Conceptualizing Context for Pervasive Advertising

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Abstract. Profile-driven personalization based on socio-demographics is currently regarded as the most convenient base for successful personalized advertising. However, signs point to the dormant power of context recognition: Advertising systems that can adapt to the situational context of a consumer will rapidly gain importance. While technologies that can sense the environment are increasingly advanced, questions such as what to sense and how to adapt to a consumer's context are largely unanswered. In this chapter, we analyze the purchase context of a retail outlet and conceptualize it such that adaptive pervasive advertising applications really deliver on their potential: showing the right message at the right time to the right recipient.

1 Introduction

As pervasive computing technologies (radio-frequency identification, sensors, ambient displays, networked video-systems, etc.) become more reliable and cost efficient, retailers are exploring ways to leverage them for new services. 'Pervasive Commerce' promises retailers the ability to reach out to customers electronically, at any time and anywhere in physical space. The goal is to influence purchase decisions at the right moment and in an efficient way. Because the point of sale is still the site for 91% of earned revenue (compared to only 9% in web-based e-commerce) (Handelsverband 2010) and 75% of purchase decisions (42media 2010), advertising within retailers' business premises is key for marketing success.

Still, reaching out to the customer in the right spot (where he or she makes a purchase decision) may not be enough. In recent years, advertising effectiveness has suffered dramatically. Consumers have become blind to promotional messages as they are overwhelmed by their quantity. Only personalization mechanisms seem to promise the ability to break through the information clutter. Yet, current approaches to personalization face an identity crisis themselves. Thought leaders point to the limits of socio-demographic customer segmentation and market basket analysis. "*Using the demographics of a male, over 40, and with an income above a million euro would lead to both Prince Charles and shock-rocker Marilyn Manson; this cannot be it*", as an expert of the Metro Group – Europe's leading retailer – points out (Rehme 2010).

But what could be better than profile-driven personalization? Signs point to the dormant power of context recognition for personalization, particularly advertising adaptivity (Mueller et al. 2009; Smith 2004). Personalization mechanisms for websites (e.g., Smith 2004; Adomavicius and Tuzhilin 2005) and mobile applications (Yuan and Tsao 2003) have used contextual information for years. Recommendation systems like Amazon's 'customers who bought' suggestions are popular (e.g., Yuan and Tsao 2003; Adomavicius and Tuzhilin 2005); one of Google's key success factors is that it can powerfully adapt advertisements to a user's context (e.g., language, location, current search interest, etc.). It appears that consumers' context-specific preferences, goals, and behaviors have become an integral part of how advertisements work online (Smith 2004). Why not transfer this context-adaptivity to the physical world, for instance, to the retail outlet?

Few applications for context-adaptive advertising in the 'offline world' exist. Many retailers still use paper-based promotional material in their retail outlets and are only beginning to upgrade to digital displays ('digital signage'). Experiences with this new advertising display medium are positive. Retailers such as the British supermarket chain Tesco or Spar in Germany increased sales between 25-60% by using digital point-of-sale

advertisements (NEC Display Solutions 2006; Page 2007). However, the way digital advertisements are presented is still driven by the traditions of the advertising market: Spots produced for TV are often recycled in stores. Content scheduling, display times and the order of material shown as well as pricing are based on pre-purchased sequence blocks and upfront media planning. The online concept (or 'Google Model') of scheduling and charging for advertisements in real time, on the basis of market demand for specific consumer contexts and response rates, is currently unseen in physical outlets.

Present media planning practices are partly driven by business realities. Advertising agencies still need to adapt their processes and business models to new opportunities. In addition, technical challenges are partially responsible for the small number of context-adaptive systems in physical commerce environments. Despite grand visions for contextual computing at large (e.g., Ferscha et al. 2009b; Ferscha et al. 2009a; Black et al. 2009), research on context-adaptive systems is scattered and prototype-driven. In the field, the research community works on different individual problems that need to be solved in different phases of system construction (i.e., data collection challenges, data aggregation, adaptivity, etc.). However, no holistic and systematic methodology has outlined how a context-adaptive system, such as an advertising system, should actually be constructed. System designers find it difficult to elicit user requirements for these systems because challenges arise from implicit or indirect interaction with the system. Users often only interact with the system indirectly, while engaged with another primary task. For example, a person who is shopping may perceive an adaptive advertising screen only in the periphery. As a result, engineers often do not know what data they should collect and how they should combine them in a way that creates a meaningful adaptive service. User-centered designers, meanwhile, gather information by interviewing users about their tasks. But what should users be asked in the context of advertising, when they tend to perceive advertising screens only in the periphery? Requirements engineering in the field is still the result of a few user interviews combined with a dose of engineers' gut feeling rather than of a systematic approach.

Against this background, the present chapter pursues three goals: First, we propose a high-level process model for context-adaptive service development. This model provides a structured overview of the step-by-step challenges involved in the provision of pervasive, context-adaptive advertising services. Furthermore, the model allows for a better understanding of the current research landscape for contextual computing.

We then turn to the first phase of context-adaptive service construction, a phase we call "conceptualization of context". Systematic context conceptualization is a system development phase that has not been defined yet for adaptive system design. It aims to help engineers in the early requirements engineering phase understand what information they should collect and combine. We introduce and define the conceptualization of context and argue for its importance because this process deconstructs a personalization situation into measurable and logically disjunctive information units. We strongly believe that an upfront conceptualization of context is vital for engineers working to understand the full bandwidth of a given service environment; with this understanding, engineers can compose meaningful adaptive applications. By describing in detail how we conceptualized context for pervasive advertising, we propose one possible methodology for this phase.

Finally, we outline a concrete context model for context-adaptive retail advertising.

2 The Process of Context Adaptivity

In computer science, researchers use context to relate information processing to aspects of situations in which such processing occurs (Schmidt et al. 1999). Researchers aim to relate tasks and devices to the situation of usage in which they are embedded. Context-adaptive systems have been studied from myriad angles, with researchers employing various terminologies. However, it is often unclear whether 'context-aware' or 'context-sensitive' systems are the same as 'context-adaptive' ones. Computer science researchers in the field tend to give different names to similar problems while concentrating on working architectures, prototypes and toolkits (Baldauf et al. 2007; Dey and Abowd 2000; Hong et al. 2009) and data capture and aggregation challenges (Ferscha et al. 2002). Little systematization of these diverse activities has occurred. As real-world deployments emerge, a more structured view of the field's activities and achievements may be beneficial. To engineer market-driven requirements, researchers must understand the relationships and dependencies between the various technical components of an adaptive system. We therefore set out by proposing a process model for context adaptivity that integrates the different research threads of context-aware computing; this model also provides an overview of the sequence of challenges engineers face when designing a fully functional and meaningful adaptive service (such as contextual advertising).

As depicted in Fig. 1, there are four phases of challenge.

