

Location-based advertising on mobile devices

A literature review and analysis

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Abstract Location-based advertising (LBA) allows the delivery of advertising messages to consumers in places that are known for their particular high and positive advertising effect. While LBA is recognized for static roadside billboards and the Web, LBA can now be found on mobile devices. This mobile advertising adds valuable opportunities for companies: it allows consumers to be addressed (i) individually, (ii) based on their current location, and (iii) dynamically in real-time; furthermore, (iv) content may be replaced quickly by remote access. Accordingly, within the mobile marketing domain, LBA on mobile devices turns over a new leaf. This young research field is interdisciplinary at its core and marketing and technical experts expect major impetus. To contribute to this growing field, we systematically analyze and evaluate existing literature in the field of LBA on mobile devices, and present the results of six analyses. By building bridges between the involved disciplines, we present existing research in a condensed, concise and evaluating form which will support researchers in orienting for future research in the field. Furthermore, we pinpoint selected “white spots” in research and draw attention to promising areas for future research and directions of future development trends.

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1 Introduction

The proliferation of smartphones has increased the ability of organizations to contact individuals at any time and in any place. From the perspective of marketers, mobile devices serve as a new medium that exposes consumers to advertising on the device they carry with them very often or even always (Bruner and Kumar 2007). The key is to “provide the right content in the right format to the right person at the right time” (Tam and Ho SY 2006).

Because smartphones are typically equipped with GPS (global positioning system) functionality and other sensors, these devices hold the potential for advertisers to provide information to consumers at places with a particularly high and positive advertising effect (e.g., when a consumer is in the proximity to a place where an advertiser’s products are available) (Bruner and Kumar 2007).

However, the underlying concept—the so-called ‘location-based advertising’ (LBA)—is not new per se. For decades, many roadside billboards display content that was specific to where they were placed (e.g., ‘Turn right to McDonald’s’). Recently, static billboards were increasingly replaced by digital signs that allow for dynamic multimedia presentations, whereby content can be changed quickly by remote access (Bauer et al. 2011; Harrison and Andrusiewicz 2004). Still, LBA on mobile devices adds two important opportunities for companies: First, it addresses consumers (i) individually, (ii) based on their current location, and (iii) dynamically in real-time, which is an important distinction to locally installed signs. Second, LBA on mobile devices provides flexibility concerning content. Misplaced, out-of-date or expired information may be replaced quickly by remote access (Weber et al. 2008).

Location-based advertising is one very specific type of other various types of direct marketing (e.g., infomercials, magazine advertisements, mailings, advertising e-mails, etc.). LBA is restricted to the distribution of advertising messages that are specifically tailored for the location where a consumer accesses such a message (Bruner and Kumar 2007). An even more specific type of LBA is ‘LBA on mobile devices’: it is an alternative that (1) delivers advertising messages on mobile devices (e.g., smartphones, tablets), and (2) uses information on a consumer’s location. Note that not every kind of mobile advertising is LBA, as the latter refers only to those cases where an advertising message is tailored to the consumer’s *location* (Kölmel and Alexakis 2002). LBA may be performed using two approaches of delivering the advertisements: the push or pull approach. The push approach amounts to advertisers using carriers and delivery networks to send (push) advertising messages to the consumer, whereas the pull approach occurs if consumers request some information or use a dedicated service, which in turn triggers an advertising message to be sent to the consumer (pulling information from the advertiser) (Bruner and Kumar 2007). The push and pull approaches are not limited to LBA on mobile devices but are also applicable for

other types of advertising, other types of content delivery (such as access to invoices), and other types of services (e.g., payment services, traffic information, emergency notifications, navigation systems, etc.)—regardless of if such services are accessed or delivered based on the user’s location.

In their paper, [Bruner and Kumar \(2007\)](#) predicted that “LBA is going to increase tremendously in the next few years”. Indeed, in the same year, Apple’s iPhone—equipped with GPS—entered the market, which—for the first time—provided the opportunity to empirically research LBA and its effects, and for marketers to pick up LBA on a large scale. However, while LBA continuously advanced on a technological level, this topic is rarely picked up from a marketing perspective. Dilemmas such as whether LBA is a viable alternative to traditional advertising and in which way LBA should adapt to a consumer’s location (or other kinds of context) are largely unanswered ([Bauer and Lasinger 2014](#)).

This paper aims to provide (i) an overview on this recently emerged topic, and (ii) a multifaceted analysis of scientific publications on LBA on mobile devices, i.e., a systematic literature review. In addition, our work supports the process of orientation in the research field of LBA, as we present existing research in a condensed, concise and evaluating form.

This paper is structured as follows: Sect. 2 outlines the conceptual foundations for LBA. Sect. 3 describes the stepwise procedure taken for the systematic literature review of scientific publications analyzing LBA on mobile devices. The analysis of the review and its results are presented in Sect. 4, whereby we analyze in detail (1) the methodological approaches that were taken for investigating the field, (2) the nature of the publications’ research disciplines, (3) the subtopics of LBA addressed in the publications, (4) the types of technology used for the delivery of advertising messages, (5) the context attributes (adaptation criteria) that are used for advertising adaptation besides the attribute ‘location’, and (6) the core findings of published studies. After a discussion of the results, the paper closes by pinpointing selected “white spots” in research and drawing the attention to an outlook on promising areas for future research and development trends.

2 Conceptual background

Advancements in information and communication technologies have always expanded marketers’ portfolios to target consumers. From outdoor, radio, print and TV to the Internet, advertisements have become more interactive, more relevant, and more contextual in their design to attract consumers and to raise the attention of the audience ([Banerjee and Dholakia 2008](#)). With the high prevalence of mobile devices, bringing advertisements to these devices is the next wave of advertising: consumers may be addressed individually, wherever they are.

However, large groups of consumers feel overwhelmed by the quantity of advertisements they receive, making it difficult for additional advertisement to break through the clutter ([Ha and McCann 2008](#); [Pieters et al. 2002](#)). Advertisements are said to be more effective if they are relevant for a consumer, and if the consumer also perceives it as relevant. Relevance raises attention and stimulates, for instance, brand recall

or positive attitude to a product (e.g., [Dahlén 2005](#)). A large volume of work exists that investigates how advertisements can achieve relevance. Research in this field is manifold because it tackles various fields and uses various concepts and terms. In the following, a selection of terms used in related literature is given, as far as it relates to our work. Personalization (e.g., [Montgomery and Smith 2009](#); [Vesänen and Raulas 2006](#)) is a rather broad concept that represents tailoring advertisements to consumer needs, goals, interests, knowledge, or other consumer characteristics ([Zimmermann et al. 2005](#)). Segmentation (e.g., [Reutterer et al. 2006](#)) refers to dividing the anonymous mass market into internally homogenous segments and providing each segment with a specific, tailored advertisement for that segment. In the specific case where each consumer is addressed individually with a tailored advertisement, researchers refer to it as “individualization” ([Reutterer 2003](#)). Profiling (e.g., [Bilenko and Richardson 2011](#)) connotes tailoring an advertisement to given consumers based on attributes composing their profiles, whereby attributes may be explicitly obtained (i.e., provided by the consumer) or implicitly (i.e., inferred based on prior behavior such as past search patterns, browsing history, shopping transactions, etc.). Behavioral targeting (e.g., [Yan et al. 2009](#)) focuses on a consumer’s current or past behavior for tailoring the advertisement. Context adaptation (e.g., [Bauer and Spiekermann 2011](#)) includes not only consumer characteristics but also considers consumers’ context (e.g., their physical environment) in a particular situation. These terms and concepts are partly overlapping and partly used synonymously. [Vesänen \(2007\)](#) suggests a conceptual framework that integrates “the many faces of personalization”. [Bauer and Lasinger \(2014\)](#), in contrast, break down the ‘holistic construct’ and differentiate between person-centric and situation-centric adaptation strategies of advertising, whereby both approaches may also be combined. In line with [Bauer and Lasinger \(2014\)](#), we will use the neutral expression ‘adaptation of advertisements’ throughout this paper.

