

Platforms as service ecosystems: Lessons from social media

Cristina Alaimo¹, Jannis Kallinikos² 
and Erika Valderrama²

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Abstract

The growing business expansion of social media platforms is changing their identity and transforming the practices of networking, data and content sharing with which social media have been commonly associated. We empirically investigate these shifts in the context of TripAdvisor and its evolution since its very establishment. We trace the mutations of the platform along three stages we identify as search engine, social media platform and end-to-end service ecosystem. Our findings reveal the underlying patterns of data types, technological functionalities and actor configurations that punctuate the business expansion of TripAdvisor and lead to the formation of its service ecosystem. We contribute to the understanding of the current trajectory in which social media find themselves as well as to the literature on platforms and ecosystems. We point out the importance of services that develop as commercially viable and constantly updatable data bundles out of diverse and dynamic data types. Such services are essential to the making of the complementarities that are claimed to underlie ecosystem formation.

Keywords

Digital platform, platform ecosystem, data, data-based services, complementarities, social media, social networking, user participation

Introduction

Since their inception, social media platforms have been bound up with the role of users as active platform participants. User-generated content has been emblematic of social media. YouTube, Facebook or Instagram are prominent examples that attest to the importance that large populations of users and their practices of networking, content creation and sharing have had for social media. It is hardly surprising, therefore, that user involvement has figured as a defining attribute of social media across various literatures (see, for example, boyd, 2015; boyd and Ellison, 2008; Oestreicher-Singer and Zalmanson, 2013).

Justified as it may seem, the focus on users has nonetheless tended to downplay the structural, technological and economic forces that have driven the evolution of social media to complex and operationally diversified business actors. The contrast has become even more pronounced over the last few years as a result of the expansion of the commercial operations and industry involvement of key social media players. Facebook, for instance, has introduced payment services via Facebook Messenger and is now about to introduce its own cryptocurrency. LinkedIn has steadily extended its networking

capabilities to the provision of talent and recruiting services to organizations and TripAdvisor has begun to sell travel service packages across the entire holiday value chain, allowing users to review but also compare accommodation or restaurant information and make their booking. These developments provide alternative revenue sources (revenues from direct service charges in the case of LinkedIn and commission revenues in the case of TripAdvisor) to advertising that has been the dominant business model for a great deal of social media platforms. Critically, such changes expand, diversify and restructure the flows of data on the basis of which social media operate as economic organizations. Data from business transactions are added on and variously complement data derived from user interaction that for years have marked social media platforms.

¹University of Surrey, UK

²London School of Economics and Political Science (LSE), UK

Corresponding author:

Jannis Kallinikos, London School of Economics and Political Science (LSE), London WC2A 2AE, UK.

Email: j.kallinikos@lse.ac.uk

It is hard to tell whether these developments reflect wider changes in the digital economy or are just symptomatic of a limited group of social media companies. Yet, on many signs to judge (e.g. Facebook or LinkedIn's commercial growth and diversification), they are indicative of wider transformations. The study of TripAdvisor we report in this article suggests that these developments are associated with the growing involvement of the platform within a larger business ecosystem of diverse services. We deploy the concept of ecosystem to refer to the synergies and complementarities achieved between the activities, resources or outputs of several organizations. Such synergies and complementarities are portrayed in the literature as being resource or service specific in ways that strongly reinforce the value or returns of ecosystem participants (Adner, 2017; Jacobides et al., 2018; Teece, 2018). Ecosystems emerge around specific, value-reinforcing activity and resource complementarities that usually cut across several organizations, industries and platforms.

Building on and extending the current literature, we consider digital data (hence data) as central to the dynamics of social media platforms and essential to understanding their ongoing passage to platform ecosystems. This is an argument that takes the significance of data and their economic impact well beyond big data or big data analytics (Kallinikos and Constantiou, 2015). Data, we suggest, are an essential and specific type of resource whose value is contingent on its constant updatability, portability and sharing (Kallinikos, 2007), attributes that require new practices of collaboration across boundaries (Arthur, 2017). But data are also a key medium by which business relationships and connections are forged in the digital economy. Many contemporary services traded across platforms and their ecosystems are data made or data underwritten. Such services are essentially data relations. Hotel popularity indexes, hotel room or restaurant table availability on real-time are typical examples. Data services of this sort are indexes and measures achieved by the computation of steadily updatable data, collected, aggregated and mashed up along paths that cut across several sources, organizations or platforms. Hence, we aim at investigating how different kinds of data are drawn upon to establish the type of resource links and service complementarities that underpin ecosystem formation. Specifically, we ask, how do data generation, structuration and commercialization drive ecosystem formation? We know that user-generated content, social and networking data play a key role in sustaining social media platforms (Helmond, 2015; Oestreicher-Singer and Zalmanson, 2013; Van Dijck, 2013). Yet, very little is known about the dynamics by which such data are linked to business transaction data. How do the links between different types of data look like and how do they shape new economic practices, platform evolution and the formation of platform ecosystems?

We seek to address these questions through a longitudinal case study of TripAdvisor (Akemu and Abdelnour,

2018; de Reuver et al., 2018). The study retraces the pattern of transformations the platform has undergone from its establishment onwards along three major stages: search engine, social media platform and end-to-end service ecosystem. Each stage is linked to several data practices whereby specific data types and formats are produced, combined and used. In turn, such data practices are sustained by distinct platform functionalities. Data and functionalities are instrumental to the design and implementation of the various roles actors take and are made to perform as users on the platform, that is, end-users switching between producers, reviewers and consumers of data services or hotel owners acquiring an active role as subscribers of TripAdvisor's services.

The findings from the study of TripAdvisor have relevant implications for understanding how social media platforms are transforming into service ecosystems. In line with previous studies, we find that ecosystem formation is driven by the achievement of specific and value-reinforcing complementarities across several ecosystem participants (Adner, 2017; Jacobides et al., 2018). In contrast to previous research, we find that such complementarities are often achieved by the systematic exploitation of different types of data which are drawn upon to assemble more complex data services (popularity index, booking packages, data analytics subscriptions, etc.). Data-based complementarities are established by the practices of data and data service generation and exploitation, the functionalities underlying these practices and the technologies and systems that support service exchanges. This implies that this type of service ecosystems, which are dependent on the practices of data complementarities, will be more likely to overwrite physically embedded and other types of constraints and to lead to cross-industry ecosystem emergence and innovation (Kallinikos et al., 2013; Yoo et al., 2010).

We contribute to the literature by tracing the development of data-based services and their role in establishing data complementarities, which we define as a specific type of data synergies that lead to the emergence of service ecosystems. Our study contributes to understanding the mutations social media currently undergo and has important implications for the study of digital platforms and digital ecosystems. The study suggests that successful social media platforms fashion complex and constantly shifting data services out of the diverse and dynamic sources of data they are able to produce or to get from partners. Complex data-based services are likely to require complementarities that give rise to business relationships which eventually lead to the emergence of ecosystems across organizational, sector or industry boundaries.

The article is structured as follows. In the next section, we review the literature on social media, online platforms and ecosystems. We position ourselves vis-a-vis this literature and expose the issues we feel may require further attention and research. We subsequently present our case

study of TripAdvisor. After outlining our research methodology and describing our data collection and analysis, we move on to reconstructing at some length the evolution of TripAdvisor from a travel search engine to a central actor of the global travel and hospitality industry. We subsequently analyse our empirical narrative and place the evolution of the platform against the broader framework of the issues presented in our literature review and the wider literature on platforms and ecosystems and delineate our contribution to that literature. We conclude by a brief note on the wider relevance of our findings.

Literature review and positioning

Since their emergence, social media have been widely perceived as sites of networking and community building and, accordingly, referred to as social networking sites. The term carries the heritage of the early years and the perception of social media as predominantly online spaces of individual self-presentation and networking. Increasingly, such a view has been complemented by the understanding of social media as complex arrangements of actors, technologies and practices (Helmond, 2015; Srnicek, 2017; Van Dijck, 2013). As it now stands, the literature on social media spans over a large and cross-disciplinary landscape, extending from networking sites to platforms. While an exhaustive review of that literature is beyond the scope of this article (see, for example, de Reuver et al., 2018; Helmond, 2015), we outline below what we take to be the most representative perspectives on social media against which we position our research.

The first perspective we outline frames social media as social networking sites. It sees the emergence of social media as being closely associated with the establishment of a new paradigm of technology-mediated interactivity (boyd, 2015)¹ brought about the transformation of the Web from a space of information display to an interactive environment in which users are able to act upon, create, share and modify content (Zittrain, 2008). The initial definition of social media as *social networking sites* is indicative of the understanding of social media as online facilities through which people link and interact with one another (e.g. boyd and Ellison, 2008; Ellison and boyd, 2013). The perspective stresses the centrality of social media users and focuses on the social, personal and political conditions underlying the morphing of groups, communities and networks online.

The conception of social media as sites of networking is obvious and, in certain sense, hard to dispute. If there is anything distinctive with social media, then this pivots around the massive presence of users and the shifting networks or communities that emerge (and dissolve) as users create, share and consume content online (Berger et al., 2014; Kane et al., 2014; Shirky, 2008). While germane, such focus overlooks the structural, technological and

economic forces that shape the morphing of user networks and, ultimately, the behaviour of users (see, for example, Alaimo and Kallinikos, 2017, 2019a). The rapid development of data handling technologies, recommender systems and machine learning have transposed the ubiquitous interactivity of social media upon a technological context in which backend technologies and their links increasingly erode and considerably shape interaction patterns at the frontend.

The growing economic involvement of social media has furthermore put their conception as sites of conviviality and networking under a hard test. A great deal of social media sites has over time grown to complex and operationally diversified business actors. In the second perspective we outline, these developments have been gradually associated with the understanding of social media as platform organizations facilitating certain kind of exchanges. In the wake of Rochet and Tirole's (2003, 2006) pioneering work on two-sided markets, online exchange facilities of this sort have been conceived as *multi-sided markets*. It is characteristic of such settings that the benefits of each group of participants on each side are contingent on the other side(s) by what is often referred to as indirect or cross-side network effects (Parker et al., 2016). This two-way interdependence constitutes multi-sided platforms as a distinct type of digital intermediaries and confers value to the role of intermediation they perform (Rysman, 2009).

The notion of multi-sidedness is a useful lens to approach social media as digital platforms and to study how the various types of stakeholders interact with one another in ways that benefit themselves and the platform owners. The mutual relationship between different sides is particularly valuable for multi-sided markets and is often perceived in terms of indirect or cross-side network effects (Boudreau, 2010; Evans and Schmalensee, 2005, 2016; Parker et al., 2016). Such an outlook confers a novel understanding of the economics of social media, yet it tends to subsume social media platforms under the more general category of digital platforms without regard for what might be the distinctive attributes of social media. The role of users as active generators of content and data, for instance, is seldom acknowledged. User data, their economy and their specific contribution to sustaining the operations of social media are often lost from sight. Digital platforms, we suggest, are more than marketplaces and their operations are considerably shaped by cultural and technological forces.

The two perspectives outlined so far largely relegate technology to the background of social media operations. A third approach to digital platforms sees them as *technological infrastructures* or assemblages of various technical components (e.g. Helmond, 2015). Similar to other complex socio-technical systems, social media are sustained as entities by a number of technologies and technologically attuned operations that are held together by a variety of

technical links and architectures. The activities of users or platform participants on social media are conditioned by the interdependence of these technologies and organizational capabilities into a dynamic and reasonably functioning whole. Most social media are known to maintain complex data management systems through which data are standardized, structured and made portable within and across platforms and large portion of the Web (Alaimo and Kallinikos, 2016; Gerlitz and Helmond, 2013). These operations, in turn, require suitable user interface designs to foster specific forms of user participation and a range of data management tools (e.g. recommender systems, data analytics) that considerably impact upon the behaviour of users or platform participants (Alaimo and Kallinikos, 2017, 2019b; Van Dijck, 2013).