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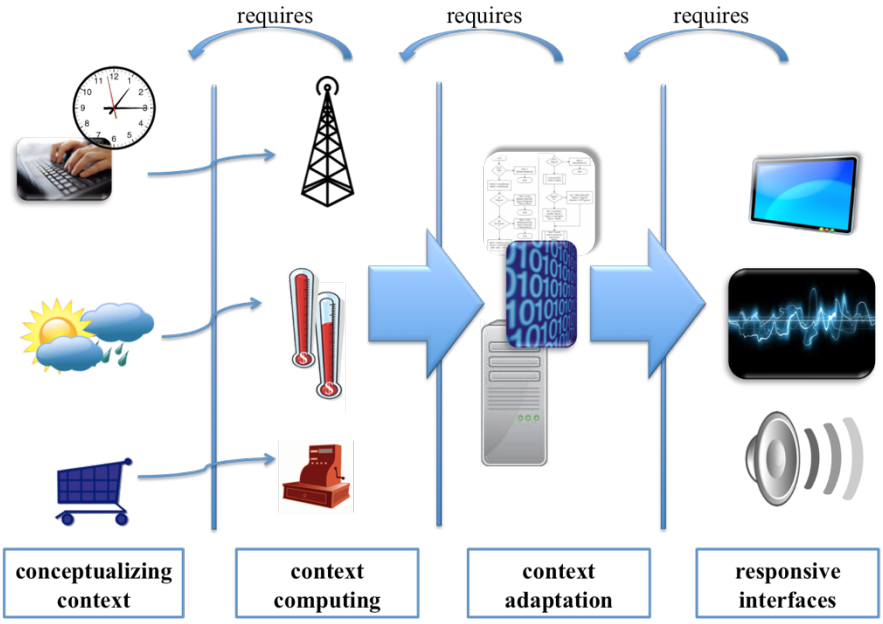

Fig. 1 The process of context adaptivity

The first step is to 'conceptualize context': to systematically identify the full spectrum of context variables that can be used to meaningfully interpret a specific adaptive service. In the second step of the process, 'context computing', relevant sources of context information are identified and collected. The stored context information is used to trigger events that mark the beginning of the 'context adaption' stage of the process. The goal of this phase is to intelligently adapt to the context that has been detected. Adaptivity mechanisms then use an algorithm to translate the captured context into the desired action. Finally, in the responsive interfaces stage, the computed personalization action is operationalized and presented.

In the following sections, we describe the four phases of adaptive service engineering in more detail and comment on what these phases imply for the realization of pervasive advertising scenarios.

2.1 Conceptualizing Context

To seamlessly support a user's activities, one must understand context from various viewpoints (Bradley and Dunlop 2005). "How are dimensions of context identified, quantified, and interrelated for each situational purpose?" (Bradley and Dunlop 2005). The first step to answering this question is to conceptualize context.

> We define context conceptualization as ***the process*** by which a personalization situation is deconstructed into measurable and logically disjunctive information units, all of which must be combined to create an adaptive service.

Some scholars already work to deconstruct and identify disjunctive information units. Common information categories used to understand context include a user's location and environment, the identities of nearby people and objects (entities), and changes to those entities (Dey 1998; Schilit and Theimer 1994). Schmidt et al. (1999) tried to systematize information categories for mobile systems. They relate context information to two domains: human factors and the physical environment, both in the broadest sense. They then operationalize human factors as information about users themselves, their social environment and their tasks. Likewise, the physical environment is described by location, infrastructure, and physical conditions.

Bradley and Dunlop (2005) take a multi-disciplinary approach to context, integrating linguistics, psychology, and computer science. Combining and building upon existing models from these three domains, they distinguish the world of the 'user' from that of the 'application'; for both, they consider 'incidental' and 'meaningful' context. In a circular layer that surrounds both worlds, they add a third 'contextual' world, which they break down into six dimensions: task, physical, social, temporal, cognitive and application's context.

But are these categorizations of information units valid? That is, are they complete, adaptable and usable for all kinds of service contexts? We challenge these categorizations, because we believe that an understanding of the context situation and the identification of available and meaningful information for adaptive service delivery can only be achieved as the result of a *process* methodology. Predefined information categories, which may be more or less complete depending on the situation, are insufficient.

Conceptualizing context for pervasive advertising, for example, involves thinking about the context of the advertiser, the brand, and promotion and inventory levels.

Another possible consideration is the stage in the buying process in which consumers find themselves at the moment an advertisement is displayed. Yet none of these variables are considered by existing information taxonomies.

Against this background, we will suggest and demonstrate below (Sect. 3) one methodology we used to conceptualize the context for pervasive adaptive advertisement services. This approach may be reused for other application domains and can amend and replace existing information categories.

2.2 Context Computing

After all potential variables of context adaptivity are listed, context computing (Ferscha et al. 2004) is responsible for the actual identification, collection, transformation, interpretation, provision and delivery of context information (Dey 2001).

To identify and collect relevant information sources, we use sensors and other context sensing technologies (Pascoe 1998) such as radio- frequency identification (RFID), global positioning system (GPS) and eye-tracking. Context sensing is the most basic computational level of context computing (Pascoe 1998).

Low-level context information obtained by sensing must be transformed, structured, aggregated and interpreted (context transformation) to be represented in an abstract context world model (context representation) (Ferscha et al. 2004). Contextual augmentation (Pascoe 1998) such as tagging (Dey and Abowd 2000; Ferscha et al. 2004) combines context transformation and interpretation. This technique provides an opportunity to extend information about the environment with additional information. This is achieved by associating the particular context with related digital information (Pascoe 1998). The context information is stored in a centralized or decentralized fashion and is used to trigger context events (context triggering) (Ferscha et al. 2004).

The following example illustrates this phase in the context of pervasive advertising: A person is identified via a loyalty card, which is scanned by a cashier. The company-owned databases are searched for relevant information about that particular user. Using an eye-tracker, the system recognizes that two eyeballs are looking at the display next to the cashier. Combining the information from the loyalty card scan and eye-tracking, the system interprets that this particular person's attention is drawn to the display. This information could then trigger a response such as the display of a specific advertisement.

2.3 Context Adaptation

Context-adaptivity mechanisms take the 'results' of context computing and 'react' to this context based on a defined algorithm. We can distinguish three categories of algorithms: the presentation of context information to a user (e.g., showing the current time), the automatic execution of a service (e.g., personalized content), and the tagging of context to information to support later retrieval (Dey and Abowd 2000; Dey 2001).

