A Survey of the Role of Viewability within the Online Advertising Ecosystem

MARTA EXPÓSITO-VENTURA[1,2], JOSÉ A. RUIPÉREZ-VALIENTE[3] (SENIOR MEMBER, IEEE), JAVIER PARRA-ARNAU[1] AND JORDI FORNÉ[1]

[1]Network Engineering, Universitat Politècnica de Catalunya, 08034 Barcelona, Spain (e-mail: marta.exposito@upc.com, javier.parra@upc.edu, jforne@entel.upc.edu)
[2]ExoClick, 08005 Barcelona, Spain
[3]Complutense University of Madrid, 28040 Madrid, Spain (e-mail: jruipere@ucm.es)

Corresponding author: Marta Expósito-Ventura (e-mail: marta.exposito@upc.com, ORCID: 0000-0002-2839-6970)

ABSTRACT Within the online advertising ecosystem, viewability is defined as the metric that measures if an ad impression had the chance of being viewable by a potential consumer. Although this metric has been presented as a potential game-changer within the ad industry, it has not been fully adopted by the stakeholders, mainly due to disagreement between the different parties on the standards to implement and measure it, and its potential benefits and drawbacks. In this study, we present a survey of the role that viewability can have on the main challenges of the online advertising ecosystem depicting the main applications, benefits and issues. With this objective, we provide an overall picture of how viewability can fit within the ecosystem, which can help the different stakeholders to work on its adoption, integration and establishing a research agenda.

INDEX TERMS Viewability, PRISMA, online advertising, web technologies, human-computer interaction.

I. INTRODUCTION

The online advertising ecosystem is complex and it requires the interaction of many stakeholders and technologies to work properly. Since its origins, it has grown and evolved so fast that it has resulted in a lack of implementation standards, which have generated inconsistencies and confusion between the involved parties. For this reason, advertising organizations, such as the International Advertising Bureau (IAB) or the Media Rating Council (MRC), have been joining efforts to improve the online advertising ecosystem by defining technical standards, software and services that can be implemented by the different stakeholders.

One of the standards created by the IAB and MRC is the one for measuring viewability, which is a metric that was born from the necessity of having a stronger and more evolved measure of the traditional ad impression metric. Ad impression metric is defined by the IAB as "the measurement of responses from an ad delivery system to an ad request from the user's browser." This necessity was motivated by

several studies reporting that a significant amount of impressions were never visible to users [21]. According to the MRC, viewability represents a strong step towards improving the online advertising ecosystem since it provides higher confidence that consumers have the opportunity to see the ad [103]. However, this metric has still not been fully adopted and embraced by all the ad industry.

The multiple definitions on what a viewable impression really means and the discrepancies that have been reported when measuring viewability by different accredited vendors have jeopardized the acceptance of this metric [42]. Understanding the benefits and drawbacks of viewability in the online advertising ecosystem can motivate research and industry practitioners to keep working towards its integration and full adoption, which would have a direct impact on having a more sustainable online advertising ecosystem. For this reason, in this work we survey the state-of-art of viewability with the objective of providing a landscape of how viewability is being perceived and used within the online

advertising industry as well as to synthesize the issues and benefits detected around this metric. Although we can find several general surveys in the literature about online advertising, none of them are specifically focused on the topic of viewability. In this sense, our work is completely novel and can provide a solid ground of the current state of viewability.

The remainder of this paper is structured as follows: In Section II we present viewability and why it is an important metric. We also introduce related work that has been done to model the online advertising ecosystem and, finally, we introduce its main stakeholders and challenges. In Section III, we present our research question (RQ) and the methodology we followed to conduct the survey. In Section IV, we present a use case of viewability and analyze each challenge in relation to our survey. In Section V we answer our research question and we provide some future directions of viewability and possible implications for the industry. Finally, in Section VI we explain the main conclusions obtained in this work.

II. BACKGROUND

We first present a brief introduction on how viewability has emerged as a new metric and its evolution in the ad industry. We then review related work and, finally, we present our model of the online advertising ecosystem and its challenges.

A. THE EVOLUTION OF VIEWABILITY

Ad viewability was defined by the IAB in conjunction with the MRC in 2014 as a "served ad impression contained in the viewable space of the browser window, on an in-focus browser tab, based on pre-established criteria such as the percent of ad pixels within the viewable space and the length of time the ad is in the viewable space of the browser" [72]. The need for creating this metric appeared in research performed by the IAB and MRC in 2007. In this research, they realized that it was difficult to guarantee that an ad impression was delivered in Rich Internet Applications (RIA), which are web applications designed to deliver the same features and functions normally associated with desktop applications. In those cases, it should be checked the presence of 'strong user activity' (such as clicks, typing, etc) in order to ensure a successful ad delivery. In the case that such interaction from the user was not present, it should be checked if the application was active on the user's browser during a significant amount of time in order to create a valid opportunity for the ad-serving to happen.

One year later, the first viewable impression was measured by Meetrics [1], but it was not until 2012 that the term 'viewability' started to become popular in the advertising community, as it can be seen in Figure 1. This was reinforced with numerous studies reporting that a significant amount of impressions were never visible to users [21].

The Google search trends for viewability started to grow in November 2014, when the official definition of viewability from IAB and MRC was published [72], and it achieved its peak in 2016. During that year, there were released separate guidelines on how to measure viewability depending on whether the ads were displayed on a desktop or on a mobile device. Nevertheless, in 2017 the WPP's GroupM (the world's largest advertising media company) and Unilever [2], released their own standards of viewability stating that the ones from the IAB were not sufficient for advertisers. Although the IAB and MRC standard is considered to be the official industry standard, GroupM controls a big portion of the global ad budget spent in the world, and therefore it is also taken into consideration by multiple industry stakeholders. On the other hand, big publishers like Facebook started to downplay the IAB and MRC standards because its viewability results were too low compared to the average results reported by other platforms [21]. Facebook said that social media platforms needed a different standard for viewability and that they cannot be compared with other services such as websites or mobile applications. In the academic literature, it has also been reported that the best measurement for viewability should be 75% of pixels instead of 50% [143]. Although the debate about viewability between different parties was opened, for some reason in 2018 the viewability's Google Trends searches started to decrease.

Besides the reticence from big publishers and advertisers to agree with the IAB and MRC guidelines, another issue was that the MRC released a summary [103] explaining that there is no consistency across viewability results reported by different stakeholders that were accredited by them, and that therefore, the MRC does not encourage companies to start using viewability for monetization purposes. These inconsistencies have also been reported in the literature [50, 51], where multiple implementations for measuring viewability have been tested in different devices, browsers and operating systems, showing discrepancies on all the different dimensions.

The lack of a unique standard and specific guidelines on how to implement the tracking of viewability has generated widespread confusion within the ad industry and it has questioned the effectiveness of viewability to make online advertising business decisions.

B. RELATED WORK

In the literature, we can find several works that have reviewed the literature in order to model and present the main players of the online advertising ecosystem and its challenges. Some of these works are described in this subsection.

