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TOWARDS UNDERSTANDING THE BEHAVIORAL MECHANICS OF CROWDSOURCING - INSIGHTS FROM A MOBILE TRAVEL RISK APPLICATION

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presented by
KAY NOYEN
MSc ETH

born on *04.09.1984*
citizen of
Germany

accepted on the recommendation of
Prof. Dr. Elgar Fleisch
Prof. Dr. Roman Boutellier
Dr. Felix Wortmann

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Abstract

Crowdsourcing, the act of outsourcing tasks to large and undefined online communities in the form of an open call (Howe, 2006), has proven to be an extremely powerful concept. The tremendous success of Wikipedia, an online encyclopedia where all entries are generated by voluntary contributors, has inspired many other crowdsourcing projects that attempt to accomplish tasks that have been previously reserved for small groups of specialists. However, voluntary crowdsourcing applications face a critical problem when they are first introduced. Content is a key driver of user adoption, and without content, there will be no users. Likewise, without users, there will be no content. Researchers in the domain of user-generated content have noted that the sustainability of this mechanism, known as the content generation and consumption cycle, is a decisive factor for the success of information systems that rely on voluntary user contribution.

The objective of this research project is to advance the understanding of the behavioral mechanics underlying the crowdsourcing concept to better inform the design of voluntary crowdsourcing applications. To this end, this thesis employs a design science research paradigm that focuses on the design artifact Travel Safety, which is a mobile crowdsourcing application designed to provide travel risk information. From the perspective of the Travel Safety application, two central aspects of the content generation and consumption cycle are addressed. The first aspect of our investigation is the generation of content through user contribution. In particular, we propose social normative feedback as a

catalyst to foster user contribution and evaluate our proposal by conducting a field experiment with 768 participants to study short-term and long-term effects. The second aspect of our investigation is content consumption. Previous research indicates that crowdsourced content might generally be perceived as not credible or trustworthy compared to content provided by known, established sources. We investigate the effect of crowdsourced content on usage intentions by performing an experiment with 87 participants, with a particular focus on the travel risk context of Travel Safety.

There are several findings resulting from this thesis. We tentatively assess the design artifact Travel Safety and its role as an innovative Information Technology (IT) artifact. In addition, we address the challenge of creating a voluntary crowdsourcing application from the ground up and discuss the design decisions that greatly affect the implementation of Travel Safety. We present the findings of our investigation and discuss how to foster sustainable contribution behaviors in voluntary crowdsourcing applications. Our results show that social normative feedback is a highly effective means to fostering contribution in the short-term. However, evidence from our study suggests that such feedback reduces users' intrinsic motivation and may eventually harm longer term contribution. In our study on how crowdsourced content might affect usage intentions by users of the application, we found a small but significant negative effect that suggests that crowdsourced travel risk content should not be used recklessly.

This thesis contains a number of contributions to the literature as well as to practice. The results of the research add to existing literature in the fields of information systems, social psychology, user-generated content, crowdsourcing and human computation systems. In particular, this thesis followed the call for research by Sidorova & Evangelopoulos (2008), who called for an intensified investigation of psychological interventions in information systems, and Davis et al. (1992) and Gerow et al. (2012), who called for a deeper understanding of the effects of extrinsic motivation and the sources of intrinsic motivation related to social norms. By investigating usage intention in the context of a consumer application, we followed the call for research by Nicolaou & McKnight (2006). Our findings will further inform artifact development and will be useful to practitioners by providing guidance on how to design voluntary crowdsourcing applications, with a particular emphasis on the cautious use of social normative feedback interventions.

Zusammenfassung

Das als Crowdsourcing bekannte Konzept des Auslagerns von Aufgaben („Outsourcing“) an grosse Online-Communities („Crowd“) (Howe, 2006) hat sich in der jüngeren Vergangenheit als ein besonders leistungsfähiges Verfahren etabliert, das in der Praxis häufig Verwendung findet. Insbesondere der herausragende Erfolg der Online-Enzyklopädie Wikipedia inspirierte eine grosse Welle innovativer Crowdsourcing-Anwendungen, die nun das Ziel verfolgen, vormals Experten vorbehaltene Aufgaben der breiten Masse zugänglich zu machen. Während das Potenzial des Crowdsourcing-Ansatzes unumstritten ist, birgt die Einführung neuer Crowdsourcing-Anwendungen jedoch zentrale Herausforderungen. Weil die von den Nutzern erzeugten Inhalte ein entscheidender Treiber für die Nutzung der Anwendung sind, kann eine Anwendung mit anfänglich nur wenigen Inhalten oft keine neuen Nutzer anziehen. Gleichzeitig werden aber nur dann Inhalten generiert, wenn die Anwendung bereits ausreichend viele Nutzer hat. Forscher aus dem Bereich der nutzer-generierten Inhalte haben diese wechselseitige Abhängigkeit unter dem Schlagwort “Content Generation and Consumption Cycle” (zu dt.: “Kreislauf aus Inhaltsgenerierung und -konsum”) diskutiert und als zentralen Erfolgsfaktor für Informationssysteme identifiziert, die auf freiwilligen Nutzerbeiträgen beruhen.

Das Ziel dieser Arbeit ist, das Verständnis der dem Crowdsourcing-Konzept zugrundeliegenden Verhaltensmechanismen weiterzuentwickeln, um die Wissensgrundlage für die Gestaltung von freiwilligen Crowdsourcing-Anwendung zu erweitern. Zu diesem Zweck bedient sich diese

Arbeit eines Design Science Ansatzes, der sich auf das Designartefakt Travel Safety fokussiert. Travel Safety ist eine mobile Crowdsourcing Anwendung für Reisesicherheitsinformationen, die im Rahmen dieser Arbeit entwickelt wurde. Basierend auf dem Design von Travel Safety, werden zwei zentrale Aspekte des “Content Generation and Consumption Cycles” behandelt. Zunächst steht die Erzeugung von Inhalten und insbesondere der Einsatz von sozial-normativem Feedback als Treiber für die Erstellung von Nutzerbeiträgen im Vordergrund. In einem Feldexperiment mit 768 Teilnehmern werden dazu kurz- und längerfristige Feedbackeffekte untersucht. Die Arbeit widmet sich dann dem Konsum von nutzer-generierten Inhalten. Vorherige Untersuchungen haben gezeigt, dass durch Crowdsourcing generierte Inhalte unter Umständen als wenig glaub- und vertrauenswürdig wahrgenommen werden. Weil sich dies negativ auf die Nutzungsabsichten der Anwendung auswirken könnte, wird dieser Effekt genauer im Kontext von Travel Safety in einem Experiment mit 87 Teilnehmern untersucht.

Die in dieser Arbeit durchgeführten Untersuchungen führen zu einigen neuen Erkenntnissen. Wir geben eine erste Einschätzung des Designartefakts Travel Safety ab und bewerten seine Rolle als innovatives IT Artefakt. Darüber hinaus adressieren wir die Herausforderung eine auf freiwilligen Nutzerbeiträgen basierende Crowdsourcing-Anwendung von Grund auf zu entwickeln und reflektieren die dafür kritischen Designentscheidungen in der Implementierung von Travel Safety. Darüber hinaus diskutieren wir, wie nachhaltiges Verhalten im Hinblick auf die Erzeugung von Nutzerbeiträgen gefördert werden kann. Unsere Ergebnisse zeigen, dass sozial-normatives Feedback ein sehr effektives Werkzeug ist, um die kurzfristige Erzeugung von Nutzerbeiträgen zu fördern. Jedoch deuten unsere Ergebnisse auch darauf hin, dass solches Feedback die intrinsische Motivation der Nutzer reduziert und sich negativ auf das längerfristige Beitragsverhalten auswirken kann. Schlussendlich identifizieren wir einen signifikant negativen Effekt von nutzer-generierten Inhalten im Kontext von Travel Safety. Wenn dieser auch klein ist, so legt unsere Untersuchung doch nahe, dass Crowdsourcing-basierte Reisesicherheitsinformationen mit

Vorsicht einzusetzen sind.

Die Ergebnisse der in dieser Dissertation vorgestellten Forschung erweitern die bestehende Literatur in den Bereichen Informationssysteme, Sozialpsychologie, nutzer-generierte Inhalte, Crowdsourcing und Human Computation Systems. Insbesondere folgt diese Dissertation dem Aufruf zu einer intensiveren Untersuchung psychologischer Interventionen in Informationssystemen (Sidorova & Evangelopoulos, 2008). Im speziellen adressiert sie Forschungsbedarf im Kontext (intrinsischer und extrinsischer) Motivation und sozialer Normen (Davis et al., 1992, Gerow et al., 2012). Mit der Untersuchung von Nutzungsabsichten im Kontext einer auf Konsumenten ausgerichteten Anwendung folgen wir darüber hinaus dem Forschungsaufruf von Nicolaou & McKnight (2006). Die Ergebnisse der Arbeit tragen zur Weiterentwicklung des Designartefakts Travel Safety bei und dienen als mögliche Leitlinie zur Entwicklung weiterer Crowdsourcing-Anwendungen, die beispielsweise die Erzeugung von Nutzerbeiträgen auf der Basis von sozialnormativem Feedback fördern wollen.

Previously Published Work

This thesis contains parts of working papers and previous publications by the author. Please also refer to the following contributions when building upon the results of this thesis:

Noyen, K. & Wortmann, F. (2014a). Travel Safety: A Crowdsourced Mobile Travel Risk Application. In *Design Science Research in Information Systems and Technologies* (pp. 373–377). Miamißß

Noyen, K. & Wortmann, F. (2015). Perceived Information Quality on Twitter: The Effect of Information Source for Travel Risk Information. In *European Conference on Information Systems (submitted)*

Noyen, K. & Wortmann, F. (2014c). User-Generated Travel Warnings on Twitter: An Explorative Analysis. *i-com*, 13(2), 26–31

Noyen, K. & Wortmann, F. (2014d). Using Twitter as a Source for Travel Warnings: Understanding the Role of Information Source and Target Audience. In *Multikonferenz Wirtschaftsinformatik* (pp. 1694–1706). Paderborn

Noyen, K., Wortmann, F., & Fleisch, E. (2015). Fostering Contribution in Human Computation Systems on the Basis of Social Normative Feedback - Insights from a Mobile Travel-Risk Application. *Information Systems Journal (submitted)*

Noyen, K. & Wortmann, F. (2014b). User Contribution in Online Communities - The Influence of Advertising on the Effectiveness of Social Normative Feedback. In *18th Pacific Asia Conference on Information Systems* (pp.34). Chengdu

Table of Contents

List of Figures

List of Tables

List of Abbreviations

IS	Information System
IT	Information Technology
HCS	Human Computation System
HCT	Human Computation Task
API	Application Programming Interface
REST	Representational State Transfer
OCR	Optical Character Recognition
GPS	Global Positioning System
iOS	Apple iPhone Operating System
B2B	Business-to-Business
B2C	Business-to-Consumer
P2P	Peer-to-peer
RQ	Research Question
R&D	Research and Development
SNF	Social Normative Feedback
SDT	Self-Determination Theory
TAM	Technology Acceptance Model

TRA Theory of Reasoned Action
PIQ Perceived Information Quality
RSK Perceived Risk
TRU Trusting Beliefs
ITU Intention to Use
EU European Union
G-20 The Group of Twenty (Major Economies)
TCS Touring Club Swiss
CHF Swiss Franc (Currency)
USD United States Dollar (Currency)
SMS Short Message Service
ANOVA Analysis of Variance
PLS Partial Least Squares
AVE Average Variance Extracted
CR Composite Reliability
SD Standard Deviation
M Mean Value
df Degrees of Freedom
F F-Statistic
p p-Value
χ^2 Chi Squared Value
n Sample Size
R^2 R Squared Value

1

Introduction

1.1 Motivation

Today, the Internet is a place where individuals can actively engage and contribute (Majchrzak & Malhotra, 2013, Tsai & Bagozzi, 2014, Wasko & Faraj, 2005). The term Web 2.0 (O'Reilly, 2007) evolved as a meta description of this development, which led to a new wave of Internet applications such as social media, wikis and blogging platforms that use user contributions to expand beyond static web pages (Chau & Xu, 2012, Kane et al., 2014). The idea of crowdsourcing, a blend of the word “crowd” and “outsourcing”, is part of this development and has been described as the act of outsourcing tasks to large and undefined online communities in the form of an open call (Howe, 2006). There are many well-known applications of crowdsourcing. By outsourcing all editorial efforts to the crowd, Wikipedia[1] has revolutionized encyclopedias and influenced the publishing industry (Carroll, 2011). iStockPhoto[2] disrupted the stock photography market(Brabham, 2010). The open innovation platform InnoCentive[3] became an important part of corporate high-tech Research and Development (R&D) (Allio, 2004). More recently, the rise of smartphones and mobile platforms has led to the development of a new wave of crowdsourcing innovations (Rosen & Greve, 2012, Soliman & Tuunainen, 2012), in particular driven by the ubiquity of smartphones and their integrated sensor technology (Newell & Marabelli, 2014). Recent state-of-the-art examples demonstrate the power of crowdsourcing on mobile platforms. Waze[4] is a social navigation system that utilizes crowdsourcing to acquire traffic information. Its superior performance is challenging traditional navigation systems (The Economist, 2013). Another example is Vivino[5], a crowd-based wine guide (Higgins et al., 2014). Its strong growth suggests it will soon be the most consulted wine guide in the world. These success stories show the great potential of crowdsourcing and reflect its core concept: “[...] the power of the many can be leveraged

[1] www.wikipedia.org
[2] www.istockphoto.com
[3] www.innocentive.com
[4] www.waze.com
[5] www.vivino.com

to accomplish feats that were once the province of a specialized few." (Howe, 2006).

While contributors to applications such as Innocentive and iStockphoto are incentivized through monetary rewards, users of other crowdsourcing applications such as Wikipedia, Vivino and Waze contribute on a voluntary basis, which researchers generally attribute to their intrinsic motivation (Yang & Lai, 2010). However, because the content that makes applications such as Wikipedia valuable is generated by its users, crowdsourcing applications that rely on voluntary user contribution face a critical problem when they are first introduced. The few initial users typically do not generate sufficient content to sustain the initial user base and to make the application valuable to new users. This leads to the generation of even less content, thus making the application less valuable and ultimately rendering it obsolete. To overcome this downward spiral, crowdsourcing applications need to acquire a critical mass of contributing users that generate sufficient content to make the application valuable to other users. This content generation and consumption cycle in Web 2.0 applications, such as those based on crowdsourcing and social networks, is a current topic of research in the academic literature and shares similarities with research on user-generated content (Kumar, 2009, Zhang & Zhu, 2011). In accordance with the above described example of a downward spiral in content generation and consumption, recent studies note that the dynamics of content generation are governed by network effects (Shriver et al., 2013, Ahn et al., 2011). The theory of network effects originated in the economic literature. Metcalfe's law states that the utility of a network is proportional to the number of unique connections, which depends on the number of users (Madden et al., 2004, Shapiro & Varian, 1999). This exponential relationship, broadly referred to as the network effect, has been cited as the main cause of the difficulty in creating new Web 2.0 applications; however, it is also the cause of the tremendous success of established platforms (Hendler & Golbeck, 2008). In light of this concept, the content generation and consumption cycle seems to be a determining factor for the sustainability of voluntary crowdsourcing applications. However, it is unclear how to address the challenge of creating sustainable content generation and consumption cycles in the design of new applications.

Embracing the trend of crowdsourcing on mobile devices, the starting point of this thesis is the development of Travel Safety, a mobile crowdsourcing application for travel risk information. There are a variety of reasons why high-quality travel risk information, such as timely and descriptive travel warnings and guidance, are important. International travel involves risks concerning personal safety. Natural disasters, political instability, terrorism, diseases and crime pose severe threats to travelers, particularly when travelers are in unfamiliar environments (Reisinger & Mavondo, 2006). Natural hazards can be life threatening and can cause immense harm to unprepared travelers (Blaikie, P., Cannon, T., Davis, I., Winser, 1994). Political instability and unrest is a major cause of travel warnings and advice not to travel in foreign countries (Sönmez et al., 1999). Terrorism and its consequences pose a steady threat to the safety of international travelers (Fischhoff et al., 2004). Tourists are particularly vulnerable to crime that occurs in most urban areas (Dimanche & Lepetic, 1999). Because unknown environments in foreign countries hamper both travelers' ability to acquire safety-related information and to assess risky situations, travelers are often subject to great uncertainty. This uncertainty can be reduced with the timely acquisition of adequate travel risk information (Löwenheim, 2007). Although it does not reduce travel risks, travel risk information reduces individual uncertainty and allows travelers to make informed choices and avoid situations that expose them to risk. Hence, travel risk information is a crucial component of personal risk management before and during an individual's journeys. In general, high-quality travel risk information is important for three types of stakeholders (Löwenheim, 2007). Individual travelers do not want to take severe risks. However, they also do not want to unnecessarily cancel or postpone trips. The same argument holds true for companies and their employees, who are the second group of stakeholders. A third group of stakeholders are countries and their economies. Information on severe risks can lead to a significant decline in tourism. However, actual incidents have a major and long-lasting impact as well. Therefore, current and precise risk information is of the utmost importance, especially for larger, less well-known countries with varying regional risk conditions.

The integration of travel risk information into a mobile application promises to provide travelers with various benefits. Travelers are prone to being under-informed about imminent dangers because they usually do not have regular access to suitable information outlets and often do not speak the local language. In case of an emergency, travelers usually do not have sufficient knowledge about local emergency infrastructure, thus preventing them from reacting appropriately in critical situations. The ubiquity of smartphones allows applications to provide travel risk information when and where it is needed, further help travelers take appropriate precautions before traveling, and prevent dangerous situations from affecting travelers in advance by indicating generally risky travel destinations. Today, official travel warnings are issued by governmental institutions (Löwenheim, 2007), and news outlets play an important role in the distribution and public perception of warnings (Hall, 2002). Leading mobile travel risk applications, which provide travel warnings and assist their users in critical situations, include AON Worldaware [6] and the Risk Management Platform by Drum Cussac [7]. However, although these corporate travel risk applications increase personal safety during travels, they are also expensive and typically not available to the average traveler. The integrated travel risk information in corporate travel risk applications is assembled, processed and distributed by specialized agencies that charge high fees. The intention behind Travel Safety is to broaden the information base, provide more detailed first-hand information (Becker et al., 2012) and overcome the high cost of existing travel risk applications.

The information provided by Travel Safety is sourced from the Twitter accounts of foreign offices. Because computers are unable to understand the provided information in the context of the real world, users of Travel Safety voluntarily contribute by filtering and classifying the information via an integrated Human Computation System (HCS). HCSs are a class of Information System (IS) that leverage the crowd to solve problems that computers cannot yet solve (von Ahn, 2009). The particular HCS implementation in Travel Safety is therefore posi-

[6] www.aon.com/worldaware

[7] www.drum-cussac.com

tioned as a crowdsourcing framework that involves outsourcing tasks to the crowd in the form of an open call (Howe, 2006). The research in this thesis, which is based on Travel Safety, addresses the underlying behavioral mechanics of both the generation and consumption components of the content generation and consumption cycle to inform the further development of Travel Safety and to advance the understanding of the design of sustainable mobile crowdsourcing applications.

The following section describes the research background of this thesis and provides state-of-the-art examples of existing applications. The section first explains the crowdsourcing concept in more detail. Then, it outlines the implications of crowdsourcing on mobile platforms. Next, it describes HCSs and their relation to crowdsourcing. The next section motivates the research questions presented in this thesis. The introduction chapter closes with a description of the thesis structure.

1.2 Research Background

1.2.1 Crowdsourcing

In parallel to the development of Web 2.0, the Internet emerged as a large network of potential laborers, thereby enabling the powerful concept of crowdsourcing (Poetz & Schreier, 2012, Yang et al., 2008a), which has been widely recognized in the IS domain (Geiger et al., 2011, Tripathi et al., 2014). While its universally valid definition remains controversial (Estelles-Arolas & Gonzalez-Ladron-de Guevara, 2012), crowdsourcing is commonly referred to as the act of outsourcing tasks to large and undefined online communities in the form of an open call (Howe, 2006). The idea of crowdsourcing is used in many applications (Schulze et al., 2012) such as collaborative knowledge creation (Cress & Kimmerle, 2008) and open innovation (Chesbrough, 2006). By revisiting the applications introduced above, the following section further explains the concept of crowdsourcing and highlights its potential.

