. This unique insight into the interaction of IT freelancers represents a new contribution to the existing literature.

Moreover, our study indicates that interaction in online forums (as our analyzed data source) is a promising and rich source of information and help for IT freelancers, potentially replacing the actual lack of colleagues and social connections on digital labor platforms. This aspect is particularly relevant in the IT sector because, as described, IT freelancers often rely on collaboration and need to continuously develop their skills, where lack of support from supervisors and training provided by them can be replaced by help from other IT freelancers. Thus, we contribute to the literature around the concept of the holding environment (Petriglieri et al., 2019, 2018) by explaining and adding online forums as support for working on digital labor platforms. Thus, connections with people are possible through the use of online forums. We also show that this way of using online communities can be a promising source for IT freelancers as knowledge workers on platforms, contributing to the literature on online communities and participation in them (Chung, Park, Wang, Fulk, & McLaughlin, 2010; Wang, Chung, Park, McLaughlin, & Fulk, 2012).

Synthesizing and extending challenges for IT freelancers

As a second theoretical contribution, our paper extends the literature on digital labor platforms and freelancing by synthesizing the challenges of online IT freelancing and structuring them in terms of where they occur (Fig. 3). We identified the aggregate dimensions of platform start, gig acquisition, gig execution, finances, and platform and client relationship, each of which encompasses distinct topics. In addition, we described many challenges within the topics through a qualitative analysis of the forum posts. Thus, we can clarify in the following which aspects we contribute to the freelancing challenges already identified in the literature. In Table 4, we connect the previous literature (Table 1) with our empirical findings (Table 3) along the aggregated dimensions and illustrate the areas in which further research is needed in Table 5.

Platform start: When IT freelancers enter the platform labor market, competition is particularly high and onboarding is very challenging as it is difficult to get the first job without prior reviews. Platform lock-in develops because reviews are not potable. A switch to other platforms is therefore difficult and the platform dependency increases with increasing success on the platform.

Gig acquisition: In addition, we contribute to the literature that has identified global competition and high necessary job application costs as freelancing challenges, often resulting in working unsocial and irregular hours (e.g., Wood et al., 2019). We found that for IT freelancers, it also takes a very large number of requests or applications that are often ignored or rejected to get a job. We also show that IT freelancers feel a lot of uncertainty regarding the visibility of their profile on the platform and do not understand the algorithm. They are afraid of the impact on their visibility and ranking. Thereby, we contribute to the literature that has studied algorithmic control and its implications as freelancing challenges (e.g., Möhlmann et al., 2021).

Gig execution: To the challenge of personal responsibility regarding gig work management (e.g., Caza et al., 2022) we add the strong dependence of IT freelancers on clients, who hold a high position of power. In addition, regarding the research on work monitoring on platforms (e.g., Wang et al., 2022), we highlight the critical aspect of data protection and privacy for example by automatic screenshots of

Table 4 Comparison of previous literature and findings on the challenges of IT freelancing

Topic	Theme	Corresponding literature stream	Contribution
1	Platform Onboarding and Platform Switch	Challenge not identified in the literature	High competition in the beginning, increasing platform lock-in
2	Job Application	Global competition, wide range and high heterogeneity of clients and jobs, high costs and time expenditure (Claussen et al., 2018; Zheng et al., 2015)	Large number of requests or proposals required
3	Platform Visibility	Algorithmic control and monitoring with job matching and freelancer rankings (Möhlmann et al., 2021; Rahman, 2021)	Uncertainty about visibility and fear of its degradation
4	Gig Project Management	High personal responsibility, freelancers are self-employed and lack the context of a fixed organization or permanent employer, high career path uncertainty (Ashford et al., 2018; Caza et al., 2022)	Dependence of IT freelancers on clients and power of the client
5	Platform Labor Monitoring	Algorithmic control and monitoring, with job matching and freelancer rankings (Wang et al., 2022; Wu et al., 2019)	Data protection and privacy issues
6	Feedback and Rating	Reputation system, freelancers depend on feedback and reviews from clients to get new jobs (Tóth et al., 2022; Wong et al., 2021)	Strong impact of negative ratings
7	Gig Project Finances	Financial instability, precarity, unpredictable work is leading to highly fluctuating incomes (Graham et al., 2017; Wood et al., 2019)	Pricing for jobs is difficult and changes with increasing success
8	Entire Finances of Freelancing	Financial instability, precarity, unpredictable work is leading to concerns about maintaining basic incomes, high personal responsibility, freelancers lack the context of a fixed organization or permanent employer, high career path uncertainty (Durward et al., 2020; Kost et al., 2020)	Uncertainties about tax issues or the high fees that the platform charges
9	Client Management	Digital organization and mediation of work, problems in interaction and communication between clients and freelancers including challenges regarding feedback (Ludwig et al., 2022; Silberman et al., 2010)	Clients exploit their position of power to the disadvantage of IT freelancers
10	Platform Rules and Sanctions	Challenge not identified in the literature	The power of the platform in the form of (not always fair) sanctions can have severe consequences

Table 5 Future research agenda

Aggregate dimension	Directions for future research
Platform start	• What are the main reasons why online freelancers give up and exit a digital platform career in a highly competitive environment? • How can platform owners foster and support the lack of initial trust between online freelancers and clients when there are no client relationships or platform reputation yet?
Gig acquisition	• How do negative client reviews affect careers and platform visibility and what are suitable strategies to circumvent negative feedback? • How do aspects such as discrimination or social and cultural barriers affect gig acquisition and how can diversity and inclusion be ensured in such online markets?
Gig execution	• How do new innovative technologies (e.g., generative artificial intelligence) affect gig execution or do such technologies destroy jobs on digital labor platforms? • How can a transfer of platform reputation to the offline labor market or to other digital platforms be designed and how can offline experiences be transferred to digital platforms?
Finances	• What impact do geographical location factors, exchange rates, inflation or economic fluctuations have on competitiveness and prices on digital labor platforms? • How does price dumping and unfair competitive practices unfold on these platforms?
Platform and client relationship	• How do illegal practices occur on digital labor platforms (e.g., reuse of work results or circumvention of the platform) and what ethical problems arise from these practices? • What factors are relevant from the client's perspective and how do clients efficiently cut contracts and manipulate and manage online freelancers?
Topics unique to freelancing in the IT profession	• How can the dissonance between the growth of digital labor platforms and the limited collaboration of IT freelancers be addressed and what dimensions of new types of virtual organizations and collaboration can be identified on digital platforms? • How can platform owners help to protect the property rights of online freelancers and what specific role do data protection rules and regulations play in IT work on digital platforms?