Infrastructural conditions therefore carry important implications with respect to how platforms operate (see, for example, Contini and Lanzara, 2008; Hanseth and Lyytinen, 2010). Yoo et al. (2010), in particular, conceive of business relationships in the current digital world as conditioned by modular and layered technological architectures. As distinct from integral and often physically embedded architectures that feature links between the constitutive components of a system that are hardly decomposable (Ulrich, 1995), modularity and layering loosen component interdependencies (Baldwin and Woodard, 2009; Henfridsson et al., 2014, 2018) and allow recombinant innovation along several paths. These infrastructural conditions help establish a dynamic space of action and innovation whereby platform components can be brought into revisable configurations that render them able to respond on a constant basis to the shifting demands of the broader platform environments into which they are embedded (Baldwin and Clark, 2000; Henfridsson et al., 2018; Zittrain, 2008).

A final stream of research we consider is on platform ecosystems. The concept of *platform ecosystem* or simply *ecosystem* has become increasingly used over the past few years as a means of accounting for the advantages conferred to ecosystem participants by resource or activity links that cannot be attributed to standard supply chain configurations or other resource and action interdependencies associated with the concept of industry, cluster or network (Adner, 2017; Gawer, 2009, 2014; Langlois, 2003). Such links have become widely diffused in the digital economy, calling for an explanation of the forces that govern their establishment, development and eventual decline. Social media platforms and the apps they host are a case in point (Nieborg and Helmond, 2018). The concept of ecosystem and the study of the forces that underlie its formation emerged in this context as a way of pursuing questions that cannot be addressed by recourse to the conceptual tools associated with industry dynamics and the analysis of supply chain networks.

Adner (2017) defined an ecosystem as the formation of multilateral links on the input, activity or output side that

are not attributable to the sum of bilateral associations between the participating actors. Thus viewed, an ecosystem is more than the sum of the bilateral business relationships in a network of firms. This *ecosystem-as-structure* perspective, as Adner calls it, contrasts with the view of ecosystems as networks of affiliated organizations. From this perspective, an ecosystem is the organic pattern of multilateral connections between firms and their activities that fosters synergies and complementarities that would otherwise not emerge. The concept of complementarities is particularly relevant here as it explains the formation of ecosystems. Jacobides et al. (2018) attribute ecosystem formation to the structure of complementary roles, resources and activities between a group of firms. Similar to Adner (2017), Jacobides et al. (2018) consider such complementarities as non-reducible to bilateral business relationships. Ecosystem-conducive complementarities develop as the result of unique or specific links between several firms and are thus different from generic complementarities that do not require specific coordination mechanisms and have, under normal circumstances, been handled well by the market. It is the nature of specific complementarities entailing relationships of the type 'more of A makes B more valuable' and vice versa that tends to lead to ecosystem formation (see Jacobides et al., 2018). In simpler words, it is the strength, dynamicity and specificity of complementary relationships on the input, activity or output side that lead to ecosystem formation. The literature on ecosystems is much more diverse with reference often to platforms as the focal actors around which complementary relations between the core of the platform and its peripheral components, activities or resources develop (see, for example, Boudreau and Jeppesen, 2015; McIntyre and Srinivasan, 2017; Teece, 2018; Tiwana et al., 2010; Wareham et al., 2014). However, the arguments put forward by Adner (2017) and Jacobides et al. (2018) express much of the *geist* of current research on ecosystems.

There is still very little on the literature of ecosystems about social media. It can be conjectured that the ideas of specific and value-reinforcing complementarities across a group of components, services or firms are directly applicable to their case but this is far from clear. The same, by and large, applies to the other two strands of literature that deal with digital platforms as multi-sided markets or infrastructures. Occasional references to social media across these literatures indicate they are often seen as particular instances of the wider phenomenon of digital platforms. By subsuming the specific phenomenon of social media under the more general category of digital platform, much is gained but much is lost as well. The specificity of social media is compromised and so are the ways by which users are involved in the creation and diffusion of content, the generation of data and the shaping of social media platforms more generally. Neglect of data and the technologies by which they are sustained is common to management and economics from

Table 1. Different approaches to social media and digital platforms.

	Social media as networking sites	Platforms as multi-sided markets	Platforms as infrastructures	Platforms as ecosystems
Focus	User networks	Exchange mechanisms	Component links and architectures	Input, activity and output links
Key concepts	Network formation, user-generated content	Network effects markets and platforms	Modularity, core and periphery relations	Ecosystem structure and complementarities

which two strands of the literature reviewed above emanate, that is, digital platforms as multi-sided markets and platform ecosystems. However, it applies as well to the other research strands we briefly reviewed in this section, namely social media as networking sites and, surprisingly, platforms as infrastructures. While the literature on platforms as infrastructures has produced unrivalled explanations on how component architecture matters (see, for example, Henfridsson et al., 2018; Rolland and Monteiro, 2002; Yoo et al., 2010), the distinction between data and the technologies by which they are produced has remained often lurking and, thus, untheorized in this literature. Table 1 summarizes the four stands of literature reviewed, their primary focus and the key concepts they use.

We consider data as central to understanding the dynamics and specificity of social media platforms and the ecosystems in which they are embedded. Theorizing data and the critical role they play in shaping the current digital economy represents a major intellectual challenge. Similar perhaps to money, data are a dual entity. They are a specific kind of resource for the making of services but also the medium through which social, economic and material relationships are expressed and ultimately perceived. Reputation metrics, popularity or trending metrics are typical examples. Cast in this light, many contemporary services are data mediated, data made or data underwritten. By the same token, a great deal of the input and activity complementarities discussed in the case of the ecosystem literature are essentially constituted as data resource or data activity links. For instance, the complementarity developed across TripAdvisor and The Fork (a restaurant-booking platform) are data links underwritten by the data resources by which they are described (reviews/ratings on TripAdvisor linked to restaurant availability and price comparisons). Certainly, data services, resources or activities have at some point to enter the physical, social or economic world and be redeemed by the consumption or use of physical resources such as hotel rooms and restaurant food. At the same time, it is important to realize that TripAdvisor, as many other social media platforms, does not trade physical products or resources but the availability of these products or resources (data) and their conditions such as prices, location and reputation (again data or metadata). All the services offered by these platforms are made possible by the standardization and computation of data collected, aggregated and mashed up along the data value chain (Alaimo and Kallinikos, 2017, 2019b).

We assume that social media platform evolution is significantly shaped by the development of the ecosystem within which platforms are embedded and, particularly, by the *structure of resource* and *data links* underpinning the relationships of ecosystem participants. The structure of links is, in turn, fashioned by the *technological systems* and the wider technological *infrastructures* underpinning ecosystem exchanges and operations (e.g. Yoo et al., 2010). Understanding the structure of links in the case of social media further requires charting the *models of user involvement* and the critical roles users play as *content* and *data generators* together with the technologies that support that goal (e.g. Alaimo and Kallinikos, 2016, 2017, 2019b; Gerlitz and Helmond, 2013; Helmond, 2015). Building on and extending the literature reviewed, we aim at investigating how different forms of data are drawn upon to establish the links that underpin ecosystem formation. Specifically, we would like to understand how data generation, flow and commercialization drive ecosystem formation and account for the functional contribution data make to the emergence of ecosystem relationships. The role user-generated content, social and networking data play in sustaining social media platforms is generally well researched. However, less is known on the mechanics by which such data are brought to bear on business transaction data. How do these emergent links between different forms or types of data (e.g. transaction and user-generated data) shape platform evolution and the rise of platform ecosystems? What lessons can we draw from the study of TripAdvisor as regards the role such diverse types of data and the links they occasion play in ecosystem formation? Ultimately, do such developments drive social media platforms away from their reliance upon data traditionally derived from practices of networking, content generations and sharing?

Research design and methodology

We conducted a case study of TripAdvisor, from its establishment in the year 2000 to the end of 2017. Our ultimate research objective has been to use the empirical evidence as the basis for advancing *analytic generalizations* (Yin, 2009)² on the patterns of social media evolution and ecosystem formation. The case study consisted of two stages (see Table 2). The first stage is a pilot study of seven hotels, five restaurants and three attractions working with TripAdvisor. The study lasted 4 months and was conducted

Table 2. Data stages and sources.

	Data sources
Pilot case	15 semi-structured interviews 10 days of in situ observations Documents and videos: 1. TripAdvisor insights (www.tripadvisor.com/TripAdvisorInsights) 2. TripAdvisor business owner websites (forums, articles, tutorials, etc.), TripAdvisor For Developers (https://developer-tripadvisor.com), including API technical description 3. TripAdvisor's connectivity partners, websites freetobook, travelclick and sabre 4. Annual financial reports of TripAdvisor
Longitudinal case	TripAdvisor media centre (https://tripadvisor.mediaroom.com) 'Press releases': 3388 press releases from 2000 until December 2017. 1677 of these records are in English and make the primary information source of this case narrative Two secondary interviews of Stephen Kaufer, TripAdvisor CEO over the years

API: Application Programming Interface; CEO: chief executive officer.

in 2017. The second stage entails the longitudinal study of TripAdvisor, mostly based on online, publicly available archival records (Rogers, 2013).

The pilot study has had a decisive impact on our continuing involvement in the field. It revealed the immense complexity of TripAdvisor's ecosystem and underlined the need to study the data flows that underpin that ecosystem. For instance, booking a hotel room may seem a very simple and straightforward action. Yet, displaying real-time room availability of hotels distributed over the globe and being able to efficiently support the massive amounts of bookings arriving every minute is anything but simple. In this regard, the pilot study revealed portions of TripAdvisor's hidden ecosystem, the network of Internet Booking Engines (IBEs) through which room availability and booking are sustained as well as the complex data flows and revenue streams taking place between ecosystem participants such as TripAdvisor, IBEs, Online Travel Agencies (OTAs such as Expedia or Priceline) and hotel owners (including hotel global chains such as Marriott or Hilton). Coupled with our critical review of the literature, the pilot reinforced the idea that social media companies are embedded in complex business ecosystems and made us sharply aware of the complexity of links underpinning the relationships of ecosystem participants.

The longitudinal study entailed the collection of evidence from the TripAdvisor media centre (see Table 2). While certainly linked to the public image TripAdvisor may wish to convey, these records are factual enough and inherently not worse in quality than evidence collected through interviews, minutes and documents. In fact, their public accountability makes them more rather than less reliable. The section 'Press releases' was particularly relevant for our study as it provided first-hand, factual information about the course of events that have marked the evolution of the platform over time. Data collection was complemented with two secondary interviews of Stephen Kaufer, TripAdvisor CEO over the years.³ It is a diffused practice in case study research to use biographies or other

material such as public interviews to reconstruct historical evidence (Weick, 1993). The interviews provided information on the early stages of TripAdvisor, which is hard to find and helped us contextualize the data from our online sources.

The 1677 press releases in English were classified according to their content: rollouts, partnerships, acquisitions, awards and reports. While we base our report on the entire archive, the rollouts sub-category (216 publications) has played a crucial role as it provided most of the evidence of the features launched over time, which is key to understanding the transformations of the platform. The 216 rollout press releases were manually analysed in two consecutive cycles: codes and coding, and pattern codes (Miles et al., 2014). Under the assumption that social media are data platforms (Alaimo and Kallinikos, 2017) that provide services, the categories *data production* and *services* were set as the default themes on the basis of which the coding process was conducted. Through iterative line-by-line reading, cross-checking and juxtaposition, chunks of text were assigned descriptive labels ('codes') which were then grouped into meaningful categories and themes. A new overarching category, that is, *ecosystem*, emerged out of this process (see Figure 1).

Although this analysis allowed us to extract themes from the data corpus, it did not provide us with a timeline of events. For this, we relied on a subsection found at the bottom of most of the 1677 press releases, entitled 'About TripAdvisor', where the company describes itself over the years. We tracked changes in this section manually, which resulted in the identification of eight initial patterns that, through iterative readings and theme comparisons, were reduced to three more basic stages of development: (1) search engine, (2) social media platform and (3) end-to-end services. We superimposed this three-stage periodization (search engine, social media, end-to-end services) to the code structure of Figure 1. The results are shown in Figure 2 that maps the descriptive themes that emerged from coding on the temporal axis of the stages of TripAdvisor's evolution.