Instead of employing editors to write articles, Wikipedia relies on voluntary user contributions for the creation of its content. Today, Wikipedia is recognized as a major disruptor of the publishing industry that has largely replaced traditional print encyclopedias (Carroll, 2011). Over 4.5 million English articles, more than 20 million articles in 286 other languages and over 9 billion monthly page views (Wikimedia Foundation, 2014) are evidence of the great success of Wikipedia as a primary source of information on the Internet. The next prominent example of the successful application of the crowdsourcing concept is iStockphoto (Brabham, 2010). Stock photography is media content that is commonly licensed by companies to be used for marketing, corporate communication, editorial and other purposes. Professional providers of stock photography previously charged high fees for this service. By applying the crowdsourcing concept to the stock photography market, iStockphoto was created as an online platform that enabled anyone with a camera to offer their photography in exchange for payment. By opening the supply side of the stock photography market to amateurs and semi-professionals through crowdsourcing, the platform triggered a shift in the industry. Because companies had to pay substantially lower fees for crowdsourced stock photography of comparable quality, professional providers experienced a notable decline in demand. Acknowledging this paradigm shift, Getty Images, one of the world's largest professional stock photography providers, acquired iStockphoto for 50 million USD in 2006 (Howe, 2006). Crowdsourcing has also been recognized as an effective tool that is used to foster innovation. The application of crowdsourcing to the task of facilitating innovation is commonly referred to as open innovation (Chesbrough, 2006). InnoCentive is a well-known example of open innovation. It is an online crowdsourcing platform where companies anonymously set innovation challenges for a large open community, including individuals from various educational backgrounds and with diverse qualifications. In return for solutions to the technical problems raised on the platform, the companies offer significant monetary rewards. Although anyone can participate in the innovation challenges, InnoCentive attracted a global community of over 50,000 highly qualified scientists solving problems in chemistry, biochemistry, biology and materials science for major industrial companies with R&D budgets of well over one billion USD (Allio, 2004). Open innovation is a new approach being used by companies to find effective solutions to technical problems. While open innovation is unlikely to replace traditional company-internal R&D models, it has been proven successful and has produced good results at dramatically lower costs (Howe, 2006).

(a) Social navigation system Waze (b) Wine guide Vivino

Figure 1.1: Examples of mobile crowdsourcing applications

1.2.2 Mobile Crowdsourcing Applications

Since the first crowdsourcing applications emerged during the desktop computer era, shortly before Howe (2006) coined the term, the rise of mobile computing has made smartphones ubiquitous (Ahluwalia et al., 2014). A substantial and growing portion of the global population possesses Internet-connected smartphones. It is estimated that mobile platforms such as Apple iPhone Operating System (iOS), Google Android and Microsoft Windows Phone already account for 60 % of people's digital media time in the United States, having surpassed desktop computers in 2013 (Lella & Lipsman, 2014). This new frontier of digital connectivity has led to the creation of a new wave of crowdsourcing innovations (Rosen & Greve, 2012, Soliman & Tuunainen, 2012), in particular driven by the ubiquity of smartphones and their integrated sensor technology (Newell & Marabelli, 2014). In contrast to desktop computers, users constantly carry smartphones, thus allowing for spontaneous crowdsourcing and constant measurement of their activities. However, their small screen sizes and the typical lack of a physical keyboard also pose certain challenges to the design of mobile crowdsourcing applications. Beyond the introduction of mobile versions and extensions of existing desktop crowdsourcing applications, entirely new applications have emerged that specifically leverage the features of modern smartphone technology while also considering their limitations.

A central feature of modern smartphone technology is the Global Positioning System (GPS). The GPS allows mobile applications to geographically locate users and thereby allows applications to link user positions to contextual information. Beyond traditional location and navigation services, GPS also enables new use cases for crowdsourcing (Lequerica et al., 2010). The Israeli firm Waze was recently acquired by Internet giant Google [8] for a reported sum of over one billion USD (The Economist, 2013). Waze is a mobile social navigation system for automobile drivers that is available on iOS, Google Android and Microsoft Windows Phone. The promise of Waze is to provide better navigation results by crowdsourcing incidents such as traffic jams, police controls and accidents from its users in real time. Waze collects traffic data to in two ways. First, Waze automatically gathers data from its users' GPS sensors, and second, it lets users actively report incidents. Fig. 1.1a shows two images of the application. The left image displays the application in navigation mode, showing a user's fastest route, which is determined based on avoiding traffic incidents reported by other users.

[8] google.com

The right image displays how users can report traffic incidents in the application. At the time of its acquisition by Google, Waze had 50 million users in over 100 countries (The Economist, 2013). Integrated cameras are another important feature of modern smartphones and enable new possibilities for crowdsourcing applications. Going beyond textual communication, smartphone cameras allow users to quickly capture and communicate large amounts of information with low cognitive load. Wine guide Vivino is a highly successful recent example of a mobile crowdsourcing application leveraging the ubiquity and sensing capabilities of smartphones. Vivino incorporates a large community of wine drinkers and uses their contributions to build the ultimate wine database. Vivino allows users to identify a wine by taking a picture of its label. Image recognition techniques are used to automatically detect the wine's brand and vintage. Notably, because of the ubiquity of smartphones, wines can be scanned anywhere, including at home, in shops or even in restaurants. After scanning, users are presented with general information about the wine, price and purchasing information, comments and the wine's rating. After drinking the wine, a user voluntarily rates it according to their preference and contributes to the Vivino wine database. Fig. 1.1b shows the Vivino application, the wine scanning process in the left image and the respective product information in the right image. According to the company's blog[9], Vivino had reached 4 million users performing over 200000 wine scans per day in 2014. Because the recommendation of wines used to be the privilege of a chosen few experts (Ali et al., 2008), Vivino shows how the privileges of a few can be broken by the power of the crowd.

[9] blog.vivino.com

1.2.3 Human Computation Systems

The success of crowdsourcing provided computer scientists with a new opportunity to solve problems that computers alone cannot yet solve. The emerging research field of HCSs strives to solve these problems by building IS and incorporating online crowds and their computational ability (von Ahn, 2005). In particular, HCS are well suited to address fundamental information processing tasks such as optical character recognition, natural language processing, voice recognition, content classification and contextual reasoning (Quinn & Bederson, 2009).

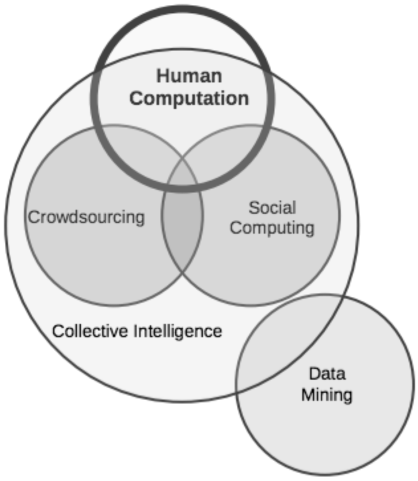


Figure 1.2: Taxonomy of HCSs by Quinn & Bederson (2009)

The concept of human computation was first introduced by von Ahn (2005), who defined it as "a paradigm for utilizing human processing power to solve problems that computers cannot yet solve." Accordingly, the idea that humans can solve problems that computers cannot yet solve is the foundation of HCS (Chan et al., 2009, Law & von Ahn, 2009, Quinn & Bederson, 2011, Yang et al., 2008b). However, certain definitions also elaborate on the socio-technical character of HCS, i.e., HCS are systems of computers and humans that work together to solve problems that could not be solved by either computers or humans alone (Quinn & Bederson, 2009, Yang et al., 2008b). Despite these unique core characteristics, there is substantial overlap between human computation and other interdisciplinary concepts (Quinn & Bederson, 2011) such as social computing (Wang et al., 2007), collective intelligence (Levy, 1999) and, particularly, crowdsourcing (cf. fig. 1.2).

This thesis focuses on the intersection of crowdsourcing and human computation. The basis of human computation is different from that of crowdsourcing, which is defined as outsourcing a job to an undefined group of people in the form of an "open call" (Howe, 2006). Human computation concerns "replacing computers with humans" and is not focused on "replacing traditional human workers with members of the public" (Quinn & Bederson, 2011). Furthermore, whereas crowdsourcing tasks can be of a varying nature (Nevo et al., 2014), i.e., they may vary from highly creative tasks to specialized problem solving to simple labor-intensive tasks (Brabham, 2010, Doan et al., 2011, Greengard, 2011, Poetz & Schreier, 2012, Wexler, 2011), human computation is dedicated to the latter category of tasks, designated as Human Computation Tasks (HCTs) (Quinn & Bederson, 2011). Although these differences distinguish the two concepts, the concepts share various characteristics. Both concepts rely on a group of crowd workers, which can be a network (Brabham, 2010), a community (Whitla, 2009, Yang et al., 2008b), or simply a set of anonymous and independent individuals (Haythornthwaite, 2009). In addition, there are various reasons for people to engage in both HCS and crowdsourcing, including monetary incentives (Geisler et al., 2011, Wexler, 2011), personal and social rewards (Brabham, 2010, Cook, 2008), fun, ideological reasons, (Nov, 2007, Proulx et al., 2011), altruism (Prasarnphanich & Wagner, 2009) and what is known as implicit work (Quinn & Bederson, 2009).

The idea behind implicit work in HCSs is "to make the computation a natural part of some activity that the users were already doing." (Quinn & Bederson, 2009). An instructive example for implicit work in HCSs is reCAPTCHA [10], a widely used service that distinguishes humans from computers on websites (von Ahn et al., 2008). Website operators need to distinguish humans from machine-triggered interactions to prevent malicious attacks such as spamming (Xie et al., 2008). reCAPTCHA requests that the user perform an Optical Character Recognition (OCR) task that is unlikely to be solved by computer software. Two distorted raster images of seemingly arbitrary words are presented to the user. To proceed, the user has to identify the words and type them into a web form. Although one word is generated by the IS, the other image contains a word that is unrecognizable by OCR software. By matching the first input with the generated (known) word, the system is able to identify the user as a human. By collecting the second (unknown) input, the system digitalizes the word through the human capability to recognize even obscure, distorted characters. Google acquired reCAPTCHA in 2009 and uses it to digitalize books on a large scale (Beaumont, 2009). Notably, the user does not know that she or he is helping to digitalize books because the task is per-

[10] www.google.com/recaptcha

formed implicitly in an activity that was already necessary. Another example of implicit work in an HCS is Duolingo[11]. By offering users the ability to learn languages for free, Duolingo leverages users' inputs to translate Wikipedia into different languages (von Ahn, 2013). Similar to the concept of implicit work, games with a purpose emerged as another class of HCSs (von Ahn & Dabbish, 2008). These games are computer games specially designed to leverage human skill to solve large-scale computational problems (von Ahn, 2006). An example of a game with a purpose is the ESP game[12], which attempts to label images on the Internet, e.g., for search engines. Two players that do not know and cannot communicate with each other cooperate to assign the same label to a random image. Because the best chance of scoring in this game is to label the image according to its content, the process typically produces accurate results (von Ahn, 2006). Players of the ESP game are motivated by their enjoyment of the game, not by its purpose of labeling images on the Internet. Altruism (Gonçalves et al., 2008) and ideology (Proulx et al., 2011) have been identified as other forms of motivation for voluntary contribution in HCSs and crowdsourcing in general. Because payment motivates contribution in many crowdsourcing applications, as in the aforementioned examples of iStockphoto and InnoCentive, monetary incentives can also be used to foster contribution in HCSs. A well-known example of a monetary incentive in HCSs is Mechanical Turk [13], which was launched by Amazon [14] in 2005. Mechanical Turk is a crowdsourced Internet marketplace that allows requesters to outsource micro-tasks (HCTs) to individuals

[11] www.duolingo.com

[12] www.espgame.org

[13] www.mturk.com

[14] www.amazon.com

for small payments (Buhrmester et al., 2011). The advertised micro-tasks include the cataloging of music, transcribing text, rating and recommending products, image tagging, filling out surveys, and writing in general. To facilitate the integration of human intelligence into any application, Mechanical Turk offers an Application Programming Interface (API) that allows external applications to access its marketplace. Ipeirotis (2010) reports that he observed over 6.5 million HITs on Mechanical Turk in the period from January 2009 to April 2010 from over 9000 requesters, with a total value of over half of a million USD.

1.3 Research Questions

The first research question addresses the content generation aspect of the content generation and consumption cycle. Payment might be a universal solution to foster content generation in crowdsourcing applications. However, monetary rewards strongly limit the potential application areas of crowdsourcing because they impose financial prerequisites. Therefore, Travel Safety relies on voluntary user contributions, which researchers generally attribute to users' intrinsic motivation (Yang & Lai, 2010). In particular, fun and ideology (Nov, 2007), in addition to altruism (Prasarnphanich & Wagner, 2009), have been identified as key drivers of content generation. Although the above examples show that the reliance on voluntary user contribution can lead to sustainable content generation and consumption cycles in crowdsourcing applications, it is also known that typically only a small fraction of users are active contributors. This phenomenon is widely referred to as free-riding behavior, and it is observed in Peer-to-peer (P2P) file-sharing systems (Adar & Huberman, 2000) and voluntary crowdsourcing applications (Huberman et al., 2009), including certain applications in the area of HCSs (Jain & Parkes, 2009). Although the substantial potential of crowdsourcing and HCSs is well established (Quinn & Bederson, 2009, Schulze et al., 2012, Yang et al., 2008b), one main challenge remains: establishing and maintaining a fruitful base of contributors. Recently, researchers in the area of crowdsourcing, HCSs and online communities have also been recognizing that psychological measures may be a powerful means of fostering contribution. Harper et al. (2010), for instance, noted that the use of social information can increase the number of user contributions. More specifically, social comparisons led MovieLens community members to rate more movies. In addition, evidence was found that messages urging users to visit discussion forums were most effective when the message compared the user viewing the message to another member. One such psychological measure to foster contribution is Social Normative Feedback (SNF) (Cialdini et al., 1991), which is known as one of the most powerful levers of behavioral change (Loock et al., 2011). Users may be confronted with IS-enabled feedback on the basis of their contributions (you versus others) and overall injunctive feedback such as “You are a great contributor. Keep up your excellent engagement”. This thesis investigates IS-enabled SNF interventions with regard to crowdsourcing and HCSs. The thesis focuses on the potential impact of SNF. The first research question is the following:

Research Question 1 *How does one foster sustainable contribution behavior in voluntary crowdsourcing applications?*

The second research question addresses the consumption aspect in the content generation and consumption cycle. To generate value for users, the travel risk information provided in the application has to enable users to make decisions based on that content. The content generation and consumption cycle will only be sustainable if the content is useful. If users do not perceive the information to be of high quality, crowdsourced content may not be consumed, which would inhibit usage and ultimately hinder content generation. This requires a high level of quality along with information and transparency about how it is presented (Lopes & Carriço, 2008). However, even though the quality of crowdsourced content can meet high standards (Lucassen & Schraagen, 2010), it is unclear how such content will affect the usage intentions of users of the application, especially in the case of travel risk information. Various studies have shown that crowdsourced content might generally not be perceived as credible or trustworthy (Kittur et al., 2008, Flanagin & Metzger, 2011) compared to content provided by known, established sources. One example is the ongoing controversy about whether it is acceptable to use references to Wikipedia articles in academia (Snyder, 2010). In the particular case of travel risk information, it seems reasonable to assume that the suitability of crowdsourced content is at least questionable. Furthermore, perceived information quality is known to be a key driver of system acceptance (Nicolaou & McKnight, 2006). This may also be the case in the context of a travel risk information application. Therefore, the second research question of this thesis is the following:

Research Question 2 *How does crowdsourced content affect the usage intentions of users of the application?*

1.4 Structure of Thesis

The remainder of this thesis is structured as follows. The research approach that was used to answer the above research questions is outlined in chapter 2. After introducing the design science paradigm and describing the setting in which this thesis was conducted, the chapter closes by describing how the design science paradigm was used in the given research setting. The following chapter 3 describes the development and implementation of Travel Safety. The chapter starts by noting the business need that was articulated by the project partner and led to the development of Travel Safety. Subsequently, the process of generating and selecting potential use cases for the design artifact is described. In addition, the main design decisions that guided the artifact development are discussed. Then, in chapter 4, the implementation of Travel Safety is described in detail. Chapters 6 and 5 present studies that address research questions one and two, respectively. Each study begins with a short summary of the addressed research question and subsequently provides the corresponding theoretical background. The research design and data collection are described for both studies followed by discussions of the respective data analysis and results. Then, we draw conclusions from the findings and outline our contributions to the research literature and practice. Finally, we note several limitations of both studies and suggest future research directions. The thesis is concluded in chapter 7, where we revisit our key findings and contributions to the research literature and practice. Finally, we summarize the limitations of our research and suggest future research directions.

2

Research Approach

This thesis follows the design science paradigm and attempts to advance the understanding of selected behavioral mechanics of crowdsourcing applications. This thesis addresses two central aspects of a functioning crowdsourcing system. This is performed by addressing the first research question: how does one foster sustainable contribution behavior in voluntary crowdsourcing applications? In addition, we address the second research question: How does crowdsourced content affect the usage intentions of users of the application? This chapter describes the research approach that was used to address the above research questions. In the next section, the design science paradigm is introduced. The following section describes the setting in which this thesis was conducted. The chapter closes with an outline of the chosen research approach, which describes how the design science paradigm was used in the given research setting.

2.1 Design Science in Information Systems

To investigate the design of sustainable voluntary crowdsourcing applications, this thesis leverages the design science paradigm, which is increasingly recognized as a fruitful approach in the IS domain (Fischer, 2011). By following the design science fundamentals of Hevner et al. (2004) and Peffers et al. (2007), an innovative artifact is designed to investigate a problem for a specific problem domain (Hevner et al., 2004). A research question is embedded in the design (Peffers et al., 2007).

IS are recognized as "tools for the recording, storing, processing, and dissemination of information designed to support groups of people acting together purposefully" (Checkland & Holwell, 1998). Accordingly, the IS discipline seeks to investigate the interplay between people, organizations, and technologies (Davis & Olson, 1985), whereas IS research "examines more than just the technological system, or just the social system, or even the two side by side; in addition it investigates the phenomena that emerge when the two interact" (Lee, 2000). Research in IS draws from behavioral science and design science because both paradigms are fundamental to the IS discipline (Hevner et al., 2004). The combination of behavioral science and design science in IS research has been widely discussed in the IS literature (Peffers et al., 2007, Nunamaker et al., 1990, Hevner et al., 2004, Walls et al., 1992). Given that the IS discipline encompasses both technologies and humans in organizations, "the design science paradigm seeks to extend the boundaries of human and organizational capabilities [...]" (Hevner et al., 2004). Although Baskerville (2008) state that design is a complex and creative human activity that arises in many different disciplines, in design science, "knowledge and understanding of a problem domain and its solutions are achieved in the building and application of a design artifact" (Hevner et al., 2004).