IT freelancer screens. In addition, there is some research on feedback and rating on digital labor platforms that has highlighted freelancers' dependence on good reviews (e.g., Yoganarasimhan, 2013). We add to this challenge that IT freelancers need to avoid bad ratings at all costs in order to keep getting jobs. One negative review can have a very large negative impact on IT freelancer success.

Finances: Regarding gig project finances, the literature has examined the strongly varying incomes (e.g., Ashford et al., 2018). Through our analysis, it is also clear that pricing individual tasks is very challenging and that the pricing strategy changes with increasing success of IT freelancers. Moreover, when considering the freelancer's overall finances, it is already understood that there is no base income for freelancers and they are on their own without a supporting organization (e.g., Scuotto et al., 2022). However, there are also uncertainties regarding taxes or the high fees that the platform charges.

Platform and client relationship: Through the digital organization and mediation of work, communication challenges arise, which also affect the feedback for freelancers (e.g., Wong et al., 2021). We contribute to this literature by clarifying that IT freelancers have to deal with the power of the client, who often do not pay or post scam projects. Furthermore, clients often require IT freelancers to break the rules of the platform, which can have negative consequences for freelancers. Finally, it is evident that the previous literature has not yet identified platform rules and sanctions as a freelancing challenge. We illustrate that sanctions such as platform exclusion can have large career consequences for IT freelancers. They are very dependent on their platform profile, as the reputation they have developed is not transferable to other platforms. The power of the platform can therefore have negative consequences.

By synthesizing our findings and comparing them to the previous research literature (Table 4), we clarify below what our results regarding the aggregate dimensions imply in an integrated context. To this end, we propose a future research agenda (Table 5) and illustrate how the implications of our findings should be further explored.

Specifics of IT work on digital labor platforms

The third theoretical contribution of our paper to IS research is the identification and investigation of the specifics of IT work on digital labor platforms. Freelancing in the IT industry has been around for a very long time, but work on digital platforms has not progressed as far. Some of the IT characteristics already identified in the literature, such as the high demand for IT professionals (Prommegger et al., 2020) or the rapid technological change, which requires constant

learning and training (Benamati & Lederer, 2001; Joseph, Tan, & Ang, 2011), also apply to digital labor platforms. However, some aspects need special attention on digital labor platforms. Therefore, in our paper, we contribute new aspects to previous IT literature. In our LDA analysis, we identified four IT-specific challenges arising from the two IT characteristics described in the Literature review section: Starting in IT and Support (topic 11), Rights and Property (topic 12), IT Teams and Collaboration (topic 13), and IT Skills (topic 14). In the following, we will contrast the specifics of IT work with the aspects of work on digital labor platforms and thus specify IT work in a new context: IT freelancing on digital labor platforms. In doing so, we show how the four identified IT topics can be classified and that the IT specifics on digital labor platforms are special and thus contribute to the IS literature dealing with the specifics of IT work.

First, IT work requires a high level of skills, which are related to extreme demands on the profession in the context of constant change in IT (Guzman et al., 2008; Niederman et al., 2016). Furthermore, the facets of knowledge required and the necessary continuous refinement and adaptation of the knowledge base distinguish the IT profession from other professions (Riemenschneider & Armstrong, 2021). We could find these aspects in the IT-specific topics "Starting in IT and Support" and "IT Skills." However, on digital labor platforms, the described aspects are particular. As technological developments in IT result in frequent skill obsolescence, IT freelancers need to respond to this with appropriate updating, learning, and training. On digital labor platforms, however, they are on their own on the one hand, which is why they have to take care of training and updating on their own without organizational support. On the other hand, the digital labor platform enables a broad and simple market overview through the easy visibility and transparency of the job situation and competition in the field of work. This makes it easier to recognize which skills are in particular demand at which point in time and where it would be most worthwhile to continue training and learning. Nevertheless, these two arguments also mean that the starting process in IT on digital labor platforms is especially difficult compared to other freelancing jobs such as translation tasks. In traditional markets, the demand for IT staff is very high, which is why professionals often do not have a problem finding employment. This is less easy on digital labor platforms due to the global competitive situation. In addition, specialization in a certain skill area is often not possible at the beginning of a platform career, since building a reputation requires accepting simpler jobs that may not be from the IT field. However, this generalization to several skills is not efficient in the long run, especially in IT, because, as described above, technology develops quickly in each skill area and the IT freelancer has to stay up to date in order to continue to get jobs on the digital labor platform.

Secondly, IT work and projects in IT often require a lot of collaboration, for example, to integrate different components (Levina, 2005; Majchrzak et al., 2005), as well as teamwork (Ang & Slaughter, 2001; Kudaravalli et al., 2017). We were able to find these aspects in the IT-specific topics "Starting in IT and Support" and "IT Teams and Collaboration." On digital labor platforms, in turn, these IT specifics are also particular as collaboration among online freelancers is not common and they have limited opportunities for interaction. The exchange between IT freelancers is therefore restricted by the platform and few integrated collaboration tools are available. Especially the digital nature of the workspace and the work itself leads to problems regarding the formation of IT teams on the platform. This makes coordination and collaborative work more difficult. Yet, as described, this is often necessary in IT and despite the challenge of limited collaboration, digital labor platforms continue to grow, especially in IT. Consequently, help from other IT freelancers with specific problems is particularly important in IT, but is also made more difficult on the platform by limited opportunities for communication between the IT freelancers.