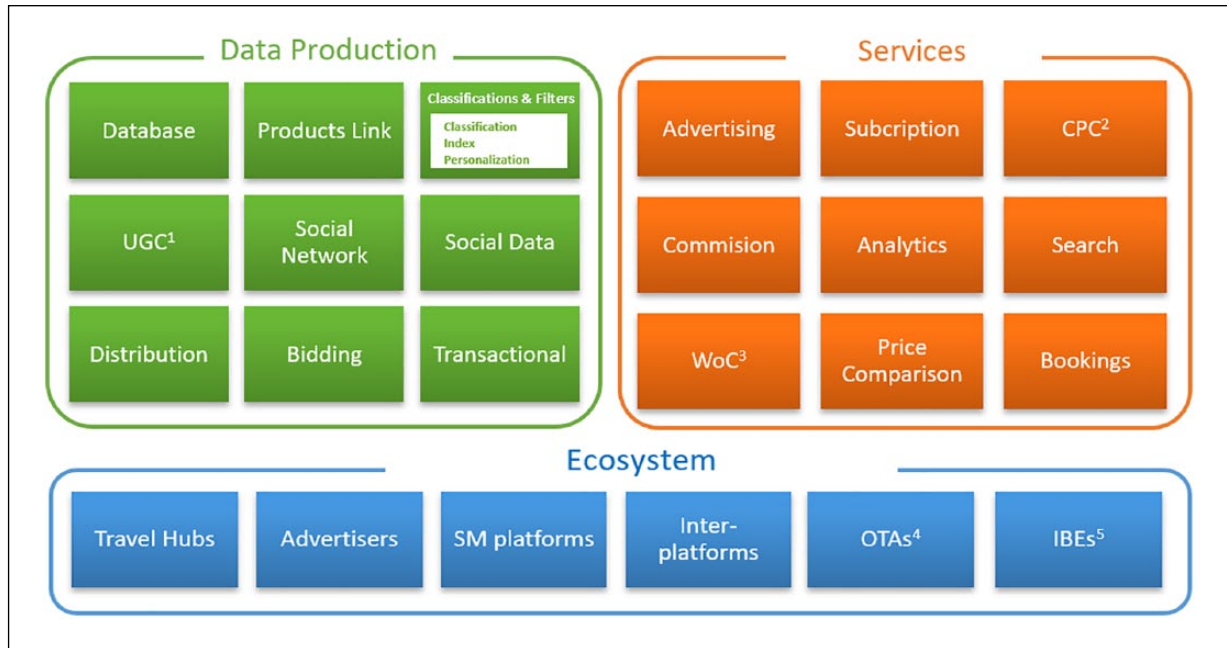


Figure 1. Code structure.

UGC: User-Generated Content; CPC: Cost Per Click; WoC: Wisdom of Crowd; OTA: Online Travel Agency; IBE: Internet Booking Engine

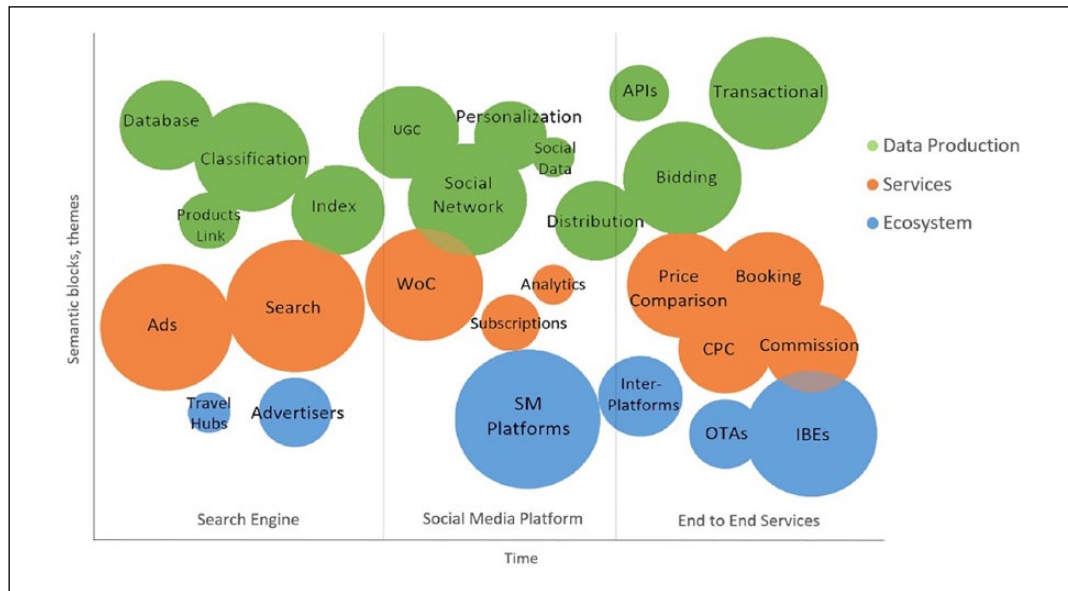


Figure 2. Code periodization.

We assessed and validated the thematic analysis with *co-term network analysis*, a text mining technique that facilitates uncovering hidden meaning patterns and structures embedded in a specified text corpus. This technique measures the frequency of appearance of terms in a text both in isolation and in conjunction with other terms. It provides an overview of the term structure and makes visible the clusters of topics embedded in a text corpus by aggregating the terms that are more densely connected.

The process of generating a co-term network analysis is semi-manual and involves several steps (see Figure 3). We used CorText, an online tool for text corpus analysis, to support the process. The co-term network analysis is a reductionist, bottom-up data process. It starts by building a dictionary with relevant terms. In our case, we built our dictionary based on the 300 most frequent two-to-three consecutive words that CorText identified in the corpus. These terms were manually cleaned by removing terms that

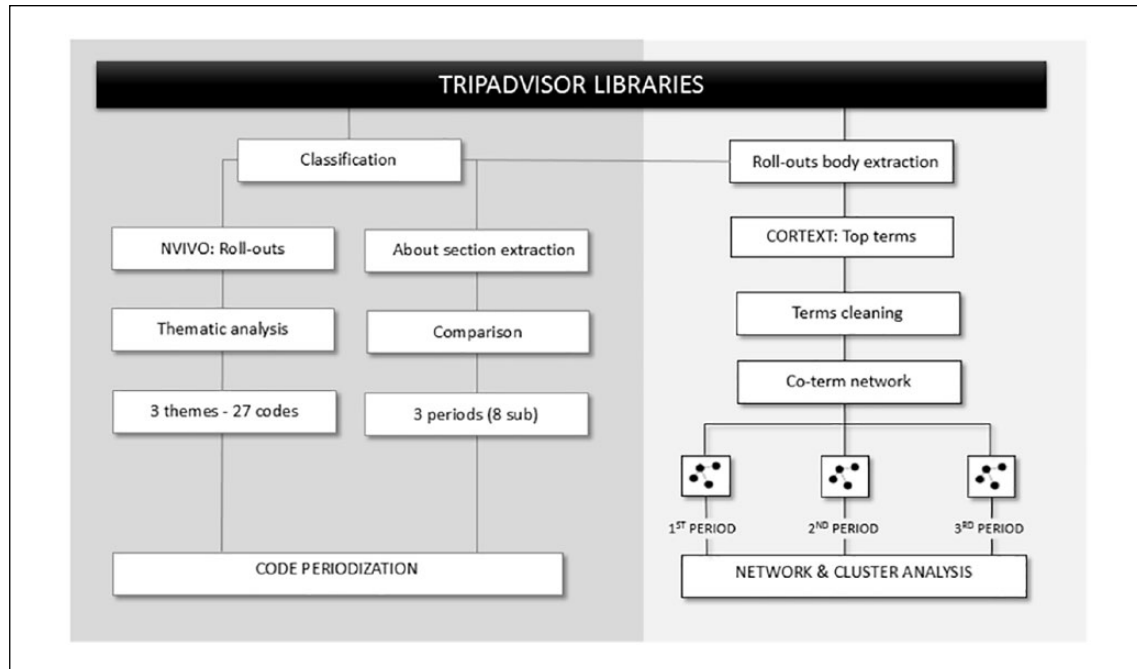


Figure 3. Data analysis methods.

did not contribute to the production of meaning (such as names). Also, terms with the same meaning were grouped together. For instance, among the top 300 most frequent terms appear connectivity partners, booking engines, IBEs and TripConnect partners. These terms in the text corpus are synonyms and for this reason they were subsumed under the same term (connectivity partners). The cleaning required understanding the meaning of the terms and context in which the terms appear to reduce the amount of noise without losing meaningful terms. This was essentially aided by the thematic analysis we outlined above.

The final step of the process is the generation of the co-term network. To do this, we used CorText to compute the dictionary so as to obtain all the significant co-occurrences of the terms and their connections in the corpus. In our network, the nodes are the terms in our dictionary whose size depends on the number of occurrences in the text corpus. The edges are the links between nodes and represent the co-occurrence of them. The thickness of the edges is given by the number of times that two terms are mentioned together in a text corpus. The network spatialization and its interpretation depend on the selected layout algorithm as these algorithms emphasize different characteristics of the network. We used the Atlas force algorithm that simulates a force system in which the nodes repel each other and the edges bond the nodes together. Densely connected nodes are located at the periphery of the graph surrounded by the nodes connected to them. The agglomeration and dispersion of nodes facilitate the visualization of topical clusters. We assigned different colours to clusters to further simplify visual inspection. To be clear, clustering is a mathematical

operation that imposes a division where it does not exist. This is particularly relevant to have in mind for nodes that are on the boundaries of clusters, since in these cases the assignment to a determined cluster is not definitive. We divided the corpus into the three stages of evolution previously identified in the thematic analysis and generated each of their co-terms network graph. This allowed us to better understand the landscape of topics in each period and to uncover patterns in TripAdvisor's evolution. The co-terms analysis lends further support to the pattern of transformations TripAdvisor has undergone over time (see Figure 2). Figure 3 illustrates the two methods of data analysis.

Results: the pattern of TripAdvisor's evolution

Each of the three stages in TripAdvisor's evolution we have identified is marked by the development of certain type of services and the links to various actors in the platform's surroundings. While often sustaining diverse types of resource exchanges, most of the times these links generate specific types of data that variously underpin the operations of TripAdvisor and its services.⁴ Figure 4 provides an overview of the key features rolled out in each period and the services and partnerships with which they are associated. From 2000 to 2004, TripAdvisor operated mostly as a search engine. This is evidenced by the growth of search and advertising services that mark the establishment of TripAdvisor as a search travel database and a travel advertising platform. The second stage is closely associated with the development of social (or Web 2.0) mobile features and inter-platform

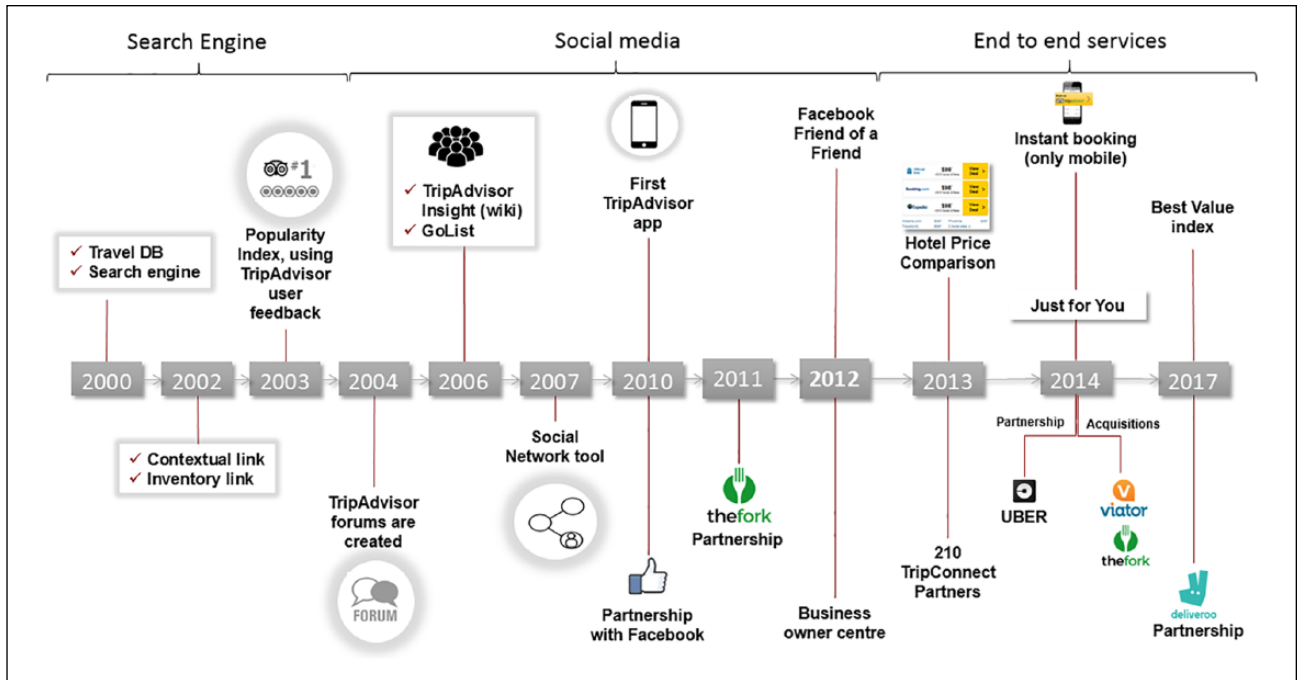


Figure 4. TripAdvisor's evolution.

connectivity. Although the first social media features were rolled out in 2004, it is not until the beginning of 2006 that TripAdvisor starts to portray itself as a user-generated content (UGC) platform. The third and last stage coincided with the introduction and enhancement of booking and end-to-end services that are part and parcel of the broader transformation of TripAdvisor from a social media platform to a hub of a complex ecosystem of other entities and platforms.