One possible strategy to break through the information clutter is location-based advertising (LBA), where an advertisement is tailored to the location where a potential consumer accesses the advertisement ([Banerjee and Dholakia 2008](#)). LBA includes roadside advertisements and billboards, which are statically bound to the location where they are installed. LBA on desktop computers, by contrast, is more dynamic: a user’s location may, for instance, be inferred by detecting the IP (internet protocol) address or by his or her self-stated location, which is frequently asked for when registering on a website; the advertisement is then dynamically adapted to the user’s location in real-time. Bringing the LBA concept to mobile devices breaks new ground, as the location can be measured on a much more minute level (e.g., using GPS). GPS Standard Positioning Service receivers provide a horizontal accuracy of better than 3.5 meter ([National Coordination Office for Space-Based Positioning Navigation and Timing 2014](#)) (for details on localization sensors integrated in smartphones cf. [Mok et al. 2012](#); [Zandbergen 2009](#)). Here, location is a truly dynamic aspect of advertising, because people move with their mobile devices. This movement changes the proximity to potentially relevant stores (where advertised products or services may be purchased), which may be analyzed and adapted to in real-time. Location-detecting and location-inferring technologies and methods have advanced ([Alt et al. 2012](#)) to the point that various domains, including the advertising domain, are enabled to pick up these technological developments and use them in their fields. The implementation

of the GPS component within smartphones was a key enabler and driver for LBA on mobile devices (Bruner and Kumar 2007). A retailer, for instance, may send out a notification to a passersby near its premises that all products in the store are 10 % off until a set time (Alton 2015).

Still, the subtlety of the concept 'location' is frequently underestimated (Dobson 2005). Location does not only correspond to a place in terms of its absolute location, but also needs to consider the position of other elements that are relevant to the service (Schmidt et al. 1999; Paay and Kjeldskov 2007). A simple question such as 'where is X' may lead to a high number of possible answers. GPS and related systems typically provide the absolute position in Cartesian coordinates (e.g., 40°26'30"N, 80°0'0"W), which is meaningless for most systems, unless it can be combined with information about what else is at these coordinates that may be relevant for the service (Dobson 2005). For instance, location may be considered on a macro-level (e.g., a country, a town, or a region) or on a micro-level (e.g., next to the fridge) (Bauer and Spiekermann 2011). 'Close to shop X' uses the distance as a dimension and could be also expressed as direction (e.g., '100 meters east') (Li et al. 2000). 'At home' or 'at work' add a functional meaning to location. 'With Jane' is an expression of co-location; for some services it may be sufficient to know that they are together, regardless where exactly they are together. Arminen (2006) argues that location characteristics relating to a user or system's activities and interactions provide more meaningful location information than the geographical location (e.g., 'at work' versus 'in 5th Avenue').

Overall, published research on LBA frequently refers to specific settings and LBA is frequently looked at as by-product of research in context of a broader field. Hence, the 'big picture' of LBA is missing.

3 Methodology

The core contribution of this paper is a systematic literature review of scientific publications in the relatively young field of LBA. In this section, we outline the stepwise procedure for searching, filtering, analyzing and categorizing publications in the field of LBA on mobile devices, which is visualized in Table 1 and described in detail in the following subsections.

3.1 Online query for relevant publications

We sampled publications that we found in the five most common scientific online databases in the fields of computer science, information systems, and management: ACM, EBSCO, IEEE, SpringerLink, and Wiley Online Library. The rationale behind the choice of those five databases was to retrieve research contributions from the interdisciplinary area where management science and computer science/informatics overlap.

First, we explored the five online databases for publications containing the terms 'location-based marketing' and 'location-based advertising' in the full text. To obtain a wide bandwidth of results, we also performed search queries for the following terms: 'Location-based marketing', 'location-based advertising', 'targeted advertising', 'per-

Table 1 Overview of the stepwise procedure for the systematic literature review

Process steps		Described in	Activities	Results of the activities
1st step	Online query for relevant publications	Sect. 3.1	Search in 5 databases with 6 search terms	1718 hits
2nd step	Data cleansing and preselection of publications for the sample	Sect. 3.2	Elimination of duplicates and evaluation of title and abstract; rough check for relevance	101 preselected publications
3rd step	Review of preselected publications in full text	Sect. 3.3	Review of full text	66 publications in final sample
4th step	Quantitative analysis of the sample	Sect. 3.4	Coding of publications using 6 categories and 21 subcategories	Final quantitative review results; (for results cf. Sects. 4.1 to 4.3)
5th step	Qualitative assessment of the sample	Sect. 3.5	Content analysis of the sample	Final qualitative review results; (for results cf. Sect. 4.4)

sonalized advertising', 'location tracking', and 'context aware advertising'. We added the terms 'mobile' or 'smartphone' for each of the selected terms in order to retrieve publications that consider LBA on mobile devices only.

Using the outlined search terms, a set of 1718 hits referring to publications was retrieved from the five online databases: ACM (336), EBSCO (482), IEEE (546), SpringerLink (148), and Wiley Online Library (206). Table 2 shows in detail the disaggregation of the 1718 hits regarding search terms and sources.

3.2 Data cleansing and preselection of publications for the sample

The process of data cleansing was applied to the 1718 hits resulting from the online query. Data cleansing aimed to find and eliminate multiple appearances of publications in the databases, as well as evaluate and review the titles and the abstracts of the remaining publications concerning their thematic relevance. All in all, data cleansing resulted in a set of 101 publications, while 1617 hits from the online query were not further pursued because they either appeared multiple times in the sample (as they were listed in more than one of the chosen online databases), or because their content was unrelated to the topic at hand.

3.3 Review of preselected publications in full text

We critically reviewed the full text of the remaining 101 publications according to the following four criteria, whereby each criterion had to be met:

Table 2 Retrieved hits per source and search term

search terms	ACM	EBSCO	IEEE	SpringerLink	Wiley online library	Total
'Location-based marketing' + 'mobile'	9	130	20	4	7	170
'Location-based advertising' + 'mobile'	54	161	126	16	25	382
'Targeted advertising' + 'mobile'	172	101	265	84	124	746
'Personalized advertising' + 'mobile'	37	20	63	28	28	176
'Context-aware advertising' + 'mobile'	11	3	16	1	2	33
'Location-based marketing' + 'smartphone'	3	24	4	0	3	34
'Location-based advertising' + 'smartphone'	16	27	20	3	6	72
'Targeted advertising' + 'smartphone'	55	13	28	7	8	111
'Personalized advertising' + 'smartphone'	7	3	3	5	3	21
'Context-aware advertising' + 'smartphone'	2	0	1	0	0	3
Total	366	482	546	148	206	1718

- The publication is thematically related to *location-based services* and *targeting*;
- The publication is thematically related to *marketing* and *advertising*, respectively;
- The hardware used in the publication is a *mobile device* (e.g., mobile phones, smartphones, tablets, etc.);
- The publication is an *original work*.

After this review, another 35 publications were eliminated from the sample because they did not match each of the four criteria. Many publications had to be eliminated either because the topic did not fall into the context of 'advertising' (e.g., [Hynes et al. 2010](#); [Roy et al. 2012](#); [Wicker 2012](#)), or—despite the advertising context—they did not consider advertising on 'mobile devices' (e.g., [Krumm 2011](#); [Goldfarb 2013](#)), or they considered mobile marketing but without location orientation (e.g., [Ma et al. 2009](#)). The remaining 66 publications made up our final sample (for a complete list see the tabulation in the Web-Appendix that is available at the publisher's website).