In this sense, Erdur [47] performed a systematic literature review of the ad technological issues that were changing the advertising industry, such as the rise of mobile devices, social networks, data brokers, real-time bidding and behavioral targeting, without considering the relationships between these issues with the main players in the ad industry. Yuan et al. [142] presented a schematic view of the online advertising ecosystem together with a survey of the research issues and
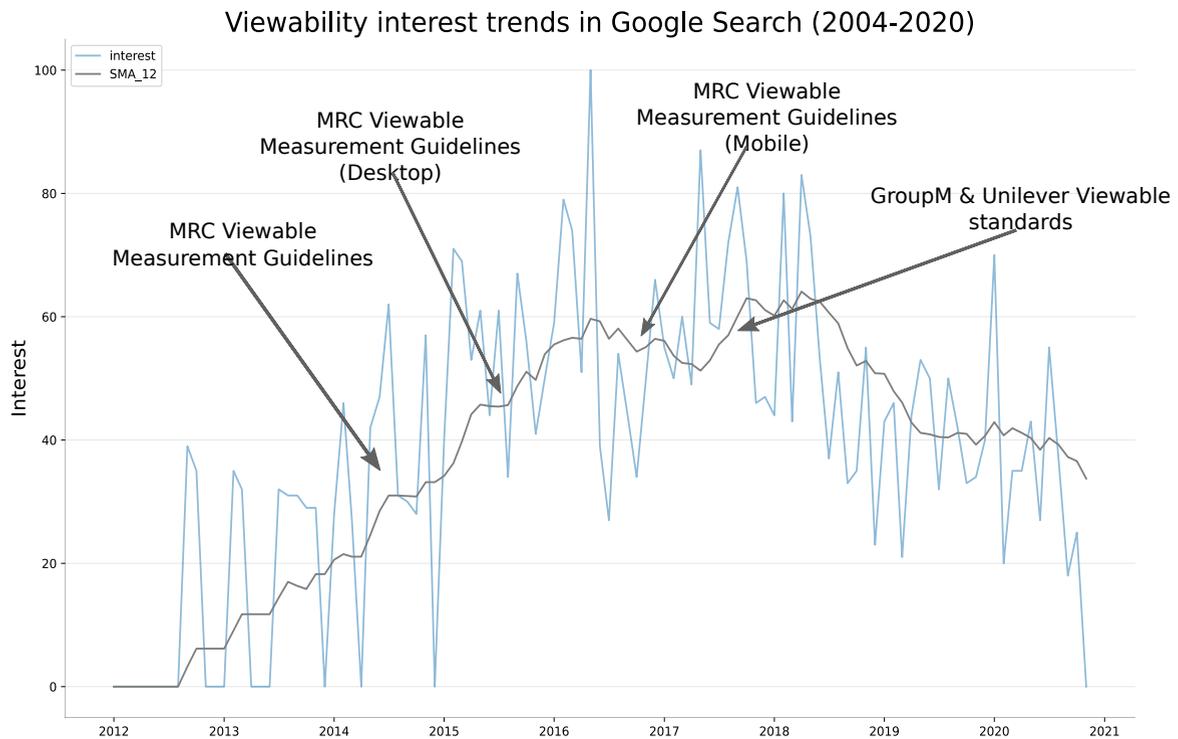
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[1] https://www.meetrics.com/en/company/

[2] https://www.unilever.com/about/who-we-are/about-Unilever

Viewability interest trends in Google Search (2004-2020)

FIGURE 1. 12-Months moving average of Google Trends searches of viewability in the category of "Advertising & Marketing". Numbers are relative to the highest point on the chart, which was produced on November 2014, the same date of the definition of viewability from IAB.

methods used to solve the challenges of each player with the objective of highlighting future prospects. Estrada-Jiménez et al. [48] have also modeled the online advertising ecosystem with a schematic visualization which they used to detect the misuse of real-time bidding technologies. Many other works have proposed different models to represent the online advertising ecosystem workflow, which motivated Stallone and Klaas [127] to propose the first attempt to standardize such workflows.

All those models focused on visualizing the stakeholders involved in the online advertising ecosystem, but the models did not represent their goals, actions and interactions. In Mun and Yazdanifard [104], a review of the main challenges and benefits of online advertising was performed, but they did not describe in detail how each challenge relates to the stakeholder or how those challenges could be solved. In Singh [126] the author reviewed the effects of online advertising, but just focusing on the service sector. Finally, in Choi et al. [40] the authors presented a survey on the display advertising ecosystem for guaranteed selling channels (direct sales) vs non guaranteed also focusing on the challenges and perspectives of each stakeholder.

The most similar work we found in the literature to what we propose to do here was Cai et al. [27], where they presented the main stakeholders on the online advertising ecosystem, a model of their main interactions in a separate schema and a review of the main threats on security and privacy for each stakeholder. They also created a linkage

chart in order to identify the relationships between attack methodologies, threats and related players. In this work, we propose something similar but focused on viewability. Instead of identifying the challenges of viewability, we aim to detect all the challenges in online advertising and, later, to perform a critical survey of the viewability relationship on each one of these challenges and players. On another hand, note that Cai et al. [27] identified the publisher, the advertiser, and the consumer as the main stakeholders in their model, whereas in our work we also include the ad tech companies (such as the ad networks or the ad exchanges) and the policymakers responsible of creating regulatory frameworks for advertisements, since they are highly involved in defining the online advertising directions and priorities. Finally, note that none of the aforementioned studies in this subsection have presented this online advertising ecosystem model with respect to viewability, and thus our study is completely novel within the literature.

C. STAKEHOLDERS AND CHALLENGES WITHIN THE ONLINE ADVERTISING ECOSYSTEM

Advertisement, per se., has been used for many years, although its origins are still uncertain. Some studies trace it back to the origin of the printing press (in the seventeenth century), but there is evidence supporting that early Mesopotamian, Chinese, Greeks and Romans were already using some forms of advertisement such as trademarks on their products, for branding purposes, and by using the "word

of mouth" technique to promote their offerings between their potential customers [12].

In any case, advertisement has always been evolving together with the different forms of communication and technology used in our society. With the invention of the World Wide Web, the first online banner ad did not take very long to appear [39] and with it, everything that we knew about advertisement changed radically. Actually, the disruption was so big that it has caused that nowadays we differentiate traditional advertising from online advertising.

Although online advertising might seem something relatively recent and new, during these 26 years it has gone through a re-imagination process, appearing in online games, social media, blogs and mobile applications [19]. It has also trespassed the boundaries of targeting global populations to a more personalized and efficient approach, which is specially tailored to the interests of each individual by using recommendation engines powered by the 'big data' era [17].

Many of the current online businesses and portals base their revenue models on earnings from online advertising (ad revenue), allowing the end-user to have access to high quality contents or services free of charge [49]. Given the rapid growth of internet users around the world, the ad revenue has also increased dramatically. In fact, according to the historical data of the IAB, the total expenses in online advertising in the US during 2019 was 124.6 billion dollars, which represents 16% more than in 2018 [73]. This ad revenue is generated by an agreement between the person who wants to show an ad (advertiser) and the person that offers a place for that ad (publisher), and this agreement usually requires a set of conditions (campaigns objectives) to be met, in order to perform the payment.

We have modeled this process in Figure 2 as a flowchart diagram. In this diagram, we have represented the three main stakeholders involved in the online advertising ecosystem in different colors: the advertiser (in orange), the publisher (in green) and the user (in purple). We can also see a cloud of stakeholders in the middle in blue color. These are the third parties that act as a marketplace to sell and buy ad inventories, which are often known as 'ad tech companies.' Moreover, a fourth stakeholder called policymaker wraps the whole online advertising ecosystem. Policymakers are the legal and industry figures in charge of creating policies to ensure the security of all the involved parties and also of defining technological guidelines and standards that should be followed by all the stakeholders.

The advertiser and publisher objectives of this transaction are represented in rounded squares at the bottom of the model, which are to generate a good Return On Investment (ROI) for advertisers and to generate ad revenue for publishers. However, to accomplish these objectives, the campaign objectives have to be met and this only happens with the interaction of the user. In order to understand better the complexity of such an ecosystem, we focus on each stakeholders' point of view and all the processes and interests involved from their side.

1) Advertiser

As mentioned before, the goal of an advertiser is to generate ROI. That means that the money spent on the auction process has to be at least recovered by the benefits generated by the campaign. Therefore, the advertiser wants to maximize the ROI obtained by designing a good strategy, and this success can aim for very different objectives, such as achieving a purchase or increasing the popularity of the advertiser's service.

Once this strategy has been defined, the advertiser has to create an ad campaign. This ad campaign will consist of several **campaign settings**, such as the ad type that will be used, all the targeting parameters (e.g., targeting per country or device), the maximum budget, frequency capping or the pricing method. There are multiple pricing methods available but the most common ones are:

- *Cost Per Click (CPC)*. This is one of the most popular pricing methods available because it is based on a direct interaction of the user with the ad, more specifically on its click-through rate (CTR). This CTR has been widely related to the user interest in the product [35]. However, the "IAB best practices for conducting online ad effectiveness" research pointed out [70] that this metric is no longer recommended as a measure of the user interest in a product. The rationale is that the average CTR value has been decreasing from 2-4% in 1998 to below 1% in 2004 [82]. Additionally, there is no guarantee that after a user clicks on an ad, that user will continue and perform a purchase or any action that benefits the advertiser.
- *Cost Per Mille (CPM)*. This was the first pricing method ever used in online advertising and it is based on displaying an impression of the ad 1,000 times.
- *Cost Per Action (CPA)*. With the CPA model, the advertiser only pays for those impressions that lead to a conversion or goal (a purchase, a sign-up, a follower, etc). However, CPA sometimes cannot distinguish efficiently between conversions coming from display advertising or other channels such as TV commercials.