In what follows, we describe each of the three stages with a focus on the services, data and actors that prevail in each one of them. We conclude the description of each stage with a brief explanation of the main results of the thematic and co-term network analysis (detailed in the figure captions).

Kick-off: search engine and advertising

Back in 2000 the Web was populated with rich travel content sites, yet travel information was fragmented and hard to find. Having seen the opportunity of providing a service, TripAdvisor quickly positioned itself as a search engine and built a database with up-to-date travel content by indexing relevant online travel sites and manually classifying them (Livingston, 2007: 364). As part of improving the retrieval of comprehensive travel information about destinations, TripAdvisor was one of the first sites able to respond to multidimensional queries and launched a dynamic hotel index that provided an 'up-to-date view of the most popular hotels in a given city' (TripAdvisor, 2002b):

In contrast to other hotel indexes which statically rank hotels alphabetically or by price, TripAdvisor's new hotel index is the

first of its kind to dynamically rank hotels worldwide based on the popularity of a given hotel, as measured by both the quantity and quality of content written about the hotel on the web.

To monetize its search services, TripAdvisor implemented contextual link advertising. This refers to the display of highly targeted ads selected automatically on the basis of user data (i.e. profile, search queries). By 2002, contextual link advertising signified a break away from traditional banner advertising. Unlike traditional banners, a contextual link matches user search data with related ad categories, displaying relevant ads that eventually are clicked through. This change brought about a considerable improvement in the conversion rates of advertising (TripAdvisor, 2001). The offering of contextual links required indexing advertisers' products to TripAdvisor's database (Livingston, 2007; TripAdvisor, 2002a). To do this TripAdvisor built Inventory Link, a lead generation service, which 'automatically indexes an advertiser's entire product database, creates unique HTML commerce links for each product and syncs these links with its search database without involving the advertiser' (TripAdvisor, 2002a).

The main services offered by TripAdvisor in this period were thus search tools for travellers that were monetized through advertising (see Services in Figure 5). The metadata on the basis of which travel content and products were indexed and classified in TripAdvisor's database (see Data Production in Figure 5) facilitated data consultation (e.g. multi-queries) and enabled the implementation of dynamic indexes, further enhancing TripAdvisor search services.

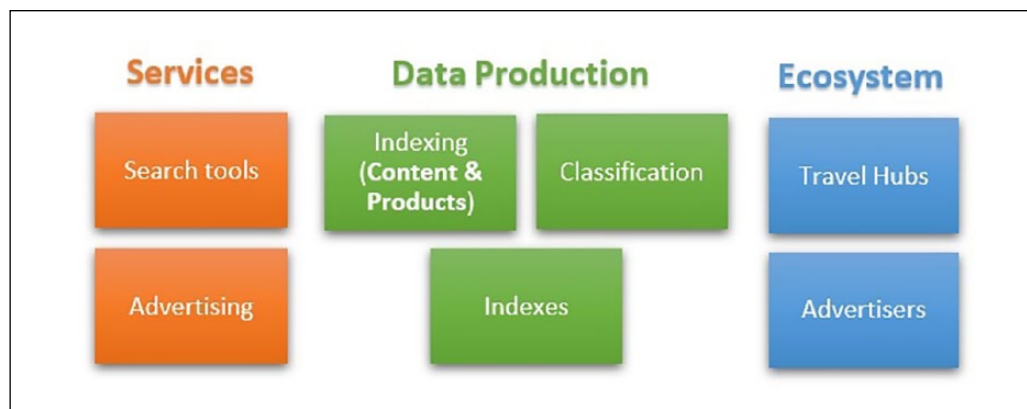


Figure 5. First-period thematic analysis.

Already at this stage, TripAdvisor adopted user ratings that were, however, indexed from other travel hubs and then manually classified and weighed. During this period, data were mainly procured from travel hubs and advertisers (see Ecosystem in Figure 5).

The first period's co-terms network graph (see Figure 6) gives an account of the structural relations between terms making visible three clusters of topics. These clusters represent different and distinct groups of terms that tend to co-occur next to each other. The green cluster accounts for 38% of the archival entries of the first period. The size of the node 'TripAdvisor search tools' shows that this is the term that occurs more frequently in the archival entries of the first period; 'travellers search' is the term that has more connections as it is in the middle of the cluster and features many thicker edges. The terms grouped into the two clusters at the bottom reflect the advertising services that TripAdvisor offered. The terms in the orange cluster suggest a comparison between traditional advertising (banners) with the one that TripAdvisor provided (contextual links), while the highlighted terms on the blue cluster describe how TripAdvisor implemented its advertising service. Interestingly, the 'Travel Site' node is situated in the middle of the network graph and it is the only connection between the top cluster and the bottom one (see the caption of Figure 6 for a detailed reading of the image). The topical clusters obtained by the co-terms graph reinforce the perception of TripAdvisor produced by the thematic analysis and show search and advertising as standing at the centre stage of the platform operations and the services it offered during this period.

Social media platform and inter-platform connectivity

TripAdvisor evolved into social media in a stepwise fashion by attributing growing importance to user participation as a means for generating content and data. The first real social media feature launched was *the Interactive Web*

Forums in 2004. The Web forums enabled users to read comments, post questions and reply directly to other users' posts, generating interactive discussions about a topic. This is why we take this year as the starting point of the second stage of TripAdvisor's evolution. Overall, this stage is marked by the enhancement of social or, as they are often called, Web 2.0 functionalities. The introduction of *Wiki functionalities* or *goList* allowed users to share their collective knowledge about destinations around the world. The move was in line with bigger changes on the role of users in generating and assessing Web content and TripAdvisor used it to gain traction as innovator sustained by users. Unlike most of the travel guidebooks written by a few professionals, TripAdvisor was able to feature real-time travel information posted and voted by users and rich content on a variety of topics. Reflecting these developments, the definition of the hotel popularity index changed at the beginning of 2005. While the previous index measured popularity using Web information, a new algorithm was developed that used 'real reviews by real travellers posted on TripAdvisor.com' (TripAdvisor, 2005). This change signalled a turning point in TripAdvisor's evolution as it made user-generated content and other user data produced on the platform a milestone of its operations.

In the middle of 2007, TripAdvisor launched its first networking feature called *Traveller Network*, which signalled another milestone in TripAdvisor's evolution towards enriched connectivity, community building and increased reliance upon the wisdom of the crowd (TripAdvisor, 2007a). This feature allowed TripAdvisor users to connect directly with other users and share travel information. Through this social networking functionality, TripAdvisor started to gather data on user behaviour on the top of data about destinations. Further improving these services, TripAdvisor launched in 2010 *TripAdvisor Trip Friends* in partnership with Facebook. This ground-breaking feature made it possible for TripAdvisor users to obtain advice from their Facebook friends. Similar to the *Traveller Network* feature, *Trip Friends* displayed a list of Facebook

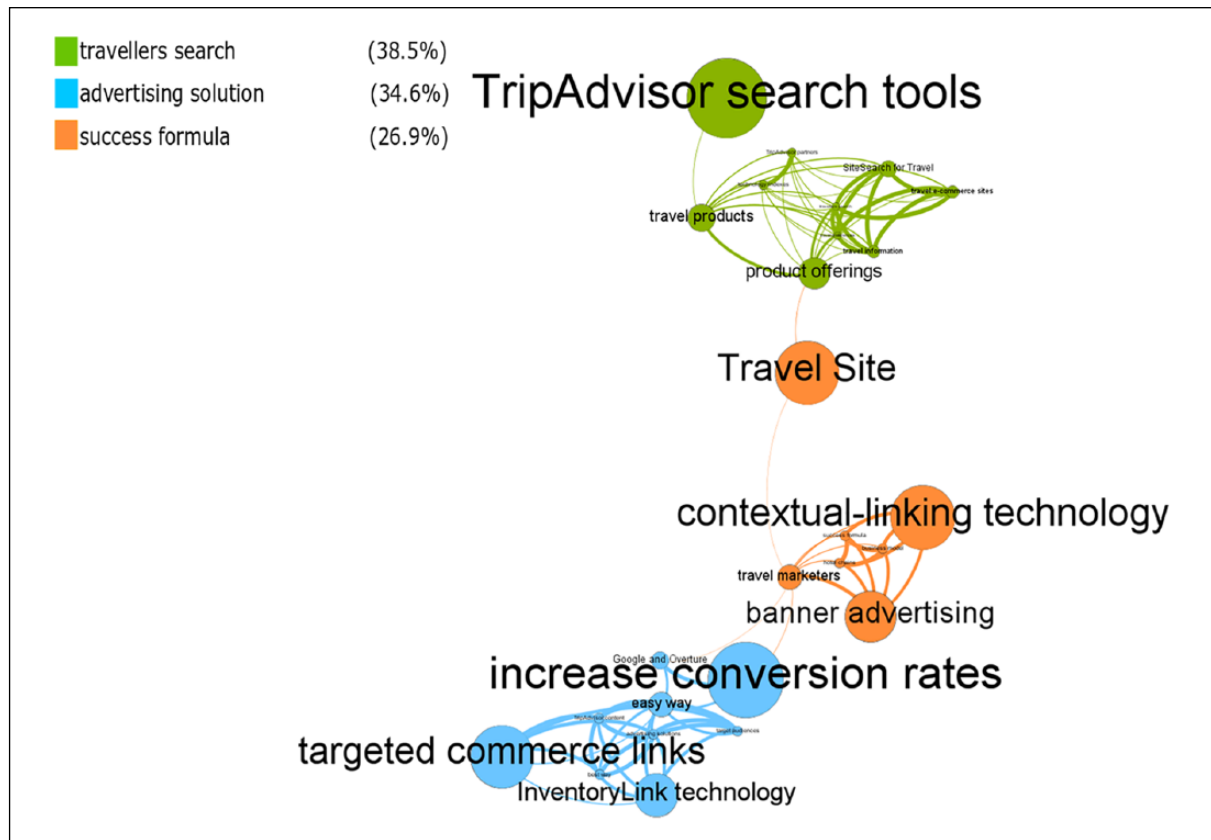


Figure 6. First-period co-term network graph.

