The Determination of Customer Location as Human-Computer Interaction in the Retail Trade: Potentials and New Business Models

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Abstract: The Customer Journey has to be better grasped and understood, so that enterprises will be able to exist at the stationary trade regarding the future of digital competition. The seamless transition from outdoor to indoor navigation and analyses of movement streams enable many new fields of application, which improve the Customer Journey. The derivation of new fields of application and business models requires knowledge of a market's needs and potentials. The aim of this work is to determine the needs and potentials for the regulation of indoor location as well as the derivation of new cases of application and potential business models. For this purpose, interviews with experts from leading software and technology companies as well as specialists of retail trade with many years of professional experience were conducted.

1 INTRODUCTION

Humans spend a large part of their time in buildings, regardless of whether in the working or in the private life. Location Based Services are, for many years, an established expansion of the outside-living. There, they have proved themselves as a driver of digital innovation, for example the health, mobility and logistics sector and also in the retail trade. Indoor Location Based Services will extend the existing spectrum in future and change our dealing with products, enterprises and customers in buildings and rooms.

The housing industry as well as the retail trade and other economies in industry have a paramount interest in the regulation of an indoor position (Conti et al., 2016). Therefore, this paper focuses on the retail trade, which offers a huge potential for applying an indoor positioning system. In doing so, this research is intended to identify specific needs and potentials for the retail trade. As the best-fitting, already available technical infrastructure for indoor positioning, an ultrasonic-based solution is determined. It contains the advantages that the existing loudspeaker systems in the salesrooms can be used for navigation and they do not need an extra installation of hardware, which allows a particularly fast realization of implementing the navigation.

Further, the system is able to communicate with a lighting system, which allows a combined application of Visible Light Communication (VLC).

The second chapter will describe the used methodology of research, beginning with the literature research about the preparation of the interviews up to the analysis of needs and potentials. Hereinafter follows the examination of the current status of the research. The fourth chapter describes the determined cases of application. The analysed needs are derived from it. Afterwards, the potentials will be considered. The work ceases with a final view of all summarized results.

2 PROCESS OF RESEARCH

The paper answers the following research questions:

- Which cases of application can be supported by the regulation of an indoor location?

- Which needs does the retail trade have in regard to the regulation of an indoor position?

- Which potentials does the regulation of an indoor location offer to the retail trade?

The research's methodical attempt contains five steps: first - literature research, second - execution of a guided interview, third - derivation of application

cases, fourth - analysing of needs and fifth - potential analysis.

2.1 Literature Research

The first step of the research procedure is the literature research about LBS and the research's current status in relation to the regulation of indoor positioning. Important publications are, among others, „Progress in Location Based Services in 2018" (Kiefer et al., 2018), Philipp Jäcks' research about the ultrasonic-based regulation of indoor positions (Jäcks, 2016) as well as a survey of the ILA about the regulation of indoor locations (Conti et al., 2016) with specific cases of application in different branches. The results of the literature research represent the current status (chapter 3), are fundamental and lead to the questions of the guide-supported interviews.

2.2 Guide-supported Interview

The interview's aim is to determine personal information, knowledge and experiences. The number of interviews is currently limited to five selected experts. It is assumed, that already a low number of interviews can determine the main cases of application, needs and potentials. The literature describes this phenomenon of data acquisition as a saturation, which means that conducting more interviews would not lead to new knowledge (Krüger et al., 2014).

The qualitative analysis of the interviews occurs in three steps: elevation, processing and analysis of the material (Krüger et al., 2014). The elevation is based on guide-supported interviews. The processing is occurred by coding (Mayring, 2010). The analysis takes place with the help of a quantitative and a qualitative content analysis.

2.2.1 Preliminary Considerations

The interviews' circumstances in relation to the execution, the audio recording, the interview partners as well as the validation are the result of the preliminary considerations.