3.4 Quantitative analysis of the sample

We performed six different analyses on the 66 publications of the final sample:

1. type of publication outlet (journal vs. conference) (for results cf. Sect. 4.1.1);
2. discipline of publication outlet (technical outlet vs. business outlet) (for results cf. Sect. 4.1.2);

3. methodological approach (design-oriented approach, social science experiment with users, computational experimental analysis, and survey) and, for survey work, additionally the method(s) used for the survey (questionnaire, interviews, panel, focus group) (multiple assignments) (for results cf. Sect. 4.2);
4. type of the major subtopic of the publication (e.g., user acceptance of LBA, privacy, business models) (for results cf. Sect. 4.2.1);
5. type of technology in delivering LBA to mobile devices (e.g., SMS notifications, display advertising, etc.) (for results cf. Sect. 4.2.2); and
6. context attributes that were used for the adaptation (adaptation criteria) (multiple assignments), for which a classification scheme was developed inductively from raw data (for results cf. Sect. 4.3).

Analyses 1 and 2 were derived from the citation information, while analyses 3 through 6 were derived from an in-depth analysis of the full text of the publications (for the analyses 1 through 3 cf. the tabulation in the Web-Appendix that is available at the publisher's website).

The entire set of 66 publications in the final sample were coded and evaluated by two independent coders. In the instances where disagreement emerged (96 % agreement; overall Cohen's Kappa 0.7527), the coders discussed the issue until *complete* consensus was established.

3.5 Qualitative analysis of the sample

We applied text and qualitative content analysis (e.g., [Mayring 1983](#)) to evaluate and consolidate the findings from the publications of the sample. We used the "summary" technique to reduce the material from the publications of the sample in full text. We applied the "structuring" technique to provide a systematic presentation of the findings. In order to increase inter-subjectivity, two researchers undertook the qualitative assessment. The findings of this analysis are discussed in Sect. 4.4.

4 Results

We performed six different analyses and present the results in the following subsections, where 4.1 through 4.3 contain results from the quantitative analysis, and in Sect. 4.4 we discuss findings that resulted from the qualitative analysis.

First, we present the outlets in which research on LBA on mobile devices is published (Sect. 4.1.1), and whether the outlet is rather a business-oriented or a technically oriented one (Sect. 4.1.2). Second, we present those approaches that were adopted in the publications to investigate on LBA on mobile devices (Sect. 4.2). In Sect. 4.2.1, we show the subfields of research that had been investigated in the publications and outline which subfields had been investigated by which methodical approach. In Sect. 4.2.2, we provide an overview of the various types of technology in LBA delivery (e.g., via SMS notifications, as display advertising, etc.) as used in the analyzed publications. In Sect. 4.3, we present the context attributes that are considered for advertising adap-

tation in addition to ‘location’ (e.g., time, preferences, etc.). Finally, in Sect. 4.4, we summarize and discuss the core findings of the analyzed publications.

4.1 Characteristics of the publication outlet

LBA on mobile devices is a topic that is highly interdisciplinary at its core, because it leverages technology for business purposes (i.e., advertising). First, in Sect. 4.1.1, we analyze whether the topic is published in refereed conference proceedings or in refereed journals. Second, in Sect. 4.1.2, we analyze whether LBA on mobile devices is published still from a rather technological perspective or from a business point of view, as suggested by [Okazaki and Taylor \(2008\)](#).

4.1.1 Type of publication outlet

Twenty-nine (29) publications are refereed journal publications, while 37 publications appeared in refereed conference proceedings (Table 3). This finding confirms our expectations, because LBA on mobile devices is a young research field and we expected early results to be mainly presented at conferences. However, the type of publication outlet chosen by researchers may also be influenced by the scientific discipline they are rooted in: Researchers in the discipline of management science may rather publish in journals, whereas in technical disciplines, it is more common that researchers present their findings at conferences and less frequently in journals (see also Sect. 4.1.2).

4.1.2 Research discipline of the publication outlets

Our analysis shows that LBA on mobile devices is currently approached from a technological perspective rather than from a business one; this is still in line with [Okazaki and Taylor \(2008\)](#), who observed this phenomenon in the early days of LBA. More than 70 percent of the articles in our sample were published in technically oriented outlets (47 publications) (Table 3). Half of the analyzed publications have been published in technically oriented conference proceedings (33 publications).

The high share of technology-oriented publications in the sample manifests itself by the fact that technical feasibility is a precondition for further research on LBA from a business perspective (i.e., advertising).

Of the 47 publications that appeared in technically oriented outlets, only 30 % (14 publications) are journal articles. In contrast, in our sample, almost all business outlets are refereed journals (15 publications out of 19).

Given the general assumption that technically oriented scientists tend to publish their work more frequently in conferences than business scientists do whereas the average business scientist has a publication ratio that favors journals over conference contributions, the distribution of the analyzed publications among outlets suggests that the topic of LBA on mobile devices is (still) predominantly investigated by technically oriented scientists.

Table 3 Type and research discipline of publication outlet

Publication	Outlet (journal/conference name)	Type of publication outlet		Research discipline of publication outlet	
		Referred journal contribution	Referred conference contribution	Business outlet	Technological outlet
Al Shoaibi and Al Rasan (2012)	1st International Conference on Internet Operating Systems (ICIOS 2012)	–	x	–	x
Albers and Kahl (2008)	10th IEEE Conference on E-Commerce Technology and the 5th IEEE Conference on Enterprise Computing, E-Commerce and E-Services (CEC/IEEE 2008)	–	x	–	x
Banerjee and Dholakia (2008)	International Journal of Mobile Marketing	x	–	x	–
Benisch et al. (2011)	Personal and Ubiquitous Computing	x	–	–	x
Benou et al. (2012)	Information Technology and Management	x	–	–	x
Bruner and Kumar (2007)	Journal of Interactive Advertising	x	–	x	–
Bulander et al. (2005)	2nd IEEE International Workshop on Mobile Commerce and Services (WMCS 2005)	–	x	x	–
Conti et al. (2012)	BCS HCI, People and Computers XXVI (HCI 2012)	–	x	–	x
Cremonese et al. (2010)	3rd Workshop on Mobile Video Delivery (MoVID 2010)	–	x	–	x

Table 3 continued

Publication	Outlet (journal/conference name)	Type of publication outlet		Research discipline of publication outlet	
		Referred journal contribution	Referred conference contribution	Business outlet	Technological outlet
D'Souza and Ananthanarayana (2012)	International Symposium on Cloud and Services Computing (ISCOS 2012)	–	x	–	x
Dhar and Varshney (2011)	Communications of the ACM	x	–	–	x
Durresti et al. (2013)	16th International Conference on Network-Based Information Systems (NBIS 2013)	–	x	–	x
Evans et al. (2013a)	7th International Conference on Complex, Intelligent, and Software Intensive Systems (CISIS 2013)	–	x	–	x
Evans et al. (2012)	6th International Conference on Complex, Intelligent and Software Intensive Systems (CISIS 2012)	–	x	–	x
Evans et al. (2013b)	27th International Conference on Advanced Information Networking and Applications Workshops (WAINA 2013)	–	x	–	x
Fawaz et al. (2011)	7th International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob 2011)	–	x	–	x
Fayaz and Sarrafian (2013)	International Journal of Electronics	x	–	–	x

Table 3 continued

Publication	Outlet (journal/conference name)	Type of publication outlet		Research discipline of publication outlet	
		Refereed journal contribution	Refereed conference contribution	Business outlet	Technological outlet
Frank and Wuersch (2006)	International Journal of Mobile Marketing	x	–	x	–
Gao et al. (2013)	7th ACM Conference on Recommender Systems (RecSys 2013)	–	x	–	x
Gidofalvi et al. (2007)	International Conference on the Management of Mobile Business (ICMB 2007)	–	x	x	–
Haddadi et al. (2010)	5th ACM International Workshop on Mobility in the Evolving Internet Architecture (MobiArch 2010)	–	x	–	x
Hardt and Naith (2012)	19th ACM Conference on Computer and Communications Security (CCS 2012)	–	x	–	x
Ho (2012)	Decision Support Systems	x	–	–	x
Hristova and O'Hare (2004)	37th Hawaii International Conference on System Sciences (HICSS 2004)	–	x	–	x
Kaasinen and Yong-Ik (2013)	International Conference on Information Networking (ICOIN 2013)	–	x	–	x
Kam-Yiu et al. (2013)	27th International Conference on Advanced Information Networking and Applications Workshops (WAINA 2013)	–	x	–	x