From the top: the green cluster accounts for 38% of the archival entries in the first period. The size of the node 'TripAdvisor search tools' shows that it is the term that occurs more frequently. 'Travellers search' is the term that has more connections as it is in the middle of the cluster and features many thicker edges. Other significant terms insofar as co-occurrence is concerned are 'travel preference', 'travel information' and 'SiteSearch for travel'. All these terms stand for and confirm that TripAdvisor at the time was mainly focused on search capabilities. The orange cluster accounts for 27% of the entries in the first period. 'Contextual-linking technology' is the most frequent term in the cluster; 'success formula' and 'business model' are the terms that tend to occur more frequently with other terms of the clusters. Also, 'banner advertising' and 'travel marketers' are part of this cluster. The terms grouped into the two clusters at the bottom reflect the advertising services that TripAdvisor offered in this period. The terms in the orange cluster suggest a comparison between traditional advertising (banners) with the one that TripAdvisor provided (contextual links), while the highlighted terms on the blue cluster describe how TripAdvisor implemented its advertising service. The blue cluster at the bottom accounts for 34% of the entries in the first period. In this cluster, 'increase conversion rates' and 'targeted commerce link' are the terms that occur more frequently and 'advertising solutions' and 'easy way' are the terms that have more co-occurrences with other terms. Other terms that have a higher level of co-occurrences are 'InventoryLink technology', 'target audiences' and 'TripAdvisor content'. Interestingly, 'Travel Site' node is situated in the middle of the network graph and it is the only connection between the top cluster and the bottom one.

friends who had already been to the location a user was searching for. To use *Trip Friends*, users were required to log-in via Facebook, making possible the identification of the association 'friends-locations' via the *Cities I've Visited* – a TripAdvisor app on Facebook. *Cities I've Visited* was one of the most popular travel applications on Facebook for nearly 3 years, with more than 5 million monthly active users and highlighted over 1 billion destinations (TripAdvisor, 2010). Adding an extra tier in the network that TripAdvisor's (2012) users could maintain on Facebook, the *Friend of a Friend* feature was launched in 2012. Sharing friends of friends allowed the expansion of a user's network which in turn soared to tens of thousands of users in the average social graph of users on TripAdvisor (the network of user relations on a social media platform).

The expansion of social graph is directly connected to the number of opinions available to each user as TripAdvisor used it to display its reviews results. In a further move toward personalized services, in late 2014, TripAdvisor launched the *Just for You* feature which sorted hotels based on a user's individual preferences and search history on the platform (TripAdvisor, 2014d).

Seeking to expand and capture relevant content and data, TripAdvisor started to connect with other social media platforms through the development of apps (*Cities I've Visited*, *Traveller IQ Challenge* and *Local Picks*). These apps were able to access public profile information available on the host platform, including users' friend lists, interests, photos and albums, video, as well as status and mood (TripAdvisor, 2008). During the same period, TripAdvisor

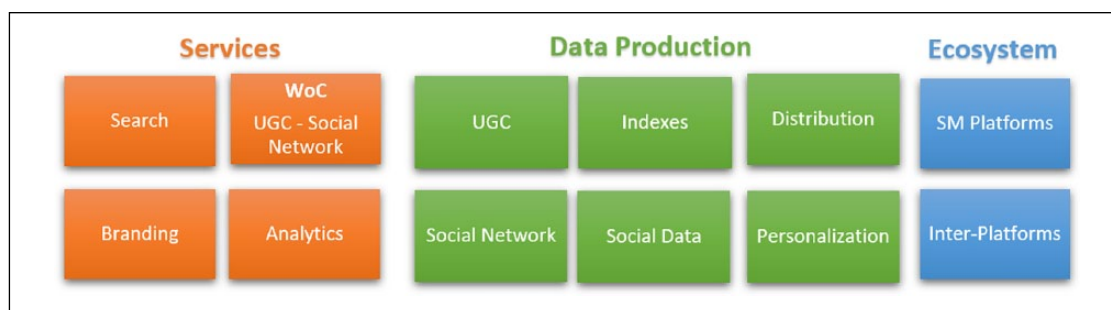


Figure 7. Second-period thematic analysis.

continued strengthening its connectivity with other platforms and expanding its user services. Thanks to the partnership with OpenTable, Toptable and TheFork – leading providers of online restaurant reservations – TripAdvisor's users were able to find and book restaurants. TripAdvisor also offered dynamic maps, using Google maps to show where restaurants are located and, taking advantage of the mobile geolocation capabilities, helped users find the best restaurants, as rated by locals.

Fostering its relationship with business owners (hotels, restaurants), TripAdvisor launched at the end of 2008 the 'owner centre' that helped businesses manage their online presence and engage with TripAdvisor's community. For instance, registered businesses received notifications of new reviews, had access to management response tools, as well as instructions for updating property listings, uploading videos and photos, and so on. Also, an analytics dashboard was implemented. This made it possible to obtain an instant assessment of customer satisfaction and competitive landscape. At the beginning of 2010, TripAdvisor launched the 'Business Listings' feature, which enabled owners to add or update content to their TripAdvisor profile. For example, owners were able to add a link to their websites or select three reviews to be shown upfront. Also, they could promote 'special offers' to be accessed only by TripAdvisor users. These special offers acted as a differentiator with respect to other businesses by increasing the visibility on the site. The businesses that had special offers were displaying them in upper positions, in addition to the fact that the offer itself was highly promoted on the site. To encourage users to give their feedback about the businesses, TripAdvisor developed *Review Express*. This tool gave business owners the opportunity to gather feedback and reviews through customizable emails which were set up in the owner centre by adding emails to past customers.

The features launched in this period highlight the development and proliferation of two groups of services (see Services, Figure 7). The first group (Wisdom of Crowd – WoC) gathers typical networking services that enable users to access opinions and comments directly from fellow travellers on TripAdvisor and from their online social network and consult with the popularity index. The second group of

services are directed to business owners and mark the beginning of a more active role for them in the generation of the content of their platform profiles. In this stage, we can see the consolidation of UGC production and other social features that started timidly in the previous stage. UGC (reviews and posts), social network (links between users) and social data (e.g. likes and tags) are a fundamental part of the delivery of WoC services (see Data Production, Figure 7). Also, the display of business profiles becomes constantly updatable, reconfigurable and customizable for each user, depending on their past activities on the platform and their online social network. Another fundamental difference with the previous period is the steady growth of connectivity with other platforms, especially with social media platforms (see Ecosystem, Figure 7) that increases the distribution and circulation of data throughout the platform ecosystem.

The co-term network graph for this period (see Figure 8) identifies seven topical clusters. In the upper part of the graph, the dominant cluster is the orange which accounts for 15% of the archival entries of the second period. The most frequent terms and connected terms are 'Business Listings subscribers' and 'Owner Management Center'. The terms in these two clusters refer to the services that TripAdvisor provides to business owners and are only available for businesses which have a subscription through the TripAdvisor business site (the Owner Management Center). In line with the thematic analysis, these two clusters show a proliferation of branding and analytics services available for business owners. Also, these clusters and the thematic analysis both reveal that business owners started to have an active role in the generation of content in the platform which did not occur in the previous period.

The central and lower part of the graph gathers the most frequent terms that are related to user involvement and the services TripAdvisor offers to users. The central part of the graph is dominated by the terms that belong to the green cluster and features 'reviews and opinions' as the largest node in the cluster and in the network. This cluster accounts for 20% of the entries and its most connected node is 'content distribution'. It shows that user-generated content obtains a diffused platform presence throughout this stage,

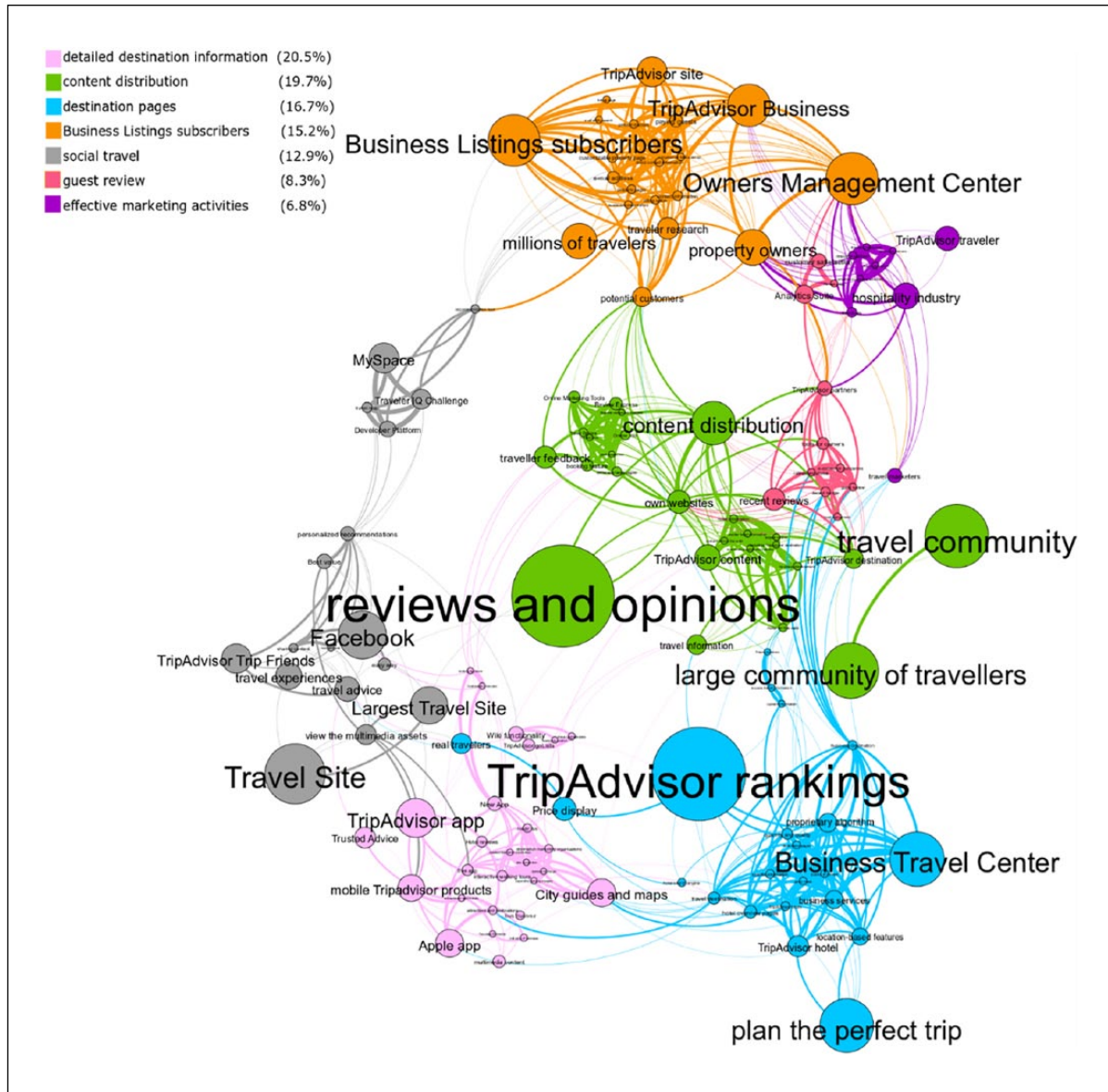


Figure 8. Second-period co-term network graph.

From the top: the orange cluster accounts for 15% of the archival entries. The most frequent terms and connected terms are 'Business Listings subscribers' and 'Owner Management Center'. Other relevant terms in this cluster are 'property owner', 'customizable property page', 'billing options', 'potential customers' and 'TripAdvisor Business'. The purple cluster accounts for 7% of the entries, the term 'effective marketing activities' is the central node due to its co-occurrences; 'hospitality industry' and 'TripAdvisor traveler' stand out for their occurrence as well as 'online reputation', 'resource platform' and 'free tools'. The central part of the graph is dominated by the terms that belong to the green cluster, featuring 'reviews and opinions' as the largest node in the cluster and in the network. This cluster accounts for 20% of the entries and its most connected node is 'content distribution'. Other relevant terms in this cluster are 'traveller feedback', 'TripAdvisor destination', 'TripAdvisor content', 'travel information', 'own websites', 'rating and photos', 'travel community' and 'large community of travellers'. The rose cluster which stands very close to the green cluster features 'guest review' as the most connected node and its most frequent terms are 'Analytics Suite' and 'recent reviews'. Other terms that stand out in this cluster are 'trust consumers', 'tools for owners', 'TripAdvisor partners' and 'e-commerce companies'. The grey cluster is located slightly out of the central point of the graph and accounts for 12.9% of the entries. The most connected node is 'social travel' and the most frequent terms are 'Travel Site', 'Facebook', 'TripAdvisor Trip Friends', 'MySpace' and 'Largest Travel Site'. This cluster makes visible the rise of networking tools and the interconnectivity with other social media platforms. The pink cluster represents 20% of the entries and features terms related to services offered through mobile devices. However, it also has terms such as 'Wiki functionality', 'TripAdvisor goLists' and 'Insider tips', which are close to the grey cluster and also related to networking tools. The blue cluster accounts for 17% of the entries but its terms do not clearly relate to a unique topic. The most connected node is 'destination pages' and the most frequent in the entries is 'TripAdvisor rankings'. One group of this cluster is related to the rankings and indexes that TripAdvisor generates with proprietary algorithms (i.e. 'proprietary algorithm', 'hotel search engine' and 'quantity and quality'). Another group can be associated to TripAdvisor content (i.e. 'plan the perfect trip', 'access travel information', 'real travellers', 'and travel destination', 'hotel overview pages'). The terms 'TripAdvisor forum' and 'location-based feature' can easily be linked to neighbouring clusters.