Many scholars refer to the tailoring of products, services or content to consumer needs as 'personalization' (Mulvenna et al. 2000). And an overlap between the literature on context adaptivity and personalization cannot be denied. From a large body of information sources, personalization provides only the information that is relevant to an individual or group (Kim 2002). Personalization is used as a means to better satisfy consumer needs and increase customer loyalty. On the Web, the technique is typically based on consumer information (Adomavicius and Tuzhilin 2005) such as specified preferences, past purchases, historical visit patterns or click stream data. The consumer who may be interested in (parts of) the contextual data from a sensory system or applications can leverage contextual knowledge by adapting their behavior to integrate seamlessly with the consumer environment (Pascoe 1998).

Personalization as it is lived in electronic commerce contexts today spans a wide range of approaches, techniques, and applications. Tuzhilin (2009), for instance, differentiates between personalized search, personalized content, personalized recommendation, personalized pricing and personalized communication. Personalized search aims to offer search results that are tailored to a user's preferences and needs. Personalized content refers to presenting information to a user that is relevant to him or her in the most suitable way. Personalized recommendation systems recommend products based on user preferences. Personalized pricing offers products or services at a price that meets the expectations of a specific consumer.

Any of these services could be transferred to the world of offline advertising. For example, a terminal next to an advertisement for a concert hall could be used to search for tickets. Search results may be tailored to a tourist's stay in a particular town. An electronic leaflet on a shopping cart could adapt its contents based on consumer preferences such as a desire for organic food. Displays may be used to recommend products based on a consumer's past purchases. Digital price tags may present personalized pricing based on the number of articles in a consumer's shopping cart. And displays may adapt advertising based on a consumer's mood. Realizing these context-adaptive services, however, entails new challenges such as dynamic data exploitation and real-time adjustment to contextual factors like consumer preferences and behavior (Eriksson and Åkesson 2008).

2.4 Responsive Interfaces

We can differentiate between two kinds of interfaces in the environment: those for input and those for output. If applications are to act *instinctively*, they have to support multimodal interaction. Multimodal interaction utilizes a number of different communication channels or modalities to enable interaction between humans and computers, either in terms of input or output (O'Grady et al. 2009).

For context-adaptive systems, the input is context. In the field of human-computer interaction (HCI), we identify context as something that can be obtained through explicit interaction or implicit interaction. Explicit interaction relies on explicit input and output by the user (e.g., involving a command-based or graphical user interface). Implicit interaction, in contrast, occurs without the explicit awareness of the user (Ju and Leifer 2008); the system 'understands' an action as input also when the user's primary aim is not to interact with the system (Schmidt 2000).

Traditionally, HCI has focused on the principle of explicit interactions. However, the principles that govern desktop computing interactions cannot be adopted for applications that "populate the rest of our lives" (Ju and Leifer 2008). Instead, implicit interactions become increasingly important (Ju and Leifer 2008; Schmidt 2000). Essentially, there are two kinds of implicit interaction. One kind involves an exchange that occurs outside the attentional foreground of the user (background interaction). The other kind involves an exchange in which the system initiates action by drawing the user's attention; for example, the system might inform the user about a computation or ask for a user response (foreground interaction) (Ju and Leifer 2008).

The output of a context-adaptive system targets one or more of the five human senses: sound, sight, smell, taste, and haptic perception. Output systems of devices have greatly improved in recent years; notable features include stereo audio output and high-resolution color screens, even on mobile phones or display systems for wearable computers (Schmidt 2000).

Human-computer interactions that demand the user's attention (foreground interaction) produce interactive output during the adaption process. In pervasive advertising, even an interaction that eludes the user's attention during processing (background interaction) finally leads to the interaction with a user's attention because the adaptation process results in the presentation of an advertisement.

The degree of human attention towards output can be manipulated by adjusting the output's perceptional prominence. Interaction design research investigates how to manipulate human attention when users are engaged in some other primary task (Ju and Leifer 2008). This research finds that systems can attract attention by using disruptive mechanisms or non-obtrusive techniques (Cutrell et al. 2001).

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3 Early-phase Requirements Engineering for Context Adaptive Advertisement and How to Conceptualize Context

All traditional system design and development methodologies include a requirements engineering phase (Kurbel 2008). Here, stakeholder interests are collected. Business expectations are formulated and potentially drawn from the strategic goals of a company or system operator. The tool-level tasks of users are also analyzed (Te'eni et al. 2007).

When engineering requirements for context-adaptive services, however, it is difficult to describe people's implicit or indirect interaction with context-adaptive services or determine user requirements. How can users relate to a context that they do not explicitly interact with? That they often relate to or see only in the periphery? That they do not pay attention to? And how can engineers determine what information they should collect and combine to create a meaningful adaptive service if they cannot interview users?

Moreover, many commercial adaptive services rely on existing company data such as inventory data, promotion data, etc. Very little requirements engineering research has investigated how existing databases should be combined for ad-hoc service delivery.

To overcome these challenges, we argue that context-adaptive services need an '*early*' requirements engineering phase that aims to 'conceptualize' context.

Conceptualization of context identifies the full spectrum of measurable and logically disjunctive information units available and/or required for a meaningful service.

We believe that the full business potential of an adaptive service can only be recognized when this full spectrum or 'information landscape' is available (see Fig. 3 for an overview). Furthermore, from our perspective, prototyping only makes sense when this 'information potential' of a service has been identified.

In the following sections, we support our argument by describing the information landscape for pervasive advertising services. We methodologically conceptualize context for this service category and thereby show how this exercise promotes meaningful understanding of an adaptive service environment (before delving into prototyping).

Our approach to conceptualizing context is both top-down and bottom-up (Fig. 2). The top-down approach is informed by a literature review and involves reflecting on the overall dimensions of the system under review. In contrast, the bottom-up approach considers information types and availabilities in each of the identified dimensions.

We used these two perspectives to analyze the service context in three phases, refining our analysis each time.

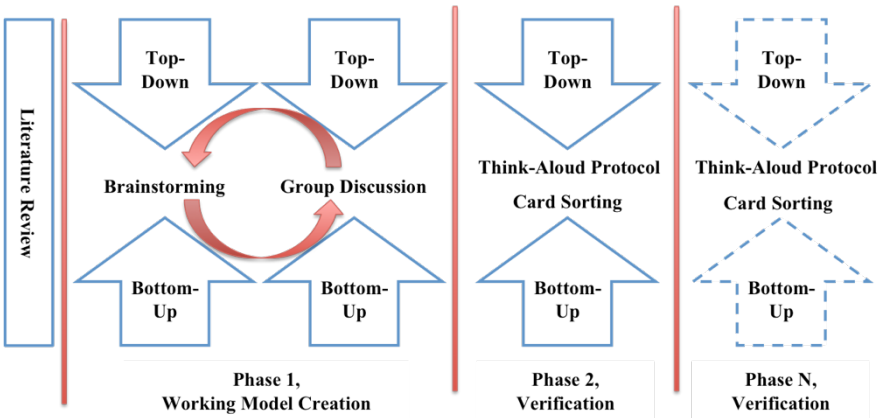

Fig. 2 Methodology for conceptualizing context. The top-level domain is broken into its compositional subsystems (top-down) while individual base elements are pieced together to form grander systems (bottom-up)

3.1 First Phase of Context-Model Development: Working Model Creation

In the following section, we describe how we contextualized the pervasive advertising domain. In doing so, we outline a methodology that may be useful for early-phase requirements engineering in other domains as well.