Table 3 continued

Publication	Outlet (journal/conference name)	Type of publication outlet		Research discipline of publication outlet	
		Refereed journal contribution	Refereed conference contribution	Business outlet	Technological outlet
Kelley et al. (2011)	SIGCHI Conference on Human Factors in Computing Systems (CHI 2011)	–	x	–	x
Kim et al. (2011a)	12th Workshop on Mobile Computing Systems and Applications (HOTMOBILE 2011)	–	x	–	x
Kim et al. (2011b)	Journal of Systems and Software	x	–	–	x
King and Jessen (2010)	Computer Law and Security Review	x	–	x	–
Kurkovsky and Harihar (2006)	Personal and Ubiquitous Computing	x	–	–	x
Leek and Christodoulides (2009)	Journal of Advertising Research	x	–	x	–
Li and Du (2012)	Decision Support Systems	x	–	–	x
Li et al. (2010)	International Conference on Multimedia (MM 2010)	–	x	–	x
Li et al. (2012)	CoNEXT Student Workshop @ ACM CoNEXT 2012	–	x	–	x
Liapis et al. (2008)	3rd International Symposium on Wireless Pervasive Computing (ISWPC 2008)	–	x	–	x

Table 3 continued

Publication	Outlet (journal/conference name)	Type of publication outlet		Research discipline of publication outlet	
		Referred journal contribution	Referred conference contribution	Business outlet	Technological outlet
Lin et al. (2013)	Personal and Ubiquitous Computing	x	-	-	x
Liu et al. (2011)	17th International Conference on Advances in Multimedia Modeling (MMM 2011) - Volume Part II	-	x	-	x
Luo et al. (2014)	Management Science	x	-	x	-
Magedanz and Simoes (2009)	International Journal of Mobile Marketing	x	-	x	-
Mahmoud (2006)	IEEE International Conference on Multimedia and Expo (ICME 2006)	-	x	-	x
Mazaheiri et al. (2010)	5th International Symposium on Telecommunications (IST 2010)	-	x	-	x
Merisavo et al. (2007)	Journal of Interactive Advertising	x	-	x	-
Okazaki and Taylor (2008)	Journal of Business Research	x	-	x	-
Pandit et al. (2014)	IEEE International Conference on Services Computing (SCC 2014)	-	x	-	x
Penev and Wong (2009)	18th ACM International Conference on Information and Knowledge Management (CIKM 2009)	-	x	-	x
Rajmakers et al. (2013)	14th Australasian User Interface Conference (AUIC 2013)	-	x	-	x

Table 3 continued

Publication	Outlet (journal/conference name)	Type of publication outlet		Research discipline of publication outlet	
		Refereed journal contribution	Refereed conference contribution	Business outlet	Technological outlet
Rashid et al. (2008)	Personal and Ubiquitous Computing	x	–	–	x
Richard and Meuli (2013)	Journal of Marketing Management	x	–	x	–
Rifat et al. (2012)	15th International Conference on Computer and Information Technology (ICCIIT 2012)	–	x	–	x
de Sa et al. (2013)	SIGCHI Conference on Human Factors in Computing Systems (CHI 2013)	–	x	–	x
Sang-Yeal et al. (2005)	International Conference on Mobile Business (ICMB 2005)	–	x	x	–
Simoes et al. (2009)	ITU-T Kaleidoscope: Innovations for Digital Inclusions (K-IDI 2009)	–	x	x	–
Tang et al. (2013)	Decision Support Systems	x	–	–	x
Truong and Simmons (2010)	Journal of Strategic Marketing	x	–	x	–
Tussyadiah (2012)	Journal of Travel and Tourism Marketing	x	–	x	–
Unni and Harmon (2007)	Journal of Interactive Advertising	x	–	x	–

Table 3 continued

Publication	Outlet (journal/conference name)	Type of publication outlet		Research discipline of publication outlet	
		Refereed journal contribution	Refereed conference contribution	Business outlet	Technological outlet
Vatanparast and Ali Hasan (2010)	International Journal of Mobile Marketing	x	-	x	-
Vatanparast and Butt (2009)	42nd Hawaii International Conference on System Sciences (HICSS 2009)	-	x	-	x
Wang et al. (2014)	Journal of the Association for Information Science and Technology	x	-	-	x
Wells et al. (2012)	International Journal of Mobile Marketing	x	-	x	-
Xu et al. (2011)	Decision Support Systems	x	-	-	x
Xu et al. (2009)	International Journal of Mobile Communications	x	-	-	x
Ya-Ching (2010)	IEEE International Conference on Software Engineering and Service Sciences (ICSESS 2010)	-	x	-	x
Yuchul et al. (2009)	IFIP/IEEE International Symposium on Integrated Network Management-Workshops (IM 2009)	-	x	-	x
Zhang et al. (2012)	21st ACM International Conference on Information and Knowledge Management (CIKM 2012)	-	x	-	x
Total number of publications		29	37	19	47

4.2 Methodological research approaches to investigate on location-based advertising on mobile devices

From the methodological perspective, we distinguish four major research approaches, i.e., (1) design-oriented approach, (2) social science experiment with users, (3) computational experimental analysis, and (4) survey. Each publication was assigned exactly to one category (no multiple assignments). In our sample, half of the publications (33) were design-oriented, 17 publications provided surveys, 8 publications reported on social science experiments, and 8 contributed with a computational experimental analysis.

In the following we perform a twofold refinement: first, the publications of our analysis allowed for an identification of 10 subtopics and aspects, and second, we distinguish between 11 technologies delivering the location-based advertisement, all of which we perform a mapping of the methodological research approaches.

4.2.1 Types of subtopics and aspects

Figure 1 presents the subfields of research that have been investigated in the field of LBA with mobile devices to date. Our analysis revealed 10 subfields of research. These categories were derived from explicit claims in the publications. Again, each publication was assigned exactly to one category (no multiple assignments).

We obtained a more detailed view of the applied methodologies by analyzing the identified problem-specific aspects (cf. Fig. 1). The set of design-oriented contributions (33 publications) is concerned with the development of algorithms, architectures, or software for delivering advertising messages and operating LBA on mobile devices. Thereby the focus lies mainly in exploring the capabilities of LBA (24 publications). Three design-oriented publications focus on privacy issues, 2 explore location techniques, 2 demonstrate viable business models, one publication considers user acceptance from a design-oriented perspective, and another one makes its contribution to the field of usability.

Of the 17 publications that take a survey approach, 9 investigate user acceptance (i.e., perceived benefit and the acceptance of LBA as well as consumers' attitudes towards LBA and, respectively, personalized, mobile advertising). Exploring the capabilities of LBA and related privacy issues from a users' perspective are researched in 2 publications each. For instance, [Lin et al. \(2013\)](#) investigates consumers' willingness to disclose their current location to advertisers. Two publications explore the capabilities of LBA using a survey. Further 2 publications compare LBA in different markets and cultures. Another publication investigates the adoption on the market with this approach. The effectiveness of LBA is also once investigated using a survey.

