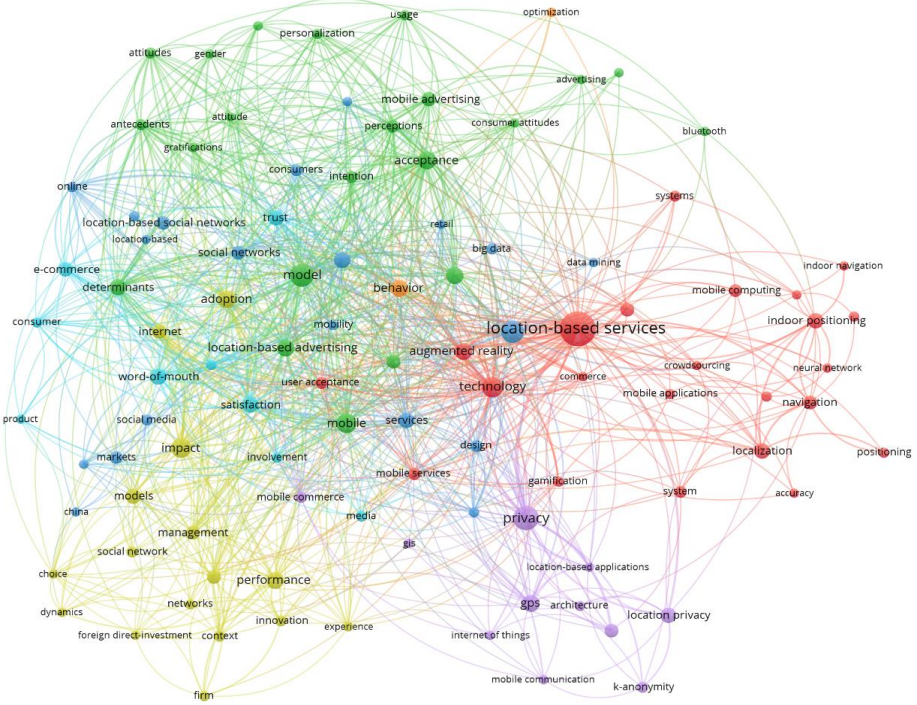
Location-based marketing



Impact paragraph

Despite noticeable progress that has been made in the past decades towards citizen-centric city services and sustainable urban living, research on geography in marketing and consumer behavior in cities is still underrepresented. The era of ubiquitous computing has given researchers many new opportunities to accelerate existing research streams and to rethink the boundaries of research fields. Ubiquitous computing devices are omnipresent in everyday life and the sensory data they collect allow for real-time observation of actual consumer behavior. The opportunities inherent in these datasets are enormous; using carefully selected methods to translate raw urban behavior and mobility datasets into meaningful implications for public and private stakeholders is the big challenge I addressed in this dissertation.

The combination of data analytics and social science with high applicability to practice was a core focus of the BISS Institute, where I spent the first 2 years of my PhD. My supervisor Jos Lemmink, initiator of the BISS Institute, imagined this research institute on the Brightlands Smart Services Campus (BSSC) in Heerlen to be a "Test Kitchen" where innovative, out-of-the-box, and interdisciplinary research ideas would fall on fruitful ground and where experimenting with the diverse data landscape of the ubiquitous computing era is supported and appreciated. This mindset has accompanied me throughout the past six years. Consequently, in my dissertation, I use urban (sensing) datasets and I examine five ways of integrating these into marketing research for deeper insights on human behavior in urban areas and on the future of location-based marketing. The resulting implications are threefold: conceptual, methodological and societal. The following paragraphs will elaborate on each of these aspects.