Form of Execution
One survey per company is conducted. Therewith, experts behave more independent concerning affiliations to the own company and their competitors. Furthermore, it is easier to arrange separate appointments for interviews, compared to a large common appointment. It is expected, that isolated interviews cause lower reworking costs

because statements are easier to allocate and thereby facilitate an appropriate documentation.

Audio Recording
It is assumed that an audio recording would influence the interviewees' answers. If there is a consideration between more accurate recordings and handwritten notes, the decision is made in favour to the (then) unrestricted interview partners. Concerning scope and detail level of handwritten notes, they are sufficient for an analysis. The constraint, that an evaluation of emphasis or other linguistic aspects subsequent to the interview is impossible, is known and accepted.

Selection of Interview Partners
The interview partners are divided in two groups. The first one is part of the technology sector and they were selected by considering the underlying technological infrastructure. The second group represents the retailers as the customers of such technologies.

Communicative Validation
Creating notes always contains the risk that the content of the notes may differ from what the interviewed person has said (Krüger et al., 2014). To counter this problem, it was decided to get the result confirmed by the respondent afterwards. This so-called "communicative validation" raises the validity of the interview data (Krüger et al., 2014).

2.2.2 Evaluation

The content analysis represents an evaluation procedure with consideration of the following scientific quality criteria: traceability, repeatability and reliability (Krüger et al., 2014).

Schmidt refers to a method of interview analysis in five steps. First, evaluation categories are formed initially, which are described subsequent to an encoding guide (Schmidt, 2004). A description of a category in the encoding guide is made out of four parts: the description and definition of the category, coding rules and examples (anchor and demarcation examples) (Mayring, 2010). With assistance of those evaluation categories, the interviews can be coded and it is possible to create substantial overviews (Schmidt, 2004). The coding's aim is the transformation of bullet points into data that can be qualitatively and quantitatively evaluated (Krüger et al., 2014). Finally, hypotheses of the individual inter-views can be examined for the purpose of a deeper interpretation (Schmidt, 2004). This research represents the characteristic aspects of each interview.

2.3 Needs Analysis

The needs analysis starts on the demand side. In addition to requirements, it also determines clusters of people. In each cluster of individuals, the same or at least very similar requirements to an ideal product exist (Berekoven et al., 2009). The needs analysis is based on the use cases of the interview partners. Some needs are specific to a use case, others are deduced from a group of use cases.

2.4 Potential Analysis

The established methods for potential analysis are useless for the analysis of technologies, because they are geared to companies and personnel.

In relation to the interviews, a question of the guideline is directly targeted to determine the potential of indoor positioning. Many potentials result from the answers of the interviews and will be examined more closely and also be classified in the following.

3 STATE OF THE ART

Together with the Open Geospatial Consortium (OGC) and the i-locate project, the InLocation Alliance (ILA) conducted a survey for the determination of indoor location (Conti et al., 2016). The ILA was founded by the cellular mobile telephone industry to accelerate the introduction of solutions for indoor positions. These solutions improve the mobile experience by creating new opportunities for consumers and industry (InLocation Alliance, 2018).

The OGC® is an international industry consortium with 519 companies, government departments and universities, which are participating in a consensus process to develop publicly available interface standards. The OGC® standards support interoperable solutions that make web, wireless and LBS, as well as current IT, location-based available (Open Geospatial Consortium, 2018).

The i-locate project was founded by the European Commission within the Information and Communication Technology Program (ICT-PSP). The project's aim is to create a public geo-portal to gather and provide information about publicly accessible buildings as Open Data, as well as an open source toolkit for integrated hybrid (indoor-outdoor) LBS to locate and track objects and people (i-locate project, 2018).

Altogether, 153 survey replies from 33 nations were collected and evaluated in the survey. The participants were composed of one-third of *users* and two-thirds of system *developers* for the determination of an indoor position. All participants are directly involved in the determination market of an indoor location and are aware of its dynamics.

The majority of the survey participants are *users* of systems for the determination of an indoor position and work in the healthcare sector or provide services for the elderly. Only a small proportion of the respondents are within the retail market. Even more important is the fact, that the *developers* of systems for determination of an indoor location recognize more than 20 different industries at the same time as their target groups. This demonstrates the broad applicability of solutions for determination of an indoor position.