It is important to bear in mind that the campaign has to compete in the auction with other campaigns and usually, the cost of the pricing methods that require direct interaction of the user (such as CPC or CPA), is higher than the traditional CPM. For this reason, CPM is usually the most widely used payment method, since its price makes it easier for advertisers to more flexibly bid on many zones and, therefore, reach a broader audience.

On the other hand, the aesthetics of the ad (commonly known as *creative*) is also important since it can be designed to catch the attention of the user by using fast animations, bright colors or text [53, 129]. Although this might generate higher response rates from the users, it can also annoy them and generate a bad-response towards the advertiser's product [2, 2, 107]. According to [74], ads that are not too large and that are combined with appropriate short messages that match the content of the publisher service, will be more
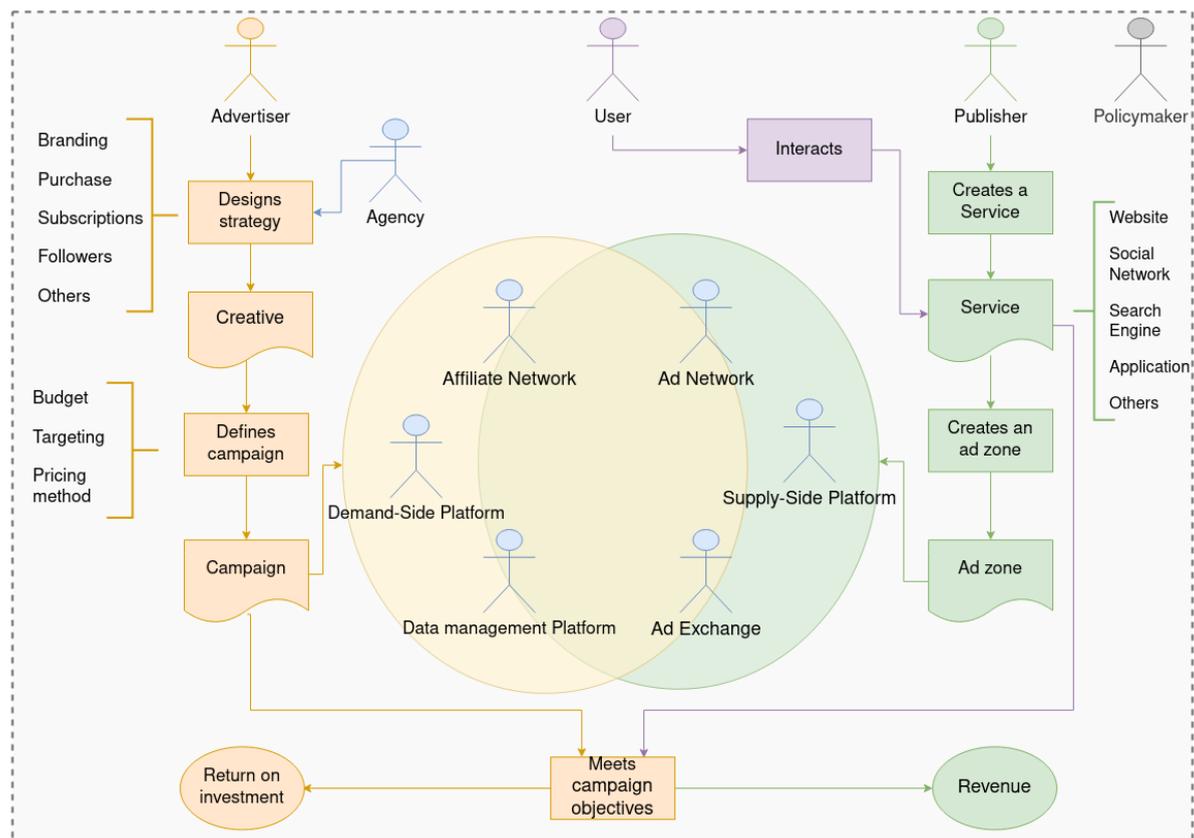
FIGURE 2. The online advertising ecosystem model represented with a flowchart.

effective in attracting users to click without annoying them. For this reason, advertisers need to heavily take into consideration the **user experience** when designing their creatives.

Finally, the advertiser has to analyze the **metrics** obtained in the campaign in order to calculate the ROI. There are certain events, such as when an ad has been served or when an ad has been clicked, that are only measured on the publisher side and the advertiser has to rely on the publisher's transparency and honesty when looking at these metrics. However, there are many factors that might alter these metrics, such as technological issues, crawlers, fraudulent traffic, and so on. For this reason, the advertiser might decide to use the services of a third party to perform these ad verification measurements and to compare the results provided by them with the ones from the publisher.

2) Publisher
In the online advertising ecosystem, the publishers' objective is to generate ad revenue. In order to do so, they can monetize their service (a website, a mobile application or any other online platform) through ads.

The first challenge here is to decide what **campaign settings** will be allowed in the service. On one hand, publishers need to consider how many ads they want to place on the service. Although it makes sense to consider that with a higher number of ads there will be more impressions and

therefore, more ad revenue, it could also happen that users decide to stop visiting the service due to the big exposure to ads [98]. Another technique to increase ad revenue without adding more ads is by using ad-refresh [100, 134], where the publisher reloads ads on a specific ad-zone based on predefined triggers such as a timer or a specific action performed by the user like scrolling. However this technique increases the computational workload and it is not recommended for mobile apps that do not require constant internet connectivity [66, 112]. On the other hand, publishers should choose which ad types will accept their zones, since some ad types are more profitable than others. However, this decision can also have side-effects, for example, pop-up ads are a type of ad that is designed to appear abruptly over the main browser window in order to force reaching the attention of the user. However, this aggressiveness has an impact, and it has been found that they reduce the user's retention from the publisher's service more than banner ads [97]. As we see, the choices that publishers take in their campaign settings will have a direct impact on the **user experience** as well.

The user experience is the second challenge that publishers face since, in order to maximize their earnings, publishers should work towards increasing the number of visits their services receive. For this reason, publishers need to take users into consideration to design an appealing service for them. In the literature, it is recommended to use basic art rules such as

the golden ratio, rule of thirds, and others when designing websites in general [11]. On the other hand, for websites containing advertisements, several studies have been done to optimize ad placement while keeping aesthetics in the website and at the same time maximizing ad revenue [84, 95].

Once the service has been designed taking into account the ad-zones and the users, the next challenge is to reach potential advertisers. Publishers can decide to auction their ad-zones on ad tech companies that have access to several potential sellers by paying them a commission for their service as a middle-platform. Nonetheless, analogously with the advertiser challenge with **metrics**, we also find potential discrepancies between publishers and ad tech companies [71, 92].

3) Ad tech companies

Ad tech companies are advertising platforms that act as a marketplace between advertisers, publishers or even between other ad tech companies. Their main objective is to generate ad revenue by earning a commission from the publisher or the advertiser. These companies can be specialized as a Demand Side Platform (DSP), by focusing on helping advertisers to choose the most adequate offer to display their ads. They can also be specialized as a Supply Side Platform (SSP), by helping the publishers to optimize their inventory and to generate more ad revenue by selecting the most profitable ad. Moreover, they can be in the middle of both demand and supply, as it is represented in Figure 2, where we find the ad networks, which contain a set of publishers and advertisers that signed up to their platforms, or the ad exchanges, which focus on connecting inventory from multiple ad networks [128]. We can also find affiliate networks, which work with affiliate marketers [80], and *Data Management Platforms* (DMP), which obtain user data from multiple channels and sell it together with analytics to the rest of platforms [46].