Our first step was to identify relevant literature from the multidisciplinary (computer science, psychology, business) domain of context (for a multidisciplinary approach to context also see Bradley and Dunlop (2005)). We chose the context model by Schmidt et al. (1999) as a starting point for the conceptualization of the pervasive advertising domain. Fig. 3 provides an overview.

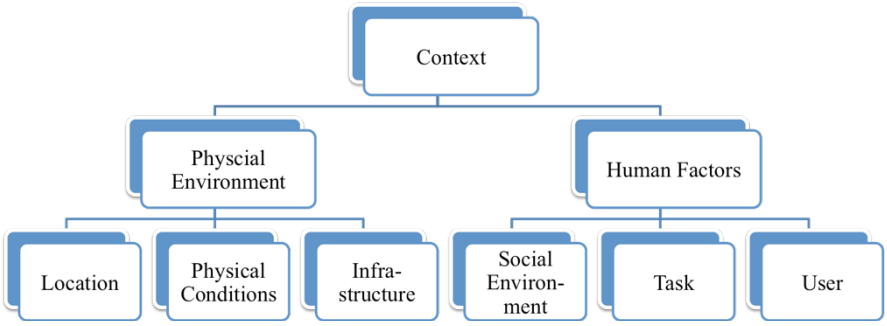

Fig. 3 Starting point – Schmidt et al.'s context information categories (Schmidt et al. 1999)

Schmidt et al. (1999) distinguish context related to human factors from context related to the physical environment. On a second level, they operationalize human factors as information about users themselves, their social environment, and their tasks. The physical environment includes information about location, infrastructure, and physical conditions.

3.1.1 Top-down Conceptualization of Advertising Adaptivity

We began the first phase of context conceptualization by challenging the applicability of Schmidt et al.'s model to the pervasive advertising context. Top-down brainstorming and group discussions led to a) a ***refinement*** of their model ***for the advertising context*** and b) an extension of the model to ***embrace all stakeholders***. More concretely, refining the top-level information taxonomy consisted of renaming the 'human factors' category to 'consumer's environment'. The refined category refers to the concrete human user type that is targeted by the service in the model. We also opted for consumer '*environment*' because the term is more precise than 'factors' when embracing social issues at lower levels of the taxonomy. Furthermore, we decided that the entity delivering the service, here the company advertising its products, should be reflected in the pervasive advertising model. To acknowledge this additional stakeholder involved in the service delivery, we added a high-level category called 'advertiser's environment'.

On the second level of the model abstraction, we kept five of the six information categories proposed by Schmidt et al.: consumer profile, social environment, task, location, and conditions (Schmidt et al. 1999); however, we again renamed and amended them. Most importantly, we found that Schmidt et al.'s context framework lacks a differentiation between 'manipulable' and 'non-manipulable' environmental conditions. 'Manipulable' conditions are environmental states that the service operator can influence (e.g., light conditions in a shop). 'Non-manipulable' conditions cannot be manipulated: they result from natural factors such as outdoor temperature. From the perspective of the service operator or engineer (for whom the requirements engineering is performed), this distinction is important: the two information categories entail different consequences for the application's operations and strategic design. Non-manipulable environmental conditions are passively sensed or observed and may or may not be used as input data for the adaptive service at hand. For example, the weather outside a retail store could serve as an input to determine whether or not to show an ice-cream advertisement inside. In contrast, manipulable environmental conditions can be actively designed for the adaptive service experience. For example, the temperature inside of a store could be tuned to correspond to the outdoor level. If it is hot outside (non-manipulable) and hot inside (manipulable), the probability of ice-cream purchases would probably be higher than if air-conditioning cooled the inside of a store. This example demonstrates that manipulable environmental conditions are a powerful means to strategically design an adaptive service.

Finally, three additional information categories emerged that belong to the advertiser's environment category: product and service demand, product and service offering, and the advertising campaign itself, which is the object of the adaptive service delivery. Fig. 4 provides an overview of the refinement of the model.

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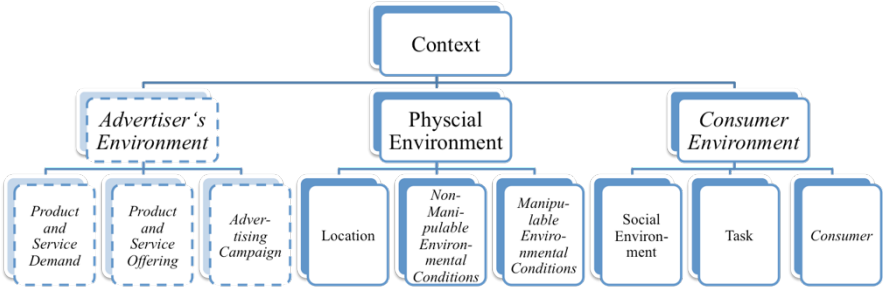

Fig. 4 Schmidt et al.'s model with extensions (in dotted lines) and refinements (in italics) for the pervasive advertisement context

3.1.2 Bottom-up Conceptualization of Advertising Adaptivity

Specifying and amending generic context models does not produce a sufficiently thorough conceptualization of context. To specify "context feature space on the third level" (Schmidt et al. 1999), we need to understand context from the consumer's situational perspective. Accordingly, we consider the specific situation in which the adaptive advertising service is provided to the consumer and try to consolidate all the specific information types needed to support service adaptivity.

To inform discussion about the specific information units needed for service delivery, we used situational scenarios involving adaptive advertisement services. One scenario focused on a hair-coloring product designed to cover grey hair. Ideally, an advertisement for this product should be specific to a customer's sex, age and hair color. Such an advertisement should only be displayed on a public display when few people other than the advertisement's target are near the display. It should be shown at the moment when the respective customer is near hair-styling shelves. And it should only be shown if the respective product is on the shelf (or at least in stock).

However, the gap between such situational detail and the broader information categories identified in Fig. 4 made plain that conceptualization of context requires further structuring. We therefore introduced a hierarchical specification of the top-down information categories on three levels: a macro, micro and situational level.

The macro level is valid for all model applications. It should be considered as a further refinement of the information categories in Fig. 4, but specific to the pervasive advertising context. For example, the task of a consumer is specified as 'shopping', while the location of the service is the region where an advertisement is launched.