Concerning conceptual implications, in the introduction of my dissertation, I define LBM as *a direct marketing strategy that uses location information to deliver marketing content on mobile devices relevant to a particular location*. In Chapter 1, it becomes evident that LBM currently applies a rather narrow definition of location and mainly uses the current consumer positioning to place advertisement for nearby shops. At the end of the first chapter, I argue that researchers should broaden the definition of location and include dynamic consumer movements and static location information of the surrounding area. The following five chapters demonstrate use cases and approaches for LBM research with a broader definition of location. Thereby, these chapters advocate for LBM to approximate the definition of CBM. CBM refers to *a geographically bounded form of LBM that includes more data about the city and urban living*. Depending on the goal, the scope, and the datasets of an LBM research project, the geographical boundaries are not necessary or not feasible for reasons such as privacy. However, they are helpful for deriving clear implications for a target region.

Apart from extending the LBM definition towards the CBM definition and including more data beyond the static customer positioning, I challenge the long-standing proposition that the consumer is the focal unit of analysis in marketing research. In the end, I agree with this proposition because marketing usually aims at selling a product, services, or idea to a consumer in the most appropriate and efficient way. At the same time, I believe that many other topics and units of analysis can the studied to learn more about human behavior and after all, to deliver a marketing message successfully. In the context of this dissertation, we saw that even though the consumer is still at the focal point in behavioral research, their decisions and choices are complex (Chapter 1).

Infrastructure and service performance determine their choices and routines (Chapter 2), locations can be attractive to consumers for multiple reasons (Chapter 3), and people with similar demographics behave and choose alike (Chapter 4). Data privacy restricts research opportunities (Chapter 5) and all these aspects directly or indirectly influence consumers' activity-based mode of transport choice (Chapter 6).

Regarding methodological implications, my dissertation disseminates the potential of spatial data in marketing. Spatial data can include static information about the landscape, built environment, or physical infrastructure of an area as well as dynamic observations such as human trajectory data, traffic volumes, pollution levels, etc. Many of these observed circumstances influence or are influenced by humans and their daily movements in their environment. Consequently, marketing research would benefit from integrating more such datasets into research projects that have a clear connection to the physical context. Throughout my dissertation, I highlight the benefit of spatial data in my research projects and point out that some insights would not have been observed if I had not used these datasets. Precisely, in Chapter 2 and Chapter 4, I demonstrate that both infrastructure and human trajectory data can assist researchers in uncovering service gaps in a city. In a second step, similar datasets and additional neighborhood information from national statistics centers allow developing a deeper understanding of neighborhood dynamics and consequently, developing personalized services and curated marketing offers that fit the need of citizens.

As a second methodologically contribution—and in line with the guiding thought of researching in a "Test Kitchen"—, I tested and critically assessed five different approaches to spatial data in marketing and corresponding methods that fit my use cases. As a result, I work with MIT's UNA toolbox to identify optimal UAM VTOL sites from a demand perspective (Chapter 2), and I employ regression analysis on spatial data to model location attractiveness based on its surrounding infrastructure (Chapter 3). Further, I spend time becoming acquainted with the world of data visualization for geographic data and utilize a variety of visualization options to discover urban dynamics (Chapter 4). I show that careful data pre-processing, clever feature engineering and the DBSCAN clustering algorithm can bridge data gaps from privacy regulations; with this unsupervised method, I reverse engineer the trip purpose of recorded movements, identify common characteristics of each cluster and categorize clusters into broader purpose categories (Chapter 5). Additionally, I apply k-means clustering to activity-based mode of transport choices observed via a complementary survey and describe four distinct behavioral clusters of mobility users (Chapter 6). For generalizability, I ensured that all introduced methods are transferrable to other cities and regions as long as suitable datasets are available.

The last set of implications—societal implications—are the most important ones for applied research from a "Test Kitchen". Universities are government's and society's institutions for the creation of new knowledge; in the past decades and centuries, universities have had a major impact on developing the society we live in today. I strongly believe that research always needs to have a societal and practical impact, because if a project does not help anybody or does not advance practices of any societal group, then what is the point of running the project. To make sure my research would have concrete practical implications, I worked together with the City of Maastricht to

recruit participants for my data collection and I used additional information from CBS and BAG to enrich my datasets. This gave me a concrete geographically bounded area of research and knowing the region from living there was an additional benefit.