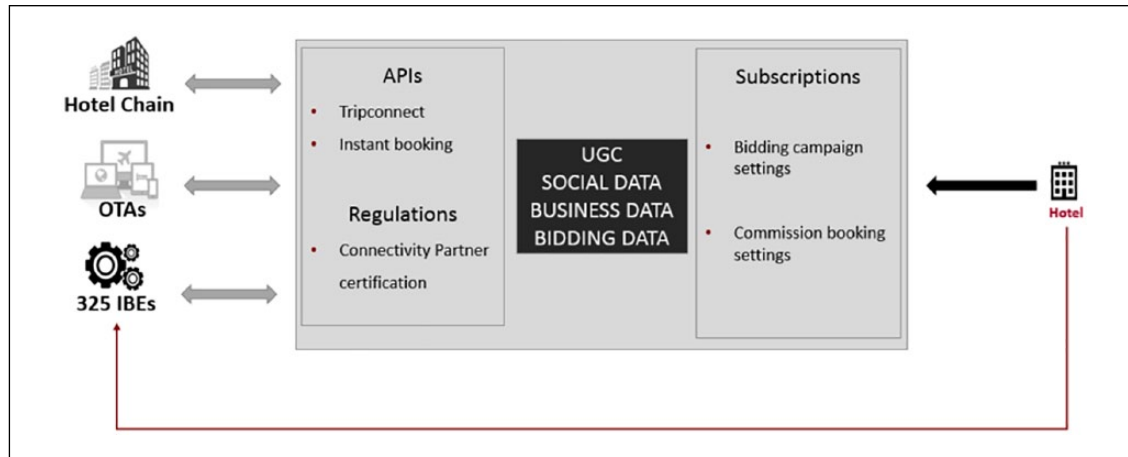


Figure 9. TripAdvisor data flow ecosystem.

corroborating the results of our thematic analysis. One of the key characteristics of this period is the central role of the user-generated content in the operations of TripAdvisor's and, ultimately, its services. The rose cluster which stands very close to the green cluster is a good example of it. The most connected node is 'guest review' and the more frequent terms are 'Analytics Suite' and 'recent reviews'. The nodes 'Analytics Suite', 'customer satisfaction' and 'review page' are located closer to the cluster at the top rather than to the other nodes of their cluster, because they are tools available through the owner management centre. This cluster highlights TripAdvisor tools that owners can use to encourage their guests to write reviews and to see their business performance based on ratings and reviews. The grey cluster is located slightly out of the central point of the graph and it accounts for 12.9% of the entries. The most connected node is 'social travel'. This cluster reveals the rise of networking tools and the interconnectivity with other social media platforms. Similar to the thematic analysis, the co-term analysis shows that networking tools are a key characteristic of this period. The caption of Figure 8 offers a more detailed reading of the network graph.

End-to-end service ecosystem

This stage is marked by the proliferation of partnerships that enable TripAdvisor to offer end-to-end services, whereby users are allowed to experience the entire travel consumption process ending up with booking. Similar to the previous passage from search engine to social media platform, the transition to end-to-end services has grown stepwise, building on the previous stage, as the partnerships with OpenTable, Toptable and TheFork indicate.

Hotel Price Comparison, launched in June 2013, marked a watershed in the offering of end-to-end services from the display of prices to booking (TripAdvisor, 2013a). TripAdvisor was the first to match real-time pricing and availability with TripAdvisor's reviews and

opinions in a simple layout. Price and availability are obtained from multiple booking partners (OTAs and IBEs) and displayed in one view. When users pick the dates of stay, TripAdvisor displays a list of available hotels with their prices. By these means, users can search and compare hotel prices at a glance, without having to leave the platform. Users can easily select and book their hotel by clicking through to the booking partners' sites to complete the transaction. With the implementation of this service, accommodation owners could partake in services previously limited to major OTAs and large hotel chains (TripAdvisor, 2013b, 2013c). Hoteliers take part in the bidding process that sorts the display of booking options to the users which is important to drive direct bookings to their own site. In addition, TripAdvisor rolled out *Instant Booking* which made it possible for users to complete the whole booking process onsite. This feature was first available for mobile devices in June 2014 and extended to all devices in the United States and the United Kingdom by September 2015 with a global rollout in 2016 (TripAdvisor, 2014a, 2015).

The interface simplicity and immediacy of *Hotel Price Comparison* and *Instant Booking* conceal a thick layer of interweaving messages and data flows among TripAdvisor, OTAs, hotels and IBEs (see Figure 9). IBEs, for instance, are not visible on TripAdvisor's site, yet they play a key role as they provide hotel room availability information in real-time. Importantly, the circulation of this information (and thus of booking service) occurs only for hotels which have IBEs with TripAdvisor connectivity-partner certificate and have a premium subscription. Also, OTAs and hotel chains need to be a TripAdvisor connectivity partner. To obtain the connectivity-partner certificate, partners are required to implement TripAdvisor APIs and complete two integration testing processes.

Leveraging on the acquisition of TheFork in 2014, TripAdvisor launched *Instant Reservation* (TripAdvisor, 2014c). This feature allows users to complete their restaurant's

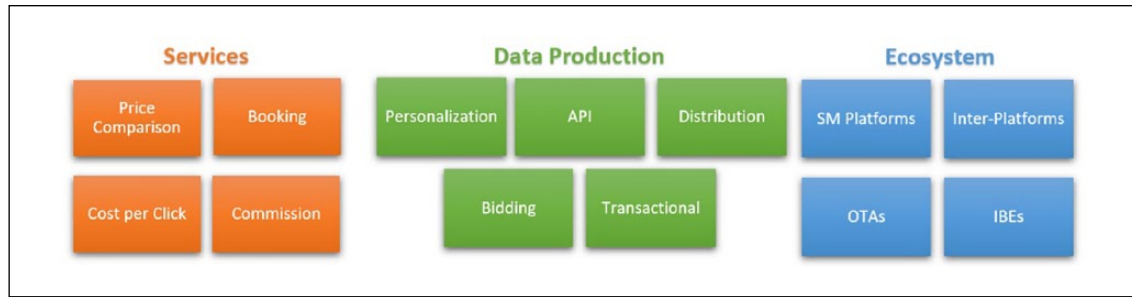


Figure 10. Third-period thematic analysis.

table reservations without leaving the site. On November, also the *Attraction* section exhibited an Instant feature by integrating tour inventory display and pricing data from Viator, which had been acquired by TripAdvisor in August 2014. When users visit an *Attraction* page on the site, they are presented with up to three tour options, such as small group, private or skip-the-line options, along with descriptions and prices for each. An instant booking functionality complements the offering.

As part of the inter-platform connectivity expansion, in 2014 TripAdvisor announced a new feature for mobile called *Ride there with Uber* (TripAdvisor, 2014b). This allowed users to easily reserve a ride with Uber to restaurants, attractions and hotels. TripAdvisor was one of the first to integrate Uber functionality into its platform using Uber APIs. When users search for restaurants, attractions and hotels on TripAdvisor they are presented with an estimate of Uber car fares and the waiting times for pickup. Clicking the *Ride there with Uber* button allows redirecting to Uber, thus completing the reservation and having a car sent to the user location. In a similar move, TripAdvisor teamed up with Deliveroo enabling its users to access to Deliveroo's restaurant network. The scheme connected more than 20,000 restaurants across 12 countries throughout Europe, the Middle-East and the Asia Pacific regions. Restaurants listed in both TripAdvisor and Deliveroo have displayed a button order online. By clicking it, TripAdvisor visitors are redirected to the specific restaurant on the Deliveroo app to complete their orders.

The launch of end-to-end services clearly dominates the third stage of TripAdvisor's evolution. The thematic analysis highlights that users receive or are able to visualize prices and options of reservations while business owners can now actively participate to these services through two price schemes, cost per click (CPC) or commission (see Services in Figure 10). To be clear, once a search is performed on TripAdvisor hotel results are displayed using proprietary algorithms (for instance, 'Best Value'). Each hotel displayed has a list of booking options and corresponding prices. Hotel chains, OTAs and hotels subscribe to or bid to get the higher position in this booking option list. Commission and CPC are two price schemes which belong to two different modalities of participating in the

display of booking options on TripAdvisor. Hotel chains or OTAs subscribing a commission model agree to pay 15% or 12% of commission on their room price to have their booking option displayed at least 50% of the time in the top position. In this case, the booking process occurs on the TripAdvisor's site. The remaining 50% of times the order by which a booking option is displayed is regulated by auction. In this model, the hotel or OTA winning the auction process takes the top position and pays the agreed CPC to TripAdvisor independently from the completion of the booking. If booking is finalized, it happens on TripAdvisor's partner site (OTAs or hotel chains).

To be able to provide these services, TripAdvisor significantly extended its links with OTAs and IBEs. These links, in turn, play a crucial role in the circulation of data and messages related to booking services, leading to the emergence of a complex booking network (see Ecosystem in Figure 10). A fundamental difference from the previous stage concerns the production of different data and the delivery of data services that did not exist before, such as the personalized destination profiles that are based on user participation data (e.g. just for you) and the production of transactional data (e.g. hotel prices or booking) that circulate along the TripAdvisor ecosystem (see Data Production in Figure 10). Data are primarily distributed by TripAdvisor APIs that govern the circulation of data in the ecosystem.

The co-terms network graph shows eight clusters that are agglomerated mainly at the upper and lower parts of the graph (see Figure 11). In contrast to the previous period, the most frequent terms tend to be at the top of the network and are related to the booking services and other features available for business owners. These terms appear in 56% of the entries. The orange cluster is related to booking services and, significantly, the most connected node is 'TripAdvisor Instant', the name of the API (Application Programming Interface) that rules the direct booking (11% of entries). Similar to the thematic analysis, the co-term graph shows the importance acquired by the development of booking services and the increasing involvement of business owners in the platform. The structure at the lower part of the graph is very similar to the one in the previous period. The purple cluster features terms related to the services available through mobile devices. The most connected among these