The micro level then filters this macro level information category and helps apply it to a specific application environment (e.g., a specific store in a region that has specific climate conditions, specific clientele, etc.). The specific application environment is embedded in the macro environment. Accordingly, the specific application environment supplies more detailed information than the macro factors.

Finally, the situational level describes an 'adaptive incident' or 'moment of service delivery' that happens in the application environment. For example, a female consumer with blond hair, age 18, is supposed to see a hair-color advertisement on a display integrated in a Douglas store shelf in the first district of Vienna.

For context-adaptivity, the situational level is eventually determining, as systems have to adapt to the actual conditions at the scene at the moment of service delivery. Still, understanding the micro and macro level has proven useful for identifying the full spectrum of available information sources.

Fig. 5 provides an overview of the structuring approach, summarizing an excerpt of the pervasive advertisement context model we developed.

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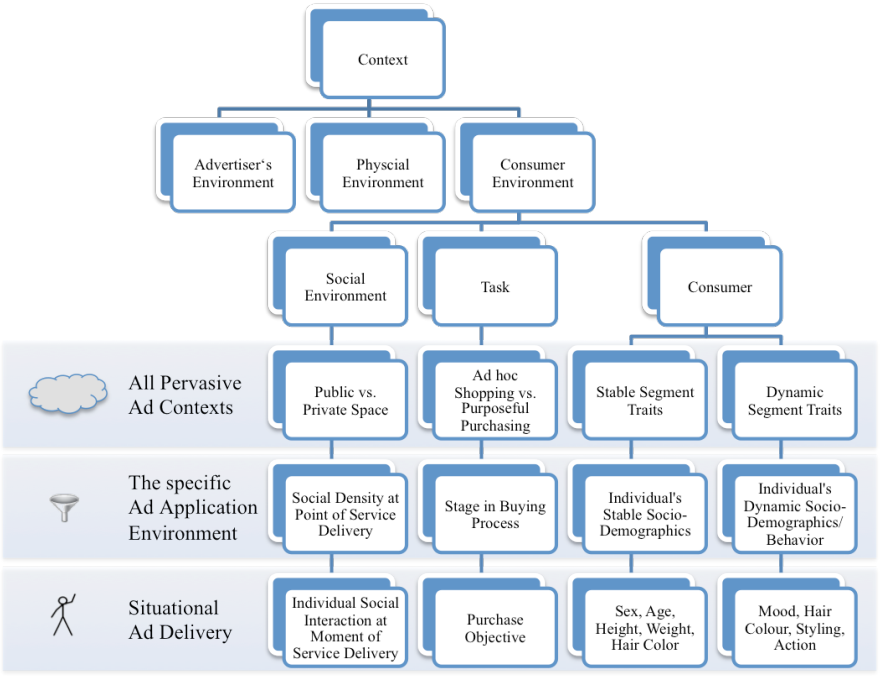

Fig. 5 Specifying high level information categories for a context-adaptive service situation

3.1 Second Phase of Model Development: Working Model Verification

The second phase of model development aimed to verify the working model by applying a strict methodology. We invited five academic experts to serve as participants. On a plain wall, the context model was depicted with sticky notes, with each model item written on a single note.[1] Participants were briefly informed about the context of the research, the first level of the model and the concept of the macro, micro and situational level. When a participant did not understand the meaning of a term, brief clarification was given. To avoid priming, no other questions were answered. Participants were encouraged to present ideas for renaming a category or introducing a new one.

Participants were first asked to interpret the overall working model (top-down conceptualization) while thinking-aloud so that their thoughts could be captured. They were also instructed to rearrange the sticky notes or introduce new ones until they were satisfied with the model.

In a second exercise, participants were asked to classify a specific advertising adaptivity situation according to their rearranged working model (Bottom-up Verification of Advertising Adaptivity). For this purpose, we told them to assume that a fully functional pervasive advertising system would be installed in a store. We asked them to recall one of their last shopping experiences in a physical store and imagine that they encountered a context-adaptive advertisement. Again, they then had the opportunity to rearrange the sticky notes or introduce new ones until they felt that they could accurately classify the situation.

The think-aloud exercise, which lasted 191 minutes, was audio taped and transcribed. The interviewer took additional notes on paper.

The result of this two-sided approach of card sorting was a rephrasing and rearrangement of many of the categories on all three (macro, micro, and situational) levels. The next section presents each part of the context model we developed for pervasive advertising. This model incorporates all changes initiated by the expert exercise. Fig. 9 depicts the consolidated end result of the model.

[1] Additionally, the participants had a printout of the working model at their disposal. The interviews were held in German, while the model on the sticky notes and printout were in English.

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4 A Context Model for Adaptive Advertising

Following the method described in Sect. 3, we outline the conceptualized context for an adaptive digital advertising service. The full model is depicted in Fig. 9. It presents the spectrum of measurable and logically disjunctive information units that are available to design adaptive advertisement services.

Note that the model only represents what can be measured on a macro, micro and situational level. The model does not contain information about how measurement should be performed, whether information sources are accessible, or how the measured information could be combined to extract additional meaning from it. This information would be part of the later adaptation phase of the context adaptivity process.

In describing the context model's details, we presume that networked digital displays (digital signage) are spread out in retail outlets and other public and semi-public spaces and are being used as an interface to transmit highly personalized context-adaptive advertising messages. Digital displays can be mounted onto shelves, hang from ceilings, be part of a shopper's cart or meet him or her at waiting points, such as sales counters. We also presume that many current hurdles associated with reliable data collection and aggregation as well as dynamic content delivery have been resolved.

We are aware that the description of the context model for adaptive advertising is in parts highly futuristic from the perspective of today's operations. That said, we believe that our assumptions are realistic and that, due to the increasing availability of context-sensitive technologies, this model could soon be realized for advertising at the point of sale.

4.1 Data Involved in Grasping the Advertiser's Environment

Naturally, a conception of context for advertising has to include the advertiser's perspective, as the advertiser is the key stakeholder and service operator in this context. At the macro level, advertisers have three core information categories that capture their operational environment and should drive adaptive advertisement delivery (Fig. 6): the current market demand as reflected in the consumers' shopping basket (at the macro level), the products and services that the advertising company offers, and an advertising campaign that may promote specific products or services.

4.1.1 Product and Service Demand

On the macro level of consumer demand, the typical shopping basket consists of a set of items purchased by an average customer during an average shopping occasion. The methodological toolbox that enables researchers to study the composition of such product bundles is referred to as market basket analysis and is typically done at the national level (Mild and Reutterer 2003; Manchanda et al. 1999). On a micro level, the shopping basket can be broken down for a certain store; i.e. on the basis of purchase data. On the situational level, measurements can relate to an individual shopper; for instance, one can measure the actual contents of a shopping cart.

In one scenario, a market basket analysis computes high demand for rye bread by an average customer. The system recognizes that a particular customer does not have rye bread in her shopping cart. In a next step, based on a certain algorithm (predefined in the adaptivity phase), the system presents an advertisement for rye bread on a nearby display.