The survey's aim was to create a broad overview of requirements and cases of applications for the determination of an indoor position. Furthermore, trends, challenges and opportunities should be gathered.

In the following chapters the requirements, interests and cases of applications of determination of an indoor location will be represented.

3.1 Requirements

The evaluation of the survey revealed the following requirements:

- *Privacy* as a whole is regarded as the most critical barrier because of its social (concerning the user perception) and legal implications.

- The current *level of interoperability* is considered inadequate. The increase of interoperability would lead to cost minimisation.

- As seen from the software perspective, the developments in future should focus on *platforms* that permit the use of *several location technologies*.

- Hardware developments should focus on technologies that gather data in a passive system with *low latency and small energy demand*. Furthermore, the solutions should be easy to configure.

- Two requirements have turned out clearly: good *position accuracy and long-lasting site infrastructures* that can be used for a variety of different applications.

3.2 Users and Providers Interests

The described survey shows a high agreement of interests at the determination of an indoor position by users and providers of localization systems (Conti et al., 2016):

- **Localization of People**
  The evaluation resulted in two possibilities of localization: Determination of the position in the mobile device or via network environment. The first category implies a major interest in navigation, orientation- and real-time position determination, which is necessary for pathfinding and visitor interaction applications. The second category contains analytics, geo-fencing, approach recognition and other functions related to setting up context sensitive environments. The interest in Location Based Marketing (LBM) and Location Based Social Network (LBSN) is very low.

- **Localization of Objects**
  Two interests stand out clearly: tracking and real-time positioning. In comparison to systems for the localization of people, there is a low interest in analyzing the location of objects.

3.3 Explicit Cases of Application

The following section describes specific cases of application, which were compiled by the participants of the aforementioned survey. The core topic of this work is a special focus on the retail trade. The cases of application were reduced and sorted in a descending order from the point of view of the content-related closeness to the retail trade:

- **Retail Trade**
  The survey participants mention the following cases of application: localization of a product in a salesroom, navigation to Point of Sale (PoS) terminals with contactless payment, location determination of people and the provision of targeted advertising. Referred to marketing, the participants mention the Location Based Marketing (LBM) and the Location Based Advertising (LBA). Retailers can use precise location determination to increase their profit margins, to manage warehouse replenishment more efficient, to avoid empty shelves and to offer custom-made advertising (Giaglis et al., 2002).

- **Ambient Intelligence**
  With the identification of approaching and distance measurement between objects and people, the participants describe two basic functions of the ambient intelligence. A utilization is the information transmission of street lighting by VLC.

- **Facility Management**
  The evaluation is especially interesting for facility management. Within this, the survey's participants are interested in functions like e.g. monitoring the passenger flow in the interior space, object tracking, security and authentication. As another aspect, the analytics are mentioned. Here, the usage data can be used in different granularities (buildings, floors or individual rooms) to develop a comprehensive spatial database of the interior space.

- **Security**
  In the security area, geo-fencing and person tracking are examples for cases of application. Another case is the reference of emergency exits or safe areas, even if the lighting breaks down or smoke reduces visibility.

- **Corporate Offices**
  One way to use the determination of indoor positions in an office is a virtual reception of visitors and their navigation to the desired destination. Another example is the official tracking and work control. Thereby, the duration of staying and movement patterns of people and objects in and between different institutions can be gathered.

4 INTERVIEW EVALUATION AND DERIVATION OF THE CASES OF APPLICATION

In this section, the first research question is answered: Which uses of application can be supported with the determination of an indoor location?

4.1 Qualitative Analysis

The qualitative analysis investigates the mentioned cases of application per interview.