Third, IT professionals often work with large amounts of client data, which is confidential. Furthermore, work results such as software are frequently licensed. We could find these two aspects of IT work in the IT-specific topic of "Rights and Property." Although these characteristics of IT work are usually not very problematic in traditional labor markets, they can lead to a number of challenges on digital labor platforms. For IT freelancers, as described, it is essential for success to demonstrate a reputation and show past work results to potential new clients in order to build trust and get jobs. A portfolio of work samples can facilitate this convincing of new clients. However, this may be impossible for IT freelancers if the completed IT work results are confidential or licensed. Also, the nature of IT work often makes it difficult to create and present work samples to clients, as software can be difficult to tangible and show.

Practical contributions

This research also has practical implications. Along the six aggregated dimensions, we provide a basis for online freelancers, clients, and platform owners to be aware of, evaluate, and respond accordingly to the challenges of platform work.

First, we clarify the difficult platform start. However, freelancers should not quit, because the competition will be less as they become more successful. Nevertheless, they should focus on one platform early on to build a reputation. Clients, in contrast, should also give a chance to freelancers who do not yet have reviews on the platform, because reputation is not the only indicator of quality. Second, our results show that in terms of gig acquisition, it often takes many requests from freelancers and good proposals to get jobs. The clients

should give positive feedback if possible to support the further development of the freelancers. Platform owners could additionally make the platform algorithms more transparent in the future to remove uncertainties of the freelancer rankings. Third, we underline the need for platform owners to pay attention to data protection and privacy within gig execution when monitoring freelancers' work. Clients should be aware that negative reviews can harm freelancers' careers. Fourth, in terms of finances, we show that freelancers can sensitively adjust prices over time and should take care of financial security on their own. Fifth, the platform and client relationship is characterized by power imbalances and platform owners should not favor clients at the expense of freelancers. Both parties should not exploit their power position and the platform rules should be fair and comprehensible. Finally, our findings on IT specifics on digital labor platforms illustrate that IT freelancers can particularly benefit from the help of other IT freelancers, both at the beginning of their career and through team building during career development. On the one hand, this allows workers to receive content-related support in completing their tasks. On the other hand, it also helps them build an emotional network to be more successful. In addition, IT freelancers should always keep their knowledge up to date and deal with IT-specific challenges such as data protection. It also highlights a necessary response from platform owners. They should react to the IT specifics with suitable measures to retain and support IT freelancers on the platform in particular.

Overall, it is clear that new challenges arise for workers on digital platforms compared to traditional employment. In the current design of platform work, the attractiveness of the work situation of IT freelancers on digital labor platforms is reduced by the enormous challenges. Especially if platform owners are aware of the identified challenges and IT specifics, they can make their platforms more successful and make platform work in the form of freelancing overall fairer.

Limitations and future research

We acknowledge several limitations of this study. As described in the "Data and method" section, we chose words as IT search terms that are typically, but not necessarily exclusively, used in the IT context, which can lead to the fact that other posts (not related to IT work) were also included in the LDA analysis. Some of these posts fall into the excluded topic of writing and translation, others belong to areas adjacent to IT, such as video editing, and occur as noise over all topics. We argue that this does not distort our findings, since our explanations do not rely on the word lists only, but considers the underlying full posts, where we deliberately did not recognize these posts for this reason.

Moreover, in our paper, we only consider the Reddit area in relation to the Upwork platform. Although freelancers from other platforms are also active on this forum, future research could specifically examine other platforms. Platforms such as Fiverr or Freelancer.com, for example, function similarly to the Upwork platform in terms of mechanisms and job allocation, so we assume generalizability of our results to these platforms, which should be verified in future research. In addition, many freelancers are not only active on one platform, which is why their challenges probably exist across platforms. Also, our dataset includes posts from a limited time period, 2019 to 2022, so we were only able to identify topics that were discussed during that time period. However, this temporal limitation ensures a high degree of timeliness of the analyzed content. In addition, there could also be other IT-specific topics that are not discussed in the Reddit forum. The advantage of the Reddit website is that it is not monitored by e.g., labor platform owners and IT freelancers can express their opinions more freely. We still used the subforum for IT workers in the official Upwork forum, mentioned in the methodology, for a cross-check of our results, and were able to validate the main points, but less explicitly. This is justifiable by a discussion culture influenced by stronger monitoring and moderation, and by the smaller size of the dataset, due to fewer users, and less activity. However, we cannot exclude that there are further topics and challenges, which aren't discussed in the considered sources. Particularly, we only examine the information discussed by freelancers who engage in communication outside of the platform. Future research could additionally analyze other sources where IT freelancers exchange opinions (such as other platform own forums or social media groups) or use surveys and interviews to investigate whether there are further challenges that are not discussed in online forums.

Finally, it must be mentioned that we had to interpret the topics generated by the LDA analysis, since the algorithm used does not label the topics. Therefore, we used a qualitative approach to code the topics. Using grounded theory to interpret the topics generated by the LDA analysis allows for the identification of relevant mechanisms and their interactions with each other, as it aggregates the topics into higher-order dimensions, allowing for an understanding of the essential components of the underlying data. However, this may result in self-biased conclusions. Furthermore, our research primarily aims to explain an initial approach to the topic framework of IT freelancers on digital labor platforms. Therefore, future research should leverage the topics we have identified and presented to further test them empirically, either quantitatively or qualitatively.

Appendix

Latent Dirichlet Allocation

The most commonly used topic model is the Latent Dirichlet Allocation (LDA) model, a hierarchical Bayesian

model that describes a generative process of document generation (Blei et al., 2003). The goal of this unsupervised modeling technique is to infer topics as latent variables from the observed distribution of words in each document. In particular, a topic is defined as a multinomial distribution over a vocabulary of words, a document is a collection of words from one or more topics, and a corpus is the set of all documents. In the following, we explain how we use the LDA analysis to derive topics from the document corpus. The LDA analysis procedure is shown in Fig. 4.