In order for these companies to select the best match between a campaign and an ad-zone there is the **ad-serving** process, which happens within the ad-server, and basically consists of the following steps:

1) *Filtering valid campaigns*. Whenever there is an ad-request in one ad-zone, the ad-server first selects the campaigns that are valid for such ad-zone. Campaigns that have been already shown to the user, that do not match the campaign targeting criteria from the advertiser (e.g., country, device type, or browser) or the criteria from the publisher (e.g., specific categories of products or creative content) will be discarded [85].

2) *Internal auction*. In order to select the most suitable campaign for the specific ad-zone, the ad-server ranks the campaigns by their bidding value. However, each campaign might be using different pricing models. Based on the historical data, the system needs to generate a common ranking, which is done by using a single measure to compare them: the effective Cost Per Mille (eCPM).

$$eCPM = \frac{Ad\ revenue * 1000}{impressions} \qquad (1)$$

Finally, this ad-serving process needs to happen with the lowest latency possible in order to not cause a delay in serving the ad to the publishers' service, as otherwise, this issue could have a negative impact on the **user experience** [7, 9].

3) *Sending ad code*. Once the ad-server has selected the winner ad based on the two previous steps, it will send the ad-response with all the campaign details to the publishers' ad-zone. Once this ad-response is received and executed on the publisher's side, it will send back another ad-response to the ad-server, who will register an impression. The same happens when there is a click or with other potential ad events.

4) User

From the point of view of the user, the goal is to consume the publisher's content or service, and in doing so the user is also exposed to ads. This exposure may entail difficulties in the user's reading and browsing activities [22]. According to PPC Protect (a cybersecurity company for digital advertisers, which is part of the IAB Tech Lab [3]), in 2020 the average person was estimated to encounter between 6,000 to 10,000 ads per day [32]. This overwhelming exposure to ads hurts the **user experience** up to the point that sometimes users decide to install ad blocking software [124] or to ignore certain page elements that resemble banners while reading a web page (i.e., "banner blindness phenomenon" [16]). On the other hand, websites that serve too many ads usually have longer loading times which is negatively related to users' opinion towards such services [44, 116].

Another issue is the amount of data and personal information that is being tracked from users in order to deliver advertising tailored to the user's interests. This practice seems to increase the advertising effectiveness, especially on sites with general content [64]. At the same time, if ads are too personalized, it might also lower CTR rates and purchase intentions because users might perceive them to be too intrusive [18]. For this reason, several government regulations around the world have emerged to protect users' **privacy**. One form of notifying users about these behavioral targeting practices is by providing Online Behavioral Advertising (OBA) disclosures next to the advertisement, but those have been found to not be very effective [88].

Finally, users are generally not happy about ads, although being aware that they are the reason for having access to certain services free of charge. The main reasons, according to a survey performed by GlobalWebIndex [15], are because users consider ads to be too aggressive and intrusive. Because of this, the Coalition for Better Ads [4] developed a set of standards to identify what ad experiences should be banned,

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[3]https://iabtechlab.com/about-the-iab-tech-lab/
[4]https://www.betterads.org/standards/

and what ad formats are more suitable in terms of user experience and ethics [13].

5) Policymakers

Governments from many countries have developed their own advertising regulatory frameworks in order to protect the security and **user experience** of their citizens when advertisement is offensive, false, misleading or unfair [68]. On the other side, there are also industry advertising self-regulation frameworks developed by institutions and organizations such as the MRC and the IAB. These organizations also define standards that can be used within the industry and offer audit and accreditation services to companies. These two models of regulation generally work independently, although online advertising industry prefer self-regulation rather than governmental involvement [26]. Legal regulations have a clear economical impact on online advertising. According to [64], after Europe passed the Data Protection Directive in order to protect the **privacy** of users, advertising effectiveness decreased a 60% relative to the rest of the world. Another research that proofed this was performed by Goldfarb and Tucker [63]. They showed that search advertising prices were higher in states with targeting regulations.

On another hand, according to the research performed by Truong and Simmons [135], consumers have the perception that government should be more involved in the regulation of online advertising. In this sense, there is a growing trend towards "co-regulatory" systems, where both legal and industry policymakers work together to regulate advertising [94]. This co-regulatory system would protect both public and private interests [62].

6) Main challenges

After reviewing the different points of view of each stakeholder, we have summarized the challenges in the following categories:

Challenge 1. Campaign settings. The selection of what creative should be used, what format (image, text, video) and how it should be displayed affects the ROI that the advertiser might generate, the ad revenue of the publisher and the interaction of the user with the ad.

Challenge 2. Ad-serving. Comparing all of the bidding campaigns for each specific ad-request in order to deliver an ad campaign winner is crucial for achieving the objectives of all the stakeholders.

Challenge 3. Metrics. Having clear standards and transparency of the metrics is very important in order to have trustworthy business economical transactions between the different stakeholders.

Challenge 4. User experience. Taking into account the user experience might generate a better attitude towards the product of the advertiser and increase the reputation of the publisher's services.

Challenge 5. Privacy. Having in mind user privacy when designing the targeting strategy is important to avoid being too intrusive as well as for protecting users' personal information and their rights.

We have also classified all the literature reviewed for this analysis based on the challenges we identified in Table 1. In the next section, we present the methodology followed to analyze how viewability fits within each one of these challenges.

III. METHODOLOGY OF THE SURVEY

In this section, we detail the methodology we followed to perform our survey. In this sense, we started by defining the scope of our survey following the taxonomy proposed by Cooper [43]. Next, we continue by stating the RQ that emerged from our background review. Finally, we implemented the search process with its belonging inclusion and exclusion criteria following the PRISMA 2020 framework for systematic literature reviews [109]. The entire methodology process is represented in Figure 3.

A. DEFINITION OF THE SURVEY SCOPE

According to the guidelines for literature reviews proposed in [25], the first step is to define the scope of the survey. In this sense, we use the taxonomy of literature reviews proposed by Cooper [43]. This taxonomy contains the following six characteristics: (1) the **focus** or central interest to the reviewer, (2) the review **goal** or what the author hopes to accomplish, (3) the **perspective** or the reviewer's point of view, (4) the **coverage** or how the reviewers include relevant works in their review, (5) the **organization** of the review, and (6) the intended **audience** of the review. We detail each characteristic below:

- **Focus**. We focus our review on all types of articles (academics and from practitioners) that analyze empir-
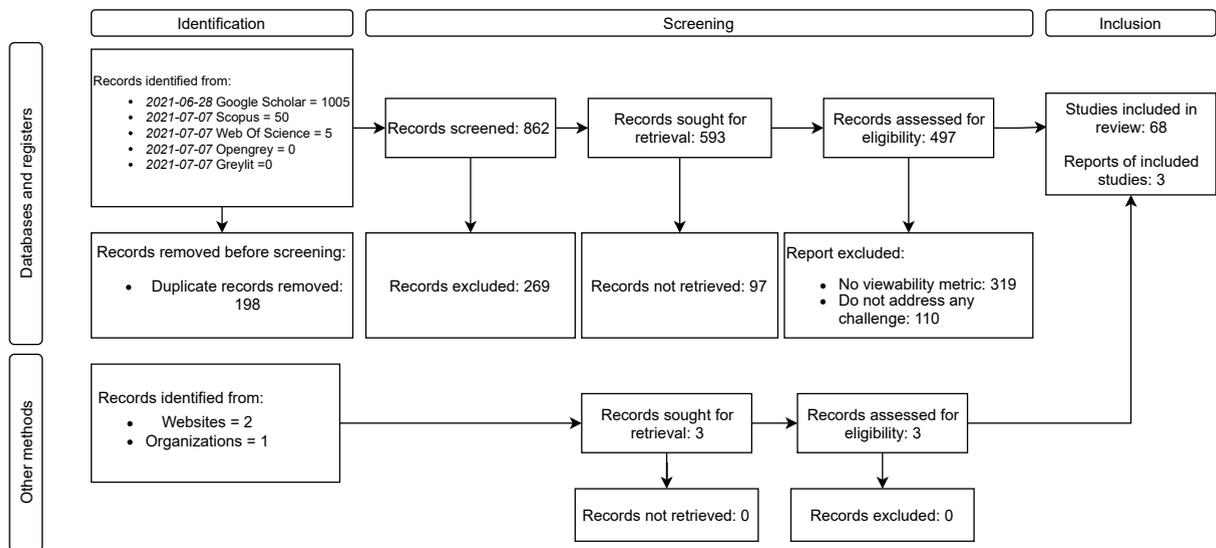
Paper	Campaign settings	Ad-serving	Metrics	Privacy	User experience
Harker [68]	✗	✗	✗	✓	✓
Bush et al. [26]	✗	✗	✗	✗	✓
Goldfarb and Tucker [63]	✓	✗	✗	✓	✗
Ginosar [62]	✗	✗	✗	✗	✗
Marsden [94]	✗	✗	✗	✗	✗
Truong and Simmons [135]	✗	✗	✗	✗	✓
Sundar and Kalyanaraman [129]	✓	✗	✗	✗	✗
Fiore et al. [53]	✓	✗	✗	✗	✗
Acquisti and Spiekermann [2]	✓	✗	✗	✗	✗
Imsa et al. [74]	✓	✗	✗	✗	✓
Chandon et al. [35]	✗	✗	✓	✗	✗
Kazienko and Adamski [82]	✗	✗	✓	✗	✗
Wang et al. [140]	✗	✗	✓	✗	✗
McCoy et al. [97]	✓	✗	✗	✗	✓
Marszałkowski and Drozdowski [95]	✓	✗	✗	✗	✓
Kumar et al. [84]	✓	✗	✗	✗	✓
McCoy et al. [98]	✗	✗	✗	✗	✓
Mehta et al. [100]	✗	✓	✗	✗	✗
Truong [134]	✗	✓	✗	✗	✗
Prochkova et al. [112]	✗	✓	✗	✗	✗
Gui et al. [66]	✗	✓	✗	✗	✗
Mansour et al. [92]	✗	✗	✓	✗	✗
Stone-Gross et al. [128]	✗	✓	✓	✗	✗
Jurišová [80]	✗	✓	✗	✗	✗
Elmeleegy et al. [46]	✗	✓	✗	✗	✗
Lang et al. [85]	✗	✓	✗	✗	✗
Arkhipov et al. [7]	✗	✓	✗	✗	✗
Bai and Cambazoglu [9]	✗	✓	✗	✗	✓
Brajnik and Gabrielli [22]	✗	✗	✗	✗	✓
Shiller et al. [124]	✗	✗	✗	✗	✓
Ramsay et al. [116]	✗	✗	✗	✗	✓
Danaher and Mullarkey [44]	✗	✓	✗	✗	✓
Goldfarb and Tucker [64]	✗	✗	✗	✓	✓
Boerman et al. [18]	✗	✗	✗	✓	✓
Leon et al. [88]	✗	✗	✗	✓	✗
Benes [15]	✗	✗	✗	✓	✓
Belanche [13]	✓	✗	✗	✓	✓
Nguyen et al. [107]	✗	✗	✗	✗	✓

TABLE 1. Classification of the literature reviewed for each one of the challenges identified.

FIGURE 3. PRISMA web-based flow diagram followed to conduct our literature survey on viewability

ical or theoretical aspects of viewability in any of the challenges identified before.

- **Goal**. The goal of our review is to synthesize the state-of-art to identify the issues that have prevented the adoption of viewability and to provide suggestions on how these issues could be overcome, as well as to detect questions and future directions of work.
- **Perspective**. According to Cooper [43], in a review the author might adopt a neutral representation, which consists of synthesizing the different points of view from a topic, or a second perspective focused on demonstrating the value of a particular point of view. In this work, our aim is to understand the benefits and drawbacks of viewability, and therefore we adopt a neutral representation of all the works reviewed.
- **Coverage**. In this work, we decided to perform an exhaustive coverage of the literature and to base our conclusions and discussions on this all-inclusive literature base.
- **Organization**. We use a conceptual structure to organize our survey, specifically we group the literature in the five challenges of the online advertising ecosystem that we identified previously.
- **Audience**. The aim of this review is to help researchers and practitioners to keep working towards the integration of viewability in the online advertising industry. Because of this, we pay attention to explain all the concepts, jargon, and details to help any reader to understand the benefits and issues of viewability.

B. RESEARCH QUESTION

Previous Section II raised the issue that although viewability has been recognized by important institutions of the online advertising community, it still far from being fully adopted in the industry. In this context, in order to motivate research

and industry practitioners to keep working on viewability, we formulate the following RQ: What benefits and/or limitations viewability offers to the main challenges of the online advertising ecosystem?

C. LITERATURE SEARCH: PRISMA 2020 FLOW DIAGRAM

In order to have a consistent literature database capable of answering our RQ, we followed the latest version of the PRISMA web-based flow diagram framework [109], which consisted on the following stages: identification of records through searches on databases and other sources, screening and, finally, inclusion of the relevant reports. The details of each stage are presented hereafter.

1) Identification

The identification stage of the PRISMA framework refers to the eligibility criteria that has been used to search for reports and include them in the review. As we see in figure 3, we have selected five different indexed databases, from which two of them were gray-literature databases.

For each one of these databases, we searched for reports that met, anywhere in the article, the following query:

"online advertising" AND ("viewability" OR "viewable")

This query consists of different boolean operators and keywords to narrow the scope of our search to viewability in online advertising. We obtained 1060 reports from all the databases. Afterward, we removed 198 duplicated records, identifying a total number of 862 articles.

On another hand, in the identification stage, we also searched for technical reports from the IAB and the MRC organizations, since they have played an important role in the standardization and definition of viewability. Also, we included two reports from important advertising companies

such as Meetrics (which is commonly known in the industry as a reference point in the analysis of viewability) and Criteo [5]. This search provided us with three records about viewability to include in our survey.

2) Screening
The second stage of the PRISMA methodology consists on the screening process. This process is responsible for deciding which reports will be included in the survey and which ones will be discarded, and in our case we did it on three iterations. In the first iteration, we performed a fast reading of the title and abstract of each record to discard those that clearly did not fit the online advertising topic or that were not written in English. This iteration removed 269 reports. In the second iteration, we searched for the records' full text online or through our university's subscription and we discarded 97 records that were not retrievable. Finally, in the last iteration, we performed a more in depth reading on the remaining records and discarded those where viewability was not related to ads or where viewability appeared only in the references section of the report, discarding 319 records. In this iteration, we also discarded 110 reports where viewability was not analyzed in any of the challenges identified in our background.

3) Inclusion
Once our database has been screened, we arrive to the inclusion stage of the PRISMA framework. In this stage, we added all the eligible records together, from the indexed databases and the other sources. We ended up with 71 articles to be analyzed.

IV. RESULTS OF SYNTHESIS AND ANALYSIS
In this section, we start by presenting an example of a use case of viewability in the industry. Next, we analyzed and synthesized the survey data in order to provide answers to our RQ.

A. ANALYSIS OF THE ROLE OF VIEWABILITY WITHIN EACH CHALLENGE
In order to understand the impact of viewability on the online advertising ecosystem, Figure 4 represents a use case of an ad auction process that implements viewability. We have defined each vignette with a capital letter and we include the numbers of the different challenges that we identified in subsection II-C6. Next, we proceed to detail each scene of this viewability use-case example:

- **(A.)** In vignette A we see the advertiser (in orange), who wants to promote a new laptop.
- **(B.)** In vignette B, the advertiser decides to create a campaign, where viewability can be selected as pricing method.
- **(C.)** Meanwhile, in vignette C, the publisher (in green) has created a website and he wants to monetize it with ads.

The publisher wants to maximize the ad revenue without heavily impacting user experience, thus he decides to increase the number of ads served by implementing ad-refresh technology driven by viewability.

- **(D.)** In vignette D we see the user (in purple) visiting the website of the publisher. When accessing the web page, the ad-zone is still not visible in the users' device viewport, therefore, the ad has not become viewable yet.
- **(E.)** In vignette E, while the website is loading, we see that the publisher ad-zone is being auctioned in order to have a winning ad campaign, which in this case, is the one of the advertiser who wanted to promote a new laptop. This advertiser is bidding with a payment method based on viewability, which has a higher price than its competition using CPM or CPC.
- **(F.)** Finally, in vignette F, once the user scrolls the website and the ad-zone appears viewable on the viewport, the advertiser has to pay the impression as viewable to the publisher.