Applying the aforementioned methods in Maastricht and South Limburg, I find the following practical implications for the region. First, in Chapter 2, I show that there is a transport service gap in some areas of the city and a subset of these is suitable for UAM services. By overlaying multiple data layers, I propose four VTOL sites across the city and argue why they would be frequently used and by whom. More precisely, I identify two locations in the city center, which people would be using for direct regional flights to avoid traffic or to reach the densely built city center fast, and two in the outskirts of the city in wealthy neighborhoods, which residents would use for fast intra- and intercity connections.

Second, in Chapter 3, I divide the region into 300m grid cells and demonstrate that we can use people inflow to a grid cell as an indicator of location attractiveness, especially in a marketing and behavioral context. When testing the direct effects of destination features on location attractiveness, I find that denser areas are more popular than rural areas and that certain grid cell functions (used as a proxy for trip purpose) are more popular than others are. Further, I find that competition between businesses has an effect on location attractiveness and that public transport access varies in importance by cell function. Additionally, the results indicate that trip origin features moderate the attractiveness of the destination location, meaning that depending on the function of the origin, certain destination functions are more popular than others are and we can clearly differentiate between chain trips, short trips within the direct surroundings and trips to or from home.

Third, in Chapter 4, different data visualization techniques uncover urban dynamics and service gaps previously unrecognized. Here, the combination of multiple graphs and representations is key and data visualization has the unique ability to present multiple dimensions of a dataset in an understandable way through colors and glyphs. For Maastricht and South Limburg, I detect traffic peak hours which differ between weekday and weekend; I find that some cell functions are more dominant in specific areas of the region and that the flow to and from these functions differs during the day. The heat maps of flow hotspots show the main activity in Maastricht, Heerlen and Sittard and I compare these results between weekdays and with a hotspot analysis of buildings. Moreover, I illustrate the flow links by mode of transport; there seems to be a minority of people who commute between Maastricht and Heerlen or Maastricht and Sittard by regional train as well as a few bus trips within Maastricht. Walking is naturally bound to short distances within cities. Cycling mainly takes place within city boundaries, with few movements to the closest northern and southern suburbs of Maastricht.

Fourth, in Chapter 5, I cluster all observed movements and identify 12 categories, which I can label with a certain trip purpose based on the common characteristics of each cluster. Such characteristics include average trip length and duration, mode of transport used, weekday, time of the day, urbanization level, and cell function. I find clusters of trips where people go for lunch during a break from work or study, where people go home after work or after leisure activities or where people leave their home

in the morning to go to work or school. Further, I am able to group the 12 clusters into four broader themes: food-related trips, home trips, career-related trips and sports-/health-related trips. Having an understanding of the most likely purpose behind a trip is interesting for public and private stakeholders alike. Amongst other use cases, public stakeholders can provide the necessary transport services and infrastructure to manage the flow volume and private stakeholders can use trip purpose information to market their business.

Last, in Chapter 6, I use activity-based mode of transport choice patterns to allocate citizens to one of four behavioral clusters: Leisure drivers, persistent drivers, frequent walkers, and persistent cyclists. People within one cluster have very similar choice patterns whereas people in other clusters choose quite differently. More precisely, I find that the persistent cyclists build the largest cluster in the region and that most of these people live within the city boundaries of Maastricht. Together with the frequent walkers, they show a high environmental consciousness, whereas persistent drivers care less about sustainability. Thus, in a sustainable mobility campaign for Maastricht, the persistent cyclists and frequent walkers should be rewarded for their non-motorized transport use to keep them motivate to behave similarly in the future, while persistent drivers need to be targeted differently with incentives such as less parking issues, less traffic, and higher flexibility.

In summary, integrating geography research into marketing and behavioral research is still a big challenge and there is a long way left to go. However, we see some first promising steps of interdisciplinary research in this area and continuous attempts to deploy new algorithms and methods in social sciences use cases. Additionally, researchers worldwide increasingly value applied research projects and pay close attention to the societal impact of their work.