Before running the LDA on our collected data, we needed to do some preprocessing steps. First, in accordance with prior work, we grouped posts and comments into documents and converted the documents into word lists. Second, we transformed the data with common practices from the natural language processing area in order to prepare them for the topic modeling as previous organizational studies in the context of topic modeling have done (e.g., Hannigan et al., 2019; Kaplan & Vakili, 2015). With respect to Stop-Word Elimination and Lemmatization, we employed WordNetLemmatizer in the NTLK package, a leading platform for building Python programs to work with human-language data. Furthermore, we removed low-frequency words, which only appear in less than ten documents, and high-frequency words, which appear in more than 50% of all documents.

In the following LDA analysis step, we employed Gensim, one of the most commonly used open-source Python topic-modeling packages, used and cited in over 500 commercial and academic applications. Thus, we worked with the Python library Gensim to build a topic model and trained an LDA model with variational Bayes (VB) sampling (Hoffman et al., 2010).

The analysis is based on the hyperparameters alpha, beta, and the number of topics. Here, alpha controls the topic distribution per document and beta controls the word distribution per topic. The alpha and beta values used for this study were determined based on the recommendations of the developers of the model (Griffiths & Steyvers, 2004). The alpha value is equal to 50 divided by the number of topics and the beta value is equal to 0.01.

As mentioned, LDA needs to be given, a priori, a parameter that tells it the number of topics in the corpus. Selecting a number that is too small could cause unnecessary generalizations, whereas choosing an overly large number could cause redundancy. Therefore, regarding the optimal number of topics, we used the coherence score as a measure to evaluate the results of the model. A widely used measure for evaluating topic models, originally also used by Blei et al. (2003), is perplexity. It measures how well a trained LDA model can predict a sample of documents in terms of their topic distribution. Measures such as perplexity, while useful for measuring model performance, are not able to determine the meaningfulness of the computed topics from a human perspective (Chang et al., 2009). For this reason, coherence measures have been proposed that directly evaluate the retrieved topics based on their semantic coherence. In the domain of coherence measures, the Cv measure shows the highest correlation with human topic ranking (Röder et al., 2015; Syed & Spruit, 2017). It is an indicator of how interpretable a topic is to

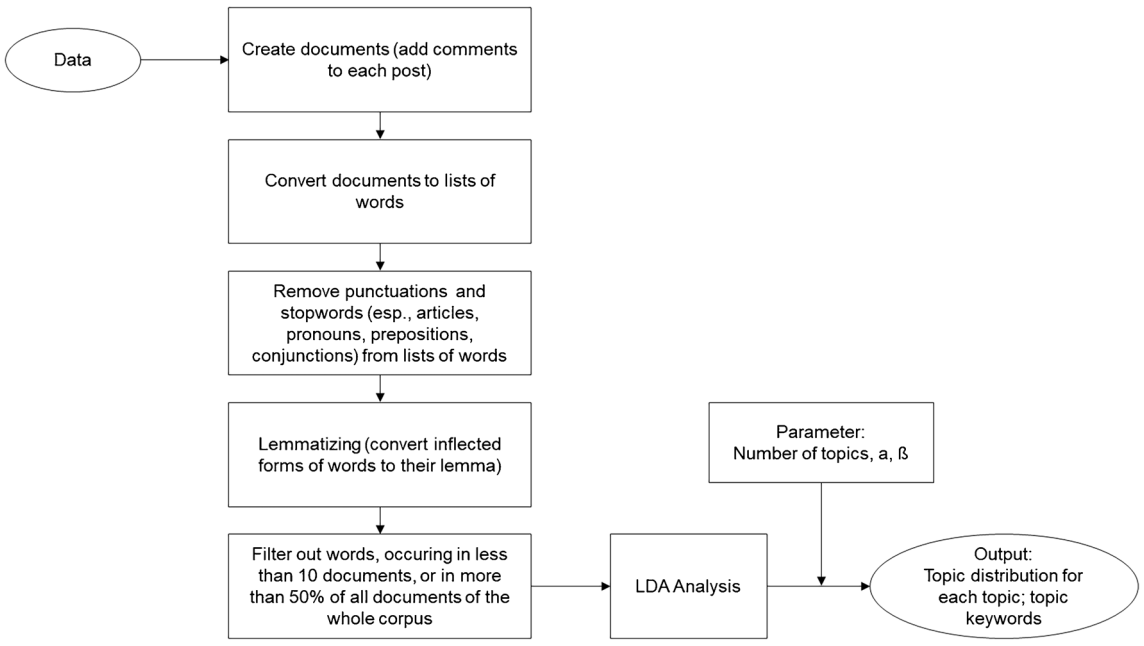

Fig. 4 LDA analysis procedure

Table 6 Coherence values for different numbers of topics

Number of topics	Coherence value
5	0.331797
10	0.368639
15	**0.380043**
20	0.376696
25	0.375529
30	0.376842
35	0.376465
40	0.373677
45	0.368708
50	0.365096

The critical value of 15 topics with the coherence value of 0.380 is highlighted in bold

humans. In this study, interpretability is the most important factor for the output of topic modeling to derive challenges of online freelancers during the subsequent grounded theory coding process. To determine the optimal number of topics, we ran the algorithm for different topic numbers and evaluated the emerged topics, whose scores are shown in Table 6. Up to the number of 15 topics, the coherence score increases to the value of 0.380. However, if the number of topics is further increased, the score slowly decreases, which means that a more adequate division of topics is not achieved. We have therefore set the topic number at 15.

Funding Open Access funding enabled and organized by Projekt DEAL.