In this Figure, we see one example of how viewability could be used, but there are many more possible scenarios. In the following subsections, we proceed to analyze the benefits and limitations of viewability identified in our survey per each challenge.

1) Campaign settings
According to our survey, we observe that, in relation to the campaign settings, the most common topics analyzed are: the usage of viewability as a targeting option and its consequences, the optimization of viewability with other KPIs, and the usage of viewability as a pricing method. We proceed to detail each topic hereinafter.

In terms of using viewability as a targeting option, it has been discussed the usage of a viewability probability threshold. In this way, the campaign would decline to bid on any impression with a viewability probability value lower than the threshold set [123, 130]. However, according to [130], this threshold might, in the long term, harm bid pacing and the campaign CPC. One possible explanation for this is that, according to Kitts et al. [83], it is not advisable to mix viewability constraints in the campaign setting together with other constraints such as a good ratio of CTR, since that might reduce the available inventory to buy. This has also been highlighted by other studies that advise to only use viewability in the campaign settings if the objective is to increase brand awareness, whereas if the objective is to increase clicks, it would be better not to use viewability as a constraint [33, 96, 133].

The second topic most discussed in our survey in relation to the campaign setting is the proposal of different algorithms to optimize viewability and other KPIs (such as engagement or video completion) in video ad campaigns to improve brand recognition and ROI [24, 60, 77, 81, 120]. Viewability could also be optimized in the campaign creation by selecting those ad formats that are more likely to be viewed. In this sense, in [99] it is reported that billboard ads, which are a large
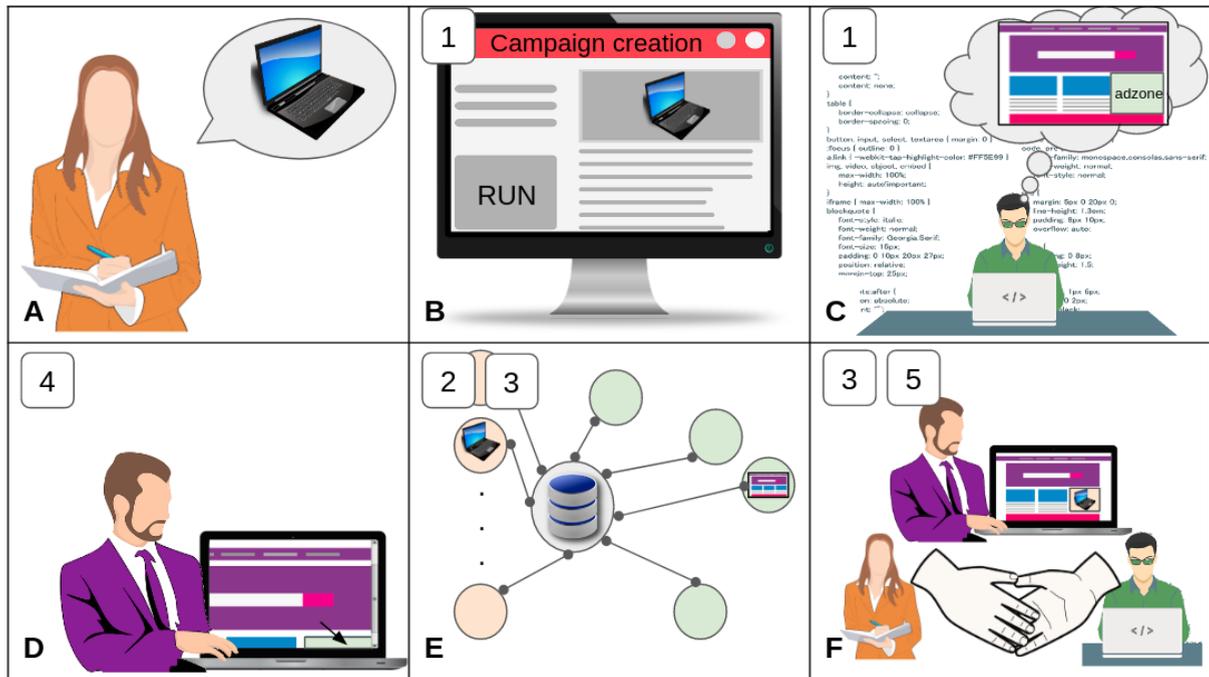
FIGURE 4. Schematic view of how viewability fits into the online advertising ecosystem, from the advertiser creating a campaign until it appears in front of a user's viewport. Each number represents the challenges listed in Subsection II-C6 and the main players are represented in the same colors as in Figure 2.

horizontal type of ad that usually appears at the top of the website, have lower viewability ratios than half-page ads, which are a vertical type of ad that is usually placed on the sides of the website.

Finally, the last topic is the possibility of using viewability as a pricing method [38, 52, 56, 78, 101]. This is usually called Cost Per View (CPV) however, according to [20, 103], the adoption of CPV in the industry is challenged by operational difficulties when implementing viewability tracking methods, discrepancies reported between different accredited vendors' solutions when measuring viewability, and by the limited volume of viewable inventory available. Even though these challenges represent real difficulties, there are studies [89, 137–139] that believe that CPV will become very popular in the future, especially for real-time bidding (RTB) and video campaigns, and for this reason they presented viewability rate predictors that could be used to calculate the CPV.

2) Ad-serving

The process of serving ads is usually managed by the ad tech companies. From our survey, we identify a major challenge that emerged during this process: the lack of consensus between these ad tech companies on how to define viewability.

In this sense, some works state that this lack of consensus is due to the fact that the viewability standard defined by the IAB and MRC is too strict for publishers [56, 93, 117]. Because of this, and according to [102, 106], Facebook and YouTube decided to use a different criteria to consider their video ads viewable.

From the advertiser's point of view, these works [56, 93, 117] also suggest that the viewability standard given by the IAB and MRC is too lax. For this reason, in order to make it more accurate for the advertiser, Zhang et al. [143] performed an empirical investigation to find the viewability measurement that was more similar to the responses of 20 participants regarding their ad recall. Uhl et al. [136] did something similar by analyzing view-through rates for various viewability criteria to quantify the causal effect of viewability. Also, Bellman et al. [14] explored several video completion thresholds to be used to detect viewability in video ads. However, according to [1, 36, 54, 99], these empirical studies might be biased by the experimental design used to obtain the results (like the display size used by the users to access the websites, the browsing settings, or the ad format selected) or the user perception towards the website and the advertised products.

On another hand, Rosen [118] suggested that it is very difficult to have a viewability standardization that satisfies all the stakeholders. Instead, he suggested that viewability should match each marketer's objective individually. Other works advocate for having multiple definitions of viewability depending on the device used to access the website [51, 58, 93, 114]. Their main motivation is that the standard defined by the IAB and MRC is not considering the user scrolling action and speed experienced with mobile devices in their viewability definition.

Finally, besides having different viewability definitions for each marketer's objective or depending on the device used, in our survey we find studies that discuss the possibility of

adding extra criteria to flag an impression as viewable. In this sense, it has been discussed whether viewability should also consider screen coverage [105]. Screen coverage refers to the proportion of the screen that the ad covers. According to Nelson-Field [105], there is evidence that website clutter affects the attention of the user and, therefore, it makes sense to include it in the viewability measurement besides the percentage of pixels and the time in-view. In [75], it is also mentioned that the in-view time considered to flag an impression as viewable should also take into account the physical user away time from the computer or if the user switched to a different tab or application. Something similar is also studied in [121], where viewability measurements and others ad attention models are compared against data from an eye-tracking experiment, and they found that the current standard provided by the IAB and MRC of viewability identifies ad attention substantially worse than other models.

We can conclude with the critical analysis performed in [41] where it is discussed that, although viewability measurement is still inaccurate and there is no clear consensus on its definition, it is already having a big impact on the industry. Moreover, in this critical analysis, it is also mentioned that although official ad industry organizations have invested time and important efforts to create a unique standard, powerful players in the advertising industry have been able to influence the debate to move that standard towards their interests.

3) Metrics

In accordance with our survey, many works have focused on analyzing the issues and benefits of viewability as a metric in the online advertising ecosystem. We can summarize their research and analysis in the following areas: the lack of transparency on how viewability is measured, the analysis and limitations of the available implementations to measure viewability, and the usage of viewability to improve other important metrics in online advertising.