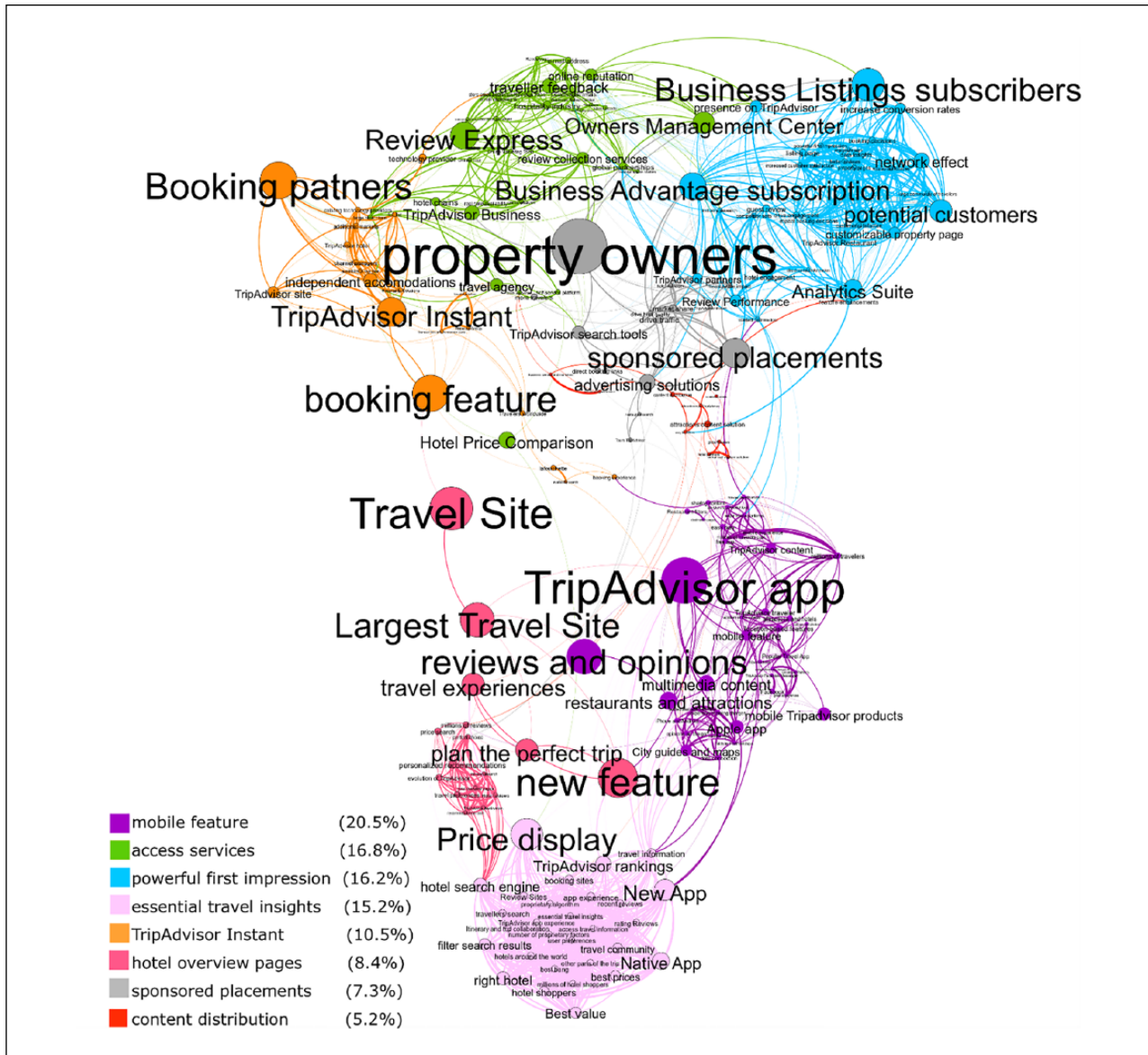


Figure 11. Third-period co-term network graph.

From the top: the orange cluster is related to booking services. 'TripAdvisor Instant' is the most connected node and the name of the API that rules the direct booking (11% of entries). Other relevant terms in this cluster are 'Connectivity partners', 'booking features' and 'independent accommodation'. The terms in the green cluster are mostly related to features available for business owners through the 'Owners Management Center'. 'Review Express', 'Customizable emails', 'latest trend', 'review collection services', 'customizable property page', 'Online Marketing tools' and 'online reputation' are all functionalities to facilitate the branding. Also, this cluster features terms such as 'travel agency', 'Hotel Price Comparison' and 'own websites' that are related to CPC booking services. Business owners with a subscription can set their bets through the 'Owners Management Center'. In the blue cluster, the terms 'Business Listings subscribers' and 'Business Advantage subscription' excel for their size. The business listings subscription provides access to the booking services and a basic number of branding and analytics tools, while the business advantage subscription has full access. Meaningful terms in this cluster are 'customer satisfaction', 'Analytics Suite', 'data insights', 'increase conversion rates', 'Review Performance' and 'competitors sets'. These terms represent the tools that TripAdvisor offers to visualize business performance. Also in this cluster are terms more related to branding services like 'customizable property page', 'network effect' and 'drive engagement'. The grey cluster also refers to advertising options available for premium subscription. Its most connected node is 'sponsored placements' and other relevant nodes are 'advertising solutions' and 'drive traffic'. This service places property link in a prominent location when a potential customer is looking in the property area.

terms is 'mobile feature' and the most frequent is 'TripAdvisor app'. Interestingly, 'reviews and opinions' is located in the middle between the purple and the rose clusters, which is more related to the website. This may reflect

the increase in traffic through mobile devices. The terms in the pink cluster refer to filters, indexes and rankings that TripAdvisor uses to display data, while the rose cluster represents the content TripAdvisor offers to users.

Table 3. The evolution of TripAdvisor.

	Search engine	Social media	End-to-end services
Data types and formats	Hotel data Destination data (both imported from hotel websites and the Web) Product data (HTML links)	Social data (actions and opinions by user platform participation Network data (friends' and friends of friends' data from social media platforms) User-generated content (reviews, forum, Q&A)	Transaction data (booking generated by users and bidding generated by hotels and OTAs)
Technological functionalities	Indexing and classifying Searching (multi-query)	Networking Producing and consuming content (wikis, rating, reviewing) Personalizing results (filtering, selecting) Subscribing	Comparing (price and content) Booking Bidding
Configurations of types of actors, roles and positions	Advertisers (OTAs and big hotel chains and travel sites at the beginning)	Social media platforms App development and decentralization Advertisers	OTAs IBEs Sharing economy platforms
Ecosystem formation	Media model		App acquisition, integration of services and recentralization

HTML: Hypertext Markup Language; OTAs: Online Travel Agencies; IBEs: Internet Booking Engines.

Discussion

In what follows, we interpret and theorize the events we have outlined in our empirical narrative. We first link the evolution of TripAdvisor to the practices by which the company has sustained its steady innovation and expansion over time. A great deal of these practices pivot around the original production and use of various types of data. We subsequently explore how these data practices are associated with the formation of the ecosystem in which TripAdvisor is currently embedded and the links that tie ecosystem participants together.

Data, technologies and actor configurations

While sharing some essential attributes with one another, each of the three stages in TripAdvisor's evolution features distinct set-ups of organizational operations and capabilities. Each stage, furthermore, develops within particular business environments made of diverse configurations of actor positions, roles and interdependencies (see Table 3). All of these can and, in fact, have often been studied with a focus on the managerial and economic rationalities that drive the development of market strategies and organizational capabilities, and the formation of business networks or alliances (see, for example, Adner, 2017; Gawer, 2014; Jacobides et al., 2018; Parker et al., 2016; Teece, 2018). While insightful, research of this type tends to gloss over the link between economic rationality and the technological conditions that make some courses of action possible while rendering others less successful or even obsolete (see, for example, Teece, 2018). Placed upon a larger time window, technological conditions establish the framework within which particular actions and choices develop and, in this regard, need careful consideration and analysis.

Linking technology to economic action is, no doubt, a non-trivial challenge that requires approaching technology as a structuring force that shapes economic and social relations (Borgmann, 1999; Faulkner and Runde, 2013; Kallinikos et al., 2013) and frames what actors can and cannot do (Orlikowski, 1996; Zuboff, 1988), a task that may be considered insidious and unattractive. Be that as it may, relegating technology to a background condition would seem out of tune with the current world in which economic relationships are increasingly expressed, instrumented, conducted and monitored by means of various blends of specific and generic technologies (Arthur, 2017; Teece, 2018). In the context of platform ecosystems, in particular, the transformations we describe in this article are supported by ongoing technological developments with respect to the functioning of the Internet, the diffusion of standards, devices and technologies that intermingle with the daily pursuits of people and bring about new patterns of exchange, interaction and communication (Alaimo and Kallinikos, 2017, 2019a; Hanseth and Lyytinen, 2010). Aligned with the theoretical concerns sketched at the frontend of this article, we link the evolution of TripAdvisor to the inventive establishment of data practices by means of which the platform has sought to tune with and take advantage of the pervasive nature of data and the critical importance data management operations have acquired in the making of the current digital economy (Alaimo and Kallinikos, 2017, 2019a; Barrett et al., 2015; Henfridsson et al., 2014; Yoo, 2013).

Table 3 offers an analytic summary of our findings and the practices that underpin the transformation of TripAdvisor from a travel search engine to a salient travel social media platform and subsequently to a central hub of a travel service ecosystem. To begin with, each of the three stages is linked to different *types of data* that constitute the pervasive 'material' underpinning most operations and key

services of the platform. The first transition from the original travel search engine stage to social media travel platform and network stage essentially coincides with the shift from the use of traditional and already available travel data sources (hotel, destination and product data) to a new and until then largely unknown data type, produced by large user crowds contributing their reviews, ratings and networking data to the platform amass. This transition remains pivotal to the market position and the public image of TripAdvisor alike and forms one of the foundations on which more recent transformations are based.

The second transition to the end-to-end service ecosystem is marked by the growing use of several types of transaction data. While such data serve operations such as bidding and booking, they are also used in conjunction with other data types to develop data-based services that feature the cross-syndication of data to large data pools (aggregation) out of which a variety of metrics and scores are computed (Alaimo and Kallinikos, 2017, 2019b). Take the example of the display of hotel results which now works on the basis of (1) traveller ranked, (2) best value, (3) lowest price and (4) distance. The first measure is still obtained by crunching traveller data. Yet the second of them (e.g. best value) is far more complex and entails miscellaneous types of dynamic data from several sources. Best value is computed using 'TripAdvisor data, including traveller ratings, confirmed availability from its partners, prices, booking popularity, location and personal user preferences' (www.tripadvisor.com). Hotels are ranked on the basis of their real-time room availability which is, in turn, conditioned by the deals that hotels have with partners and with TripAdvisor. Furthermore, TripAdvisor is now able to compute data on booking popularity across all the partners (325 IBEs, OTAs, hotels and hotel chains) and to refine its knowledge on user personal preferences across a number of services and platforms.

All these operations are linked to and variously supported by different *technological functionalities* (Table 3). The transition from travel search engine to social media travel network corresponds to an underlying technological switch from indexing-classifying-searching to the use of social or interactive (Web 2.0) technologies characteristic of the second stage. In a roughly similar fashion, the transition to the third stage coincides with the development and implementation of a technological infrastructure that supports dynamic price comparison, bidding and booking, allowing TripAdvisor to become a major hub in the travel service ecosystem to which it belongs. Studying the transformation of TripAdvisor over time without regard for the data practices and technologies that underpin the creation of new services made of data amounts to glossing over the nature of the developments we have reported in this article and, particularly, how they have been materialized (Kallinikos et al., 2012).

Finally, the types of data and the technological functionalities that underpin the evolution of TripAdvisor are linked to varying *configurations of actors, roles and their positions*

(Aaltonen and Tempini, 2014; Constantiou et al., 2017; Henfridsson and Lindgren, 2005), in each of the wider settings that roughly correspond to each stage. The first stage is marked by the ubiquity of contextual advertisement and the consequent importance of advertisers (OTAs or advertisement agencies) and Internet users as travel information seekers. The second stage features the importance of users not simply as information seekers but crucially as producers of data (reviews and ratings, networking data) on the basis of which TripAdvisor develops key services such as hotel and place popularity indexes and personalizes offerings to travellers. Actors at a remove from the boundaries of the hospitality industry, such as app developers and other social media platforms (notably Facebook), rise to important partners at this stage. Many of these actors continue to hold strong positions in the current ecosystem, yet their relative importance is redefined by the introduction of new actors such as IBEs, Uber or the Fork and the ubiquity of operations such as bidding, booking and price comparison. Positions and roles are increasingly dependent on the acquisition of technological and data production capabilities. IBEs, for instance, have risen to be an important player within the ecosystem because they are able to command the real-time flow of data on room booking and availability from small and medium hotels to TripAdvisor.

It remains a key question whether the last stage of TripAdvisor's transformation we identify with the end-to-end service ecosystem is indicative of its transition away from the importance end-users have historically obtained in defining the public image of TripAdvisor as a social travel platform and network and, certainly, its economic success. It would be hard to imagine that TripAdvisor can afford to dispense with the contribution users as data producers make to its economic well-being. User-generated content, social and networking data still continue to play an important role in the services TripAdvisor offers (personalized services, popularity indexes) while user reviews and ratings contribute to the public attraction of the platform. On the other hand, it is reasonable to assume that the propagation of services that rely on transaction data (e.g. bidding, booking) and are linked to the formation of the end-to-end-service ecosystem in which TripAdvisor is a central hub by implication reframe the relative importance of user-generated reviews and ratings, social and networking data and, more generally, the role end-users have so far had in the platform. A better understanding of these issues requires dealing with the question of how different types of data lead to the formation of service ecosystems.