First Interview

The first interview partner describes a difference between analyses with and without additional data. Personal data about the customer's profile as well as items in the shopping basket are mentioned as additional data. Without them, applications like navigation, surveys, and location-based advertising can be implemented anyway, by using information

from the paths and residence times. With additional data in form of customer profile and demographic information, it would be possible to build cohorts and to compare them among each other. Furthermore, correlations from the shopping basket to the customers' path, to articles and residence times could be analysed. By using the data per costumer, one could considerate the comparison of branches, locations or industries. Besides to the analysis, the navigation to products and the retrieval of product information were mentioned as cases of application.

Second Interview

When asked about the cases of application, the second interview partner mentions analyses, product navigation along a shopping list and location-based advertising. For the employees, it could be possible to use the determination of indoor locations as a path optimization in the pick-and-pack-navigation at the warehouse. Another case of application affects the advice. Here it is conceivable that a customer calls for an employee instead of seeking for one.

Third Interview

The third interview partner divides the cases of application into the following four groups: customer campaign, customer friendliness, employee efficiency and analysis. The customer campaign includes location-based actions. The group of customer friendliness contains the navigation to products and path optimization along a shopping list. The group of employee efficiency comprises the navigation at shelf stocking and the pick-and-pack navigation. No specific examples are mentioned for the analysis.

Fourth Interview

The interviewee focuses on the navigation: from the employee to the customer, from the customer to the employee as well as from the customer and employee to the product. The interview partner mentions the measurability of the return on marketing activities and investments as a current problem. He would like to be able to analyse the effectiveness of brochure advertising. The determination of indoor positions represent a solution, from his point of view.

Fifth Interview

The interview partners of the fifth interview define the completeness audit of guests on board as an case of application: The determination of indoor position can be used to equalize a return to the last harbour because of the apprehension of forgotten guests. An analysis could represent a location-adjusted view of the shop assortment. It is impossible to represent every product at a prominent place on the shelf. Consequently, this means that the sales figures of the same product in two various attractive positions can

be different. Therefore, it may appear the conclusion that because one product sells less often than another and it therefore should be taken out of the assortment may be wrong, if the position was not considered. The aim of the location-adjusted view would be to determine the effect of the product positioning inside the shop.

4.2 Quantitative Analysis

The analysis is the only case of application, which is mentioned by all interview partners. Thereby, two of the interview partners mention that hot spots, residence times and A/B tests are specific aims for an analysis. Four interview partners declare themselves in favour of location-based advertising and navigation. Two interview partners indicate that customers could be navigated to the products along a shopping list. It would also be possible to route employees to customers or vice versa. Figure 1 shows the four most frequent cases of application.
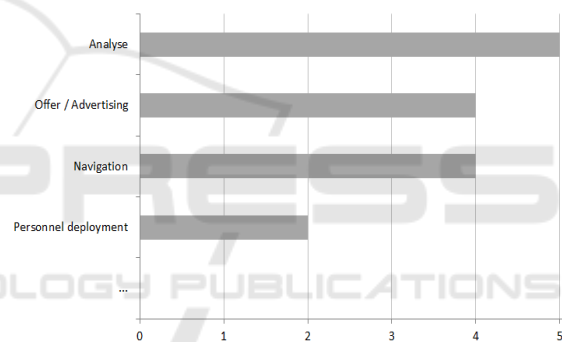

Figure 1: Frequencies of applications.

Respectively, application cases with one mention are surveys, the demand for product information, the position recording of products on the shelf and notifications.

5 NEEDS ANALYSIS

In this section, the second research question is answered: Which needs does the retail trade have in regard to the determination of an indoor position?

Within the needs analysis, some people clusters are determined, which have the same or at least similar claims to an ideal product. These groups of customers are partly derived from the interview partners and include the following stakeholders:

- Hardware and software developers for the determination of an indoor location, derived from the technological perspective as well as

- Employees, retailers, and costumers in operative business. According to the interview partners, the customers and employees most urgently need the navigation or rather the path optimization. On the other hand, the retailers have a great interest in analytics.

The following paragraphs describe the derived needs for each case of application. The section ends with a short summary of the needs.