In the first place, Adshead et al. [3] reported the concern between some interviewees about the lack of transparency on how Google assessed viewability in his platform. This is also mentioned by Porter [111]; they explained that the primary competition and consumer authority of the United Kingdom (the CMA) found that big companies such as Google and Facebook introduce opacity on viewability and brand safety metrics. The main issue of this lack of transparency regarding viewability is that, according to [10, 21], it could be used by opportunistic publishers as a revenue management tool. For example, publishers might set superior prices for viewable impressions than the average ones of the market.

On another hand, some works have focused on analyzing the available viewability implementations and their limitations [30, 50, 51]. These works explain that some implementations rely on monitoring the browser frame rate in order to detect when the ad is being rendered in the viewport. Such implementations are capable of detecting if the ad is in the viewport but they fail to accurately measure the percentage of pixels that are in-view. Other implementations look at the

geometric properties of the ad relative to another element of the site (such as the viewport). These implementations are dependent on the browser supporting JavaScript and might not work with unfriendly iframes (i.e., an iframe hosting a source from a different domain to the site). Because of this, they fail to reach a 100% viewability detection rate.

The last topic mentioned in the survey regarding the viewability metric is its use to assess the quality of an impression [10, 28, 29, 31, 54, 108, 110], to improve brand-safety control [59] or for conducting experiments to assess the ad effectiveness in predictive models [67, 69]. Viewability can also be used to improve the ratio of invalid traffic [38, 55, 65, 141]. For example, by detecting those ads that are not registering any views but are receiving clicks. Also, it could be used as a diagnose tool for SEM advertising to detect issues in a rank-bidding strategy [122]: if the ad is viewable but it is not receiving clicks, the advertiser might want to focus on improving the ad design to make it more stimulating to click. Finally, Fulgoni [57] suggested that those viewable impressions that were flagged as invalid traffic, should not be counted as viewable, since they were not being seen by a real customer.

4) User Experience

The relationship between user experience and viewability has also been studied in the literature, specifically how to use viewability to increase the user ad exposure and its consequences, and the relationship between viewability and the user's interest in the ad.

In the first place, some studies suggest that viewability could be used by publishers to improve their website layout [138, 139]. These studies mentioned that by predicting if a user will scroll down to the bottom of the website, publishers could move the ad slot position higher to increase the viewability ratio of their ad zones. However, this might be counterproductive, since according to [132], users that visit websites with many ads covering the viewable area (ad cluttering) have a bad user experience, which leads to lower viewability ratios in the website. Moreover, this bad user experience could incentive users to install ad-blockers software to avoid advertising nuisance [21, 115].

Besides modifying the layout of the website, viewability ratios could also be increased with a better design of the ad [79]. According to this work, if an advertiser wants to obtain as many views as possible, they should not use many colors and the ones used should be warm. On the other hand, to have longer in-view times (regardless of the number of views), advertisers should use between five to seven different colors, taking into account aggressive colors such as red. Also, animated and photograph images capture better the attention of the user than static and graphic pictures. All these creative features have also been considered in [8] to create an AI algorithm to predict viewability based on its content features.

On another hand, some works focused on analyzing the effect of different in-view ad exposure times on users. Brak-

enhoff and Spruit [23] suggested that ads with longer in-view time receive fewer clicks than those with shorter in-view time during the web browsing experience. However, according to [61], longer in-view times produce a higher engagement in direct search behaviors. Finally, in [79] it is mentioned that the longer the in-view time the more likely it is that the ad affects the user.

The last topic studied regarding the user experience and viewability is its use to understand the user interest on the ad [131, 137]. However, in [5, 121], it is discussed that viewability should not be considered as a proxy of ad attention, since it does not tell you if the user saw the ad, just if the ad had the chance of being viewed.

5) Privacy
In our literature survey, some works also expressed some privacy concerns regarding viewability. For example, viewability could be used to learn more about consumer's interests and preferences in advertising [86]. Other works defend that, although advertisers are very interested in maximizing the viewability of their campaigns, it is very important to develop viewability models that respect the privacy of the end-users [76]. In this sense, they proposed to use a viewability predictor model that only uses data about the publisher, partner and low-level banner features, but not the user behavior and interaction data.

On another hand, in [45] it is mentioned that viewability could be used to capture user's selective attention. Although this particular study does not discuss how this analysis on the user's attention might be perceived by users, other works stated that this practice generates privacy concerns between users [4].

Finally, in [90], it is mentioned that websites with high viewability ratios are more likely to show to the same user an ad that has been already displayed to him in another website, generating also privacy concerns to him.

V. DISCUSSION
In this section, we start discussing the benefits and drawbacks of viewability that we identified earlier. We have summarized the main results in Table 2. Afterward, we discuss the future directions of viewability and possible implications within the industry practitioners.

A. ROLE OF VIEWABILITY WITHIN THE CHALLENGES OF THE ONLINE ADVERTISING ECOSYSTEM
In our analysis, we saw that viewability might bring multiple benefits to the ad industry. In the creation of campaigns, viewability can be used as a pricing method, to improve targeting or to optimize campaign effectiveness by, for example, selecting those ad types that are more likely to be viewed. From the publisher's point of view, it is important to note that if they decide to sell their inventory to advertisers paying for views, it is important that they optimize their zones as well to increase their viewability ratios or otherwise their likelihood of being paid would also be low. Another

option for publishers is to sell their views more expensively by setting higher floor bids. However, in the long term, this would negatively impact those advertisers that are not interested in views or branding promotion but rather in clicks or conversions.

On another hand, the integration of viewability in the ad serving process is not trivial. Besides the multiple definitions of viewability, something that has not been debated in our survey is how the viewability pricing method would be included in the ad-serving process that ranks the creatives/campaigns. Moreover, in this ad-serving process, ad tech companies need to decide which telemetry data regarding viewability will be stored. Besides knowing if an impression is viewable or not, ad tech companies could also use the exact percentage of pixels that appeared on the viewport, the in-view time, the mouse over the ad, and other available data that would provide valuable insights to understand all the ad process. However, that would also have an impact on the infrastructure cost that will be needed to store and process all these new data, as well as the data protection protocols that will be followed to ensure a correct treatment of this information.

Regarding the measurement of viewability, in the online advertising ecosystem is very important to have commonly defined metrics between advertisers in order to make business transactions based on fair common grounds. Despite that, when an advertiser buys a viewable impression from a publisher, the advertiser is usually not informed about what criteria or technology have been applied to consider an impression as viewable. In order to be able to use viewability metrics to detect implementation issues on campaigns and websites and to improve invalid traffic measurement, we first need to reduce the viewability mismatch between publishers and ad tech companies.

Once the industry agrees on how to define and measure viewability, this metric might incentivize advertisers to enter a re-imagination process to design new ads that can be attractive and more viewable without damaging the user experience. In this sense, instead of using flashy or misleading elements in their creatives (such as fake close buttons that can increase clicks), they could analyze what aesthetic elements on the creative increase its viewability ratio. On the other hand, publishers would also be more encouraged to sell their inventory to advertisers paying for views rather than for clicks, since the strategies used to increase views are less aggressive than the ones used for clicks and, therefore, the user experience would be better.

Publishers could also decide to use techniques such as ad cluttering or to increase the ad coverage in the viewport of the user to increase the website viewability ratio. Notwithstanding, this would harm the user experience which in turn would also harm the viewability ratio of the website. For this reason, it is advisable that publishers design their website layout taking into account the user experience and that they reduce the number of ads in the viewable area.