In the sample, social science experiments with users are mainly chosen for investigating the effectiveness of LBA (4 publications). This type of experiment is also the approach of choice in 2 publications on privacy issues with respect to location sharing, for researching user acceptance of adapted advertisements from the perspective of consumers in one publication, and for evaluating presentation styles in one publication. Typically, the experimenters provided participants with mobile devices and sent

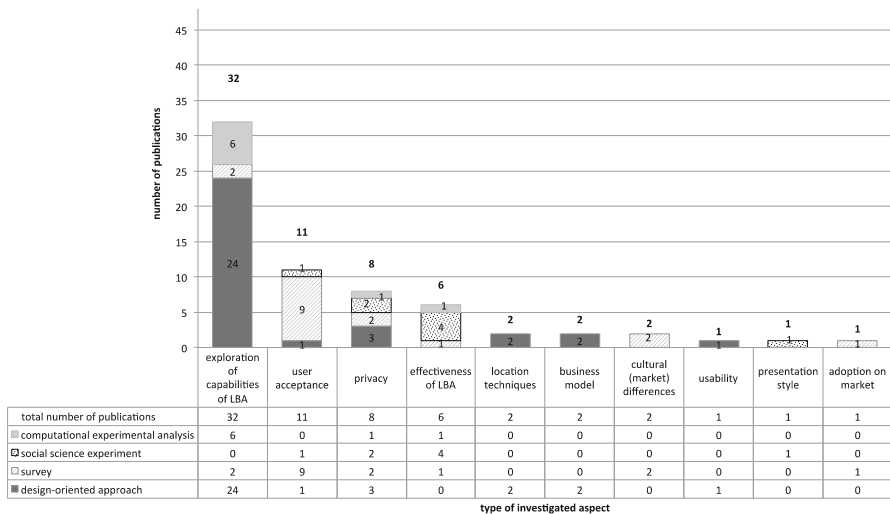


Fig. 1 Number of publications per methodological approach and per investigated aspect

advertising messages to these devices; the participants' reactions were either directly observed or the participants were asked for a self-assessment via questionnaire.

Similar to the design-oriented approach, the computational experimental analysis explores and demonstrates the capabilities of LBA from a technical perspective (6 publications). Furthermore, for researching privacy issues and the effectiveness of LBA, the computational experiment was the approach of choice in one publication each.

For reasons of refinement, we analyzed in detail the methods that were used in the 17 survey studies. The majority of survey studies (15 publications) are based on (online) questionnaires. Five publications used more than one method: [Conti et al. \(2012\)](#) and [Okazaki and Taylor \(2008\)](#) combined questionnaires and interviews. [Truong and Simmons \(2010\)](#) conducted a qualitative study based on interviews. [Vatanparast and Ali Hasan \(2010\)](#) is the only publication in the sample that used a panel, and [Tussyadiah \(2012\)](#) is the only one using focus groups in the research design.

4.2.2 Types of technologies in delivering location-based advertising

Our analysis revealed that 16 publications investigated LBA with having sent SMS or MMS notifications. Thereby, [Unni and Harmon \(2007\)](#) specifically analyze the differences between SMS as a push or pull medium. Eleven publications analyzed a within-app advertisement, whereby 8 of them applied a design-oriented approach and the other 3 chose a computational experimental setting. Eight publications investigate LBA operationalized as display advertising; 3 publications use a social science experiment setting, one a computational experimental analysis, and 4 publications take a design-oriented approach. Furthermore, 5 publications investigated LBA within social networks. Other types of technologies in delivering LBA were investigated in rare cases in the sample, whereby the design-oriented approach is the primary method

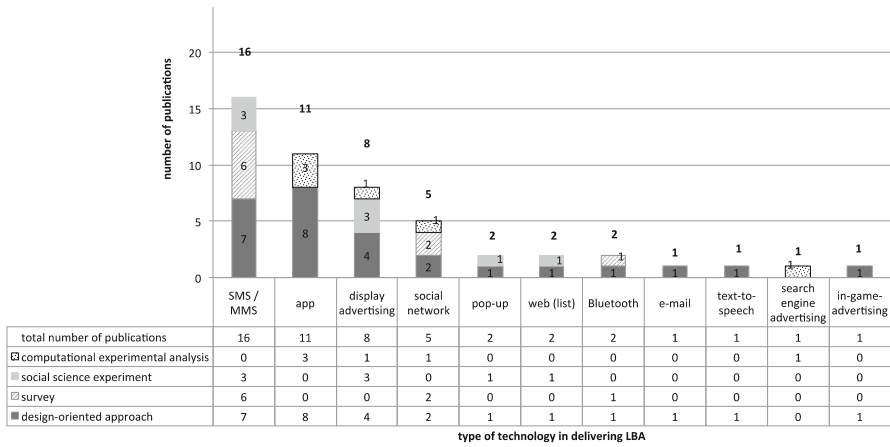


Fig. 2 Number of publications per type of technology in delivering LBA and applied research approach

used in these publications. Figure 2 visualizes the number of publications per type of technology and applied research methodology.

4.3 Context attributes as adaptation criteria

Another part of our analysis focuses on context attributes that are considered for adaptation in addition to ‘location’. The classification scheme was developed inductively from raw data and resulted in the following subcategories:

- **Location:** this context attribute implies that an advertisement is sent or shown to a consumer according to his or her current location. Thereby the location may be represented, for example, as the respective Cartesian coordinates, the labels ‘at work’ or ‘at home’, ‘in the proximity of shop X’, etc.
- **Time:** advertisers may address a consumer at a time that is assumed to be convenient for him or her to have the advertisement being more effective (e.g., leisure time versus office hours). Thereby ‘time’ may be expressed as a certain time of a day (e.g., 11:30 a.m.) or labeled, for instance, as ‘at working hours’, ‘at leisure time’, ‘during lunch time’, etc. Combining time and location data of a consumer may constitute richer information to an advertiser. For instance, when at a certain place close to work at noon, a consumer may be very likely to have lunch break.
- **Profile:** a profile subsumes a user’s attributes and interests, which may be captured and consolidated by the advertiser, a third party, or may be set up by a consumer him or herself (Cremonese et al. 2010). A user profile is typically considered static (Liapis et al. 2008).
- **Interest:** although no less than 12 publications in the sample consider tailoring advertisements to a user’s interest, they do not provide a clear-cut definition for this attribute. Still, Kaasinen and Yong-Ik (2013) points out that interest is not static and tracking a user’s transaction history could be extremely helpful in order to determine a user’s likes and interests.

- Preferences: while behavior is usually logged by a consumer's actual activities, consumers typically state preferences themselves (e.g., favorite movie, favorite band, favorite food, etc.). While scientific studies usually ask their participants for their preferences in a questionnaire, in real-world applications such data is collected when the consumer registers for a platform, social communities, or for mobile apps.
- Behavior: this category implies that an advertisement is sent or shown based on a consumer's behavior, which may be obtained and analyzed from online behavior (e.g., search patterns when using search engines, clicking behavior in a browser), or from sensing and analyzing behavior in the 'offline' world. Future advertisements such as rebates or recommendations may then be steered based on the consumer's prior behavior. For instance, if having data on what a consumer is frequently searching for (e.g., through search term analysis), a compatible advertising message may be addressed to this consumer. This kind of adaptation of advertising messages is also known as 'behavioral targeting'.
- Demographics: similar to preferences, demographical data is typically asked for when registering for a service or an online community. This data (in many cases demographics are reduced to age and gender) may be used to tailor the advertising message to the particular demographics. For instance, an advertisement for a shop for ladies wear would only be delivered to women.
- Weather: contents may orientate on a consumer's current weather situation (e.g., temperature, humidity, wind force). This information may, for instance, be obtained from combining a consumer's location data with data from weather services.
- Characteristics of surrounding environment: this attribute concerns the physical context of a consumer at his or her current location.
- Mobile device: information about the specification of a consumer's device (e.g., display resolution, operating system) can be used to adapt, for instance, the graphics of an advertisement displayed to the corresponding display resolution.
- Situation: while authors typically use explicitly the term "situation" [e.g., [Merisavo et al. \(2007\)](#); [Kim et al. \(2011b\)](#)], we claim this term is too fuzzy as an adaptation attribute. Actually, this category circumscribes a consumer's perceived readiness for consuming. For instance, if a consumer is at home or at work absorbed in a certain task, the probability is low that he or she would pay attention to an advertisement and follow up with a purchase. If he or she, instead, is searching for a restaurant at lunch break or is shopping, the probability to follow up the advertisement's message is higher.
- Nearby objects: this category is closely related to the attribute "characteristics of surrounding environment", as it also relates to the physical context of a consumer. [Hristova and O'Hare \(2004\)](#), for instance, relate to restaurants, museums, etc. that are close-by as objects that may be relevant for a consumer at a certain location.
- Social context: this category reflects whether the user's location is associated to a specific social event, which can be used to tailor advertisements to the user. Moreover, also knowing whether consumers are by themselves or part of a group provides possibilities for adapting advertisements (e.g., not advertising a deal for a one-person meal when a user is with several people) ([de Sa et al. 2013](#)).