References

Ågerfalk, P. J., & Fitzgerald, B. (2008). Outsourcing to an unknown workforce: Exploring opensourcing as a global sourcing strategy. *MIS Quarterly, 32*(2), 385. https://doi.org/10.2307/25148845

Agrawal, A., Horton, J., Lacetera, N., & Lyons, E. (2015). Digitization and the contract labor market. *Economic Analysis of the Digital Economy*. (219). Retrieved from https://www.degruyter.com/document/doi/10.7208/9780226206981/pdf#page=227

Alexa Internet (2022). *The top 500 sites on the web: Global*. Retrieved from https://www.alexa.com/topsites

Alpar, P., & Osterbrink, L. (2020). Consequences of the COVID-19 pandemic for IT work. *Information Systems Management, 37*(4), 339–342. https://doi.org/10.1080/10580530.2020.1820638

Ang, S., Joseph, D., and Slaughter, S. A. (2015). IT Professionalsand the IT Profession. In Cooper, C. L. (ed.), *Wiley Encyclopedia of Management* (pp. 1–6). Wiley. http://soonang.com/wp-content/uploads/2012/08/2012-Ang-Joseph-Slaughter-WEOM.pdf

Ang, S., & Slaughter, S. A. (2001). Work outcomes and job design for contract versus permanent information systems professionals on software development teams. *MIS Quarterly, 25*(3), 321. https://doi.org/10.2307/3250920

Ashford, S. J., Caza, B. B., & Reid, E. M. (2018). From surviving to thriving in the gig economy: A research agenda for individuals in the new world of work. *Research in Organizational Behavior, 38*, 23–41. https://doi.org/10.1016/j.riob.2018.11.001

Bellesia, F., Mattarelli, E., Bertolotti, F., & Sobrero, M. (2019). Platforms as entrepreneurial incubators? How online labor markets shape work identity. *Journal of Managerial Psychology, 34*(4), 246–268. https://doi.org/10.1108/JMP-06-2018-0269

Benamati, J., & Lederer, A. (2001). Rapid information technology change, coping mechanisms, and the emerging technologies group. *Journal of Management Information Systems, 17*(4), 183–202. https://doi.org/10.1080/07421222.2001.11045663

Blaising, A., Kotturi, Y., Kulkarni, C., & Dabbish, L. (2021). Making it work, or not. *Proceedings of the ACM on Human-Computer Interaction, 4*(CSCW3), 1–29. https://doi.org/10.1145/3432925

Blei, D. M., Ng, A. Y., Jordan, M. I., & Lafferty, J. (2003). Latent Dirichlet Allocation. *The Journal of Machine Learning Research., 3*, 993–1022.

Brawley, A. M., & Pury, C. L. S. (2016). Work experiences on MTurk: Job satisfaction, turnover, and information sharing. *Computers in Human Behavior, 54*, 531–546. https://doi.org/10.1016/j.chb.2015.08.031

Bucher, E., Fieseler, C., & Lutz, C. (2019). Mattering in digital labor. *Journal of Managerial Psychology, 34*(4), 307–324.

Bunjak, A., Černe, M., & Popovič, A. (2021). Absorbed in technology but digitally overloaded: Interplay effects on gig workers' burnout and creativity. *Information & Management, 58*(8), 103533. https://doi.org/10.1016/j.im.2021.103533

Burke, A., & Crowling, M. (2015). The use and value of freelancers: The perspective of managers. *International Review of Entrepreneurship*. Retrieved from http://crse.co.uk/sites/default/files/the%20handbook%20of%20research%20on%20freelancing%20and%20self-employment_0.pdf#page=16

Caron, M., Gulenko, M., & and Müller, O. (2021). To the moon! Analyzing the community of "degenerates" engaged in the surge of the GME stock. *ICIS 2021 Proceedings*. Retrieved from https://aisel.aisnet.org/icis2021/social_media/social_media/13/

Caza, B. B., Reid, E. M., Ashford, S. J., & Granger, S. (2022). Working on my own: Measuring the challenges of gig work. *Human Relations, 75*(11), 2122–2159. https://doi.org/10.1177/00187267211030098

Chandler, D., & Kapelner, A. (2013). Breaking monotony with meaning: Motivation in crowdsourcing markets. *Journal of Economic Behavior & Organization, 90*, 123–133. https://doi.org/10.1016/j.jebo.2013.03.003

Chang, J., Gerrish, S., Wang, C., Boyd-Graber, J., & Blei, D. M. (2009). Reading tea leaves: How humans interpret topic models. *Advances in Neural Information Processing Systems, 32*, 288–296.

Chung, J. E., Park, N., Wang, H., Fulk, J., & McLaughlin, M. (2010). Age differences in perceptions of online community participation among non-users: An extension of the Technology Acceptance Model. *Computers in Human Behavior, 26*(6), 1674–1684. https://doi.org/10.1016/j.chb.2010.06.016

Claussen, J., Khashabi, P., Kretschmer, T., & Seifried, M. (2018). Knowledge work in the sharing economy: What drives project

success in online labor markets? *Economics of Networks Journal*. https://doi.org/10.2139/ssrn.3102865

Croidieu, G., & Kim, P. H. (2018). Labor of love: Amateurs and lay-expertise legitimation in the early U.S. radio field. *Administrative Science Quarterly, 63*(1), 1–42. https://doi.org/10.1177/0001839216686531

Deng, X., Joshi, K. D., & Galliers, R. D. (2016). The duality of empowerment and marginalization in microtask crowdsourcing: Giving voice to the less powerful through value sensitive design. *MIS Quarterly, 40*(2), 279–302. https://doi.org/10.25300/MISQ/2016/40.2.01

Dinger, M., Thatcher, J., Treadway, D., Stepina, L., & Breland, J. (2015). Does professionalism matter in the IT workforce An empirical examination of IT professionals. *Journal of the Association for Information Systems, 16*(4), 281–313. https://doi.org/10.17705/1jais.00392

Duggan, J., Sherman, U., Carbery, R., & McDonnell, A. (2020). Algorithmic management and app-work in the gig economy: A research agenda for employment relations and HRM. *Human Resource Management Journal, 30*(1), 114–132. https://doi.org/10.1111/1748-8583.12258

Durward, D., Blohm, I., & Leimeister, J. M. (2020). The nature of crowd work and its effects on individuals' work perception. *Journal of Management Information Systems, 37*(1), 66–95. https://doi.org/10.1080/07421222.2019.1705506