Navigation

To realize the most appropriate navigation, not only the aim but also the knowledge of possible barriers is necessary. Walls, shelves or locked doors are examples for typical obstacles. The generated database is dedicated to calculate the route. Since the system navigates people threw buildings, a distinction between floors is necessary to reach the targeted place.

When using the navigation system, the targeted product has to be visible within a few centimetres, so that it could be found in a large amount of products. One claim also refers to the frequency of the positions' determination. It has to be sufficiently high to detect slight position changes. In addition, the orientation of the customer is helpful, so that it could be distinguished, whether the person faces the product or he or she is adverted.

To navigate along the shopping list, the calculation of the shortest route is necessary. If a customer calls an employee for advice, the location of the customer must be visible to the employee.

Surveys

This case is triggered by certain events and schedules to fill out a survey by the customers. Events for inducing such surveys can be a long residence time, leaving or entering a business. The reliable determination of such entry events can be derived as a need. In addition to that, the respondent needs an input device.

Product Information

Similar to the navigation section, the products have to be distinguishable in this case of application as well. It is not very helpful for the customer, if he or she is in front of a shelf and all products within a radius of one metre are displayed on his smartphone. In this case, the customer would need a possibility to determine the product for which he or she needs more information. Therefore, the position of the smartphone, the viewing direction and the centimetre-precise location of the products are necessary features.

Data Acquisition of Products on the Shelf

In this application case, a high precision in a three-dimensional space with an accuracy of a few centimetres is required. While of scanning a product in the shelf, the position of the scanner is captured and stored on the product.

Location-based Offers/Advertising

Two characteristics of this case of application are conceivable, depending on the personalization: one possibility without and another with profile data of the customer. In both cases, data about offers have to be available. The trigger for displaying an advertisement could be: entering an area (geofencing) or approaching a product. The grade of accuracy about the position determination depends on the trigger.

Notifications at Approaching Reduced Products

As in previous cases of application, the accuracy of location determination has to be high enough to reliably identify a convergence to products. The notification has to be transmitted to the customer.

Check Completeness of Guests on Board

The checking of completeness should make a turnaround of the boat because of the apprehension of forgotten guests unnecessary. To encounter this requirement, a high degree of reliability is needed to implement this solution in the envisaged environment. There must be no difference between the systemically determined and the indeed completeness.

Use of Personnel or Energy Usage according to Capacity

In this case of application, the reliability is very important as well. Here, the specific needs can be derived to be able to reliably determine the workload.

Analysis

The hot spot analysis requires the least amount of data. It is sufficient to evaluate superimposed location determinations. For the analysis of walking routes, the measurement data must at least be clearly assigned to the measuring device, but not to an identified person. The analysis of customer interests in relation to the residence time next to a product or in different departments needs a clear identification. Furthermore, it is interesting to generate precise predictions about the tendencies of customers out of measured data. From A/B tests, no general need can be derived. The compared situations before and after a change or at the same time in two different areas are too different to determine concrete predictions. For the comparison of locations, branches or companies, the measured position data have to be clearly assigned to one of these perspectives. The analysis of residence times requires the definition of a radius, in which several measured values are assigned to the same place in order to aggregate residence times. Only

then, the staying is distinguishable from a minimal movement. Sales and shelf positions must be gathered at the selling time, so that revenues can be analysed in a location-adjusted way. The requirement is to connect the position data of products with their sales. Therefore, it is necessary to differentiate between clothes inside and outside of the changing room, to gain information about the situation and whether it is a possible sale or just a fitting. For that, a high accuracy is required. In order to investigate the complaint subsequent to marketing approaches, it must be distinguishable whether visits by customers were induced by those approaches or not.

Summary

Derived from the cases of application, the following requirements are determined: identification of a person, connection to external data sources, orientation of the navigated person, differentiation between floors, high reliability of the position determination as well as a high spatial and temporal accuracy.