- Need: user needs may be explicitly expressed such as looking for a specific book that a user requires for study. An example for a user's current need may, though, also be implicit such as 'feeling hungry' is actually a symptom for a user's need for food.
- Activity: an activity that a consumer is currently engaged in, be it sports, entertainment, or work, may be a basis for the kind of advertisement that is relevant in this moment (Simoes et al. 2009).

Further attributes are considered just by single publications: calendar (Bulander et al. 2005), noise-level (Bulander et al. 2005), personality traits (Pandit et al. 2014), privacy policy (Benisch et al. 2011), parking place (Benou et al. 2012), price range (Durrresi et al. 2013), and computing context (Hristova and O'Hare 2004). Due to the inductive approach for categorizing, this list of context attributes is not exhaustive and represents only those context attributes that have been used in the publications of the final sample.

While 23 publications focused solely on location as an attribute for advertisement adaptation, 43 publications considered, in addition to location, further context attributes for adapting the advertisement (cf. Table 4). The most frequently used attributes used as adaptation criterion were time (24), profile (12), interest (12), and preferences (10). Bulander et al. (2005) integrate 7 context attributes for adaptation in their work (i.e., location, time, profile, demographics, weather, calendar, and noise-level). Li and Du (2012) use 6 context attributes for adaptation (i.e., location, time, preferences, behavior, demographics, and weather). Equally, Simoes et al. (2009) uses 6 context attributes (i.e., location, time, demographics, characteristics of surrounding, social context, and activity) as well as Magedanz and Simoes (2009) (i.e., location, time, preferences, weather, device, need). Interestingly, adapting advertising messages to several context attributes was much more often considered in design-oriented publications than in publications with other methodological approaches.

4.4 Core findings in publications derived from qualitative analysis

Although the analyzed publications are heterogeneous in their approaches to LBA, the analysis revealed several core findings that are shared among several publications. Overall, the results suggest that consumers may perceive LBA positively if they receive it at the opportune moment. LBA is assumed to be most useful in leisure time (Banerjee and Dholakia 2008; Conti et al. 2012; Penev and Wong 2009) and in situations when the consumer is ready for consumption such as during shopping, during lunch break, or during 'niche' times such as travel time of commuters (Banerjee and Dholakia 2008; Conti et al. 2012; Cremonese et al. 2010; Kim et al. 2011a). Interestingly, advertisements are perceived more positively if the consumer finds himself or herself at a public place instead of being at home or at work (Banerjee and Dholakia 2008; Conti et al. 2012; Cremonese et al. 2010). In situations when the consumer is not ready for consumption (e.g., at work), LBA is perceived rather negatively. Recent empirical studies (e.g., Luo et al. 2014) are performed on a large-scale basis and reveal interesting effects when mobile targeting strategies are performed; results show that balancing of temporal and geographical mobile targeting strategies is crucial when designing mobile targeting campaigns.

Table 4 Overview of context attributes used for adaptation in the publications of our analysis (publications in alphabetical order, grouped by methodological approach)

methodological approach	publication	context attribute for adaptation																number of attributes																
		location	time	profile	interest	preferences	behavior	demographics	weather	characteristics of surrounding environment	device	situation	nearby objects	social context	need	activity	calendar		noise-level	personality traits	privacy policy	parking place	price range	computing context										
design-oriented approach (33)	Al Shoaibi and Al Rassan (2012)	x	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2		
	Albers and Kahl (2008)	x	x	x	x	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5		
	Benou et al. (2012)	x	-	-	-	-	-	-	-	x	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	4		
	Bulander et al. (2005)	x	x	x	-	-	-	-	x	x	-	-	-	-	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-	-	-	-	7	
	Cremonese et al. (2010)	x	-	x	x	x	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	
	D'Souza and Ananthanarayana (2012)	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
	Dhar and Varshney (2011)	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
	Durresi et al. (2013)	x	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	3	
	Evans et al. (2013a)	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
	Evans et al. (2012)	x	-	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	
	Evans et al. (2013b)	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
	Fawaz et al. (2011)	x	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
	Fayaz and Sarrafian (2013)	x	x	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	
	Frank and Wuersch (2006)	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
	Gao et al. (2013)	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
	Haddadi et al. (2010)	x	-	x	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	
	Hristova and O'Hare (2004)	x	x	x	-	x	-	-	-	-	x	x	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	8
	Kaasinen and Yong-Ik (2013)	x	-	-	x	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	
	Kam-Yiu et al. (2013)	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
	Kim et al. (2011b)	x	-	x	-	-	-	-	-	-	x	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	
	King and Jessen (2010)	x	-	x	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	
	Kurkovsky and Harihar (2006)	x	-	-	x	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	
	Li and Du (2012)	x	x	-	-	-	x	x	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	
	Li et al. (2012)	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
	Liapis et al. (2008)	x	x	x	x	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	
	Mahmoud (2006)	x	x	-	-	-	x	-	-	-	-	-	x	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	5	
	Mazaheri et al. (2010)	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
	Pandit et al. (2014)	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
	Rashid et al. (2008)	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
	Rifat et al. (2012)	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
	Sang-Yeal et al. (2005)	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	
	Simoes et al. (2009)	x	x	-	-	-	-	-	x	-	x	-	-	-	-	x	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	6	
	Yuchul et al. (2009)	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
survey (17)	Benisch et al. (2011)	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	3		
	Bruner and Kumar (2007)	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
	Conti et al. (2012)	x	x	-	-	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4		
	Ho (2012)	x	x	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3		
Kelley et al. (2011)	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2		

lower compared to push advertising (Unni and Harmon 2007; Li and Du 2012; Conti et al. 2012; D'Souza and Ananthanarayana 2012). Generally, having the consumer's consent for delivering advertisements increases the attention to and the perception of those messages delivered (Leek and Christodoulides 2009; Bulander et al. 2005).

Another important factor in LBA is the consumers' *motivation* to use LBA on their devices—particularly when LBA is operationalized as a pull system. If the consumer assumes that using LBA will provide him or her with information about his or her friends and/or environment or will receive useful and accurate recommendations, the motivation to use LBA may be raised (Ho 2012). Beyond that, novelty and involvement have positive impact. For instance, an LBA service may be used because it is perceived as fun. Accordingly, services containing novel functionalities and facilitating interaction with a community have a higher potential to be used (Ho 2012). Particularly for the venue categories of food and travel/transport, LBA has been proven successful (Li et al. 2012).

Generally, consumers' privacy concerns are high with respect to LBA while the perceived benefit and their willingness to use LBA are relatively low. Consumers would appreciate automatized data processing (Magedanz and Simoes 2009), whereas they do not want companies to pass on personal information to others without their explicit approval (Kelley et al. 2011; Pandit et al. 2014). Transparency of the processing of data increases the acceptance of LBA (Haddadi et al. 2010; Hardt and Nath 2012; Kelley et al. 2011; Magedanz and Simoes 2009; Penev and Wong 2009).

Haddadi et al. (2010) argue that the employed advertising software should create consumer profiles based on aggregated data only in order to avoid the collection of sensitive data and misuse of personal data. Furthermore, consumers tend to react negatively to advertisements that are tailored to their person or environment once they realize that it is tailored (Malheiros et al. 2012). To 'remedy' this situation, Haddadi et al. (2010) suggest to include "Bluff Ads", which are purposeful advertisements unrelated to the respective user profile or environment; such tactics cover up that the advertisements a user receives are tailored to his/her profile and/or environment.

With respect to location sharing, the analyzed publications' results indicate that, in principle, consumers do not have a negative attitude towards disclosing their location. However, it depends on the point of time, the location, and the persons or entities to which the location will be disclosed. While consumers tend to agree to share their location with family and friends, they take a critical view of sharing their location with advertisers. If a consumer, though, is provided the capability to specify himself or herself when and for how long his or her location is disclosed to a potential advertiser, the willingness to share his or her location information increases compared to the scenario without the capability of self-configuration (Kelley et al. 2011). The more alternatives consumers have in restricting their privacy configurations, the more they are willing to disclose their location to the (restricted) circle of addressees (Benisch et al. 2011; Kelley et al. 2011; Li et al. 2012).