Fieseler, C., Bucher, E., & Hoffmann, C. P. (2019). Unfairness by design? The perceived fairness of digital labor on crowdworking platforms. *Journal of Business Ethics, 156*(4), 987–1005. https://doi.org/10.1007/s10551-017-3607-2

Frenzel-Piasentin, A., Glaser, K., Toutaoui, J., & Veit, D. J. (2022). *"No matter i'll be selected; in the next challenge i will be better!" – Understanding non-technical skill development in the gig economy*. Retrieved from https://scholarspace.manoa.hawaii.edu/handle/10125/79882 https://doi.org/10.24251/HICSS.2022.545

Friedman, G. (2014). Workers without employers: Shadow corporations and the rise of the gig economy. *Review of Keynesian Economics, 2*(2), 171–188. https://doi.org/10.4337/roke.2014.02.03

Fu, J.-R. (2011). Understanding career commitment of IT professionals: Perspectives of push–pull–mooring framework and investment model. *International Journal of Information Management, 31*(3), 279–293. https://doi.org/10.1016/j.ijinfomgt.2010.08.008

Gandini, A. (2016). Digital work: Self-branding and social capital in the freelance knowledge economy. *Marketing Theory, 16*(1), 123–141. https://doi.org/10.1177/1470593115607942

Gegenhuber, T., Ellmer, M., & Schüßler, E. (2021). Microphones, not megaphones: Functional crowdworker voice regimes on digital work platforms. *Human Relations, 74*(9), 1473–1503. https://doi.org/10.1177/0018726720915761

Geva, H., Oestreicher-Singer, G., & Saar-Tsechansky, M. (2019). Using retweets when shaping our online persona: Topic modeling approach. *MIS Quarterly, 43*(2), 501–524.

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking qualitative rigor in inductive research. *Organizational Research Methods, 16*(1), 15–31. https://doi.org/10.1177/1094428112452151

Gol, E. S., Stein, M. K., & Avital, M. (2018). *Why take the risk? Motivations of highly skilled workers to participate in crowdworking platforms*. Association for Information Systems (AIS). Retrieved from https://bura.brunel.ac.uk/handle/2438/23047

Gol, E. S., Avital, M., & Stein, M.-K. (2019). Crowdwork platforms: Juxtaposing centralized and decentralized governance. In Proceedings of the 27th European Conference on Information Systems (ECIS) (pp. 1–16). Stockholm-Uppsala.

Goles, T., Hawk, S., & Kaiser, K. M. (2009). Information technology workforce skills: The software and IT services provider perspective. In *Information Systems Outsourcing*. Springer, Berlin, Heidelberg. (pp. 105–125). https://doi.org/10.1007/978-3-540-88851-2_5

Graham, M., Hjorth, I., & Lehdonvirta, V. (2017). Digital labour and development: Impacts of global digital labour platforms and the gig economy on worker livelihoods. *Transfer (Brussels, Belgium), 23*(2), 135–162. https://doi.org/10.1177/1024258916687250

Griffiths, T. L., & Steyvers, M. (2004). Finding scientific topics. *Proceedings of the National Academy of Sciences of the United States of America, 101*(suppl 1), 5228–5235. https://doi.org/10.1073/pnas.0307752101

Guo, K. H., & Yu, X. (2020). The anonymous online self: Toward an understanding of the tension between discipline and online anonymity. *Information Systems Journal, 30*(1), 48–69. https://doi.org/10.1111/isj.12242

Gussek, L., & Wiesche, M. (2022). Understanding the careers of IT freelancers on digital labor platforms. In: *Proceedings of the 30th European Conference on Information Systems (ECIS)* (pp. 1–18). Romania: Timișoara.

Gussek, L., & Wiesche, M. (2023). IT Professionals in the Gig Economy. *Business & Information Systems Engineering*. https://doi.org/10.1007/s12599-023-00812-z

Guzman, I. R., Stam, K. R., & Stanton, J. M. (2008). The occupational culture of IS/IT personnel within organizations. *ACM SIGMIS Database: The DATABASE for Advances in Information Systems, 39*(1), 33–50. https://doi.org/10.1145/1341971.1341976

Hannigan, T. R., Haans, R. F. J., Vakili, K., Tchalian, H., Glaser, V. L., Wang, M. S., & Jennings, P. D. (2019). Topic modeling in management research: Rendering new theory from textual data. *Academy of Management Annals, 13*(2), 586–632. https://doi.org/10.5465/annals.2017.0099

Hoffman, M. D., Blei, D. M., & Bach, F. (2010). Online learning for Latent Dirichlet Allocation. In *NIPS'10, Proceedings of the 23rd International Conference on Neural Information Processing Systems - Volume 1* (pp. 856–864). Red Hook, NY, USA: Curran Associates Inc.

Holthaus, C., & Stock, R. M. (2017). Good signals, bad signals: Performance and trait implications of signaling in online labor markets. *International Conference on Information Systems, Seoul, South Korea*

Howcroft, D., & Bergvall-Kåreborn, B. (2019). A typology of crowdwork platforms. *Work, Employment and Society, 33*(1), 21–38. https://doi.org/10.1177/0950017018760136

Huang, N., Burtch, G., Hong, Y., & Pavlou, P. A. (2020). Unemployment and worker participation in the gig economy: Evidence from an online labor market. *Information Systems Research, 31*(2), 431–448. https://doi.org/10.1287/isre.2019.0896

Idowu, A., & Elbanna, A. (2022). Digital platforms of work and the crafting of career path: The crowdworkers' perspective. *Information Systems Frontiers, 24*(2), 441–457. https://doi.org/10.1007/s10796-020-10036-1

Jabagi, N., Croteau, A.-M., Audebrand, L. K., & Marsan, J. (2019). Gig-workers' motivation: Thinking beyond carrots and sticks. *Journal of Managerial Psychology, 34*(4), 192–213. https://doi.org/10.1108/JMP-06-2018-0255

Jarrahi, M. H., Newlands, G., Lee, M. K., Wolf, C. T., Kinder, E., & Sutherland, W. (2021). Algorithmic management in a work context. *Big Data & Society, 8*(2), 205395172110203. https://doi.org/10.1177/20539517211020332

Jiang, J., Adam, M., & Benlian, A. (2021). Algoactivistic practices in ridesharing - A topic modeling & grounded theory approach. In *Proceedings of the 29th European Conference on Information Systems (ECIS)* (pp. 1-16). Morocco: Marrakech.