Fig. 2.1 shows the conceptual framework for understanding, executing and evaluating IS research and builds on the work in behavioral science and design science by Hevner et al. (2004). The framework positions IS research at the intersection of the environment, which consists of people, organizations and technology (Silver et al., 1995), and the knowledge base, which is composed of foundations and methodologies. The environment determines the problem space (Simon, 1996), which is articulated as the business need and ensures research relevance. Applicable knowledge of existing foundations and methodologies from prior IS research and other related disciplines provides rigor in IS research. IS research is conducted in two complementary phases that address the design science and behavioral science paradigms. Design science addresses IS research by building and evaluating artifacts specifically designed to respond to the identified business need. Behavioral sci-

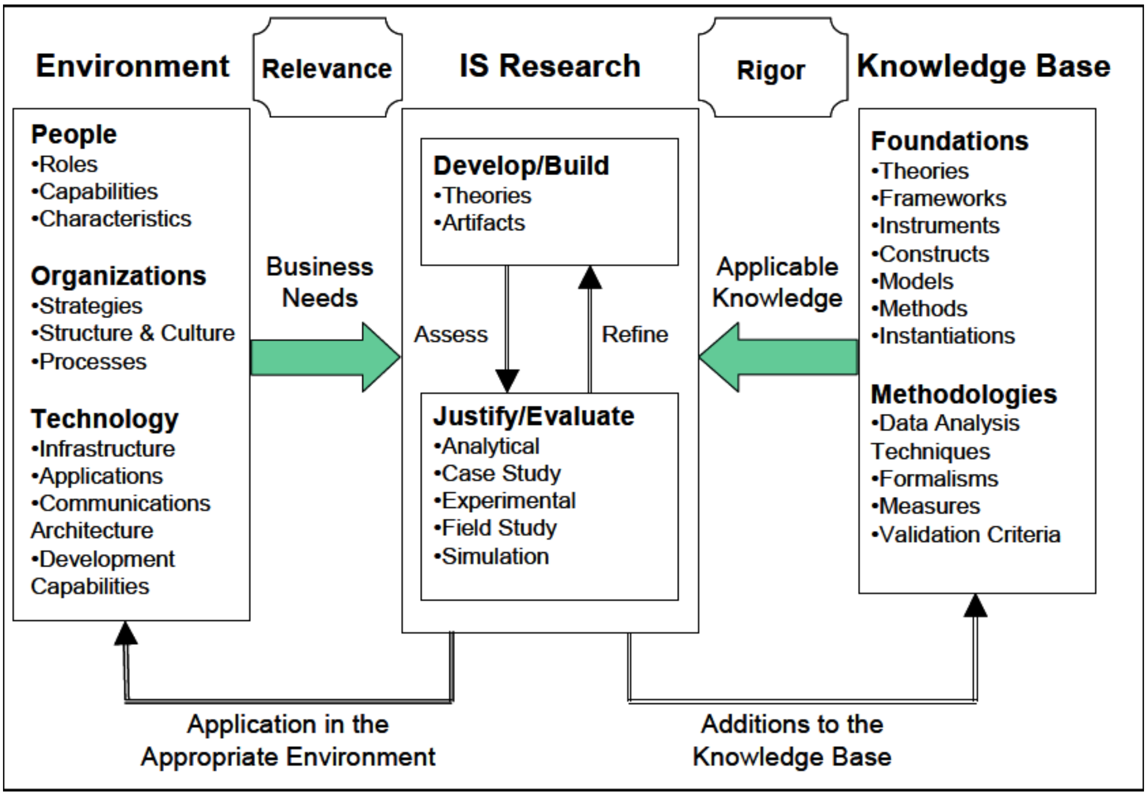


Figure 2.1: Conceptual IS research framework by Hevner et al. (2004)

ence attempts to develop and justify theories that explain or predict phenomena associated with the specific business need. The research is assessed through justification and evaluation to identify possible weaknesses, which are subsequently refined to improve the theory or artifact (Hevner et al., 2004). The two phases can be repeated multiple times. Because an IS that does not solve an existing problem or provide a theoretical contribution is not useful for the environment, it cannot add to the knowledge base or used for further research and practice. Hevner et al. (2004) argue that the contributions of behavioral science and design science have to be "assessed as they are applied to the business need in an appropriate environment" (Hevner et al., 2004). Accordingingly, contributions of the design cycle create additional knowledge that can be used in further research. Hevner et al. (2004) further provides specific guidelines on how proper design science in IS research should be conducted. Table 2.1 summarizes the seven guidelines by Hevner et al. (2004) derived from the “fundamental principle of design science research [...] that knowledge and understanding of a design problem and its solutions are acquired in the building and application of an artifact” (Hevner et al., 2004).

Guideline	Description
Guideline 1: Design as an Artifact	Design science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem Relevance	The objective of design science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design Evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.
Guideline 4: Research Contributions	Effective research must provide clear and verifiable contributions in the areas of the design artifact, verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
Guideline 5: Research Rigor	research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
Guideline 6: Design as a Search Process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
Guideline 7: Communication of Research	Design science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

Table 2.1: Design science research guidelines by Hevner et al. (2004)

Fig. 2.2 shows the nominal process model for performing design science research by Peffers et al. (2007). The model builds upon the above frameworks and provides a mental model for presenting and evaluating design science research in IS. The model is consistent with previous literature (Peffers et al., 2007). The design science process developed

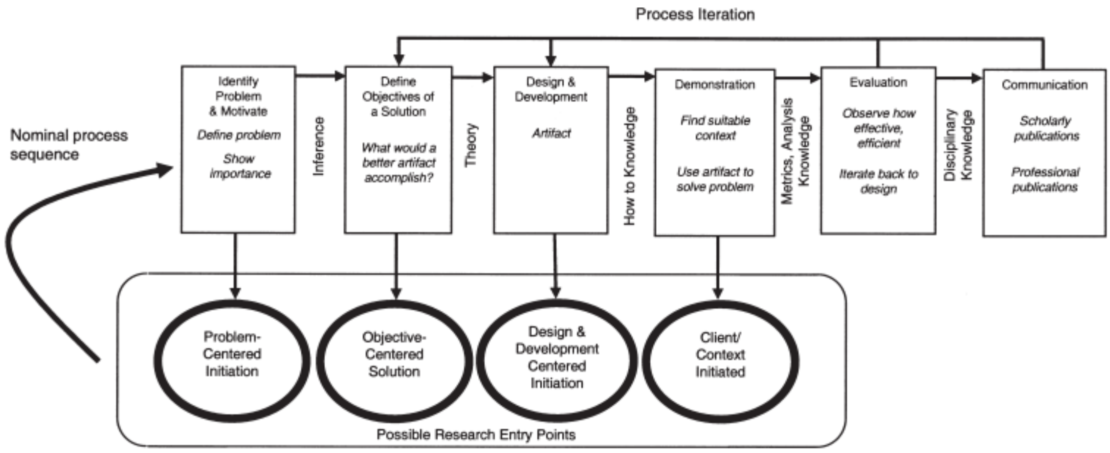


Figure 2.2: Design science research process model by Peffers et al. (2007)

by Peffers et al. (2007) consists of six steps: problem identification and motivation, definition of the objectives for a solution, design and development, demonstration, evaluation and communication. First, studies should identify a problem, one that is important and that justifies the value of a possible solution. Second, the objectives of the solutions should be defined to address the problem definition. Third, the IS artifact should be designed and developed. Artifacts can be constructs, models, methods or instantiations. Fourth, the artifact is demonstrated to show how it can be used to solve the stated problem. This can be accomplished with experimentation, simulation, case studies, proofs or other appropriate measures. Fifth, the artifact should be evaluated by observing and determining how well it solves the problem. Finally, the results of each step should be communicated to the relevant audiences. Although the nominal process sequence is detailed in consecutive steps, it provides multiple possible research entry points and, in line with the above IS research frameworks, allows for repeated process iteration.

2.2 Research Setting

The work detailed in this dissertation was conducted in the i-Lab at the Institute of Information Management at ETH Zurich. The i-Lab is a joint initiative of the University of St. Gallen, ETH Zurich, and partners from the insurance industry. The i-Lab fosters close collaboration with industry partners to identify business problems that form the foundation for relevant research. In turn, the i-Lab provides practitioners and academics with research findings based on a rigorous research methodology by publishing their results in academic journals and conference proceedings.

The research discussed in this thesis is based on collaboration with two industry partners. The first project phase of the industry collaboration that resulted in the research in this thesis was conducted with the insurance company Basler Versicherungen AG. The first phase includes identification of the business need, design objectives, use case development and design decisions in chapter 3 and the evaluation of usage intentions of crowdsourced content in chapter 6. The second phase of the collaboration was conducted with the automobile club and insurance provider Touring Club Swiss (TCS). The Travel Safety system described in chapter 4 was commissioned by TCS to be implemented by the development studio Ubique AG. Additionally, the evaluation of contribution behavior based on the field experiment presented in chapter 5 was conducted in cooperation with TCS. The field experiment, wherein TCS provided access to a large group of participants, was performed in a closed pilot phase of the project in Switzerland.

2.3 Research Approach Outline

This thesis follows the design science paradigm introduced above. This section describes how the design science paradigm was used in our research setting. Fig. 2.3 shows our research approach, which is based on a conceptual framework for understanding, executing and evaluating IS research and which builds on the behavioral science and design science work by Hevner et al. (2004).

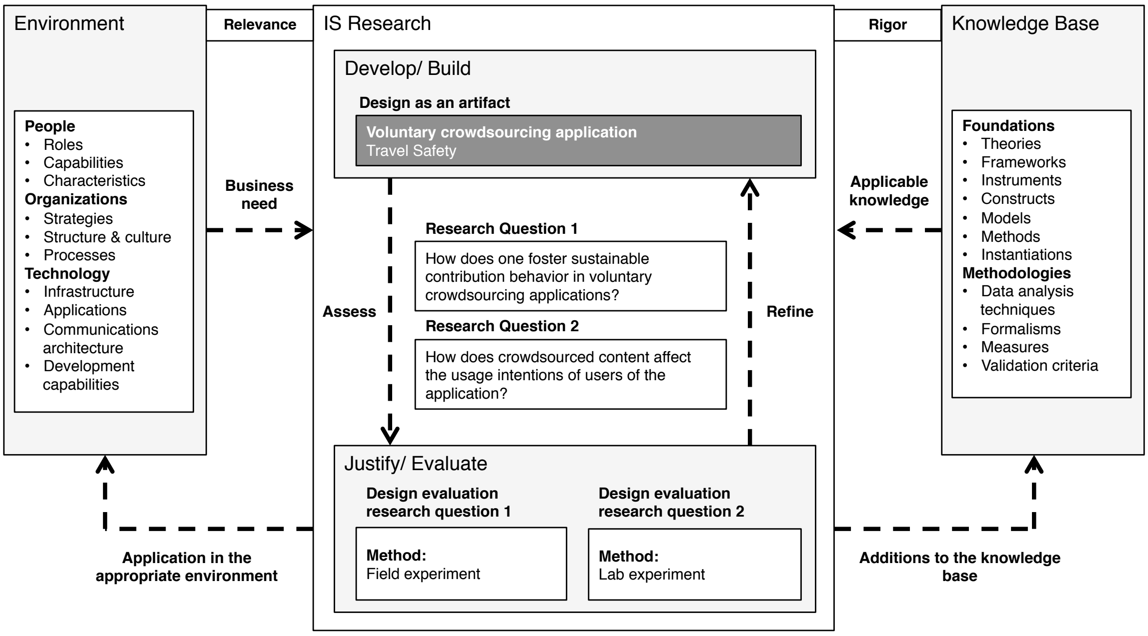


Figure 2.3: Research approach outline based on the IS research framework of Hevner et al. (2004)

As illustrated in fig. 2.3, IS research is conducted at the intersection of environments, which consist of people, organizations and technology, and knowledge bases, which include foundations and methodologies. The problem space is determined by the industry project partners and their business environment. The articulated business need ensures relevance and leads to the development of the design artifact, which is Travel Safety in the presented research. Drawing from the knowledge base, we evaluate the artifact by addressing two specific aspects relevant to the design of voluntary crowdsourcing applications, as presented by the research questions of this thesis. First, how does one foster sustainable contribution behavior in voluntary crowdsourcing applications? Second, how does crowdsourced content affect the usage intentions of users of the application? By evaluating the artifact, we attempted to advance the understanding of voluntary crowdsourcing applications to inform further artifact development and add to the knowledge base.

1. Observational	Case Study: Study artifact in depth in business environment Field Study: Monitor use of artifact in multiple projects
2. Analytical	Static Analysis: Examine structure of artifact for static qualities (e.g., complexity) Architecture Analysis: Study fit of artifact into technical IS architecture Optimization: Demonstrate inherent optimal properties of artifact or provide optimality bounds on artifact behavior Dynamic Analysis: Study artifact in use for dynamic qualities (e.g., performance)
3. Experimental	Controlled Experiment: Study artifact in controlled environment for qualities (e.g., usability) Simulation - Execute artifact with artificial data
4. Testing	Functional (Black Box) Testing: Execute artifact interfaces to discover failures and identify defects Structural (White Box) Testing: Perform coverage testing of some metric (e.g., execution paths) in the artifact implementation
5. Descriptive	Informed Argument: Use information from the knowledge base (e.g., relevant research) to build a convincing argument for the artifact's utility Scenarios: Construct detailed scenarios around the artifact to demonstrate its utility

Table 2.2: Design evaluation methods by Hevner et al. (2004)

Travel Safety is an instantiation of an artifact (Peffers et al., 2007) specifically designed to respond to an identified business need. Chapter 3 details the development of Travel Safety. Evaluation is a crucial step in the evaluation process, wherein the artifact demonstrates its ability to solve the stated problem (Hevner et al., 2004, Peffers et al., 2007, Baskerville, 2008). Hevner et al. (2004) provide guidelines for possible artifact evaluation methods. Accordingly, design artifacts can either be evaluated through observation, analysis, experiment, testing or description. An overview of these guidelines is given in Table 2.2. Travel Safety was assessed through two evaluation steps addressing research questions one and two, respectively. The first evaluation step, detailed in chapter 5, was performed in a controlled field experiment that focused on the implementation of Travel Safety. The second evaluation step, detailed in chapter 6, was performed via a lab experiment. Both evaluation steps were applied in an appropriate environment, i.e., where the business need was identified and where they can create additional knowledge that can be used in further research (Hevner et al., 2004). Applicable knowledge of existing foundations and methodologies from prior IS research and other related disciplines are outlined in chapters 6 and 5, respectively, which provide a rigorous foundation for the IS research process. In this thesis, the design iteration process is performed once. Contributions of the IS research cycle to the knowledge base are discussed in chapter 7. Finally, in accordance with Peffers et al. (2007), the results were communicated to the project partners and to the scientific community (Noyen & Wortmann, 2014a, 2015, 2014c,d,b, Noyen et al., 2015).

3

Artifact Development

In this chapter, the conceptual development of the design artifact Travel Safety is described. The following section outlines the underlying business need that was articulated by the project partner and led to the development of Travel Safety. The next section describes how potential use cases for the design artifact were generated and the particular use case Travel Safety was selected. Following that, the main design decisions that guided further artifact development are discussed.

3.1 Business Need

Businesses in many industries are continuously disrupted by IT innovations (Christensen, 1997). The transition into a connected, digital environment confronts businesses with the critical challenge of keeping pace with innovation to stay relevant and profitable. The difficulty in overcoming of this challenge has been widely discussed in the literature (Thomond et al., 2003, Corso & Pellegrini, 2007, Christensen & Raynor, 2003). In an evolving environment, businesses need to transform and integrate their traditional products into innovative digital services. This business need, articulated by the industry project partner, motivates the development of the design artifact described in this thesis. The project partner's aim was to gradually develop a sustainable mobile crowdsourcing application that leverages the network effects of the content generation and consumption cycle to drive high usage and ultimately provide a platform to engage existing customers and attract new ones. The solution space of the design artifact was constrained by specific design objectives. The overall use case of the artifact should be relevant to the insurance industry in general and specifically to the company's products. Therefore, the project partner decided that the core functionality of the application should be to warn users about risks in their environment. Furthermore, the overall use case of the application should be new so that the project partner can obtain an early mover advantage in the market. The functionality and content of the application should be easily integrated into a mobile platform for maximum consumer coverage. Providing the application should not expose the company to significant risks. The possibility of intentional exploitation for fraudulent activities and unintentional misinformation should inherently be avoided in the system design. Furthermore, the cost of operating the application should be minimal, particularly in terms of content management and editorial efforts. Nonetheless, the application and its content should be trustworthy. Finally, the implementation of the use case should be technically feasible in terms of the observability of the selected risk phenomena and the ability to dispatch warnings sufficiently early to allow users to react in a timely manner. The specific use case was selected based on an open innovation approach (Chesbrough et al., 2006), as described in the next section.

3.2 Use Case Development

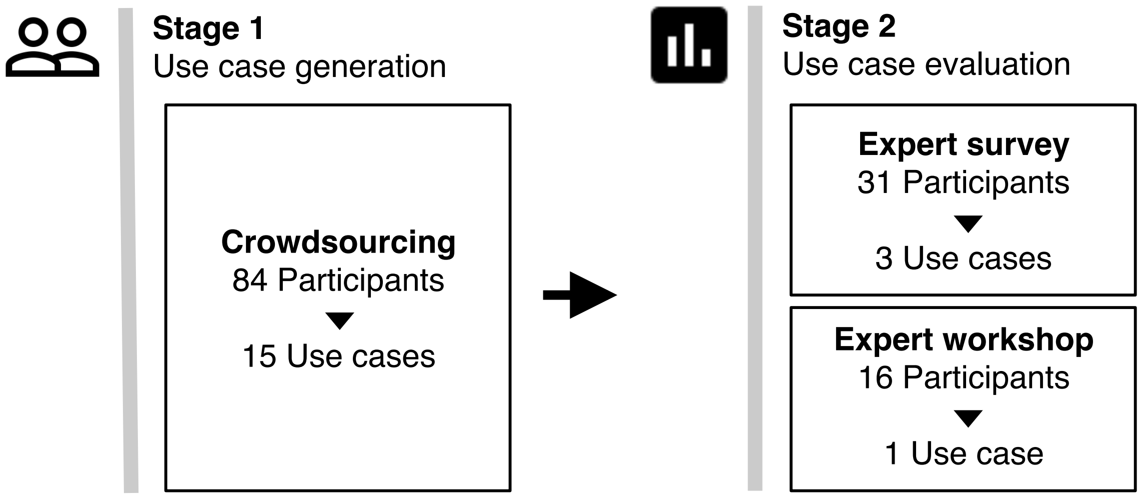


Figure 3.1: Use case development overview

The use case development process was divided into two stages, as depicted in fig. 3.1. The first stage attempted to find interesting themes and concepts for the development of a mobile crowdsourcing application. Because future user acceptance is critical for the success of the design artifact, a broad set of ideas for use cases were generated by potential users. Therefore, a crowdsourcing approach itself (in an open innovation context) was used to generate use case ideas for a mobile crowdsourcing application. While crowdsourcing is the act of outsourcing tasks to large and undefined communities in the form of an open call (Howe, 2006), the concept is widely applied to open innovation (Chesbrough, 2006), where large groups of individuals generate ideas for products and services. Because the development of a digital, connected application is not the core competence of the project partner, the open innovation approach was chosen because it is known to be a tool "which firms draw on research and development that may lie outside their own boundaries." (Chesbrough et al., 2006). After the crowdsourcing process was concluded, 15 of the most promising use case were selected for further consideration.

In the second stage of the use case development process, all 15 use cases from the use case generation stage were evaluated by insurance experts with a focus on the business need and design objectives. First, a panel of 31 insurance experts evaluated the use cases through an online survey, thus allowing evaluation of the rather large number of use cases based on the opinion of many experts. The three most promising use cases were selected based on this first evaluation step. Second, a smaller group of 16 insurance experts analyzed the three remaining use cases in a half-day workshop, specifically focusing on the business need and the design objectives. Finally, the project team selected the most promising use case based on all impressions gained during the use case generation and evaluation stages. The following sections describe both stages in greater detail.

3.2.1 Use Case Generation

The use cases that might qualify for implementation in the application were crowdsourced from a digital-friendly target audience. The crowdsourcing of use cases was conducted on a Facebook fan page. Facebook is a well-known and widely used social network. Users can create a profile on Facebook, connect with friends, communicate through text messages, and share pictures and video. Communication on Facebook is conducted either privately or publicly on a user's profile wall. Profile walls also exist on so-called "fan pages", where artists, athletes and companies present themselves to the Facebook audience. Facebook fan pages are interactive, i.e., users commonly write posts and comments on the pages and interact with the respective public entity and other Facebook users. The crowdsourcing of ideas occurred on such a Facebook fan page that was specifically equipped for this purpose. The choice of Facebook as a crowdsourcing platform was made for three reasons. First, Facebook is a sufficiently open platform, wherein anybody can sign up and participate. Second, many people already use Facebook and thus did not have to sign up for another platform. Third, using Facebook allowed the project team to easily communicate with respondents for clarification and further discussion of their ideas during the use case generation stage.