Nonetheless, publishers might be concerned that by reduc-

Challenge	Player	Issue	Viewability & Qualitative indicator
Campaign settings	Advertiser	• Ad type selection. • Pricing method. • Targeting selection.	• New CPV model. ✓ • Targeting by the viewability ratio of ad zones. ✓
	Publisher	• Zone creation.	• Zone optimization with viewability. ✓
Ad serving	Ad tech companies	• Pricing models comparison.	• Viewability ratio. ✓ • Logging new telemetry data. ✗ • New CPV model. ✓ • Viewability implementations. ✗
Metrics	Advertiser	• Transparency.	• Multiple viewability definitions ✗ and implementations. • Reinforcement of quality metrics. ✓
	Publisher	• Mismatch.	
	Ad tech companies		
User experience	Advertiser	• Creative design.	• New ad design strategies to optimize viewability. ✓
	Publisher	• Increase of ads served per visit.	• Ad refresh with viewability. ✓
	User	• Consume publisher's content despite the exposure of ads.	• New ad design strategies to optimize viewability. ✓
Privacy	Publisher		• Viewability telemetry tracking and storage. ✗
	Ad tech companies		
	User	• Data usage and processing information.	• New user data being collected and processed. ✗ • New informed consents. ✗ • Improve user profiling. ✓

TABLE 2. Viewability analysis for each challenge and stakeholder. In the last column we can see a qualitative indicator of the impact of viewability in that challenge, indicating whether it is a limitation or a benefit for the industry.

ing the number of ad-zones in their services to improve the experience of their users, their ad revenue will be negatively impacted. This concern can be overcome by using techniques such as ad-refresh, which is however usually considered as a bad practice from the advertisers' viewpoint. The rationale is that since ads might be displayed during less time, advertisers are concerned about missing opportunities of reaching their potential customers. However, ad-refresh could be triggered only when the ad has been viewable. In this way, the publisher could assure the advertisers that their ads have been viewable before refreshing the zone with a new ad. However, this should be empirically analyzed, since if users perceive ad-refresh as an intrusive or aggressive practice, the overall viewability of the website might be damaged, which in the long term might reduce the possible benefits expected from the publisher.

Furthermore, viewability implies the continuous monitoring of browsing data, possibly different from those used for other metrics. Since there is currently no agreed definition of the metric at hand and no standardized web technology by which to estimate whether or not an ad is in the user viewport, it makes it very difficult to anticipate which users' data will be collected and analyzed when viewability is fully adopted by the advertising industry.

To reliably determine if certain viewability requirements are met (e.g., the percentage of ad pixels within the viewable space and the length of time the ad is in the viewable space of the browser), new types of data and analysis techniques are very likely to be utilized. Among others, computer-mouse data (e.g., clicks, movements and use of the scroll wheel) are very promising, albeit not a new alternative [6]. As early as 2013, Facebook claimed to use mouse tracking to learn how long a user's cursor hovered over a certain part of its website, or whether a user's newsfeed was visible at a given moment on their screen [119]. One of the disadvantages of mouse tracking is that it is very difficult to prevent while browsing the web today, especially because it can be implemented silently at scale, in incognito mode, and even without JavaScript enabled [6].

A priori, the collection and processing of those data may be regarded as an innocuous practice. However, the pieces of evidence currently available [34, 113] seem to suggest that mouse tracking (when deployed presumably for viewability purposes) cannot but increase users' privacy risk. In recent years, there has been a tremendous improvement in mouse-based biometric systems and currently, it is considered a key fingerprint of browsing behavior to track users throughout the web [125]. One archetypal example of systematized knowledge on mouse tracking is the biometric system [144], which may extract features of a user's mouse-movement patterns and recognize them with about 1% error rate via those traits.

Web tracking is by no means the only risk involved in mouse-based viewability. As a matter of fact, a recent study [87] on mouse tracking suggests the possibility of inferring demographic attributes unobtrusively and at scale with reasonable accuracy. Specifically, by using recurrent neural networks, the authors of the cited work were able to estimate age ranges with an F-measure of 0.653 and an AUC of 0.712, as well as the gender with an F-measure of 0.641 and an AUC of 0.650. Obviously, when mouse data are added to the wealth of information a user may disclose (voluntarily or involuntarily) across numerous information services (e.g., social networks, web-search engines, multimedia recommenders), attackers may more easily infer, even if

in a statistical sense, circumstances and trends affecting sensitive aspects of an individual's life, including health status, religious beliefs, social relationships or work performance.

On the other hand, it is also important to mention that viewability methods can also provide more precise information about the web content users are interested in. By looking at the sections of a website and the time it takes users to read them, the advertising ecosystem may create more accurate profiles of their interests and preferences, which may raise serious privacy risks concerning social sorting or segmentation [91]. For that, no only mouse data can be leveraged, which is a reasonable proxy of visual attention [37], but also other sources of information (e.g., the refresh rate of a pixel [87]) are likely to be exploited.

Last but not least, the European General Data Protection Regulation requires companies to ask for consent before data collection processes and to give users the right to know what data will be used for what purpose. In the scenario at hand, when users visit the publisher's service they might not be aware that, from the moment they load the service, they will be monitored in order to know what is in their viewport. In this sense, it should be analyzed if a consent request should be asked to inform users of this monitoring and how these data will be treated. Besides, it is not clear if this information should be shared from the publisher side or the ad tech companies side.

B. INDUSTRY IMPLICATIONS AND FUTURE WORK

The study of viewability and why it has not been yet adopted by the industry is important for all the online advertising community, since the big advertising organizations, such as the IAB and the MRC, have been working for a long time towards standardizing viewability with little success. Without a common agreement on how viewability should be measured and defined, the conclusions about its effectiveness will be confusing and it will be very difficult to make correct business decisions. Therefore, until the online advertising industry agrees on a unique standard and commits to follow it, it is very difficult to have the benefits we have reported in this work.

However, this opens a big debate on what criteria should be used, because viewability is dependent on many variables (such as the device used, if the ad is video or display format, etc.) and it is very difficult to define a measurement that fits perfectly all the cases and the interests of all the stakeholders. This raises the question of whether viewability metric should be considered as a boolean indicator that tells "if an impression is viewable or it is not" or if it would be better to consider "how much viewable" an impression is. In this sense, each marketer could buy that inventory that is viewable enough for them, and publishers would still be able to sell those impressions with a pixel percentage in-view or an in-view time lower than the one specified by the IAB and MRC.

In any case, whatever is the viewability criteria used by any vendor, such criteria must be disclosed in a transparent way to advertisers to help them make correct assumptions on

the reported data and to perform correct marketing decisions. Moreover, the technical implementation used to measure viewability should also be disclosed in order to evaluate the possible discrepancies between different technologies and to increase the trustworthiness of the reported measures.

In this sense, it is interesting to note that although the definition of viewability standard is supposed to be defined by policymakers, in reality, the big publishers and advertisers are the ones leading the directions of viewability towards their interests. In this sense, we note the lack of participation in this process of one of the most important stakeholders of the online advertising ecosystem: the user. Although viewability was born to understand if the campaign message is being correctly delivered to the user, the user has not been ever considered in the viewability definition nor asked about.

Anyhow, in order to motivate viewability agreement, the first step is to work towards improving the general viewability ratios sustainably and optimally for all the stakeholders. To do so, future work should aim to reduce as much as possible the invalid traffic, to improve the user experience within the website, and to improve the operational difficulties to measure viewability. Once the trust of viewability is fully recovered between all the involved parties, we can start working to develop new features such as more responsive banners that appear in the most viewable position of a user session, or to develop better models to analyze and predict conversions in campaigns. Finally, another area that could hold promising new grounds is the analysis on how to monetize viewability, by for example setting different prices for the first ads that are viewable by a user or by paying in relation to how long the ad has been viewable.

VI. CONCLUSIONS

The online advertising industry presents many challenges which have motivated both practitioners and researchers to combine efforts in order to improve the web ecosystem. One of these efforts has been the adoption of viewability in the ad industry with the purpose of having a more transparent and fair metric for all the stakeholders. In this work, we have performed a literature survey analyzing for the first time the role of viewability with respect to the viewpoint of each challenge and stakeholder. Similarly to [27], we modeled the online advertising ecosystem with all the stakeholders and their goals. As we have seen, the main challenges that we have identified are the definition of the campaign settings, the ad-serving process, the definition of transparent and standardized metrics, the user experience with ads, and the privacy issues. On the one hand, we saw the benefits of viewability for each one of these challenges by providing new pricing methods, metrics that can be used for zone targeting or zone optimization, or new triggers for ad-refresh. On the other hand, we also saw some of its drawbacks, such as the infrastructure design to store and process the new telemetry related to viewability, or the multiple viewability definitions and implementations. To the best of the author's knowledge, this survey of viewability is completely novel and can provide

a solid ground of the current state of this metric as well as future lines of work for the industry.

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