From a technical perspective, 4 publications (i.e., Zhang et al. 2012; Penev and Wong 2009; Hardt and Nath 2012) propose algorithms for advertising adaptations that are effective, efficient, and scalable. Prototypical implementations of such algorithms (e.g., ranking-algorithms that, for instance, determine a trade-off between the

geographical positions of customer and advertiser versus execution-time of the advertisement) revealed the need for mechanisms that support real-time computations (Al Shoaibi and Al Rasan 2012; Albers and Kahl 2008; Durresi et al. 2013). An encapsulation of content management, logic, and procedures into separate systems make LBA systems more manageable, facilitate maintenance, and speed up the development of such a system (Benou et al. 2012). With an advertisement database on a user's device, advertisements may be displayed more timely and with minimum privacy concerns (Penev and Wong 2009). Hardt and Nath (2012) argue that reasonable levels of privacy, efficiency, and relevance can be reached simultaneously for LBA. Evans and colleagues (Evans et al. 2012, 2013a, b) take an interesting approach that circumvents the privacy issue: they do not use smartphones as mobile devices, but investigate LBA operationalized as screens that are mounted on vehicles and show different advertisements based on the location of the vehicle. As the advertisements are not tailored to an individual but solely to location, privacy is not an issue here.

Finally, when designing an LBA system, designers should be aware that sensing location frequently raises the energy consumption of the user's device (Kim et al. 2011a; Benou et al. 2012) and, hence, should look for alternative implementations. Furthermore, Benou et al. (2012) suggest integrating marketing experts in an early stage of the design and promotion of an LBA system.

5 Discussion

The results obtained by the six different analyses we performed will be discussed in the following subsections. The current state of research in the field of LBA on mobile devices, namely the investigated research fields within LBA research is discussed in Sect. 5.1. The methodological research approaches taken in the publications to investigate on LBA on mobile devices is subject of discussion in Sect. 5.2, whereas in Sect. 5.3 the types of technologies applied in delivering LBA are addressed. Section 5.4 discusses the future potential of LBA on mobile devices, and in Sect. 5.5, we refer to the limitations of our systematic research approach.

5.1 Investigated research fields within location-based advertising research

Evaluating the field of the publications' outlets showed a relatively high ratio of technology-oriented publications (47 out of 66) compared to publications taking a business perspective (19 out of 66; cf. Table 3). These ratios may be due to the fact that technical feasibility provides the basis for further research on LBA from a marketing perspective. Accordingly, an increase of advertising studies in the field of LBA is to be expected, once technical challenges (e.g., indoor positioning) and privacy challenges (cf. Haddadi et al. 2011) are overcome. The number of journal publications compared to the number of conferences (29 journals versus 37 conferences; cf. Table 3) hardly allows for any general LBA-relevant conclusions. Interestingly, half of the analyzed publications have been published in technically oriented conference proceedings (33 publications), which may be interpreted as an indicator that the topic of LBA on mobile devices is (still) in the hands of technically oriented scientists.

While research on LBA has its roots in technically oriented disciplines, it is important that research teams have competences in marketing to investigate marketing-related problems of LBA, for example. We conclude from the large ratio of technically oriented publications that collaboration between technically oriented and non-technically oriented disciplines has not yet taken up in the research field of LBA on mobile devices.

5.2 Methodological research approaches to investigate on location-based advertising on mobile devices

Overall, the evaluation of methodological approaches applied to research in LBA showed that social science experiments (8 publications) and computational experimental analysis (8 publications) seem to be slightly underrepresented in the field compared to design-oriented work (33 publications) and survey work (17 publications). In particular, social science experiments could be a valuable basis to shed light on whether LBA on mobile devices is a viable alternative to other types of advertising. Interdisciplinary work that integrates a psychological perspective would support this goal. Adopting the survey method in addressing topics such as user acceptance of LBA, its effectiveness, privacy issues or adoption of LBA on the market may be problematic, as research in various disciplines has repeatedly shown that there is typically a gap between user attitude and user behavior (cf. [Ajzen and Fishbein 1977](#)). Studies investigating these topics (i.e., effectiveness, privacy issues, or adoption of LBA on the market) in LBA research should make a clear distinction between attitude and user behavior. Generally, social science experiments observing users' actual behavior may be the better choice of method for investigating such topics. One reason behind the fact that only a few social science experiments were published to date in researching LBA may result from an assumed analogy between users' LBA attitudes and behaviors on the Web and with mobile devices. As localization techniques are much more precise with mobile devices than on the Web ([Bauer 2013](#)), a mobile device is considered a much more *personal* device than a desktop computer ([Abowd 2012](#)), and the adaptation possibilities are more versatile on mobile devices ([Yuan and Tsao 2003](#)), this assumption is likely *not* to hold. More (experimental) research is required investigating this issue. The large proportion of design-oriented work in LBA research represents a good basis, as this type of research is required to gauge the technical possibilities. However, the current set of publications adopting a design-oriented approach is rather heterogeneous with respect to technical solutions and the investigated research setting in which it is applied for evaluation. Consequently, it is difficult to compare the results of this set of publications. Furthermore, the design-oriented work investing LBA has in common that it is based on the assumption that adaptation to a user's location is perceived as good at the selected point in time. However, the state of the art of research investigating LBA (particularly the work adopting social science experiments and surveys) is not yet in a position to predict the ideal location and ideal point in time for the adaptation. As a consequence, new findings concerning ideal location and time need to be integrated in new design-oriented work to allow for better prototypes, which may then be picked up for additional experiments, etc. A further deficiency of current

results on LBA on mobile devices lies in the chosen research settings as only a few field studies approximate real world settings. The relative large number of survey work seems worth mentioning.

5.3 Types of technologies applied in delivering location-based advertising

Analyzing the sampled publications for the types of technologies delivering LBA showed a large number of publications using SMS and MMS notifications for LBA (16 publications). This may be due to the fact that SMS and MMS were among the first tools available for mobile advertising. Using LBA within dedicated applications is an interesting research field that is strongly represented in our sample (11 publications). However, existing work does not investigate whether people would indeed install applications that are especially dedicated to advertising. Further research is necessary in this field. The fact that only one publication investigates search engine advertising on mobile devices may be due to the fact that search engine advertising *on the Web* is already widely researched and well accepted in practice. However, consumers' acceptance for this kind of advertising *on mobile devices*—particularly considering a consumer's current location—may be different than the acceptance of web-based advertising. Furthermore, the effectiveness of advertising may vary between devices. In addition, our analysis reveals that those publications that take a design-oriented approach (i.e., technology-oriented publications) cover various types of technology in delivering LBA, while the publications including survey or social science experiments stick to just a few technologies. More interdisciplinary research cooperation could facilitate the inclusion of a greater variety of delivering technologies of LBA also in user-centered research.

5.4 Future potential of location-based advertising on mobile devices

Another interesting result of our analysis is that the *capabilities of LBA* is the main focus of 32 publications, while 24 thereof investigated this topic by applying a design-oriented approach and 6 with a computational experimental analysis. In other words, the capabilities of LBA were mainly explored from a technical perspective; only 2 publications with surveys included also the user perspective. It is necessary to close this gap by including the user in the loop. Investigating the user acceptance from a non-technical point of view (researched in 9 publications with surveys and one with a social science experiment) is one viable way to address this issue investigating users' attitudes towards LBA on mobile devices. Still, more user-centric research is necessary. Not only should user attitude be addressed, but actual user behavior as well. Furthermore, research on business models for LBA with mobile devices was only addressed by adopting a design-oriented approach describing technical architectures and solutions (2 publications), while business models are per se considered a business topic. We claim for research from a business perspective, as technical feasibility is only one of various factors for viable business models.