Fig. 1 in the appendix shows the Facebook fan page "RiskWhisp", where the crowdsourcing of ideas was conducted. "RiskWhisp" is a fictitious name that served as an example of an idea container for the "killer application for user-generated risk warnings". The 84 crowdsourcing participants were given the incentive of winning a tablet computer and a mp3 player for the best and second best contributions, respectively. To win one of the two prizes, participants were asked what they would like to be warned about, if they had a specific idea for the "killer application" and if they knew of any existing examples of such an application. Additionally, participants were asked to share a personal story in which the application would have been useful. To encourage discussion and elaboration of ideas, not only original contributions but also the improvement of others' ideas allowed the respective participant to be eligible to win a prize.

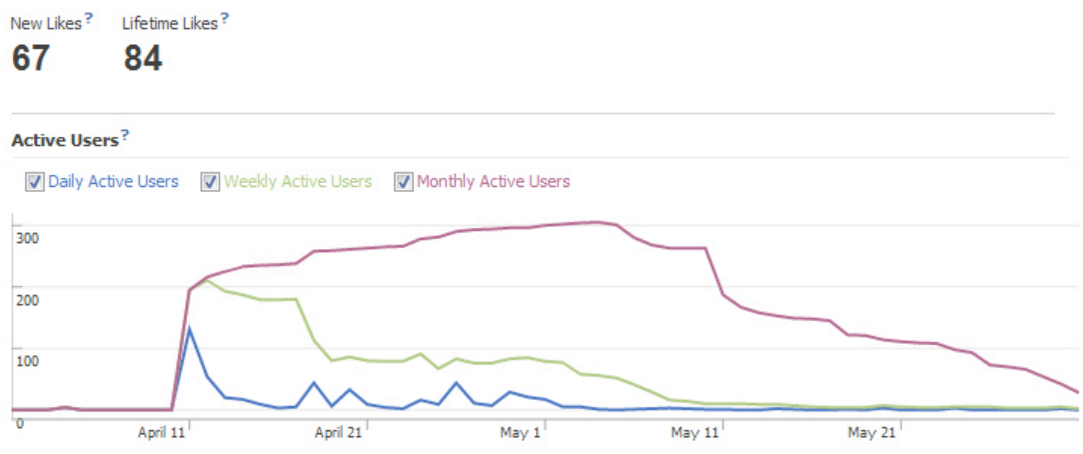


Figure 3.2: Facebook crowdsourcing usage statistics

Crowdsourcing was conducted from the 5th of April to the 29th of April in 2011. The numerous submissions expressed the respondents' interesting ideas, which were then refined and discussed among the other respondents. The project team asked additional targeted questions to encourage respondents to reflect on their ideas and further analyze them. Fig. 3.2 shows the usage statistics of the crowdsourcing Facebook page during the use case generation stage. The highest usage of the page was measured at the beginning of the stage, with a maximum of 120 daily active users. By the end of the crowdsourcing stage, the page was still regularly visited by certain participants. Fig. 3.3 shows the demographic distribution of participants by gender, age, country, city and language. The demographics resemble a typical digital-friendly potential target audience for an innovative application. Table 1 in the appendix gives an overview of the ideas generated during the crowdsourcing stage. All original contributions, comments and refinements of respondents were bundled into 15 use cases.

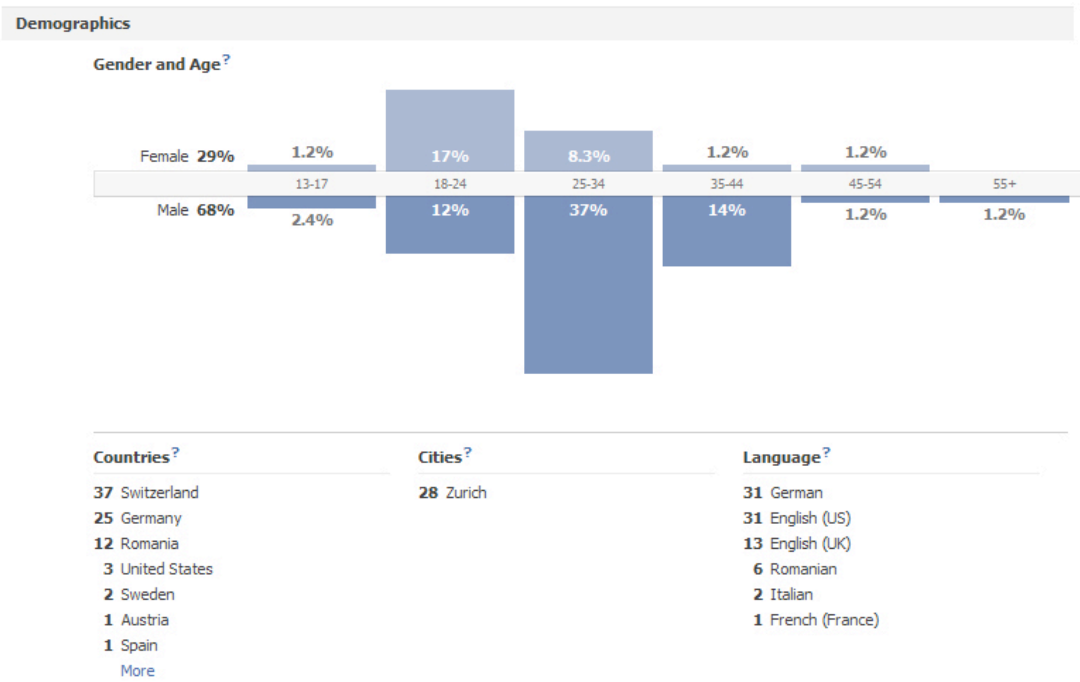


Figure 3.3: Facebook crowdsourcing demographics

3.2.2 Use Case Evaluation

In the second stage of the use case development process, the use cases were evaluated by expert groups. In the first phase of the use case evaluation stage, a group of 31 insurance experts evaluated the overall potential and novelty of each use case based on the business need and the design objectives. To ensure a thorough evaluation by a rather large group of experts, the evaluation was conducted by an online survey. In the online survey, the use cases were illustrated and described in detail to accurately reflect how the use case would function when implemented. After a short introduction, the experts were presented with the 15 use cases. The order of the presentation was random to prevent potential bias through loss of concentration over the course of the survey. The evaluation was divided into two parts. First, the experts were asked to rate the overall potential of each use case on a scale from one to ten. Second, the experts indicated whether the particular use case was new to them. Completion of the first part was mandatory to progress to the next use case. In the second part of the use case evaluation, the experts could gather arguments for or against a particular use case. Completion of the second part was optional and not necessary to progress through the survey. Fig. 2 in the appendix shows how the Travel Safety use case (2) was presented as an example. The upper part of the figure contains a description and illustration of the use case, the lower part contains the evaluation controls for the overall score and novelty of the use case. Finally, the experts could optionally enter additional ideas at the conclusion of the survey. The expert ideas for potential use cases included a radon gas warner, a dangerous rail crossing warning system, a mini firewall for smartphones, a radar trap warning, flood warning, an ozone and fine-particle pollution warning system, marten damage warning, renter damage warning, a housing brokerage, car theft warning, warning about insecure means of transportation, hiking danger warning and a witness search system. While most of the additional ideas were either technically too complex or would not address the business need, the marten damage warning was further considered but ultimately dismissed.

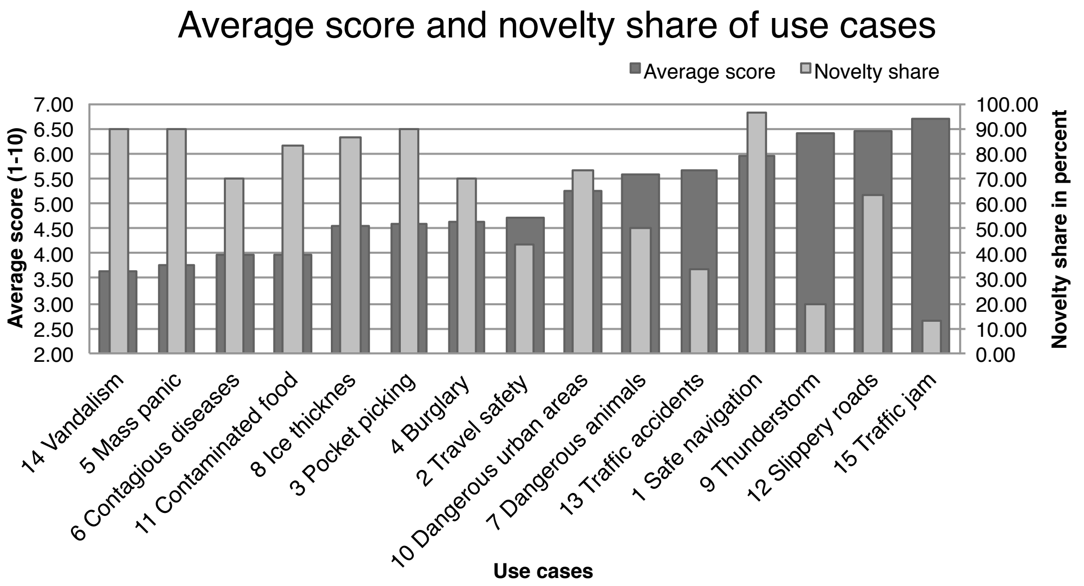


Figure 3.4: Average score and novelty share of use cases

The evaluation results of the online survey are presented in fig. 3.4. Each use case was assigned an average score and the novelty share as indicated by the participating experts. The use cases are sorted in ascending order by their average score from left to right. Average score bars are colored dark gray and correspond to the left scale. Novelty share bars are light gray and correspond to the right scale. The data clearly show that average score and novelty share tend to be inversely proportional to each other. A use case with a high average score generally has only a small novelty share, and a use case with a low average score exhibits a high novelty share. Deviations from this pattern, i.e., use cases that have high scores and novelty shares, indicate untapped potential for the implementation of the respective use case. The use cases “Slippery roads”, “Safe navigation” and “Dangerous urban areas” clearly stand out from the others in this regard. Furthermore, the most proven and familiar use cases in terms of practicality, such as “Thunderstorm” and “Traffic jam”, obtained a high overall score but yielded extremely low novelty value. When implementing such use cases, the competition by proven applications in the market could be substantial.

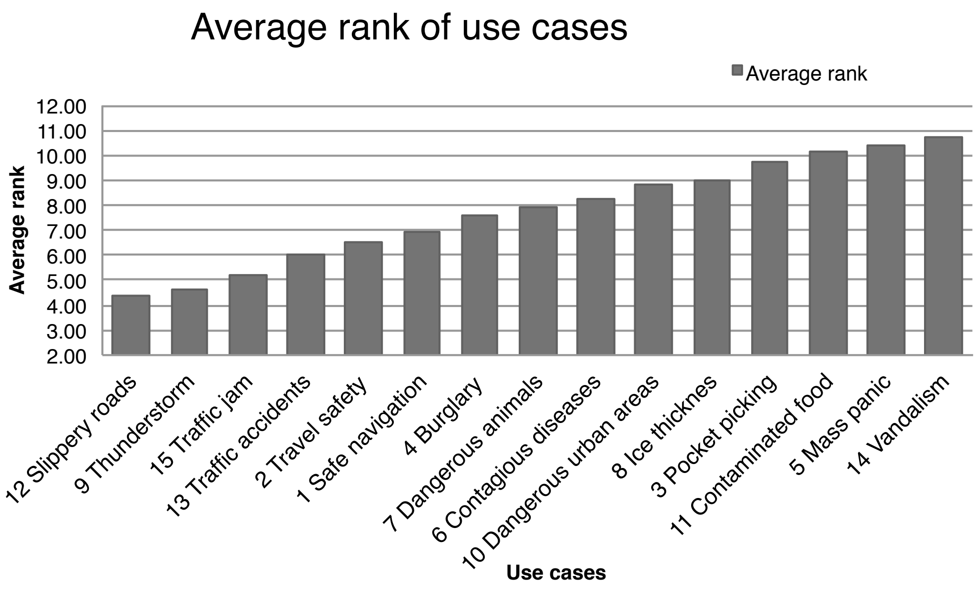


Figure 3.5: Average rank of use cases

After reviewing the 15 use cases, the experts were asked to order the cases using their personal preferences. Use cases were sorted into an ordered list from best to worst via drag & drop. Fig. 3.5 shows the average rank per use case, as indicated by the experts, sorted in ascending order from left to right. The use cases were ranked from one to ten; therefore, a higher expert preference results in a lower rank. The results of the ranking approximately correspond to the above average scores, as expected.

No	Use Case	Illustration	Description
1	Safe navigation		The navigation system in your car easily finds the fastest and cheapest route. The new application also suggests the safest route.
2	Travel safety		When traveling to foreign countries, you are often not sufficiently informed about the local safety conditions. The new application provides you with the most important information.
3	Pickpocketing		Pickpocketers often strike in large crowds. The new application puts a stop to pickpocketing activities by quickly warning other users.

Table 3.1: Proposed use cases for mobile crowdsourcing application

Based on the results of the only survey and the use cases' general fit to the business need, the project team decided to further pursue the three use cases "Pickpocketing", "Safe navigation" and "Travel safety", as illustrated in table 3.1. A full list of the original use cases is given in the appendix in table 1. The use case “Pickpocketing” achieved a high novelty score and was assessed to fit the business need well. The use case “Safe navigation” received overall high ratings. “Travel safety” received average to high rankings but was found to fit the business need exceptionally well.

In the second phase of the use case evaluation stage, the use cases were further refined and evaluated in a workshop by insurance experts. The goal of the conducted workshop was to reduce the collection of the three remaining use cases to one use case that would best fit the business need of the company. In the workshop, 16 insurance experts from various departments prepared elevator pitches that addressed the particular need for each use case, the presented approach, the expected benefits and potential competition. Elevator pitches are short presentations that are used to convincingly communicate business ideas in a short amount of time. Using the above categories, the independent group of insurance experts had to collect arguments for the realization of each use case. Finally, the elevator pitches were given in front of all workshop participants. After the four elevator pitches were given, the workshop participants voted for the use case with the highest potential for the company. The use case “Pickpocketing” was determined to be interesting, but incidents were not common enough to draw a sufficiently large audience. The realization of the “Safe route” use case was determined to be technically too complex and vulnerable to competition from technology companies.

Finally, the use case “Travel safety” was selected as having the highest potential because the travel theme provides certain compelling advantages. Traveling is a popular and frequently performed activity for private and business purposes and an omnipresent topic. People mostly associate positive experiences, such as relaxation, fun and adventure, with traveling. While travelers have increasing access to their smartphones, they often do not have access to their usual information sources such as TV and radio. Additionally, at the time of selection, there was little to no competition on the market for a “Travel safety” application.

3.3 Design Decisions

The above process resulted in the selection of Travel Safety as a use case for the design of a mobile crowdsourcing application. Therefore, based on the general outline of the use case, its core functionality is set to warn users about travel risks. In the following, design decisions that helped determine the artifact implementation are introduced and substantiated based on the above design objectives.

1. **Sourcing of external content**: As detailed in the section discussing the motivation for this thesis, voluntary crowdsourcing applications face the critical challenge of an initially unsustainable content generation and consumption cycle. This challenge is specifically addressed by this thesis; moreover, the challenge affects the design of Travel Safety in two ways. First, if the travel

risk content in the application is to be sourced from its users, it is unclear if they would contribute sufficient content to make the application valuable to other users. Second, it seems likely that crowdsourced travel risk content might negatively affect usage of the application. The design of Travel Safety considers both of the above problems by sourcing its integrated travel risk information from foreign offices on Twitter. This design decision mitigates the risk of an unsustainable content generation and consumption cycle for two reasons. First, Travel Safety is valuable to its users, even if they do not generate the content. Second, the provided content from known, reliable sources is unlikely to negatively affect usage of the application. At a later stage of development, Travel Safety may integrate original travel risk information generated by its users.

2. **HCS integration**: The externally sourced travel risk content from foreign office Twitter channels is typically of high quality and relevant for the purpose of Travel Safety. However, some of the tweets do not focus on travel risk information; these may be political statements or other irrelevant information. These unwanted tweets lead to information congestion and create a bad user experience. However, a computer system alone is unable to identify and filter out unwanted information because it does not understand the context of the tweets. Therefore, we integrated an HCS into Travel Safety to crowdsource this task to the users. Users of Travel Safety voluntarily contribute to improve the externally sourced content by filtering and classifying the content into risk categories.

3. **Geographical resolution**: Because most travel risks are geographically confined, users of Travel Safety will mostly be interested in travel risk information regarding their or others' (e.g., friends or relatives) current location or planned travel destinations. Because the integrated foreign office Twitter feeds mostly tweet about countries, as opposed to cities or otherwise defined geographical areas, travel risk information in Travel Safety is aggregated by country. Later design iterations of Travel Safety, particularly when users will contribute original travel risk information, might add higher layers of geographical resolution.

4. **Automatic warnings**: Travel Safety users will not permanently monitor the application. However, early information about potentially dangerous situations can help users react in a timely manner. Therefore, Travel Safety provides automatic travel warnings per country to increase users' personal safety. In particular, users are warned via Short Message Service (SMS) and/or push notification if the travel risk situation in a given geographical area changes. The user plays a passive role in this process and is not required to actively collect information.

5. **Static content**: Although the integrated Twitter content is near real time and dynamic, it is also transient. Therefore, Travel Safety complements the foreign office Twitter feeds with a static database of general travel risk information for each country. The data, which are sourced from an existing API, will not change for long periods of time; therefore, users always have access to the

most important general travel risk information that a traveler needs to know about a country.

6. **Mobile platform**: To ensure easy and ubiquitous access to travel risk information independent of a user's location, Travel Safety was developed as a mobile application. To reach a large target audience while minimizing development costs for the pilot phase, the decision was made to only implement Travel Safety on iOS. At the time of development, iOS was the dominant mobile platform in Switzerland (Y&R Group Switzerland, 2014), where Travel Safety was launched in a pilot phase. Further design iterations may be implemented for all relevant mobile platforms such as iOS, Android and Windows phone.

4

Artifact Implementation

Building on the above selected use case, this chapter specifies the implementation of the design artifact Travel Safety. Starting with a brief overview of its functionality, the following section focuses on the crowdsourcing component of Travel Safety. The next section provides an overview of all system components and the architecture of Travel Safety. Then, the backend and user-facing frontend implementation of Travel Safety are described in detail.

4.1 Travel Safety Overview

The primary purpose of Travel Safety is to provide timely global travel risk information and to dispatch automated travel warnings by allowing its users to register their travels and receive automatic travel warnings by country. Travel warnings are dispatched via SMS and/or push notification. To provide timely information from reliable sources, Travel Safety leverages the Twitter feeds of multiple foreign offices. This includes the US Department of State, the British Foreign Commonwealth Office, the German Auswaertiges Amt and the Swiss Eidgenoessisches Department fuer Auswaertige Angelegenheiten. All ten foreign office Twitter feeds were selected because they met the standard of providing relevant and timely travel risk information. A complete list of the included Twitter feeds is given in table 4.1. Travel Safety relies on Twitter as a source of broad and detailed information while attempting to provide this information in a clearly organized and contextually annotated manner. By automatically detecting the mentioned countries, each tweet in Travel Safety is placed on an aggregated per-country list; therefore, users can scroll through all tweets in which a specific country is mentioned. The language of each tweet is automatically detected so that the tweets can be filtered according to the user's language preference. Because there are numerous travel risks commonly associated with individual travel, Travel Safety indicates what type of risk a tweet is related to. Six predefined risk categories are available: terror, crime, political instability, health, nature and general. A full description of Travel Safety and its features is given in section 4.4.