Data and ecosystem formation

Current research on platforms and platform ecosystems conceives of the links of ecosystem participants in terms of the operational and economic advantages they confer to them. Ecosystem formation occurs as a result of specific

and value-reinforcing complementarities that extend beyond bilateral relations, entailing multilateral connections, often across industry boundaries (e.g. Adner, 2017; Jacobides et al., 2018; Teece, 2018). The multilateral relationships of TripAdvisor with IBEs, OTAs, hotel chains and independent hoteliers and restaurant owners, end-users and other social media organizations provide a good illustration of how the interdependent nature of such links leads to ecosystem formation and to resources and services that acquire higher value to the degree that they become bundled with one another. Yet, what is thus bundled is made of data. In contexts such as the ones we report here, most of the links between firms, resources or activities are expressed and instrumented as data relations and it is primarily in this form that they become the objects of ecosystem practices and exchanges. To express it bluntly: no data, no services.

Cast in this light, data emerge as a key *carrier of value* but also as the *cognitive medium* on the basis of which links between ecosystem participants are forged. Certainly, data and the actor links they underpin are dictated by economic considerations. They variously reflect the business objectives of the ecosystem participants on the basis of which they are set up and ultimately assessed, and further developed or revised. Yet, the economic analysis of ecosystems that is mostly framed as an argument about ends (interests and objectives) does not have at its disposal the conceptual means for capturing and analysing the ways services that are essentially data relations are made. It can only analyse the architecture of intentions as these latter are supposedly driven by economic considerations (e.g. competition, market share, price, resource interdependencies) and the strategies they support but fail to deal with the means by which intentions materialize into actual relations. We complement and extend this view by putting forward an argument about means (Orlikowski, 1996) or, perhaps more correctly, about the *structure of means* whose complexity, mutual accommodation and path dependence defy easy subordination to pre-established ends and the pursuits of particular actors (Arthur, 2009; Hanseth, 2000; March, 1994; Yoo, 2013). The different types of data necessary to support the operations of the ecosystem and the practices, technologies and systems by which they are managed constitute a complex grid of sedimented solutions established over time that define actions more than deliberate plans. They considerably shape the type and structure of the links of ecosystem participants and circumscribe the possibilities whereby certain things are possible to pursue while others are ruled out (Aaltonen and Tempini, 2014; Hanseth and Ciborra, 2007). The story of TripAdvisor provides ample evidence to these claims.

These observations acquire a poignant importance in the context of the digital economy in which data have become such a pervasive means for capturing, representing, conveying and assessing social and economic relations. It is crucial thus to uphold that data are not simply a very

specific type of resource but also an essential medium, instrument or channel for perceiving and acting upon reality. If, say, the hotel popularity index is rendered complementary to hotel room availability, price comparison and, eventually, booking, this is because they are all brought to bear upon one another as comparable and relatable semiotic (data) tokens. The relatability and comparability of data require a series of operations by which original data are standardized or properly formatted so as to enter into various kinds of relations and comparisons with other data (Kallinikos, 2007; Marton et al., 2013). As notational or semiotic systems, all data are in principle, if not in practice, relatable. Cast in suitable data formats, the distinctive and often incommensurable status of the different regions of reality from which they derive (e.g. social and networking data, price comparisons, local conditions) is dissolved into the medium of data relations (Kallinikos, 1999; Monteiro and Parmiggiani, 2019). In other words, data are commensurate (Espeland and Sauder, 2007).

These considerations crystallize into two important implications that contribute to the literature on social media and platform ecosystems. First, the complementarities achieved via the medium of data are not intrinsic or otherwise conditioned by the functional or physical make-up of the resources, activities or outputs which they translate or encode (Arthur, 2017; Kallinikos, 2007). Data complementarities are based on different types of data standardized enough to bear upon one another in ways that reinforce their mutual relevance and, ultimately, value. Of course, relating, say, hotel reviews to hotel prices and, eventually, booking presupposes a cultural background of practices and understandings whereby such actions are rendered meaningful (boyd, 2015; Searle, 1995). Yet, the processes through which different types of data are made to matter, related and combined are anything but trivial. They require establishing the practices that generate data of a certain kind and format (e.g. reviews and ratings) and assembling together different data in more complex services (e.g. popularity index, best value), developing the functionalities that support these practices (e.g. indexing, reviewing, bidding) and the technologies and systems (not simply algorithms) through which these data are handled, exchanged and, more generally, made commercially relevant. In the digital economy in which digital tokens figure prominently, the complementarity of resources is not exactly out there but often fashioned by the semiotic means by which it is expressed (digital data) and the formats that allow such different semiotic tokens such as numbers, text or images to be inter-operated (Monteiro and Parmiggiani, 2019; Orlikowski, 1996; Varian, 2010).

Second, data-based ecosystem formation is more dependent on the practices of data complementarities rather than on pre-existing physically embedded complementarities of traditional products and services (Teece, 2018; Yoo et al., 2010). Data complementarities are refigurative and

updatable in ways that hardwired resource or output complementarities can seldom be. For this reason, industry and activity boundaries can be crossed in many and unexpected ways (Henfridsson and Lindgren, 2005; Santos and Eisenhardt, 2005; Yoo et al., 2010) that transcend the intrinsic limitations of physical resources to which industry formation has been bound (Kallinikos, 2007). The case of TripAdvisor is revealing in this regard. The platform is now at the centre of a digital travel ecosystem that encompasses traditional services related to the hospitality industry together with new or previously unrelated services that are steadily remade, extended and upgraded. In a constantly expanding list, TripAdvisor now offers digital services related to hotel and restaurant bookings, food-delivery, private car rental, local excursions and various specialist content production and distribution services for a range of heterogeneous actors. Our longitudinal study of these data relations unveils the dynamic process of service ecosystem formation and the constant redrawing of organizational and industry boundaries (Santos and Eisenhardt, 2005) as contingent upon the fashioning of data complementarities.

Concluding remarks

The evolution of TripAdvisor and its economic success⁵ are closely related with the practices of data generation and the use of these data to support and materialize a great deal of services that require organizational and industry boundary crossing. Our longitudinal case study makes visible the set of reciprocal relations that exist between specific types of data and services, technological operations and actor roles and positions. Tracing the trajectories of these elements, our study reconstitutes the developments that have led to the formation of TripAdvisor's service ecosystem against a broader background of technological and cultural conditions (e.g. boyd, 2015; Srnicek, 2017).

We contribute to the literature on platforms and ecosystems by advancing the concept of data-based services which we define as complex and dynamic assemblages of different types of data that describe, stage and moderate the relationships of ecosystem participants (Alaimo and Kallinikos, 2017, 2019b). The capability of a platform to assemble this kind of data-based services is an important precondition for the development of data complementarities and the formation of business relationships that lead to ecosystem formation. The data complementarities that underpin ecosystem formation emerge out of the complex interactions between the prevailing practices of data generation and exploitation and the development of deliberate strategies and platform functionalities. Such interactions ride on, yet further develop the infrastructure and the wider technological and cultural conditions in which particular ecosystems are embedded.

Placed against this background, our study makes an important qualification of existing theories of ecosystems by

disclosing the role of data complementarities and the technological conditions on the basis of which such complementarities emerge or are fashioned in this hyper-technological age. If we are right, data-based service ecosystems and the practices of data complementarities they rely upon are likely to lead to cross-industry ecosystem emergence and innovation on a larger scale (Kallinikos et al., 2013; Yoo et al., 2010). In this sense, our study also contributes to the understanding of developments that transcend TripAdvisor and connect both to the present changes and the prospects facing social media. The ongoing transformation of other social media companies such as LinkedIn, Facebook or WeChat indicates that our findings have a wider relevance, far beyond TripAdvisor. These ideas no doubt need to be further developed and tried empirically in other settings. Future research needs to investigate more closely whether and how various types of data and data links are conducive to the kind of value-reinforcing relations that we associate with ecosystem formation and industry boundary crossing. By the same token, we need to better understand how social media cross the boundary between, on the one hand, community and sociality making and, on the other hand, economic action.


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ORCID iD

Jannis Kallinikos  <https://orcid.org/0000-0002-4446-2878>

Notes

1. What is often referred to as Web 2.0.
2. Yin (2009) contrasts analytic generalization to statistical generalization. In this latter case, sampling decisions are critical to ensure representability and extrapolation of findings to the entire population. Analytic generalization is not about statistical representability but empirical relevance to a construct or theory that is usually achieved by the proper design of either case studies or experiments. Not surprisingly, thus, a single case study or experiment can test and elaborate an existing theory and occasionally develop an entirely new theory (see also Goodman, 1978).
3. The first interview is published in the book *Founders at Work: Stories of Startups' Early Days* (Livingston, 2007). The second interview is on the online book titled *The Definitive Oral History of Online Travel* (Schaal, 2016).
4. See Appendix A for a brief description of TripAdvisor.
5. See Appendix A.
6. www.airfarewatchdog.com, www.bokun.io, www.book-ingbuddy.com, www.citymaps.com, www.cruiseclitic.com,

www.familyvacationcritic.com, www.flipkey.com, www.thefork.com (including www.lafourchette.com, www.eltenedor.com, www.iens.nl and www.dimmi.com.au), www.gateguru.com, www.holidaylettings.co.uk, www.holiday-watchdog.com, www.housetrip.com, www.jetsetter.com, www.niumba.com, www.onetime.com, www.oyster.com, www.seatguru.com, www.smartertravel.com, www.tingo.com, www.vacationhomerentals.com and www.viator.com

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Author biographies

Cristina Alaimo is an Assistant Professor in Digital Economy at Surrey Business School, University of Surrey, UK. She holds a PhD in Information Systems and Innovation from the Department of Management, LSE – London School of Economics and Political Science, UK. Her research focuses on the innovation brought about by data-based services and their consequences for organizations and organizing. Her recent publication 'Computing the Everyday: Social media as data platforms' in *The Information Society* (co-authored with Jannis Kallinikos) has been the first runner-up in the

category Best Published Paper Award, for the Academy of Management, OCIS 2018.

Jannis Kallinikos is Professor and Head of the Information Systems and Innovation Group in the Department of Management at the London School of Economics and Political Science. His research focuses on the impact of information and communication technologies on organizations and economic institutions. He has published widely in Management, Information Systems and Sociology journals and written several monographs including *The Consequences of Information: Institutional Implications of Technological Change*, Edward Elgar, 2007, *Governing Through Technology: Information Artefacts and Social Practice*, Palgrave, 2011. He has, together with Paul Leonardi and Bonnie Nardi, co-edited *Materiality and Organizing: Social Interaction in a Technological World*, Oxford University Press, 2012.

Erika Valderrama is a PhD candidate in Information Systems and Digital Innovation at the London School of Economics. Erika studies social media platforms and their links with the digital economy. She holds a bachelor's degree in computer science and a master's degree in information systems.

Appendix A

TripAdvisor is an online travel company that offers a range of services in the travel sector. Founded in February 2000, today TripAdvisor is a big travel media

group which operates 26 travel brands⁶ in 49 markets. The steady growth of the platform user base brought about the constant influx of new reviews and traveller ratings. In 2006, TripAdvisor had just 6 million of reviews and opinions, which by the middle of 2018, achieved 661 million, reaching 456 million average monthly unique visitors and receiving more than 310 new contributions every minute (TripAdvisor, 2018). Since 2011 TripAdvisor is an independent company and trades in NASDAQ; Figure 12 shows the stock evolution of the company. TripAdvisor financial status is divided into two segments: Hotel and Non-Hotel. The latter includes restaurants, attractions and vacation rentals. While the Hotel segment has dropped its revenue from 85% in 2015 to 77% in 2017, the Non-Hotel has had during the same period an increase from 9% to 20% (TripAdvisor, 2017, annual report).



Figure 12. TripAdvisor stock evolution.