Joseph, D., Tan, M. L., & Ang, S. (2011). Is updating play or work? *International Journal of Social and Organizational Dynamics in IT, 1*(4), 37–47. https://doi.org/10.4018/ijsodit.2011100103

Kanat, I., Hong, Y., & Raghu, T. S. (2018). Surviving in global online labor markets for IT services: A geo-economic analysis. *Information Systems Research, 29*(4), 893–909. https://doi.org/10.1287/isre.2017.0751

Kaplan, S., & Vakili, K. (2015). The double-edged sword of recombination in breakthrough innovation. *Strategic Management Journal, 36*(10), 1435–1457. https://doi.org/10.1002/smj.2294

Karanović, J., Berends, H., & Engel, Y. (2021). Regulated dependence: Platform workers' responses to new forms of organizing. *Journal of Management Studies, 58*(4), 1070–1106. https://doi.org/10.1111/joms.12577

Kässi, O., & Lehdonvirta, V. (2018). Online labour index: Measuring the online gig economy for policy and research. *Technological Forecasting and Social Change, 137*, 241–248.

Kittur, A., Nickerson, J. V., Bernstein, M., Gerber, E., Shaw, A., Zimmerman, J., Horton, J. (2013). The future of crowd work. In A. Bruckman, S. Counts, C. Lampe, & L. Terveen (Eds.), *Proceedings of the 2013 conference on Computer supported cooperative work - CSCW '13* (p. 1301). New York, New York, USA: ACM Press. https://doi.org/10.1145/2441776.2441923

Kost, D., Fieseler, C., & Wong, S. I. (2020). Boundaryless careers in the gig economy: An oxymoron? *Human Resource Management Journal, 30*(1), 100–113. https://doi.org/10.1111/1748-8583.12265

Kudaravalli, S., Faraj, S., & Johnson, S. L. (2017). A configural approach to coordinating expertise in software development teams. *MIS Quarterly, 41*(1), 43–64. https://doi.org/10.25300/misq/2017/41.1.03

Levina, N. (2005). Collaborating on multiparty information systems development projects: A collective reflection-in-action view. *Information Systems Research, 16*(2), 109–130. https://doi.org/10.1287/isre.1050.0055

Ludwig, S., Herhausen, D., Grewal, D., Bove, L., Benoit, S., de Ruyter, K., & Urwin, P. (2022). Communication in the gig economy: Buying and selling in online freelance marketplaces. *Journal of Marketing, 86*(4), 141–161. https://doi.org/10.1177/00222429211030841

Majchrzak, A., Beath, C. M., Lim, R. A., & Chin, W. W. (2005). Managing client dialogues during information systems design to facilitate client learning. *MIS Quarterly, 29*(4), 653. https://doi.org/10.2307/25148704

Möhlmann, M., Zalmanson, L., Henfridsson, O., & Gregory, R. W. (2021). Algorithmic management of work on online labor platforms: When matching meets control. *MIS Quarterly, 45*(4), 1999–2022. https://doi.org/10.25300/MISQ/2021/15333

Niederman, F., Ferratt, T. W., & Trauth, E. M. (2016). On the co-evolution of information technology and information systems personnel. *ACM SIGMIS Database: The DATABASE for Advances in Information Systems, 47*(1), 29–50. https://doi.org/10.1145/2894216.2894219

Petriglieri, G., Ashford, S. J., & Wrzesniewski, A. (2018). Thriving in the gig economy. *Harvard Business Review*, pp. 140–143. Retrieved from https://hbr.org/2018/03/thriving-in-the-gig-economy

Petriglieri, G., Ashford, S. J., & Wrzesniewski, A. (2019). Agony and ecstasy in the gig economy: Cultivating holding environments for precarious and personalized work identities. *Administrative Science Quarterly, 64*(1), 124–170. https://doi.org/10.1177/0001839218759646

Popiel, P. (2017). "Boundaryless" in the creative economy: Assessing freelancing on Upwork. *Critical Studies in Media Communication, 34*(3), 220–233. https://doi.org/10.1080/15295036.2017.1282618

Prommegger, B., Wendrich, M., Wiesche, M., & Krcmar, H. (2020). Short-term Affair or Long-term Commitment? In S. Laumer, J. Quesenberry, D. Joseph, C. Maier, D. Beimborn, & S. C. Srivastava (Eds.), *Proceedings of the 2020 on Computers and People Research Conference* (pp. 91–98). New York, NY, USA: ACM. https://doi.org/10.1145/3378539.3393860

Rahman, H. A. (2021). The invisible cage: Workers' reactivity to opaque algorithmic evaluations. *Administrative Science Quarterly, 66*(4), 945–988. https://doi.org/10.1177/00018392211010118

Rai, A., Constantinides, P., & Sarker, S. (2019). Next generation digital platforms:: Toward human-AI hybrids. *MIS Quarterly*, *43*(1), iii–ix. Retrieved from https://www.research.manchester.ac.uk/portal/en/publications/next-generation-digital-platforms(f8e763a6-7cec-4522-9ff1-ee3758911274).html

Riemenschneider, C., & Armstrong, D. (2021). The development of the perceived distinctiveness antecedent of information systems professional identity. *MIS Quarterly, 45*(3), 1149–1186. https://doi.org/10.25300/MISQ/2021/14626

Röder, M., Both, A., & Hinneburg, A. (2015). Exploring the space of topic coherence measures. *Proceedings of the Eighth ACM International Conference on Web Search and Data Mining*. New York, NY, USA: ACM. https://doi.org/10.1145/2684822.2685324

Scuotto, V., Le Loarne Lemaire, S., Magni, D., & Maalaoui, A. (2022). Extending knowledge-based view: Future trends of corporate social entrepreneurship to fight the gig economy challenges. *Journal of Business Research, 139*, 1111–1122. https://doi.org/10.1016/j.jbusres.2021.10.060

Silberman, M. S., Irani, L., & Ross, J. (2010). Ethics and tactics of professional crowdwork. *XRDS: Crossroads, the ACM Magazine for Students, 17*(2), 39–43. https://doi.org/10.1145/1869086.1869100

Silverman, D. (2013). A very short, fairly interesting and reasonably cheap book about qualitative research (2nd ed.). London: Sage Publications.