While the integrated Twitter feeds provide highly valuable travel risk information, the structure and quality of the provided content varies amongst sources and tweets. Thus, the application faces two key challenges, which Travel Safety addresses by crowdsourcing user contribution via an embedded HCS. First, certain tweets are irrelevant for Travel Safety's purpose as an aggregator and distributor of travel risk information. Naturally, foreign offices do not exclusively tweet about travel risks. For instance, certain tweets cover state visits of politicians and thus do not affect individual travel. Other tweets may express political statements, which also do not affect travel risk. This results in a substantial amount of spam, i.e., non-travel risk information. Second, the information in the tweets is largely unstructured and does not allow for automatic classification into risk categories. Although it is rather easy to detect mentioned countries, it is very difficult to systematically detect the context of a tweet (i.e., the risk category) on the basis of less than 140 characters (Corvey et al., 2010, Kouloumpis et al., 2011, Pak & Paroubek, 2010). Travel Safety addresses the outlined challenges by embedding an HCS into the application's workflow. Although the tasks of computationally detecting a tweet's language and assigning it to the appropriate country list are performed by the IS with sufficient accuracy, reliably understanding the context of the tweet is beyond the scope of current computational natural language processing capabilities (von Ahn, 2013). In contrast, it is almost trivial for a human to interpret a tweet, classify it into one of six risk categories or mark it as irrelevant. For this reason, Travel Safety crowdsources the task via its integrated HCS.

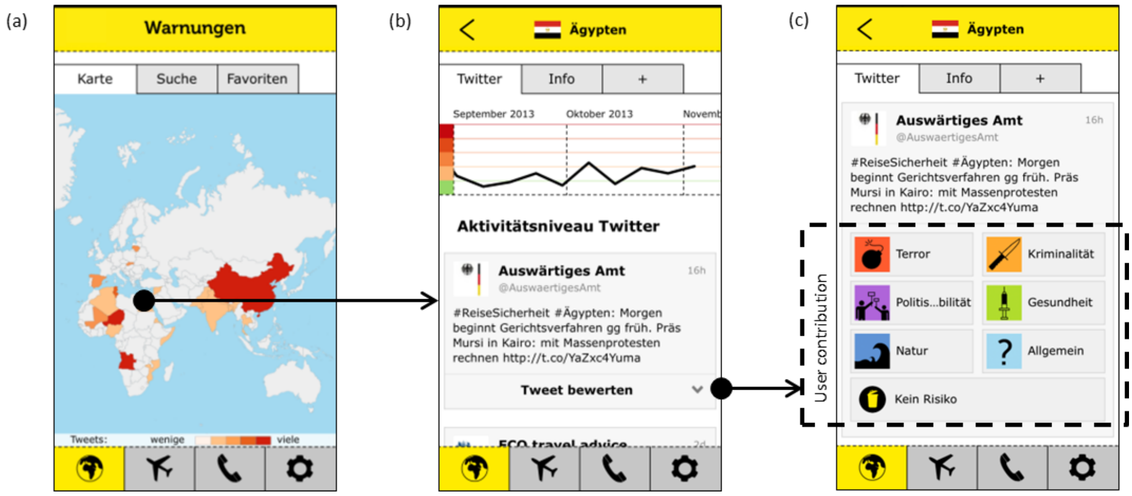


Figure 4.1: Travel Safety tweet classification HCT

Fig. 4.1 shows the HCS embedded in Travel Safety. Users navigate different countries on a travel risk heat map, which is color-coded according to the respective country's attention level, a risk indication metric further explained in section 4.3 (a). The darker a country appears on the map, the more tweets were recently submitted mentioning the country, thereby indicating awareness of foreign offices. The same indicator is visually resolved over time in the country detail screen (b). Below, users can scroll through all tweets mentioning the selected country. Once a user decides to tag a previously unclassified tweet, the classification screen (c) appears. Here, the user can choose one of six risk categories or mark the tweet as irrelevant. Quality control of user responses is ensured by statistical filtering responses. When a response is repeated by previously defined number of users, it is considered to be reliable.

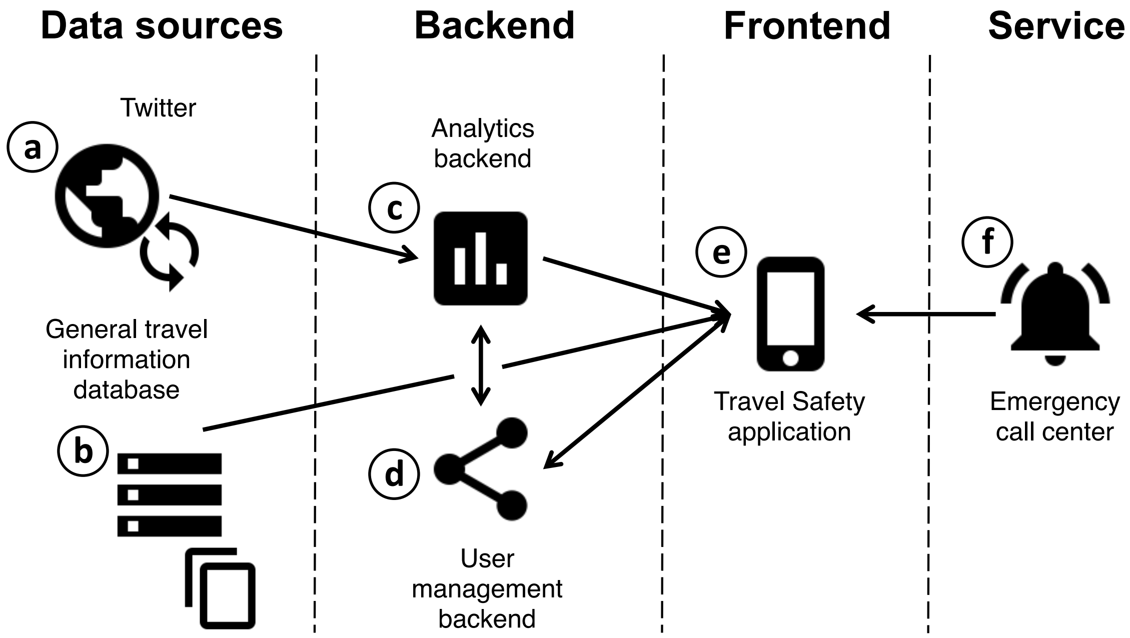


Figure 4.2: System components and architecture

In this section, a brief overview of all relevant system components and the overall system architecture is given. The system architecture is illustrated in fig. 4.2. The two data sources integrated into the application are displayed on the left. Twitter (a) provides travel risk information from multiple foreign offices. Twitter allows users to access tweets through their Representational State Transfer (REST) API. This allows developers to extend Twitter's services and integrate tweets into their applications. The database of general travel information (b) per country complements the highly current information from Twitter with editorial content. Two proprietary components provide backend services for Travel Safety. The Twitter analytics backend (c) continuously monitors the selected Twitter accounts of foreign offices through

Twitter's API, processes the data and provides it to the Travel Safety application (e). The user management backend handles user registrations and individual user preferences, manages travel warnings based on data from the Twitter analytics backend (c), receives tweet classification data from the Travel Safety application (e) and, in turn, feeds the data back to the Twitter analytics backend (c). The frontend of the system is the Travel Safety iOS application (e). The application directly obtains data from the general travel information database (b) and from Twitter (a) as well as through the Twitter analytics backend (c). Automatic travel warnings are triggered through the user management backend (d), Apple's push service or SMS (both omitted in the illustration). In case of an emergency, users have direct access to the emergency call center (f) from within the application. In the following sections, the analytics backend and Travel Safety application implementation are described in more detail.

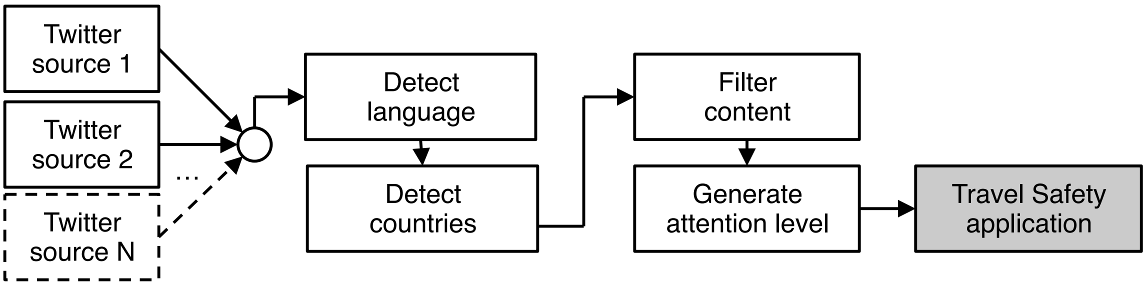


Figure 4.3: Data integration process

The main purpose of Travel Safety is to provide current, reliable and relevant travel risk information. Travel Safety is designed to source this information from Twitter instead of obtaining it from its users or expensive commercial providers. Fig. 4.3 outlines how the data obtained from Twitter are processed to meet the functional requirements of Travel Safety. The process is fully automated and does not require active human content management. Tweets are aggregated from foreign offices. A list of integrated Twitter channels is given in section 4.3.2. After detecting the language of each tweet, countries are identified by matching potential country names. Some of the irrelevant content in the Twitter sources is filter by excluding specific key words. For example, all tweets from foreign offices mentioning their country of origin are ignored. Finally, a metric called attention level is generated for each country. In the next section, attention levels and their purpose are explained in more detail.

4.3.1 Attention Level

Travel Safety uses a metric called attention level to provide an indication of travel risk. The general utility of the attention level is based on the assumption that the frequency of tweets about a specific country by the integrated foreign office Twitter channels is an approximate indicator for travel risk. Because foreign offices typically tweet about events that may expose travelers to various hazards, internal tests have shown that attention levels provide a good estimate. In other words, attention levels are an approximate indicator of how much attention the selected Twitter sources are directing at a specific country over time. However, there is room for improvement through identifying and removing irrelevant tweets. This is addressed by the HCT described in section 4.4.2.

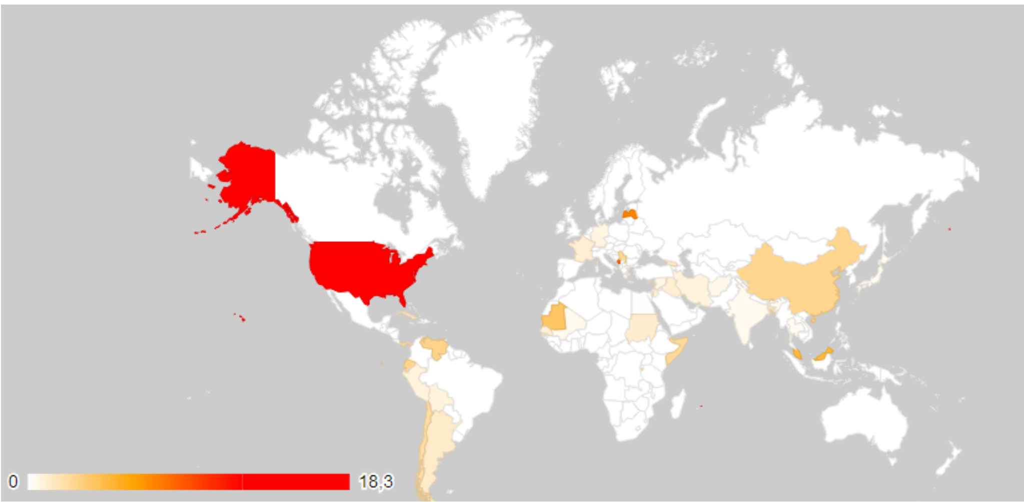


Figure 4.4: Global heat map example

Attention levels have three purposes in terms of the functionality of the Travel Safety System. Attention levels per county make it possible to generate a global heat map of current travel risk indications for each country. Fig. 4.4 shows an example of a heat map of attention levels. On the heat map, countries are color-coded from white to red depending on their current attention level. Countries with a low attention level appear white. Countries with a high attention level appear red. Furthermore, users have access to the attention level history of each country. In addition to the tweets, users can view this history in the form of a graph and obtain a quick overview of when the country was mentioned more or less often, thereby suggesting higher or lower travel risk, respectively, as shown in section 4.4.1. Finally, the attention levels for each country are the underlying metric used to issue automatic travel warnings, as shown in section 4.4.4. If the attention level of a specific country exceeds a predefined threshold, automatic travel warnings are issued to users who registered to receive notifications for that country. The travel warnings do not directly imply travel risk, but they notify users that an increased number of tweets about their country of interest have been published. For more detailed information, users can view the underlying tweets.

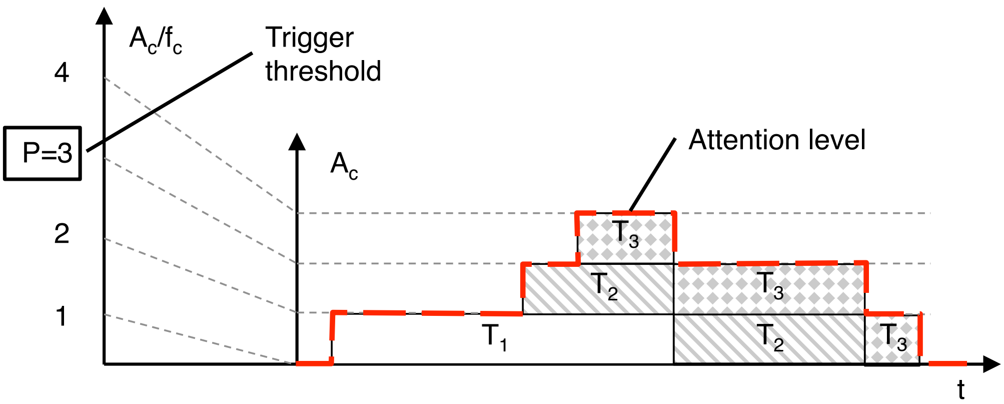


Figure 4.5: Construction of attention level

Attention levels for a specific country are determined by detecting tweets that mention the country, assigning an expiration duration window for each tweet and aggregating them with respect to their publishing date. Fig. 4.5 provides an overview of how the attention level for a country is determined. The expiration duration windows (three days) for multiple tweets with different publishing dates (T_1, T_2,T_3) are stacked on the time axis, resulting in continuous attention level for the respective country (A_c). The attention level of each country is normalized with a self-adjusting factor to appropriately trigger automatic travel warnings. Normalization is necessary because certain countries will be mentioned more often than other countries if an event occurs or for general travel advice originating from the Twitter sources. Travel warnings are triggered once a certain threshold for the normalized attention level per country is exceeded. In the next section 4.3.2, the selection of appropriate Twitter channels and attention levels is described.

4.3.2 Data Sources

A crucial requirement for the design of Travel Safety is relevant and reliable travel risk information. Today, one of the key sources of travel risk information is the Internet. Country-specific information can be accessed by individuals on the websites of foreign offices (Löwenheim, 2007). Twitter [1] gained substantial attention by providing information at unprecedented speed (Java et al., 2007). Twitter users collectively

[1]www.twitter.com

cover major events from multiple angles. Because Twitter spreads eyewitness stories so rapidly, mainstream media outlets follow Twitter and reports tweets or attached pictures as their news sources even if the information quality of the corresponding tweets cannot be validated (O'Connor, 2009). As social media gains importance and earns increasing attention from individuals, the media and government, in addition to foreign offices, have started to issue country-specific travel warnings on Twitter. To take advantage of this resource, the content in Travel Safety is exclusively sourced from foreign office accounts on Twitter. To find the appropriate sources, Twitter accounts (if available) of major, reputable organizations are considered. A full list of all of the Twitter channels used is given in the appendix. The Group of Twenty (Major Economies) (G-20) state foreign offices (table 2), European Union (EU) and Switzerland (3) and prominent international organizations (table 4) have been assessed in terms of how well the provided tweets could be integrated into Travel Safety.

All Twitter feeds have been rated on a scale of one to four. Accounts with a rating of one provide information that is sometimes related to traveling or travel risk. Accounts with a rating of two often provide information related to travel risk but not exclusively. Accounts with a rating of three mostly provide travel risk information. Accounts with a rating of four exclusively provide travel risk information and appropriately mention country names, i.e., mentions of countries are robustly detectable by the analytics backend. Twitter channels with a rating of three or more have been selected to be integrated into Travel Safety. An overview is shown in table 4.1, which lists the country name, the Twitter handle, the tweet languages, the number of followers, the

Country	**Twitter handle**	**Tweet language(s)**	**# Followers**	**# Tweets**	**Verified**	**Rating**	**Integrated**
Australia	dfat	English	11709	1658	no	3	yes
Austria	Minoritenplatz8	German	2703	1169	no	3	yes
Canada	DFAIT_MAECI	English	10106	2711	yes	3	yes
France	francediplo_EN	English	3337	1591	no	3	yes
Germany	AuswaertigesAmt	German	28639	1651	yes	3	yes
Israel	IsraelMFA	English	20693	4849	yes	3	yes
Japan	MofaJapan_en	English	5695	1434	yes	3	yes
Switzerland	travel_edadfae	German / French / Italian	877	721	no	4	yes
United Kingdom	fcotravel	English	33265	5615	yes	4	yes
United States	TravelGov	English	295834	2171	yes	4	yes

Table 4.1: Integrated foreign office Twitter representations (statistics as of 06.06.2013)

total number of tweets, whether the Twitter account has been verified as authentic by Twitter and the rating.

4.4 Travel Safety Frontend Implementation

This section describes the implementation of Travel Safety on iOS. Fig. 4.6 provides an overview of the central elements of the application frontend. The travel risk map (a) is the starting point of user navigation in the Travel Safety application. The attention levels of the different countries are displayed as a heat map and are color-coded from white to red. Countries with low attention levels are colored in white; countries with high attention levels are displayed in red. A legend for the color-coding is displayed at the bottom of the map. Buttons that are used to access a text search function to find countries without having to locate them on the map and a function to access countries saved as favorites are located on top of the map. The map provides a brief overview of the current attention levels generated from the mentions of countries in the tweets from the integrated Twitter sources. Selecting a country on the map leads the user to the dynamic travel risk feed (b) and general travel information (d) for the selected country. From the dynamic travel risk feed, users can access the tweet classification HCT (c). The main navigation bar at the bottom of the screen lets the user access additional functionalities of Travel Safety: Automatic travel warnings (e), emergency calling (f) and general settings (g). In the following sections, the central elements of the application are described in detail.