The evaluation of the context attributes revealed that besides 'location', the attributes 'time' (e.g., [Havlena and Graham 2004](#)), 'profile' (e.g., [Hristova and O'Hare 2004](#)) and 'interest' (e.g., [de Sa et al. 2013](#)) were the most frequent context attributes

for advertisement adaptation in our sample. These context attributes are well known and widely used as context attributes for adaptation of advertisements on the Web. Accordingly, seeing these 3 context attributes as the most frequent ones for LBA appears like a logical continuation of the concept, now in the mobile domain. The adaptation criterion ‘situation, which was used in 3 publications, sticks out of the other context attributes used in the sample since the concept ‘situation’ is complex and multifaceted, covering several context attributes. For instance, several attributes such as location, time, a consumer’s behavior, and the device in use may describe a consumer’s current situation.

Adaption to a consumer’s behavior was examined in 5 design-oriented publications, but only once in a survey and in no social science experiment. As it is difficult to control for behavior, this would explain why this criterion is not used in social science experiments in the field. In surveys, one has to ask for self-stated potential behavior, which may lead to statements that do not reflect real behavior [as has been revealed, for instance, in publications putting forward the privacy paradox (e.g., [Norberg et al. 2007](#))]; accordingly a survey might not be the research strategy of choice if the aim is to investigate behavioral advertising. The low use of ‘need’ as an adaptation criterion for LBA might be due to the fact that it is difficult to capture information on a user’s needs in a mobile setting without asking the user for self-stating his/her needs.

5.5 Limitations

Overall, we have chosen a systematic approach in searching and selecting literature along several dimensions: (a) choice of databases, (b) search terms, and (c) types of publication outlets (i.e., only peer reviewed outlets considered). This approach is widely accepted as a viable, scientific approach due to its systematics. However, such an approach has its limitations, as it does not guarantee that all good works in the area are finally covered by the systematics. Reasons for this are the facts that the approach represents a snapshot at a certain point of time and the results depend on the matching between the chosen search terms for queries as well as the keywords and terminology of articles. For instance, highly interesting and valuable works such as [Fang et al. \(2015\)](#) on the sales impact of LBA promotions, [Fong et al. \(2015\)](#) on how LBA cannibalizes profits on infra-marginal sales, or [Luo et al. \(2014\)](#) suggesting that understanding the when, where, and how of mobile targeting strategies is crucial are not covered by the search and selection strategy chosen.

Furthermore, having performed the systematic literature review and assessment of location-based advertising on mobile devices on a very detailed level turned out to be an opportunity and at the same time also a limitation, because the thoroughly performed filtering process narrowed the sample from the initial 1718 hits down to only 66 publications (3.8 %). On the one hand, the limited sample size of 66 publications demands for caution when it comes to generalizability and representativeness of findings. On the other hand, the limited sample size gave us the opportunity to perform a detailed in-depth analysis on several issues and various criteria, and thereby providing insights into research in this novel and promising field.

6 Conclusions

The pervasiveness of smartphones and similar mobile devices enables advertisers to contact consumers individually any time at any place. As such, devices are typically equipped with GPS functionality and other sensors, advertisers have the opportunity to provide advertising messages tailored to a consumer's location and/or choosing places for message delivery that are known to have a high and positive advertising effect. While the underlying concept—the so-called 'location-based advertising' (LBA)—is already known from roadside billboards and from the Web, LBA on mobile devices provides new opportunities for advertisers: consumers may be addressed individually (based on their current location) and dynamically (in real-time). Accordingly, within the mobile marketing domain, LBA turns over a new leaf.

We performed a multifaceted analysis of existing scientific publications on LBA on mobile devices. This analysis allows for pinpointing selected "white spots" in research and drawing the attention to presumably promising areas for future research and directions of future development trends:

(1) *Interdisciplinary research approaches*: research on LBA on mobile devices that takes a technological point of view (particularly those research endeavors taking a design-oriented approach) seems to have passed the peak of the research lifecycle; the main technical challenges are solved so far, while other disciplines related to LBA, seem to be in a phase of discovering the challenges and benefits of the topic. In neighboring disciplines, the position of LBA-related topics in the research lifecycle is in a quite early phase where location-based technologies are discovered as enablers and drivers within their discipline-specific approaches. Psychology, particularly business psychology, economic sociology, and—last but not least—marketing (in particular advertising) are the most concerned disciplines that are now demanded to pick up, integrate, and bring forward research in the field of LBA on mobile devices. Interdisciplinary collaboration of technically oriented and non-technically oriented disciplines will support rapid advancements in the field, as those (applied) disciplines that pick up and integrate those technologies into their approaches and views will benefit from the experience and background of technically oriented disciplines.

(2) *Empirical research on the effectiveness of LBA*: empirical research, in particular social science experiments, are needed to fill the gap on the question about the effectiveness of LBA on mobile devices, especially with respect to brand recognition, brand recall, and purchase behavior. Empirical and experimental research could provide valuable evidence in the field of LBA. Only few studies exist in this field, although this is a major question to be answered: is LBA on mobile devices a viable alternative to other advertising types? In this research thread it is also important to take cultural differences into account. Acceptance and effects of LBA may vary among different cultures and/or regions; for example, privacy awareness is of greater significance on a broad basis in Europe compared to privacy awareness and jurisdiction in the United States.

(3) *Context attribute bundles*: a promising research thread on LBA with mobile devices is the investigation on particularly favorable context attribute bundles. Location in terms of coordinates has no immediate connection with the real world, but by what is there else. Considering location as the only context attribute most likely will

not generate any value in an economic sense. Only a combination of the attribute “location” with one or several other context attributes (e.g., time or event, such as a wedding or a soccer match) will result in information that may be useful for LBA. Several publications consider the combination of location and time. Other context attribute combinations are only considered in some rare cases, and rarely in similar combination settings. As a consequence, studies are not comparable with respect to the effectiveness of context attribute bundles. Since location shall be studied in advantageous combinations with other contextual information, this represents another promising research thread, which would contribute to research on LBA as well as to the field of context-aware computing and context-adaptive systems.

(4) *Recommender systems*: when advertisements are tailored to a specific location and situation, and are displayed on a user’s mobile device, the borders between advertisement and recommendation become blurred. Hence, it deems appropriate to bring research forward by joint efforts in research on LBA and recommender systems in the application field of product and service recommendations.

(5) *In-car LBA*: considering particularly smartphones as the only mobile devices for LBA probably does not suffice for future application scenarios. Cars, for instance, are mobile and increasingly equipped with advanced information and communication technology, and cars are even similarly considered as very personal property and often connected with the smartphone of the driver. Integrative approaches of enhanced navigation systems or vehicular applications seem to be subject to similar rules and effects like LBA on smartphones (e.g., advertisement for next gas station, when running out of gas). Interesting exemplary applications can be found in [Kim et al. \(2011b\)](#) and [Alt et al. \(2009\)](#).

(6) *Privacy*: research on privacy issues related to LBA is a very promising and crucial field in research on LBA on mobile devices. This includes research endeavors concerning harmonization of jurisdiction on an international level, as mobile devices may be used everywhere, but also user attitude to LBA and users’ self-disclosing behavior.

In addition to the outlined research trajectories, our results suggest several immediate research tracks. For instance, we suggest investigating the combination of search engine advertising with LBA on mobile devices, as there is a lack of such research in the mobile domain. Besides the identification of main obstacles for deploying LBA on mobile devices in real-world settings, the research on its causalities (e.g., scalability, content) seem to be a promising task. Another interesting research stream in the field of LBA explores products or services that are most suitable to be advertised with LBA on mobile devices. Suggestions, recommendations, and research results in this direction would be of utmost value for industry.

Besides revealing research tracks in the field of LBA on mobile devices that are particularly promising, our paper contributes to research in several ways: (1) our approach might be an exemplary approach to perform similar studies on other interdisciplinary fields. (2) As new technologies evolve and provide further marketing opportunities, our approach might serve as framework. (3) We bundled the essence of the publications in our sample and presented it in a condensed way. (4) This work provides orientation in the young research topic of LBA on mobile devices.

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