Sison, R., & Lavilles, R. Q. (2018). Software gigging: A grounded theory of online software development freelancing. In *Proceedings of the 39th International Conference on Information Systems (ICIS)* (pp. 1–17). San Francisco, California, USA.

Stewart, A., & Stanford, J. (2017). Regulating work in the gig economy: What are the options? *The Economic and Labour Relations Review, 28*(3), 420–437.

Stol, K.-J., & Fitzgerald, B. (2014). Two's company, three's a crowd: A case study of crowdsourcing software development. In P. Jalote, L. Briand, & A. van der Hoek (Eds.), *Proceedings of the 36th International Conference on Software Engineering* (pp. 187–198). New York, NY, USA: ACM. https://doi.org/10.1145/2568225.2568249

Strunk, K. S., Faltermaier, S., Ihl, A., & Fiedler, M. (2022). Antecedents of frustration in crowd work and the moderating role of autonomy. *Computers in Human Behavior, 128*, 107094. https://doi.org/10.1016/j.chb.2021.107094

Sultana, R., Im, I., & Im, K. S. (2019). Do IT freelancers increase their entrepreneurial behavior and performance by using IT self-efficacy and social capital? *Evidence from Bangladesh. Information & Management, 56*(6), 103133. https://doi.org/10.1016/j.im.2018.12.001

Syed, S., & Spruit, M. (2017). Full-text or abstract? Examining topic coherence scores using Latent Dirichlet Allocation. *2017 IEEE International Conference on Data Science and Advanced Analytics (DSAA)*. IEEE. https://doi.org/10.1109/dsaa.2017.61

Taylor, J., & Joshi, K. D. (2019). Joining the crowd: The career anchors of information technology workers participating in crowdsourcing. *Information Systems Journal, 29*(3), 641–673. https://doi.org/10.1111/isj.12225

Tóth, Z., Nemkova, E., Hizsák, G., & Naudé, P. (2022). Social capital creation on professional sharing economy platforms: The problems of rating dependency and the non-transferability of social capital. *Journal of Business Research, 144*, 450–460. https://doi.org/10.1016/j.jbusres.2022.01.090

Upwork (2020). *Freelance forward 2020: The U.S. independent workforce report*. Retrieved from https://www.upwork.com/i/freelance-forward

Upwork (2021). *Annual report*. Retrieved from https://investors.upwork.com/static-files/f9770045-d71e-48c5-a793-20ccde8be73f

Wagner, G., Prester, J., & Paré, G. (2021). Exploring the boundaries and processes of digital platforms for knowledge work: A review of information systems research. *The Journal of Strategic Information Systems, 30*(4), 101694. https://doi.org/10.1016/j.jsis.2021.101694

Wang, C., Chen, J., & Xie, P. (2022). Observation or interaction? Impact mechanisms of gig platform monitoring on gig workers' cognitive work engagement. *International Journal of Information Management, 67*, 102548. https://doi.org/10.1016/j.ijinfomgt.2022.102548

Wang, H., Chung, J. E., Park, N., McLaughlin, M. L., & Fulk, J. (2012). Understanding online community participation. *Communication Research, 39*(6), 781–801. https://doi.org/10.1177/0093650211408593

Watson-Manheim, M. B., & Ahuja, M. K. (2019). Multiple team membership in software development gig work. *Proceedings of the 2019 on Computers and People Research Conference*. New York, NY, USA: ACM. https://doi.org/10.1145/3322385.3322424

Wong, S. I., Bunjak, A., Černe, M., & Fieseler, C. (2021). Fostering creative performance of platform crowdworkers: The digital feedback dilemma. *International Journal of Electronic Commerce, 25*(3), 263–286. https://doi.org/10.1080/10864415.2021.1942674

Wood, A. J., Graham, M., Lehdonvirta, V., & Hjorth, I. (2019). Good gig, bad gig: Autonomy and algorithmic control in the global gig economy. *Work, Employment & Society : A Journal of the British Sociological Association, 33*(1), 56–75. https://doi.org/10.1177/0950017018785616

Wu, Z., Liang, C., & Gu, B. (2019). Online labor market signaling with app-based monitoring. *Available at SSRN*

Yoganarasimhan, H. (2013). The value of reputation in an online freelance marketplace. *Marketing Science, 32*(6), 860–891. https://doi.org/10.1287/mksc.2013.0809

Younger, J. (2020). The big freelance skills needed as companies rebuild after COVID 19. Retrieved from https://en.globes.co.il/en/article-fiverr-turns-profitable-earlier-than-expected-1001338291

Zhang, X., Ryan, S. D., Prybutok, V. R., & Kappelman, L. (2012). Perceived obsolescence, organizational embeddedness, and turnover of it workers. *ACM SIGMIS Database: The DATABASE for Advances in Information Systems, 43*(4), 12–32. https://doi.org/10.1145/2398834.2398837

Zheng, A. Z., Hong, Y. K., & Pavlou, P. A. (2015). Value uncertainty and buyer contracting: Evidence from online labor markets. In Proceedings of the 36th International Conference on Information Systems (ICIS) (pp. 1–14). Fort Worth, Texas, USA.