4.4.1 Dynamic Travel Risk Feed (b)

By selecting a country on the travel risk map (a), users can view the country's dynamic travel risk feed (b). This feed contains all of the tweets from selected Twitter sources mentioning the country. The list of tweets is scrollable; therefore, users can browse through the entire tweet history of a country. The historic attention level is displayed in the form of a graph on top of the Twitter feed. This automatically

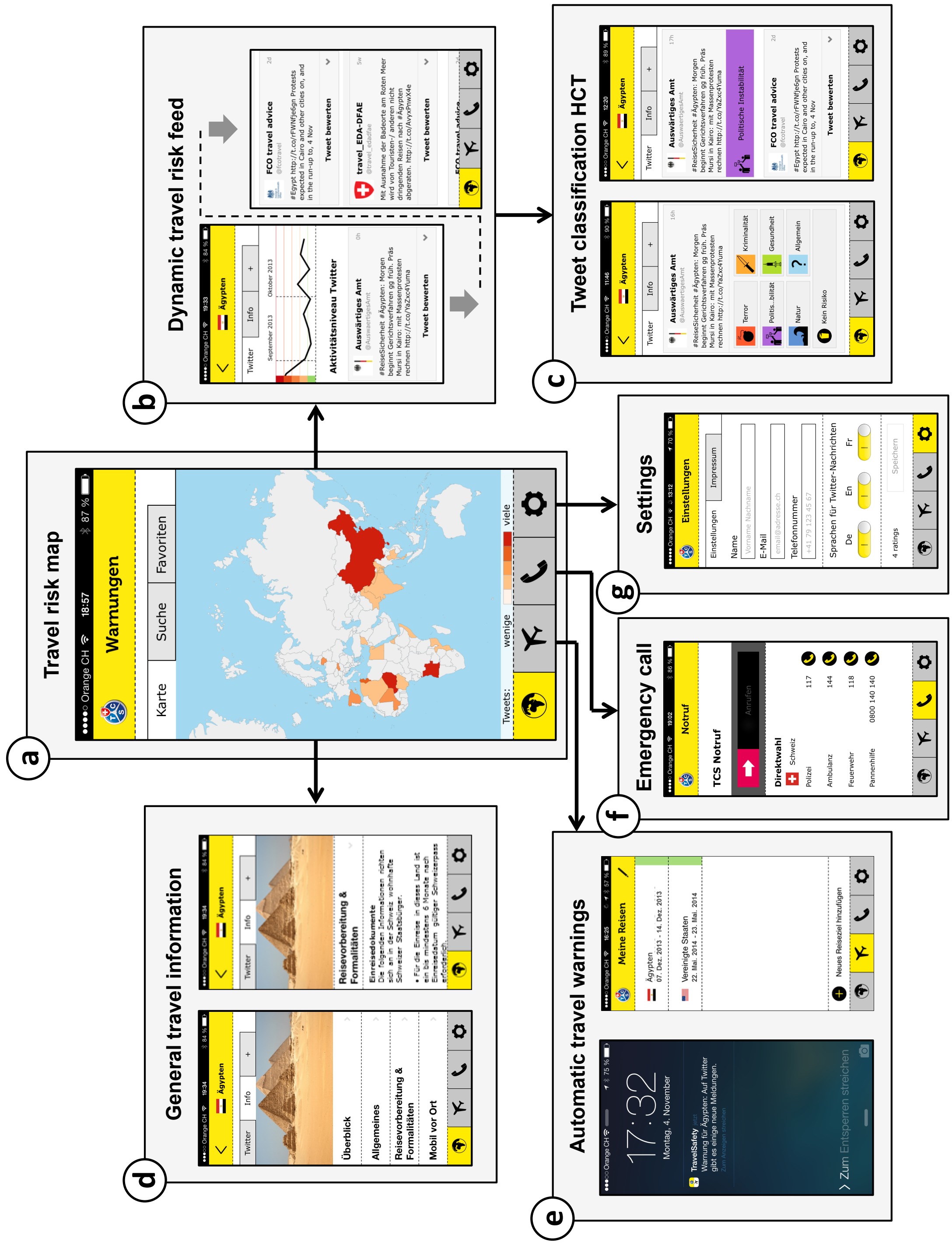


Figure 4.6: Travel Safety application frontend

adjusts to show the same time frame as the tweets displayed in the feed below. Users can view the attention level, or they can view general travel information for the selected country and add the country to their favorites list. The tweets provide detailed information about the current situation in the country. Each tweet contains the Twitter avatar picture of the respective source, the name and Twitter handle of the source, the age of the tweet and the tweet content, i.e., the message provided by the source. The tweets often contain additional links to websites that provide more detailed information than can a tweet itself as a result of its 140 character limitation. By selecting such links, users are directed to the respective web sites. At the bottom of each tweet, links allow the user to navigate to the tweet classification HCT (c).

4.4.2 Tweet Classification HCT (c)

Instead of allowing users to contribute original travel risk information in the application, Travel Safety allows users to classify existing tweets from foreign offices. This HCT generates valuable information that is used to improve the information quality in the application because irrelevant tweets can be filtered and because relevant tweets are augmented with contextual information that a computer system alone could not produce. Selecting the "classify tweet" button on each individual tweet in the dynamic travel risk feed opens the classification screen. Here, users can execute one of two actions. They can tag the tweet as "no risk", i.e., the tweet does not contain relevant travel risk information. If a user tags a tweet as irrelevant, it will disappear from her or his dynamic travel risk feed. In addition, the user's action is sent to the user management backend. If a certain number of users tag the same tweet as being irrelevant, it will automatically disappear for all users. If the user decides that the tweet is not irrelevant, she or he can instead classify its content into one of six predefined risk categories: terror, crime, political instability, health, nature and general. Following the selection of a risk category, the tweet is tagged and labeled according to the user's selection. Information about the classification is sent to the user management backend. Once a certain threshold for the same tags for a tweet by different users is reached, the tweet is labeled with this tag in all users' dynamic travel risk feeds, and additional classification is no longer possible.

4.4.3 General Travel Information (d)

Travel Safety provides general travel information on a country-specific level to complement the highly current but also transient information on Twitter. The integrated Twitter sources mostly report recent events; therefore, they are less suited to cover permanent situations in a meaningful way. Therefore, Travel Safety includes an existing database of travel information managed and edited by the application provider. The travel facts range from local emergency numbers to vaccination recommendations, drunk driving laws, addresses of embassies and visa requirements. The information is hierarchically ordered to allow for easy navigation.

4.4.4 Automatic Travel Warnings (e)

Travel Safety allows users to register their trips and receive automatic travel warnings by country via SMS and/or push notification. The second button on the left in the main navigation bar leads users to an overview screen of their registered travel destinations. Previously registered itineraries are displayed as a list with small indicators based on the color-coded current attention levels for the respective countries on the left side of the screen. User can edit previously registered itineraries by selecting them. New itineraries can be created with the "add new travel destination" button on the bottom of the screen. To register a new itinerary, users have to provide their travel destination, arrival date and departure date. If the attention level for the registered country exceeds the threshold in the specified time frame, users are notified via SMS or push notification. In the initial design artifact iteration, the distributed messages are not direct warnings of particular dangers but instead notify the user that there is an increased amount of tweets corresponding to their registered travel destination. To obtain more information about the actual situation, users have to access the application and read the tweets that triggered the warning.

4.4.5 Emergency Call (f)

The third button from the left in the main navigation bar leads the user to the emergency call screen. The emergency call functionality enables users to quickly react to dangerous situations. Users can contact the already existing emergency call center of the provider of the application by swiping the button on the upper part of the screen. The emergency call center is available 24 hours per day. To provide additional contact points in case of emergency during travel, Travel Safety displays local emergency numbers for the registered travel destinations. Users can initiate calls to local police, fire stations, and hospitals from within the application without having to look up the numbers.

4.4.6 Settings (g)

The settings screen can be accessed through the first button from the right of the main navigation bar. Users are asked to register with their full name, e-mail address and mobile number. Providing the mobile number gives users the ability to receive travel warnings via SMS, which can be useful if no data connection is available while traveling. On the lower part of the screen, users can select the languages of the tweets to be displayed in the application. The integrated Twitter sources provide German, English and French tweets. By deselecting a language on the settings screen, the user can filter tweets in languages that they do not understand. On the bottom of the settings screen, the individual tweet classification count of the user is shown. On the top of the screen, users can view the information about the publisher of the application.

5

Fostering Contribution Behavior

This chapter addresses the first research question of this thesis. The starting point of our research is the voluntary crowdsourcing application Travel Safety. The implementation of Travel Safety addresses the problem of an initially unsustainable content generation and consumption cycle by sourcing external content from foreign offices on Twitter. To improve the content, Travel Safety crowdsources the task of filtering and classifying tweets into different risk categories via an integrated HCS. In the HCS, users contribute on a voluntary basis. Although contribution through the HCS is not of vital importance to Travel Safety, a main challenge of any voluntary crowdsourcing application remains: fostering sustainable contribution behavior.

We propose and evaluate SNF (Cialdini et al., 1991), which is known as one of the most powerful levers of behavioral change (Loock et al., 2011). We evaluate it as a catalyst for user contribution in HCSs and voluntary crowdsourcing applications. Accordingly, we suggest that SNF may foster the formation of a fruitful HCS contributor base. More specifically, we investigate whether the number of human computation system contributors can be increased using SNF in the case of voluntary contribution and without monetary rewards. To evaluate our hypotheses, we conducted a field experiment with 768 participants that were users of Travel Safety. The remainder of this chapter is structured as follows. We review the theoretical foundation of our problem in the next section and develop a set of theoretical propositions. Additionally, we outline the research design of this study and describe the data collection process. Next, we discuss our data analysis and results. Then, we draw conclusions from our findings and outline our contributions to the research literature and practice. Finally, we note several limitations of our findings and suggest future research directions.

5.1 Theoretical Background and Hypotheses

5.1.1 Social Normative Feedback

A psychological theory based on social norms has been associated with the potential to promote sustainable contribution (Jenkin et al., 2011, Watson et al., 2010). Researchers from the domains of Social Psychology, Marketing, Economics and Social Science have studied social norms and have provided strong evidence that social norms affect human behavior (Heide & John, 1992, Kandori, 1992, Perkins, 2002, Reno et al., 1993). Cialdini (2001) theorizes that, particularly in situations involving uncertainty and ambiguity, individuals often base their decisions on social norms, i.e., they observe and emulate the behavior that seems to be common and socially acceptable. By providing a cognitive advantage, the reliance on social norms as a cue for decision making allows individuals to react timely but does not always produce optimal results (Milgram et al., 1969). However, acting on the basis of social norms allows for subtle yet effective manipulation (Goldstein et al., 2008).

To understand the effects of social norms on behavior, Cialdini et al. (1990) distinguish between two types of social norms in their focal theory of normative conduct: descriptive norms and injunctive norms. Descriptive norms entail information about what most others do. For instance, an early experiment by Milgram et al. (1969) demonstrated how a crowd of people at a street corner futilely staring at an empty spot in the sky caused unwitting pedestrians to do the same. The pedestrians' reliance on descriptive norms, as what many people do by staring at the sky, is revealed by their obvious arbitrary behavior to do the same. In contrast, injunctive norms entail information about "what most others approve or disapprove", thus adding a judgmental element to what is otherwise pure observation. Because descriptive norms can also trigger negative behavior, normative appeals should entail injunctive norms to optimize for a specific behavioral outcome of the recipients (Cialdini, 2003).

In addition to the omnipresent use of social norms in marketing campaigns targeted at affecting buying behavior, there are various applications of social norms in the context of promoting sustainable behavior such as encouraging guests to reuse towels in hotel rooms (Goldstein et al., 2008) or the discouragement of littering (Cialdini et al., 1990). Although feedback interventions may involve various forms of communication, including face-to-face communication, regular mail and telephone (Fujii & Taniguchi, 2006), there is growing evidence concerning the effectiveness of IS-enabled interventions, e.g., SNF can be used to encourage sustainable energy conservation (Loock et al., 2011) and e-bike commuting (Flüchter & Wortmann, 2014).

Because SNF has been shown to be an effective means of changing behaviors in various environments, we assume that SNF can also be used to activate users of HCS. However, although no one disputes that SNF has an imminent positive effect, there is little evidence of the longer term effects of SNF (Allcott & Rogers, 2012). Therefore, we hypothesize the following:

Hypothesis 1.1 *Exposure to IS-enabled SNF has a positive effect on short-term HCS worker activity.*

5.1.2 Motivation Theory

Motivation theory tries to explain the factors that drive people to perform specific actions (Ryan & Deci, 2000b). There is a widely accepted distinction based on various goals or reasons between two types of motivation: intrinsic and extrinsic motivation (Deci & Ryan, 1985, Vallerand, 1997). Intrinsic motivation "refers to doing something because it is inherently interesting or enjoyable" (Ryan & Deci, 2000a), or as Coon & Mitterer (2008) state, "intrinsic motivation [...] occurs when we act without any obvious external rewards. We simply enjoy an activity or see it as an opportunity to explore, learn, and actualize our potentials". In contrast, extrinsic motivation "refers to doing something because it leads to a separable outcome" (Ryan & Deci, 2000a), or as Brown (2007) puts it, "extrinsic motivation [...] refers to our tendency to perform activities for known external rewards, whether they be tangible (e.g., money) or psychological (e.g., praise) in nature".

The basic distinction between the two types of motivation can lead to divergent outcomes in terms of quality and performance (Davis et al., 1992).

The dominant theory used to explain motivation is Self-Determination Theory (SDT) (Deci & Ryan, 1985). According to SDT, motivation is determined by three essential psychological factors: autonomy, competence and relatedness (Ryan & Deci, 2000a). The theory suggests that individuals' perceived autonomy in fulfilling a task, their competence in being able to perform the task and their personal relatedness to the task have a positive effect on motivation. According to the theory, the attenuation or absence of any of these three factors leads to a decrease in motivation.

In the IS domain, the concepts of intrinsic and extrinsic motivation have been introduced by Davis in his Technology Acceptance Model (TAM) (Davis, 1985). Throughout the IS literature, TAM is widely used to explain behavior as well as behavioral intentions to use new technology (King & He, 2006, Yousafzai et al., 2007). The role of intrinsic and extrinsic motivation in TAM has been further investigated (Davis et al., 1992, Venkatesh & Davis, 2000). Davis et al. (1992) states that perceived usefulness represents a measure of extrinsic motivation, which is related to the expected outcome of using a system, and perceived enjoyment, which represents a measure of intrinsic motivation. Venkatesh (2000) identified playfulness and perceived enjoyment, which are both conceptualized through intrinsic motivation as antecedents of the perceived ease of use in TAM.

The interplay of intrinsic and extrinsic motivation has been a major research topic over the last four decades and remains the subject of ongoing discussion. Early research in social psychology has shown that extrinsic rewards can lead to subjective over-justification of achieved goals, thereby directly undermining intrinsic motivation (Chandler & Connell, 1987, Lepper et al., 1973). Accordingly, Amabile et al. (1976) found in a laboratory experiment that externally imposing deadlines on subjects playing a game undermined the intrinsic motivation to play. In more recent research, following a lengthy discussion in the academic literature (Wiersma, 1992), Deci et al. (1999) conducted a meta-analysis of 128 experiments to investigate the effects of external rewards on intrinsic motivation, concluding that most forms of external rewards undermine intrinsic motivation. This basic idea of extrinsic stimuli undermining intrinsic motivation later evolved to what is now known as motivation crowding theory (Frey & Jegen, 2001), which holds that extrinsic rewards may have an undermining effect on intrinsic motivation, thereby leading to below baseline post-reward behaviors. This effect has been demonstrated in numerous studies and in different settings and has been found to be relevant not only for financial extrinsic rewards but also for other external factors such as feedback (Ryan & Deci, 2000a).

According to the above research findings, which suggest effective crowding out of intrinsic motivation caused by extrinsic rewards, we assume that receiving SNF will have a negative effect on the intrinsic motivation of HCS workers to contribute. We thus hypothesize the following:

Hypothesis 1.2 *IS-enabled SNF has an immediate negative effect on the intrinsic motivation to contribute to an HCS.*

Whereas the first two hypotheses capture the short-term effects of SNF, hypothesis 1.3 focuses on longer term effects. In essence, hypotheses 1.1 and 1.2 predict a positive short-term behavior based on a decrease in intrinsic motivation, which is overcompensated by an SNF-induced increase in extrinsic motivation. However, on the basis of existing research, we also expect a negative effect of SNF on longer term behavior. Extrinsic motivation is known to be substantially more transient than intrinsic motivation (Bernstein, 1990, Dickinson, 1989). Assuming that the intervention driving the extrinsic motivation is not repeated in a timely manner, it is only a matter of time before the increase in extrinsic motivation vanishes as the reduced intrinsic motivation stays rather constant. By considering the idea that intrinsic and extrinsic motivation are antecedents of behavior (Ryan & Deci, 2000b, Vallerand, 1997, Venkatesh et al., 2003), we hypothesize the following:

Hypothesis 1.3 *Exposure to IS-enabled SNF has a negative effect on longer term HCS worker activity.*

5.1.3 Research on the influence of past behavior on future behavior

Although motivation crowding theory suggests that SNF might lead to undesired longer term boomerang effects, additional effects are likely to play a role in influencing an individual's behavior. In particular, behavioral researchers find that past behavior has an effect on future behavior (Aarts et al., 1998, de Guinea et al., 2009, Ouellette & Wood, 1998). In the context of SNF, the positive short-term behavioral response of an individual to an intervention may therefore also have a positive effect on long-term behavior.

Although the general effect of past behavior on future behavior is largely acknowledged, there is a large debate over the effect's underlying causal relationships, i.e., how past behavior affects future behavior (Ouellette & Wood, 1998). Indeed, research has focused on different mechanisms through which past behavior could be linked to future behavior. Habit, which is one possible mechanism, is the subject of intense research. There has been only limited research on habit in the IS domain (Bergeron et al., 1995, Karahanna et al., 1999, Limayem et al., 2001, Limayem & Hirt, 2003, Thompson et al., 1991, Tyre & Orlikowski, 1994, Venkatesh et al., 2003), but habit has been extensively studied in other disciplines (Limayem et al., 2007), especially social psychology (e.g., (Aarts & Dijksterhuis, 2000, Bargh & Ferguson, 2000, Sheeran et al., 2005, Verplanken & Orbell, 2003, Wood & Neal, 2007). Habit has been defined and measured in many different ways (Polites & Karahanna, 2012), and the consensus is that habit is a form of goal-directed automaticity. More specifically, habit is a “learned sequences of acts that have become automatic responses to specific cues, and are functional in obtaining certain goals or end-states” (Verplanken & Aarts, 1999), with goals defined as “desired, or anticipated, outcomes” (Aarts & Dijksterhuis, 2000). Based on these definitions, the strength of habit is defined by “the extent to which people tend to perform behaviors automatically” (Limayem et al., 2007). Therefore, research that relies on the frequency of (past) behavior as a proxy for habit should be treated with caution (Limayem et al., 2007). Although repetition is a prerequisite for habit formation, repeated occurrence is not “habit itself” because a non-automatic behavior can also be repeated frequently (Mittal, 1988).

Scholars are well aware that habit is only one particularly strong mechanism in the context of understanding the influence of past behavior on future behavior (Limayem et al., 2007). Thus, other mechanisms and concepts, such as routines or experience (Saga & Zmud, 1994, Tyre & Orlikowski, 1994), can be discussed as part of the continuum between “behavior is controlled by deliberative reasoning processes” and “behavior is performed automatically”. These concepts and mechanisms also rely on the fundamental consequences of repetition. With increasing behavior frequency, an individual gains more practice, which implies that their familiarity with the behavior tends to increase (Limayem et al., 2007). Ultimately, this leads to behavior that can be performed with less cognitive effort, even in the absence of automaticity. Thus, an activity can be performed quicker, in parallel with other activities, and with reduced attention overhead(Ouellette & Wood, 1998). This increase in processing fluency (Alter & Oppenheimer, 2009, Reber et al., 2004) is often perceived as a response to the corresponding stimulus and is not attributed to the process of repetition whereby the individual develops feelings of trust and confidence toward that stimulus (Alter et al., 2007, de Vries & van Rompay, 2009, Reber & Schwarz, 1999).

IS use is often embedded within larger, frequently practiced, higher level routines or task sequences (Polites & Karahanna, 2012). In the context of consumer applications, for example, surfing the web or clicking through applications on a smart phone is a behavior embedded in multiple daily habits such as commuting and leisure activities. Thus, the general use of an affected system can also become habitual (general IS habit). However, this does not necessary imply the development of specific IS habits on a task level (Limayem et al., 2007), e.g., always surfing the web while commuting does not necessarily imply that the same pages are being visited each time. Nevertheless, repeated behaviors, such as regular visits to a particular web page, foster conscious and habitual choice of use through increased familiarity and reduced cognitive effort (Polites & Karahanna, 2012).

The evidence in the literature suggests a positive influence of past behavior on future behavior on the basis of repetition; therefore, we assume that the positive short-term effects of SNF will also have a positive impact on longer term HCS worker activity. We thus hypothesize the following:

Hypothesis 1.4 *The intensity of short-term post-feedback HCS activity has a positive effect on longer term post-feedback activity.*

5.2 Research Design and Data Collection

5.2.1 Experimental Setup

To empirically test our hypotheses, we conducted a field study based on Travel Safety in cooperation with TCS, a major Swiss automobile club with more than 1.6 million members that offers a wide variety of products and services. The automobile club operates a large fleet of mobile mechanics that assist motorists in trouble in addition to providing insurance, training and holiday packages. Travel Safety is part of a larger initiative to launch the next wave of innovative products and services in the digital age. The cooperation allowed us to conduct a field experiment with a sufficiently large user base in a rather controlled environment. The field study occurred in a closed pilot phase in Switzerland. Most participants were selected by a major market research institute, and they were incentivized as part of a larger bonus point scheme. Bonus points were ultimately exchangeable for small monetary rewards. Because participants received bonus points only for trying out the application at their own discretion and for completing a survey, there was no direct incentive to classify tweets in the application.