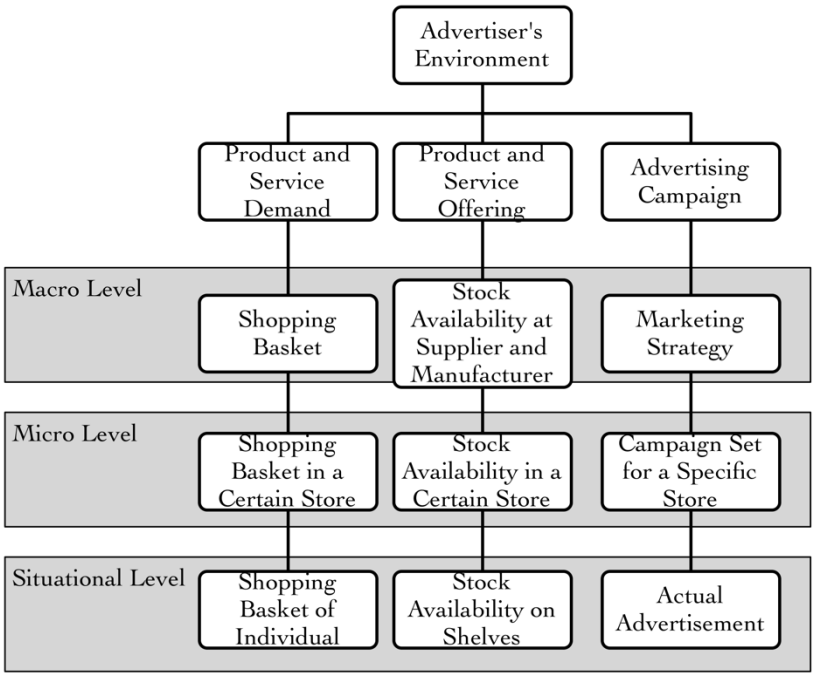

Fig. 6 Excerpt of the context model specifying the conceptualization for the advertiser's environment

4.1.2 Product and Service Offering

The macro level describing an advertiser's offer should typically recognize the availability of goods and services. General availability on the market (at the macro level) may be more abundant than availability at a specific site (micro level) or on a shelf (situational level).

This factor can be operationalized in an advertising scenario; for example, a woman who wears size 4 shoes enters a shop and sees a pair of red shoes. The system is aware that this shoe model is out of stock in shoe size 4 in this particular shop. In a next step, the adaptivity algorithm could then, for example, cause the display to show an advertisement for a similar red-colored shoe model that is available in size 4.

4.1.3 Advertising Campaign

An advertising campaign is a series of advertisements that share a single idea and message. It includes information that is adapted to the context in contextual advertising and also serves as context itself. Typically, advertising campaigns appear in different media across a particular time frame (Belch and Belch 2001).

On a macro level, we consider a retailer's marketing strategy, which provides the frame for any kind of advertising activities.

The micro level involves the campaign set for a specific site. This level considers which advertisements (out of the set of advertisements of a whole campaign) should actually be displayed and identifies controls for possible restrictions.

The situational level deals with the actual advertisements displayed. For example, there may be a '2 for 1' discount campaign or a reduced price policy for products nearing their expiration date. In a purchase situation, a consumer may encounter one of these campaigns.

For instance, a system may be configured to the marketing policy of an advertiser. In this advertiser's particular advertising campaign, there are three different advertisements for the same product. The system detects that one of these advertisements interferes with the retailer's marketing policy, which forbids showing advertisements with offensive language during morning hours. Engaging in advertising adaptation, the system would then make only the two remaining advertisements available during morning hours.

Note that advertising campaigns may increase the demand for products and services and may, therefore, lead to reduced availability of those products and services. This kind of mutual influence between different information

dimensions is not analyzed as part of the conceptualization of context. Instead, this logic is part of a later step in the adaptivity process (context adaptation).

4.2 Physical Environment

The physical environment refers to all elements that characterize the physical surroundings (Fig. 7).

One of the most discussed environmental factors for computing context is location. Furthermore, we distinguish between manipulable and non-manipulable environmental conditions.

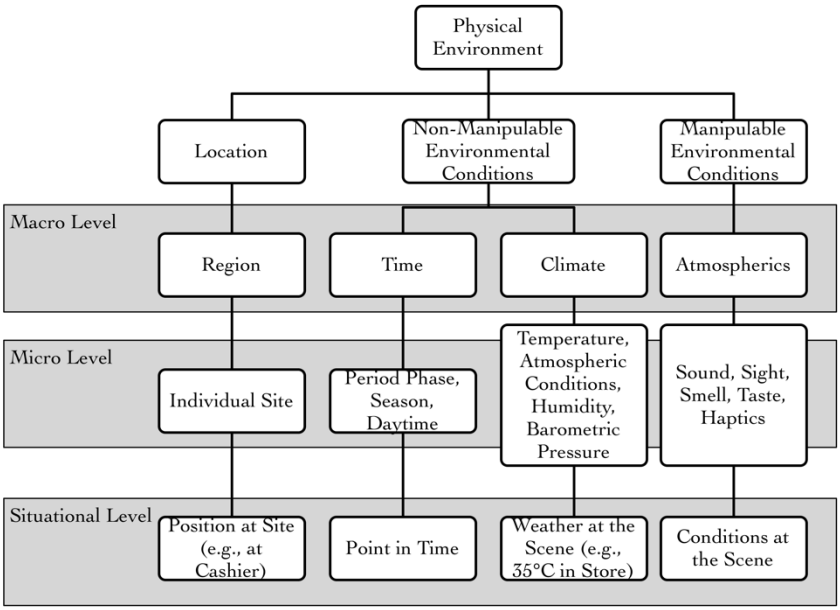

Fig. 7 Excerpt of the context model specifying the conceptualization for the physical environment

4.2.1 Location

Beyond being an aspect of the physical environment, location is frequently used to approximate more complex contextual factors (Schmidt et al. 1999). For instance, geo coordinates may give information about the social environment or infrastructure at a location. As with the advertiser's environment, deductions that lead to additional information in this way are not part of the conceptualization phase.

We take a sociological approach to location. A site with a public display in Vienna and a site with the same kind of display in Paris are unlikely to look the same. Even two stores from the same retailer in two distinct districts within a city may differ significantly, as the subcultures visiting these stores vary. On a macro level, we therefore view location from a regional perspective, considering the people and their preferences in the particular region. For example, residents of the 1st district in Paris traditionally have a higher socioeconomic status than those of the 18th district. On a micro level, we then distinguish a specific site within a region by identifying its particular 'microcosm' (Anderson et al. 2000). For instance, a specific store may correspond to the average store in the region or be an 'outlier'.