6 POTENTIAL ANALYSIS

In this section, the third research question is answered: Which potentials does the regulation of an indoor location offer to the retail trade? The database dedicated to answer this question consists of potentials for the determination of indoor position, which were named by the interview partners. In the following segments, the individual potentials are named and their frequency of mention is presented. Afterwards, they will be divided in four groups.

The most frequently mentioned potentials are the increase of comfort and the path optimization. In the latter case, two interview partners named incoming
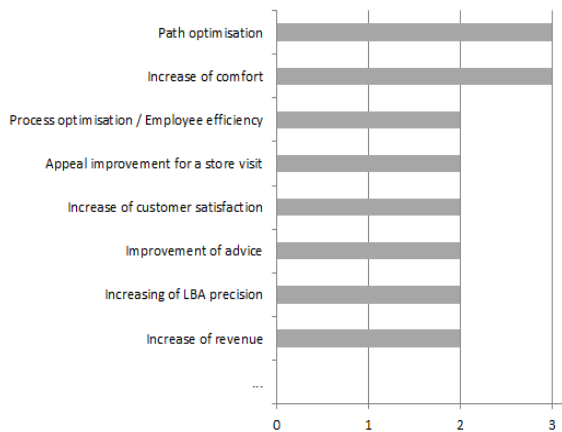

Figure 2: Frequencies of potentials.

goods and pick-and-pack. Revenue growth, increase of customer satisfaction, improvement of advice, LBA precision enhancement, process optimisation and employee efficiency, as well as the appeal improvement for a store visit were also mentioned twice. Figure 1 shows the most common potentials.

The optimisation of product placement, gamification, cost savings because of capacity-controlled energy use and the support of multichannel marketing were only mentioned once.

The analysis results in the following four groups of potentials and gamification.

Economy

Here, the interview partners recognize the following potentials: reducing personnel deployment, saving energy by product placement according to the amount of margins. Furthermore, they mentioned the increase in revenue as a potential.

The fifth interview partner describes an economically negative aspect of navigation. According to him, the number of visited touch points would be reduced. In addition, the following of a route reduces the potential that customers buy something that they coincidentally see, because their attention pertains to the route.

Efficiency

The path and process optimization are potentials in the field of efficiency. Superficially is the employees' daily tasks optimization in the retail trade.

Marketing

The potentials are the increase of the accuracy of location-based advertisements, the increase of the appeal for a store visit and the support of multichannel marketing. An identifying determination of an indoor position could reduce friction losses between online and offline analyses.

Convenience

In addition to improve the consulting, the increase in comfort and customer satisfaction were mentioned.

7 CONCLUSIONS

Digitalization is currently one of the main drivers of economic growth. As a consequence thereof, the management in stationary retail trade has to think about additionally and new digital services because of an increasing digital competition and omnipresent access technologies, as well as dynamic customer requirements. One possibility is to analyse streams of motion for a better understanding of the customer journey and a seamless transition from outdoor to indoor navigation dedicated to the detection of products. Varieties of new fields of application arise

out of this context, which have been explored more closely in this research.

To determine those applications, interviews with experts from leading software and technology companies were conducted. The interview notes were evaluated both qualitatively and quantitatively. The analysis of the customer journey, the determination of an indoor position including navigation and location-based advertising belong to the most frequently mentioned cases of application. According to the experts' opinions, they have a great *potential* for increasing customer comfort with regard to path optimization. Additionally, location-based advertising generates completely new context-related upselling potentials for the stationary trade. Furthermore, the evaluation showed that the experts still ascertain potentials especially in the fields of efficiency improvement, digital marketing approaches, promotion of convenience and gamification.

The derived experts *needs* include the identification of a person, the connection with external data, the orientation of the navigated person, the differentiation between floors, a high level of reliability and a large degree of spatial and temporal accuracy. Based on those needs, the further research should validate the findings, as the number of five interviewees does not claim to be indisputable in relation to scientific correctness. Furthermore, it could concentrate on the comparison of available technologies, the increasing of representativeness and the legally exploring of data protection to enlarge the knowledge of location based services and their possible implementation.

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