5.2.2 Procedure and Measurements

To begin the field experiment, participants were approached with an invitation e-mail that provided a short description of Travel Safety and an installation link for their smartphones. The application was not deployed through a regular App Store because the evaluation of Travel Safety occurred in a closed pilot phase. We took care to ensure that the process of installing the application was flawless to prevent participants from departing the evaluation early. During the installation, all participants were randomly assigned to one of two experimental groups: one that would receive SNF messages and one that would not receive SNF messages. On the first startup of the application, participants were asked to provide their name and telephone number to be able to receive SMS. The application then provided a short introduction on how to use it.

Fig. 5.1 shows the experimental setup used in the field study. Participants familiarized themselves with Travel Safety for two to four weeks, depending on when they first installed the application. The familiarization with Travel Safety was necessary to ensure that the predominant effects of initial application usage had subsided and that most of the participants were in an essentially steady and regular mode of application usage. The experiment was composed of three phases following the initial familiarization. The first experimental phase established a baseline to investigate the effect of the feedback intervention. It started three weeks before each individual in the intervention group received an SMS with SNF and ended on the day before the intervention. The SNF message was sent to members of the feedback group. The message consisted of descriptive and injunctive feedback: "Thank you for using Travel Safety. You have classified x tweets, while the average user has classified 7 tweets. Therefore, until now, your contribution was limited." This message was provided in the form of an SMS in either French or German depending on the user's configured preference. The second phase of the experiment started with the feedback intervention and ended three weeks later. The third phase started immediately after the second phase and captured the longer term post-feedback activity over three weeks. To gather information regarding participants' intrinsic motivation, feedback and non-feedback participants were again randomly assigned to two conditions. The first group received the corresponding questionnaire before the feedback intervention (baseline phase group), and the second group received it after the feedback intervention (feedback phase group). This setup was enforced by the provider of the application in order not to overwhelm individuals and to minimize dropout rates.

The choice of the duration of phases in which we analyzed the behavior of the participants in our field study is not trivial. This duration should not be too short because certain effects might then not be effec-

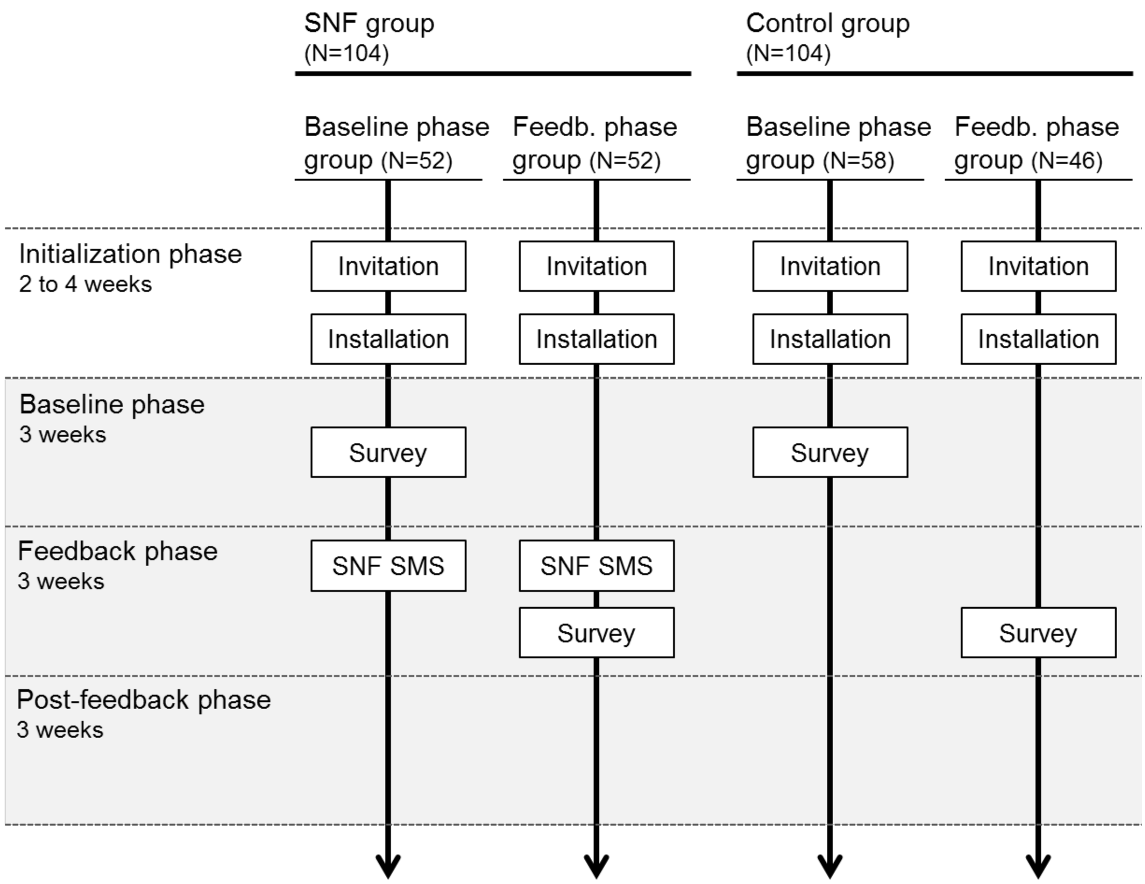


Figure 5.1: Experimental setup

tively and fully captured. In addition, the duration of the experimental phases should not be too long because the effects could be diluted if a time window that is too large is used. Based on existing studies in the context of SNF (Allcott & Rogers, 2012, Flüchter & Wortmann, 2014, Loock et al., 2011), we chose three weeks as the time frame for the experimental phases. Accordingly, user contribution was measured per user and phase on a binary basis. A user in the system counts as an active participator in a given phase if the user has tagged one or more tweets during that period. This measurement was chosen in accordance with our research focus, i.e., establishing a sustainable HCS contributor base. The same metric has been applied by other researchers to assess contribution activity (Gu et al., 2008).

Intrinsic motivation has commonly been measured by two different measures. In the so-called free-choice measure, the amount of time that participants spend on a target activity is measured when they are left alone after an experimental period and allowed the freedom to pursue either the target activity or alternative activities. An alternative approach to measuring intrinsic motivation relies on self-reporting (Vansteenkiste & Deci, 2003). Following the latter approach, we requested that participants articulate their intrinsic motivations (Yang & Lai, 2010), such as fun, ideology (Nov, 2007), and altruism (Prasarnphanich & Wagner, 2009), on a 7-point Likert scale. In this way, we found that intrinsic motivation goes beyond fun (Davis et al., 1992, Ryan & Deci, 2000a) and captures key drivers of human behavior such as selfless concern for the welfare of others (altruism) as well as overarching ideology. Similar operationalizations have commonly been used by researchers to assess intrinsic motivation on self-reporting scales (Epstein & Harackiewicz, 1992, Reeve & Deci, 1996, Tauer & Harackiewicz, 2004).

5.2.3 Sample and Demographics

Of the 768 participants who installed Travel Safety on their smartphones, 413 completed the voluntary online survey, which formed the basis for our understanding of intrinsic motivation. A total of 221 participants indicated that they were aware of how to contribute within the application. Of those, 210 participants exhibited low contribution behavior (less than seven classifications) and were thus included in the experiment. Two participants who obviously provided arbitrary answers to the survey (i.e., only strongly agree or strongly disagree was selected) were excluded from the analysis; therefore, 208 participants were included in the analysis. The low contribution cut-off value was determined on the basis of average contribution behavior in an internal pre-test. As part of the overall experimental setting, the cut-off value had to be approved by the provider of the application prior to the actual experiment. Again, the cut-off value was enforced by the provider of the application to avoid overwhelming participants who already exhibited active contribution behavior.

Table 5.1 shows the demographic data of the final sample. The sample consisted of 45% female and 55% male participants. A total of 19% of the participants in the sample were between 18 and 25 years of age. A total of 71% were between 26 and 54 years of age, and 10% of participants were older than 55 years of age. A total of 69% were employed full time, 21% were employed part time, and 10% were unemployed; most of the unemployed participants were students. 18% of the participants did not report their monthly income. A total of 5% earned 4,500 CHF or less; 21% earned between 4,500 and 7,000 CHF per month; 18% earned between 7,000 and 9,000 CHF per month; 17% earned between 9,000 and 12,000 CHF per month; 9% earned between 12,000 and 15,000 CHF per month; and 12% earned more than 15,000 CHF per month. Although the reported income seems rather high com-

Demographic	Value	Frequency	Percentage
Gender	Female	94	45.19
	Male	114	54.81
	n/a	0	0.00
Age	18-25	39	18.75
	26-54	150	72.12
	55+	19	9.15
	n/a	0	0.00
Employment	Full-time	145	69.71
	Part-time	41	19.71
	Unemployed	22	10.58
	n/a	0	0.00
Monthly income in CHF	Less than 4,500	11	5.29
	4,500 to 7,000	43	20.67
	7,000 to 9,000	37	17.79
	9,000 to 12,000	36	17.31
	12,000 to 15,000	19	9.13
	15,000 and more	25	12.02
	n/a	37	17.79
Education	Middle school	3	1.44
	Apprenticeship	64	30.77
	High school	44	21.15
	Matura (A- Levels)	25	12.02
	University	72	34.62
	n/a	0	0.00

Table 5.1: Field study sample demographics (n=208)

pared to an international standard, it is representative of Switzerland, where the study was conducted. A total of 1% of the participants completed middle school, 31% completed an apprenticeship, 21% finished the Swiss equivalent of a high school, 12% had the Swiss equivalent of A-Levels, and 35% had a university degree.

5.3 Analysis and Results

5.3.1 Descriptive Results

Individual active contribution to the Travel Safety project was measured throughout the field study. Participants contributed by solving the HCT of classifying tweets in the application. A participant counted as an active contributor if she or he classified at least one tweet. To provide an overview of the participants' contribution behaviors, we present some basic statistics in the following. Fig. 5.2 illustrates the share of active contributors over the course of the experiment. The share of active contributors per day varied between 0 and approximately 8% over all three experimental phases. The peak of active user contribution is clearly visible at the beginning of phase 2.

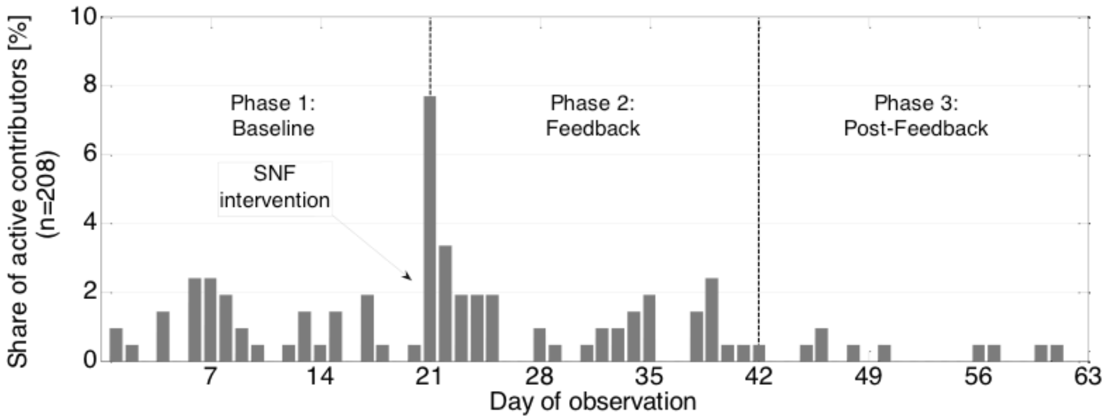


Figure 5.2: Share of active contributors in field study

In the first phase, 8.17% of all participants contributed by tagging 15.65 (SD = 27.16) tweets on average. The mean number of active contributors per day was 1.76 (SD = 1.70). The effect of the SNF intervention is clearly visible in the second phase of the experiment, in which 16.35% of all participants contributed by tagging 32.85 (SD = 78.71) tweets on average. The mean number of active contributors per day in this phase was 2.86 (SD = 3.58). In the third phase, 3.37% of the participants contributed by tagging 30.57 (SD = 71.73) tweets on average. The mean number of active contributors per day in phase 3 was 0.48 (SD = 0.60).

Overall, 8.17% of participants contributed during the baseline phase, and 66.35% used the system. In the feedback phase, 16.35% of participants contributed, and 41.83% of participants used the system. Finally, 3.37% of participants contributed, and 15.38% of participants used the system in the post-feedback phase. The obvious gap between use and contribution throughout the three phases is not unique to the system at hand; it is a well-known, general phenomenon. Travel Safety relies on a voluntary contribution mechanism and is hence subject to free-riding, an effect that has been observed in P2P file-sharing systems (Adar & Huberman, 2000), voluntary crowdsourcing applications (Huberman et al., 2009) and the area of HCSs (Jain & Parkes, 2009). Participants can use the application without obligation, i.e., they neither have to contribute nor pay for their use.

5.3.2 Influence of Social Normative Feedback on Short-Term Contribution

To understand the impact of the feedback message on participant activity and to test hypothesis 1.1, we used mixed-effect logistic regression analysis. This method was chosen for two reasons. First, our outcome variable was binary (tagging activity: yes/no), and second, we had multiple outcomes per subject (tagging activity in phases 1 and 2); thus, the subject variable was treated as a random effect. Two binary predictor variables were used in the model not only to test the first hypotheses but also to eliminate time and group effects, which could have potentially biased the results. The binary predictor variables referred to the phase of the experiment (feedback phase or baseline phase) and the experimental group membership of the participant (feedback or non-feedback). We then analyzed the tagging activity of 208 participants, 104 in the feedback and 104 in the control group, from which we obtained data that were considered valid for our analysis.

	Odds Ratio	Std. Err.	z	P>z
Main Effects				
Feedback Group (EG)	2.81	1.7	1.71	0.044
Feedback Phase (FP)	0.57	0.44	-0.73	0.232
Interaction Effect				
FG x FP	6.93	6.13	2.19	0.015

Table 5.2: Influence of SNF on short-term contribution (activity during feedback phase)

In regard to the influence of SNF on tagging behavior, we found support for hypothesis 1.1, as shown in table 5.2. A significant interaction effect between the phase and experimental group provided support for our hypothesis that SNF has a positive effect on tagging behavior. The corresponding odds ratio was 6.9. Thus, participants who received feedback are 6.9-times more likely to tag tweets in phase 2 than participants who did not receive feedback. In addition, the analysis revealed that the feedback group is in general significantly more active than the non-feedback group (odds ratio = 2.81). Furthermore, participants show a higher level of user contribution in the baseline phase than in the feedback phase (odds ratio = 0.57). However, this effect was not significant. Overall, the model was significant (Wald $\chi^2(3) = 25.57$, $p < 0.001$).

5.3.3 Influence of Social Normative Feedback on Intrinsic Motivation

To understand the impact of SNF on the intrinsic motivation of participants and rule out time and group effects, a two-way Analysis of Variance (ANOVA) was conducted. We analyzed participants' intrinsic motivation to contribute by tagging based on three items: fun ("I enjoy tagging"), altruism ("Tagging enables me to use my smartphone in a meaningful way to help others") and ideology ("Tagging enables me to be part of a community providing high quality travel information …"). All items were measured on a scale from 1 (completely disagree) to 7 (completely agree). Overall, these 3 items demonstrated good reliability, with a Cronbach's alpha of 0.87. To analyze intrinsic motivation, feedback and non-feedback participants were randomly assigned to two conditions. The first group received the survey before the intervention (baseline phase group), and the second group received it after the feedback intervention (feedback phase group). This setup was enforced by the provider of the application to minimize participant effort.

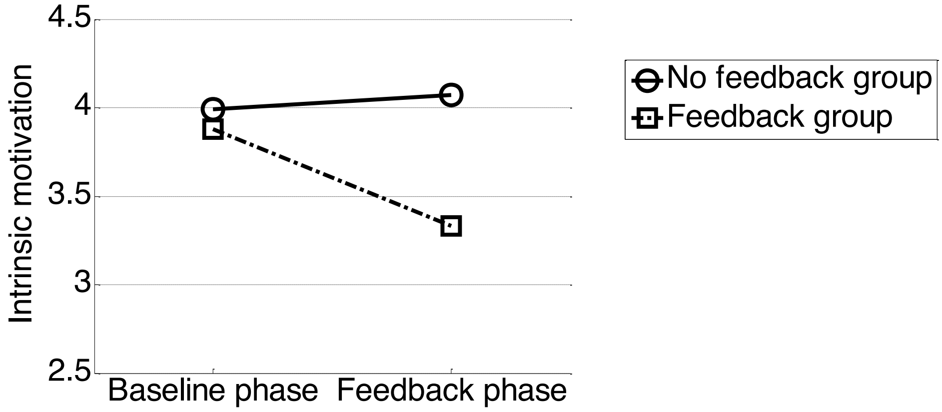


Figure 5.3: Influence of SNF on intrinsic motivation

A 2 x 2 between-subjects ANOVA was conducted for intrinsic motivation, with experimental group (feedback group, non-feedback group) and phase (baseline phase, feedback phase) as factors (cf. fig 5.3). The main effect of the experimental group on intrinsic motivation was significant, with $F(1, 206) = 5.45$, $p < .05$. Intrinsic motivation was higher for non-feedback group members ($M = 4.02$) than for feedback group members ($M = 3.61$). The main effect of phase on intrinsic motivation was not significant, with $F(1, 206) = 1.69$ and $p > .1$. The experimental group x phase interaction was marginally significant, with $F(1, 206) = 3.00$ and $p < .1$, thus providing evidence for1.2 . In the feedback phase, feedback participants' average intrinsic motivation ($M=3.33$, $SD=1.36$) was lower than that of non-feedback participants (M=4.07, SD=1.19). However, in the baseline phase, the intrinsic motivation of the feedback group (M=3.88, SD=1.46) did not differ from that of the non-feedback group (M=3.99, SD=1.20) on average. Finally, to check for additional bias, e.g., a fundamental shift in perception, we analyzed the extrinsic motivation to use the application ("The application is useful"). However, when repeating the ANOVA for extrinsic motivation, we did not find a significant interaction of experimental group and phase, with $F(1, 206) = 0.34$ and $p > .1$.

5.3.4 Influence of Social Normative Feedback on Longer Term Contribution

To understand the impact of SNF on longer term participant activity, we used a logistic regression analysis. Logistic regression was used because of the binary nature of our outcome variable (tagging activity in phase 3: yes/no). Two predictor variables were used in the model. A binary predictor variable referred to the experimental group membership of the participant (feedback or non-feedback). In addition, a second predictor variable referred to the number of active days for participants in phase 2 (feedback phase). Whereas hypothesis 1.1 focuses on participant activation, hypotheses 1.3 and 1.4 are related to the question regarding if activated participants also show sustainable longer term user contribution. We therefore only analyzed the tagging activity of 34 participants who contributed in phase 2 to see if they also contributed in phase 3 (post-feedback phase).

In regard to the influence of SNF on longer term activity, we found support for hypotheses 1.3 and 1.4, as shown in table 5.3. The main effect of the experimental group was significant, with an odds ratio of 0.07, thus providing support for our hypothesis that SNF has a negative effect on longer term tagging behavior. In addition, the analysis revealed that the number of active days in phase 2 has a significant influence on contribution probability in phase 3, thus providing evidence for our hypothesis that the intensity of past activity has a positive effect on longer term tagging behavior. Overall, the model was significant ($\chi^2(2) = 13.35$, $p < 0.01$).