On the situational level, we are even more specific within the microcosm of a site and refer to the actual position of a consumer in the store at hand (e.g., in front of the cashier, next to the refrigerated display case). Obviously, a consumer will respond differently to impulse advertisements in front of cashiers than to the same advertisements in one of the aisles where no impulse goods are sold. Actual adaptation, however, is part of a later step in the adaptivity process. The conceptualization of context involves only a consideration of location on a macro, micro and situational level for system development.

4.2.2 Non-Manipulable Environmental Conditions

This category refers to environmental conditions that are naturally produced, such as time and climate. Advertisers cannot manipulate these conditions, but can use them to their benefit.

Time. Temporality can refer to particular points in time or general time periods (Belk 1975). A point in time – for instance, 7 p.m. on a particular day – can inform the characterization of an advertisement situation. On a higher level, relevant time periods include seasons (e.g., summer, winter, Christmas, Easter) and special time periods such as Valentine's Day.

The conceptualization of a system may consider time of day as a relevant parameter. In a later step – the phase of context computing – a system could be equipped with a clock. The adaptation mechanism could then act on a schedule and, for instance, prioritize organic product advertisements between 3-5 p.m. on weekdays.

Climate. Weather is most commonly associated with temperature, rain and wind force. However, weather refers to more factors. On a macro level, we consider climate as a generic, broad factor. On a micro level, we may consider a wide range of variables such as temperature, wind force, wind-chill factor, air humidity, barometric pressure, rain or snowfall and cloudiness; we may also consider forecasts for changes in any of those variables. On a situational level, the weather determinants act in combination. While the micro level still considers the factors generally, in this level we observe the situation in a very specific setting (at a particular site at a particular point in time). While wind force, for instance, may be weak in a region, it might be much stronger right in front of a public display; this factor might imply that the area where the display is located is a chillier place than one would expect.

Let us, for instance, assume that ice-cream advertisements are most effective when the recipient feels warm and that they are not effective at all when the recipient is cold. An adaptivity mechanism could foresee to show ice-cream advertisements only when the temperature is high enough at the particular site. This, in turn, requires a consideration of climate in the conceptualization phase.

4.2.3 Manipulable Environmental Conditions

Atmospherics is perhaps the most studied manipulable contextual element for retail environments (Bitner 1992). It can affect consumers' attitudes in various ways. For instance, retailers seek to create an atmosphere that promotes cross-buying (Puccinelli et al. 2009). Cross-buying is defined as buying other products and services as opposed to buying more of what a consumer bought before (Kumar et al. 2008). We consider atmosphere at the macro level of our conceptualization. On a micro level, we include atmospheric determinants at a site including the temperature, air quality, sound, (functional) music and odor (Bitner 1992). On a situational level, again, these determinants act in combination at a particular site at a particular point in time. For instance, the system may detect that the consumer in front of a display is in a bad mood. Accordingly, it spreads scents of essential oil to put her in a happy mood.

For adaptive advertising, considering the effects of atmospherics is part of the conceptualizing phase. After these effects are identified, the system can act on them in the adaptation phase. Considering these effects, the system may present advertisements that fit the given atmospherics or create the desired atmospherics so that the presented advertisement will be effective.

4.3 Consumer's Environment

The consumer's environment subsumes all elements concerned with the consumer. As outlined above, we consider the consumer him or herself, the consumer's social environment (Belk 1975) and his or her primary 'task' (Fig. 8).

4.3.1 Social Environment

Social environment refers to an individual's perception of a space. On a macro level, we consider whether a space is perceived as public or private. Further distinctions of space perception, such as meeting points or points of transfer, can be found in Hillier (1999).

On a micro level, we refer to the social density of the respective space. A strong aspect of how individuals perceive a space is whether other people are around. If other people are around, their number and level of interaction with an individual influences that individual's perception of the space.

On a situational level, we consider an individual's interaction with passersby, co-shoppers, or a retailer's employees as situational context. For example, a system detects that a couple is gazing at a display and is aware that they sympathetically interact. Accordingly, it presents an advertisement showing a couple (thus representing a similar situation) and introducing a new product in an emotional way. This form of adaptivity mechanism can only be implemented when social density had been considered during the phase of conceptualizing context.

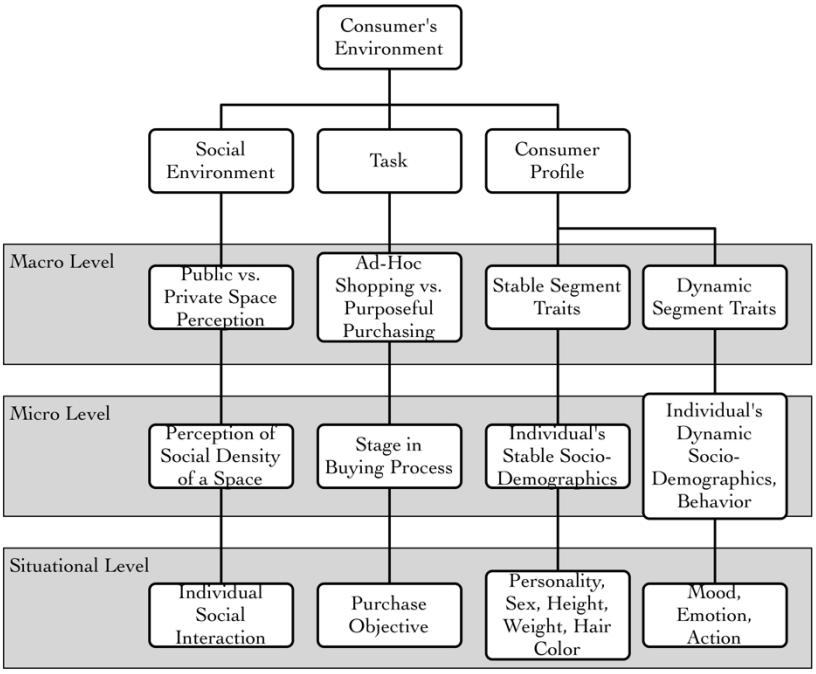

Fig. 8 Excerpt of the context model specifying the conceptualization of the consumer's environment

4.3.2 Task

On a macro level, we consider the task a consumer is engaged in when viewing a display. Naturally, there is a difference between viewing an advertisement while driving a car to work (no shopping intention) and viewing it in a shop. In a shop, the consumer might want to buy something specific (purposeful purchasing) or might just be looking around, the latter of which could lead to an ad-hoc purchase.

On a micro level, we consider the buying process. Every stage of a buying process (needs recognition, information search, evaluation, purchase, post-purchase) defines different consumer goals (i.e., shapes a different context) and triggers different consumer behavior (Puccinelli et al. 2009). Consequently, the toeholds for effective advertisements are distinct in each stage of the buying process.

On a situational level, we consider an individual's purchase objective, such as the specific product sought.

For instance, a system may detect that a consumer is evaluating a printer she wants to purchase. Accordingly, it can launch printer advertisements on the nearby display; these advertisements can include a range of printer products with detailed properties, prices or even specifications. For this example, it is crucial to consider the stages of the buying process during context conceptualization. Context conceptualization is the basis for the identification of adequate measures in the context computing phase.

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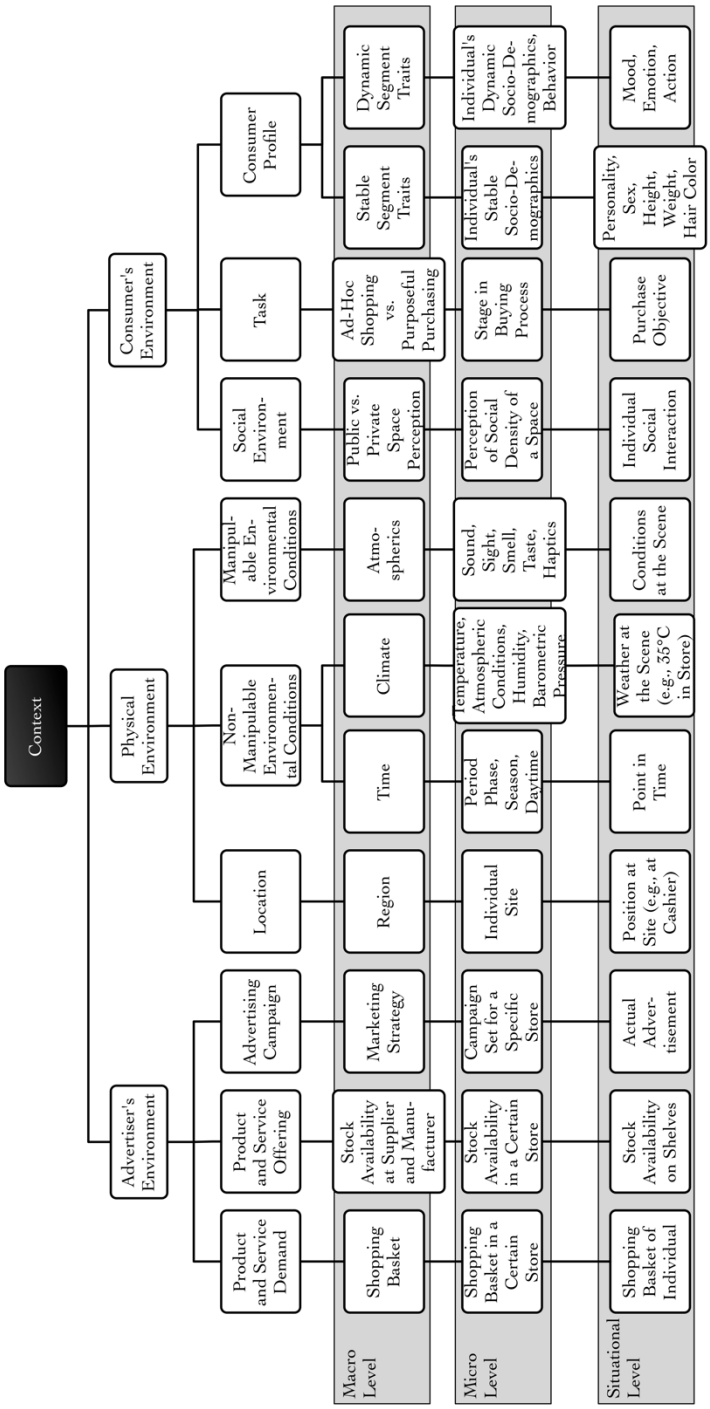

Fig. 9: Conceptualized model of context for pervasive advertising

4.3.3 Consumer Profile

Personalized advertising is typically based on some kind of consumer profiling. Consumers are classified into segments based on various personal traits. Here, we distinguish between stable and dynamic segment traits.

Stable Segment Traits. On the situational level, stable traits include those variables of a profile that cannot be changed in a specific adaptive advertisement moment (e.g., sex, height) or evolve very slowly over a consumer's lifetime (e.g., personality traits, age, social status). On the micro level, we consider the consumer profile of an advertiser's target group. This profile characterizes the typical audience of the advertiser.

For instance, let us assume that a clothing retailer's target group is defined as men in their forties. Let us further imagine that a site where a large display is situated is typically frequented by women in their late thirties. In the advertising adaptation phase, this information could be combined and interpreted to produce a new target group for the advertising: women who buy clothes for their husbands. In this case, the thorough conceptualizing of the 'stable segment traits' variable strongly contributes to the development of an effective adaptivity mechanism.

Dynamic Segment Traits. Puccinelli et al. (2009) argue that dynamic factors such as affect, mood, emotions, and feeling clearly influence all stages of the consumer buying process. They further claim that consumer affect may trigger affect-congruent memories. Pervasive advertising can call on this influence by manipulating such factors to its advantage.

Accordingly, we consider unstable, dynamic consumer variables that allow advertisers to trigger affect-congruent memories with their advertisements. On the macro level, we refer to the dynamic traits of the (market) segment. The micro level includes the unstable traits that customers may encounter. Such traits include socio-demographics and individual behavior.

On a situational level, we consider all unstable parameters – such as mood, emotion or attention – that may vary while a consumer is, for instance, visiting a store. The situational level draws from the range of unstable parameters and applies relevant ones to the specific situation of a consumer in a particular moment. For instance, when the system recognizes that a consumer is very emotional, it may display an emotional advertisement for a hedonistic product instead of product information.

5 Conclusions and Outlook

In today's advertising industry, context plays an increasingly important role. Existing adaptive advertising systems tend to account for individual dimensions without considering the big picture.

The key for any adaptive system is a thorough conceptualization of context, which considers the various aspects of context information. Taking a top- down and bottom-up approach, we have demonstrated the importance of viewing various kinds of context from different angles and integrating stakeholders' perspectives.

In this chapter, we provided a comprehensive context model for adaptive pervasive advertising. Among academic experts, the model has proven useful and coherent. In a next step, we will evaluate whether this model can be meaningfully applied. The in-depth description of the methodology should inspire scholars to take a similar approach for system design.

Against this background, we emphasize that a model of context is a dynamic process rather than a product. The long-term goal is to provide a fully integrated model; currently, the model (Fig. 3) presents context categories on all levels without fully integrating them. Still, it provides a basis for future development.

While we will never be able to compile a complete list of context variables, research needs to undergo a continuous process of conceptualization. We have provided a basis for pervasive advertising. For further advancement, researchers are encouraged to apply our context model for pervasive advertising to other adaptive advertising applications in retail.

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