	Odds Ratio	Std. Err.	z	P>z
Active Days in Feedback Phase	4.57	2.59	2.68	0.004
Feedback Group (FG)	0.07	0.11	-1.66	0.049

Table 5.3: Influence of SNF on longer term contribution (activity in post feedback phase)

5.3.5 Results

Hypotheses 1.1 and 1.2 are dedicated to short-term effects of SNF. Hypothesis 1.1 stated that exposure to IS-enabled SNF has a positive effect on short-term probability of HCS worker activity. In agreement with existing research on the effect of IS-enabled SNF interventions (Flüchter et al., 2014, Loock et al., 2011), we were able to confirm this hypothesis. Our mixed-effect logistic regression analysis showed a significant interaction effect between phase and experimental group, i.e., HCS workers were more likely to be active in the feedback phase if they received SNF. Although this effect is in line with existing research, we were surprised by the magnitude of the effect. However, the magnitude of the effect might be attributable to the chosen communication channel, i.e., we leveraged SMS as a very personal and direct manner of communication. Hypothesis 1.2 stated that IS-enabled SNF has an immediate negative effect on intrinsic motivation to contribute in an HCS. Our data indicate that intrinsic motivation decreases when SNF is applied; the two-way ANOVA shows marginal significance for the relevant interaction effect. Our findings lend further support to the crowding out theory in the context of HCS worker activity, i.e., the findings show that intrinsic motivation is at least partly replaced or reduced through external intervention (Frey & Jegen, 2001). However, we provide evidence that intrinsic motivation can be undermined on a broad basis. In contrast to existing IS-related field studies focusing on fun, we also incorporated altruism and ideology, showing that intrinsic motivation extends beyond fun.

Hypotheses 1.3 and 1.4 are related to longer term effects of SNF. Hypothesis 1.3, that exposure to IS-enabled SNF has a negative effect on the longer term probability of HCS worker activity, was also confirmed by our results. The applied logistic regression model was highly significant, thus providing evidence that the feedback group with diminished intrinsic motivation subsequently showed a reduced likelihood of contribution. Again, our findings agree with motivation crowding theory (Frey & Jegen, 2001) and existing research theorizing that intrinsic motivation is a key antecedent of behavior (Ryan & Deci, 2000b). To understand the effect of past behavior, hypothesis 1.4 was put forward. The hypothesis states that the intensity of short-term post-feedback

HCS activity has a positive effect on longer term post-feedback activity. Our analysis shows that participants in the field study were indeed more likely to contribute in the third phase of the experiment depending on the number of days that they had already contributed during the second phase. This is in agreement with the research presented above on the influence of past behavior on future behavior and habit. However, although the general importance of past behavior is well known, existing field research on (IS-enabled) SNF does not explicitly reflect this driver of behavior to the best of our knowledge.

5.4 Contributions and Conclusion

The first research question of this thesis covered the content generation aspect of the content generation and consumption cycle. Travel Safety relies on voluntary user contributions, which are generally attributed to users' intrinsic motivation (Yang & Lai, 2010). However, it is also known that typically only a small fraction of users are active contributors. This phenomenon is known as free-riding (Adar & Huberman, 2000, Huberman et al., 2009, Jain & Parkes, 2009). Thus, a final challenge remains: how does one establish and maintain a fruitful base of contributors. To address this challenge, we proposed SNF (Cialdini et al., 1991) as a catalyst for user contribution. To evaluate SNF as a means of fostering user contribution, we conducted a field experiment with 768 Travel Safety users.

5.4.1 Contributions to Research

In our research, we investigated the effect of SNF interventions on HCS worker activity. With our study, we attempt to contribute to the research fields of IS, social psychology, and, more specifically, crowdsourcing and HCS. In general, we hope to contribute to a deeper understanding of the effects of extrinsic motivation and the sources of intrinsic motivation, thus following the suggestions for research directions by Davis et al. (1992) and Gerow et al. (2012). By studying social norms and their direct and reproducible implications for IS, we also follow the call to research by Sidorova & Evangelopoulos (2008) by conducting an intensified investigation of psychological interventions in IS. In addition, we have tested the concept of SNF and investigated the effect of extrinsic feedback on intrinsic motivation in a real-world setting. This addresses a gap in existing social psychology research noted by Vansteenkiste & Deci (2003), who noted that various important studies that explore the impact of extrinsic interventions on intrinsic motivation have often been conducted in psychology laboratories, and "although this allows for the degree of careful control necessary to disentangle what elements [...] have what effects on intrinsic motivation, it does create a problem for ecological validity." Along the same lines, a significant body of extant IS literature discusses users' behavioral intention as the primary predictor of their IS usage (Bhattacherjee & Sanford, 2009). There is strong evidence of an intention-behavior gap in many fields of behavior (Ajzen et al., 2004); therefore, it remains unclear whether the dynamics reflected by intention-focused studies apply well in real-world environments. In light of these challenges, our study may contribute to a greater understanding of SNF-driven behavior beyond intentions.

5.4.2 Contributions to Practice

Our results provide evidence that SNF has a significant positive effect on imminent user contribution. However, we also provide evidence that SNF reduces individuals' intrinsic motivation to contribute, which in turn may eventually harm longer term contribution behavior. Therefore, in contrast to its popularity, we propose that SNF should in general be used with great care.

Our results may support practitioners who are interested in fostering HCS contribution by providing well-founded and empirically tested design principles. A first principle that can be derived from our work is that SNF is an effective means of fostering short-term HCS contribution. Therefore, practitioners can implement such a functionally if they are interested in short-term activity, e.g., to address pressing workload peaks. Second, we showed that SNF influences longer term activity. Practitioners should cautiously consider whether and under which circumstances SNF is an effective means of fostering long-term behavior because we also demonstrated effects that might lead to counterproductive outcomes. In particular, we have shown that SNF reduces individuals' intrinsic motivation to contribute, eventually harming longer term behavior. Therefore, SNF should in general be used with great care. In most cases, the longer term effects of SNF are simply unknown and unpredictable. Hence, the effects should be carefully monitored, and SNF interventions may have to be adjusted or abandoned if necessary.

5.5 Limitations and Future Research Directions

Various limitations should be considered during the assessment of our contribution. First, to provide a realistic and relevant setting, we conducted the field experiment in cooperation with the provider of Travel Safety. This cooperation allowed us to conduct our field experiment in a real-world context and provided a sufficiently large user base to conduct our experiment. However, the overall number of contributors throughout the different phases was low. While this phenomenon (free-riding) is well-known (Isaac et al., 1984), it obviously limits the generalizability of our results and necessitates further research and repetition on a larger scale. Second, the field study was confined to Swiss residents, and the measurement period was limited to a restricted time frame, which could further limit the generalizability of our findings. Third, even though there was no direct incentives to classify tweets in the application, participants received small monetary rewards for using the application at their own discretion and for completing the survey. It is unclear whether and how this might have influenced the results. Fourth, we also had to rely on self-reported data when measuring intrinsic motivation. It is thus possible that participants may have incorrectly completed the surveys.

Future research should continue to investigate the potential of SNF in the context of crowdsourcing and HCS. Such research may want to address specific types of HCS. A significant number of HCS rely on implicit work for solving a human computation task (e.g., reCAPTCHA and Duolingo) or offer monetary payments (e.g., Mechanical Turk). Therefore, we encourage further research to address how SNF could also play a role in these environments. For instance, it is quite possible that the performance of paid worker could be improved with SNF. Additionally, future research on how an internalization of extrinsic motivation might be achieved appears highly relevant. In addition, an exploration of how habits may be activated as a result of repetitive SNF and how this may mitigate the crowding out of intrinsic motivation should be very valuable. Finally, we encourage lab experiments to better understand cognitive processes and carefully disentangle countervailing longer term effects of SNF (the positive effect of repetition vs. the negative effect of crowding out).

6

Understanding Usage Intentions

The basis of our research is the voluntary crowdsourcing application Travel Safety. This chapter addresses the second research question of this thesis: How does crowdsourced content affect usage intentions of the application? Travel Safety was designed to source external content from foreign offices on Twitter and allows users to contribute via an integrated HCS. By engaging in a HCT, users filter and classify the externally sourced content. At a later stage of development, Travel Safety is intended to allow users of the application to contribute original content. However, it is unclear how crowdsourced content may affect the usage intentions of the application because it might generally not be perceived as credible (Kittur et al., 2008, Flanagin & Metzger, 2011) compared to content provided by known, established sources. In particular, in the case of travel risk information, the suitability of crowdsourced content seems questionable. Therefore, in this chapter, a lab experiment performed to investigate the effect of information source on users' intentions to use the application. In particular, we compare the effects of the integrated official content (from foreign offices) with unofficial content (from crowdsourcing) based on Twitter messages. Specifically following their call for research, we adopt and extend a research model by Nicolaou & McKnight (2006), which helps us to investigate the effect of the information source on Perceived Information Quality (PIQ) and its impact on usage intentions. The remainder of this chapter is structured as follows. In the next section, we present the theoretical background for our work and develop our hypotheses. Furthermore, we outline the research design of this study and describe the data collection process. Next, we discuss our data analysis and results. Then, we draw conclusions from our findings while outlining our contributions to the research literature and practice. Finally, we note several limitations of our findings and suggest future research directions.

6.1 Theoretical Background and Hypotheses

PIQ is known to be an important driver of system acceptance (Nicolaou & McKnight, 2006). Therefore, we build upon PIQ as a key construct to explain how information source (official and unofficial) affects Intention to Use (ITU). To further base our research on existing knowledge, we extend an established research model that helps us to investigate the effect of information source on PIQ and its impact on usage intention. To build upon an established research model, we conducted an intensive literature review by searching six scholarly databases (Science Direct, Proquest, EBSCOhost, ACM, Wiley Inter Science, SpringerLink, and Google scholar). These databases cover the most relevant MCS and MIS journals, books, conference proceedings, and practitioner sources. The identified literature can be categorized into three domains: tourism, risk management and IS. All three domains identify trust and risk as essential concepts that play vital roles in the interplay between perceived information quality and usage intention (cf., for example, Reisinger & Mavondo (2005), Earle (2004), McKnight (2002)). Another approach that investigates trust on social media, which is similar to our research, incorporates the elaboration likelihood model (Pee, 2012). The elaboration likelihood model describes the persuasive effect of messages on their recipient (Petty & Cacioppo, 1986). However, in contrast to application areas of the elaboration likelihood model, such as advertising messages (Petty & Cacioppo, 1986) and health care interventions (Angst & Agarwal, 2009), the main purpose of travel risk information is not persuasion in the sense of changing someone's attitude. Therefore, we instead base our research on an established, more general research model that explains PIQ on data exchanges (Nicolaou & McKnight, 2006).

6.1.1 Research Model

After examining various PIQ-related definitions, Nicolaou & McKnight (2006) define PIQ as representing cognitive beliefs about the favorable or unfavorable characteristics of the currency, accuracy, completeness, relevance, and reliability of information (Nicolaou & McKnight, 2006). This definition comprehensively covers different aspects of PIQ in the literature. Building upon the Trusting Beliefs (TRU) component of the trust concept typology of McKnight & Chervany (2002), TRU means one believes that the other party has beneficial characteristics and implies favorable perceptions about the other party (e.g., the party is honest, has integrity and keeps commitments; the other party is benevolent and responsive to the partner's interests; or the other party is competent, in that they have the ability to perform tasks required by the partner) (Nicolaou & McKnight, 2006). Nicolaou & McKnight (2006) further define Perceived Risk (RSK) as the degree to which one believes uncertainty exists about whether desirable outcomes will occur. This definition includes part of a broader risk concept discussed by Sitkin & Pablo (1992), capturing outcome uncertainty, outcome divergence likelihood, and extent of undesirable outcomes. ITU stems from the Theory of Reasoned Action (TRA) literature (Hill et al., 1977), as exemplified by research on TAM (Davis, 1985).

Nicolaou & McKnight (2006) combine the fundamental concepts of PIQ, RSK, TRU and ITU for the first time. Their research model is based on several hypotheses concerning the relationships among PIQ, TRU, RSK and ITU. In the following, we briefly recapitulate hypotheses H3 to H7 from Nicolaou & McKnight (2006). The PIQ of the application (DeLone & McLean, 2003, Boritz, 2004, Lee et al., 2002, Wang & Strong, 1996, Bovee, 2004) will positively influence the TRU in the application (McKnight & Chervany, 2002, Bhattacherjee, 2002, Gefen et al., 2003, Jarvenpaa et al., 2000). Furthermore, the PIQ will negatively influence the RSK (Sitkin & Pablo, 1992, Gulati & Gargiulo, 1999). In addition, the RSK of using the application will negatively influence the ITU (Jarvenpaa et al., 2000, Sitkin & Pablo, 1992, Pavlou, 2003, Keil et al., 2000). In contrast to RSK, TRU will positively influence ITU (Gulati & Gargiulo, 1999, Luhmann, 1979, Morgan & Hunt, 1994). Moreover, TRU will negatively influence RSK (Jarvenpaa et al., 2000, Pavlou, 2003, Pavlou & Gefen, 2004, Bakos & Brynjolfsson, 1993). The fundamental research model by Nicolaou & McKnight (2006), with our additional hypotheses that are developed in the next section, is depicted in fig. 6.1. In our case, the presented tweets are information stimuli that are all valued by the individual. The tweets are combined into one coherent perception of information quality (PIQ) that affects ITU and that is indirectly mediated by RSK and TRU. The unobservable state of ITU is turned into the observable response of actual system usage.

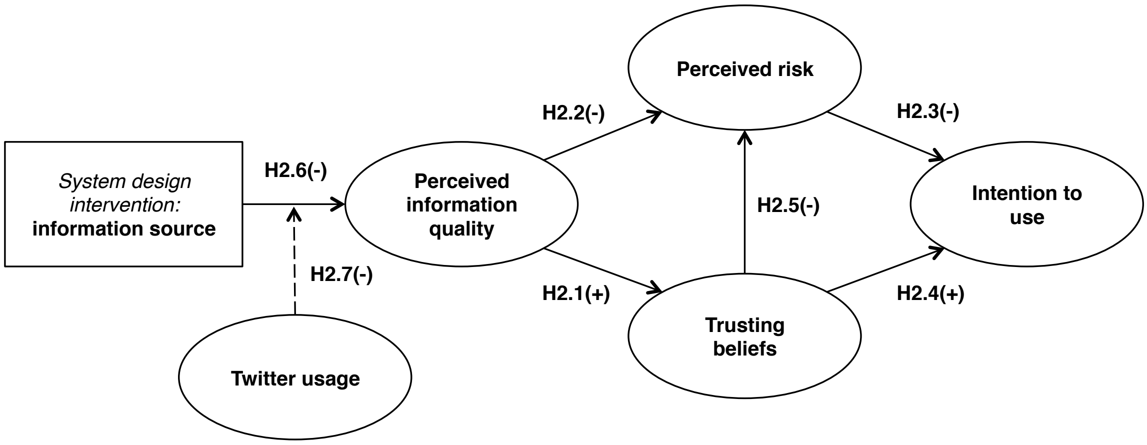


Figure 6.1: Research model and hypotheses based on Nicolaou & McKnight (2006)

6.1.2 Hypotheses

We attempt to understand the effects of the information source corresponding to Twitter messages containing travel risk information on individuals using a travel risk application providing such tweets to users. We identified PIQ, RSK and TRU as determining factors for how the information source may ultimately affect ITU. To obtain a thorough understanding of the relationships among these relevant constructs, we adopted the research model of Nicolaou & McKnight (2006). Our hypotheses are outlined in the following. The model by Nicolaou & McKnight (2006) was primarily developed in the context of Business-to-Business (B2B) inter-organizational systems. However, their argument is also based on evidence from the Business-to-Consumer (B2C) domain. To demonstrate that the model can be adapted to our context without loss of validity, we test the model in our setting and extend it by further examining the effects of our experimental manipulation.

Building on the trusting belief component of the trust concept typology developed by McKnight & Chervany (2002), Nicolaou & McKnight (2006) showed that in an inter-organizational data exchange, PIQ will positively influence trusting beliefs in the exchange provider. They found that PIQ positively influences TRU as a unitary construct that is composed of honesty, benevolence and competence (Nicolaou & McKnight, 2006). First, they argue that because PIQ entails positive information traits, such as accuracy, it should increase TRU integrity in the exchange provider. They based their argument on a study by Giffin (1967) and suggested that an audience trusts a speaker who provides credible information. Second, they argued that PIQ should increase TRU benevolence because PIQ reflects timeliness and responsiveness to the organization's needs (Goodhue & Thompson, 1995). This argument is based on evidence that benevolence relates to responsiveness McKnight (2002) in the sense that the exchange provider shows a commitment to providing helpful information (Gefen & Govindaraiulu, 2001). Third, they argued that PIQ should positively influence TRU competence because PIQ reflects the accuracy, reliability and correctness of the information source. This argument is framed in an organizational context, but it does not seem to lose its validity in a consumer context. Thus, we hypothesize the following:

Hypothesis 2.1 *Perceived information quality will positively influence feelings of trust of the application.*

Comprising a broader risk concept discussed by Sitkin & Pablo (1992), Nicolaou & McKnight (2006) define RSK as the degree to which one believes uncertainty exists about whether desirable outcomes will occur, thereby capturing outcome uncertainty, outcome divergence likelihood, and extent of undesirable outcomes. They argued that PIQ should lower RSK by reducing uncertainty regarding the outcomes of the data exchange. Furthermore, high-quality information would allow one to conduct the exchange in a controlled matter, and PIQ traits such as accuracy, currency and relevancy would lead to a mitigation of risk regarding the exchange. Although Nicolaou & McKnight (2006) argued from an organizational viewpoint, the same reasoning should hold true from a consumer perspective. Thus, we hypothesize the following:

Hypothesis 2.2 *Perceived information quality will negatively influence the perceived risk of the application.*

Direct determinants of Intention to Use

Nicolaou & McKnight (2006) built upon IS and the management literature by suggesting that risk perception will decrease the willingness to engage in risky behavior (Sitkin & Pablo, 1992, Keil et al., 2000). They argued that using the data exchange is a risky behavior because such a process may or may not proceed as expected; thus, a higher perception of risk would lead to a lower intent to use the exchange. They further based their argument on several studies. Sitkin & Weingart (1995) reported that low perceived risk causes decision makers to make riskier decisions. Studies from the B2C domain have shown that perceived risk negatively affects the intent of consumers to transact with web vendors (Jarvenpaa et al., 2000, Pavlou, 2003). Users of Travel Safety have to accept some risk when using the application because the information it provides may affect their decisions in critical situations. This may lead to positive or negative outcomes. As Nicolaou & McKnight (2006) previously argued from the consumer perspective, we can be confident that the same line of reasoning is valid in our context and thus hypothesize the following:

Hypothesis 2.3 *Perceived risk will negatively influence intent to use the application.*

Based on the argument of Nicolaou & McKnight (2006), TRU will have a positive influence on ITU because they address the competence, benevolence and honesty of the data exchange provider. Nicolaou & McKnight (2006) based their argument on several B2B studies from the IS, management and marketing literature but also drew from findings in the B2C domain. Trust has been identified as a success factor for the adoption of inter-organizational systems (Bensaou & Venkatraman, 1995) because it reduces opportunism, conflict in a relationship (Zaheer & Venkatraman, 1994) and uncertainty about the partner (Gulati & Gargiulo, 1999, Luhmann, 1979). Morgan & Hunt (1994) found that trust increases the commitment in relationships and decreases the propensity to abandon them. In the B2C domain, trust has been found to positively influence ITU of e-commerce platforms Gefen et al.

(2003). Again, the argument from the B2B perspective seems to be transferable to the consumer domain. Thus, we hypothesize the following:

Hypothesis 2.4 *Trusting beliefs will positively influence intent to use the application.*

Relationship Between Trusting Beliefs and Perceived Risk

Nicolaou & McKnight (2006) found that TRU negatively influences RSK in an inter-organizational data exchange. A portion of their argument is based on evidence from the consumer domain. Jarvenpaa et al. (2000) demonstrated the influence of TRU on RSK in a web store, and Pavlou (2003) and Pavlou & Gefen (2004) found the same relationship in the context of online auction platforms. In the B2B domain, trust has been found to decrease risk perception (Bakos & Brynjolfsson, 1993, Bensaou, 1997) and increase risk taking in relationships (Mayer et al., 1995). Furthermore, Nicolaou & McKnight (2006) argued that risk is similar to uncertainty, which is known to be reduced by trust (Gulati & Gargiulo, 1999, Morgan & Hunt, 1994, Bensaou & Venkatraman, 1995). The idea that trust reduces the perception of risk when conducting a transaction seems to be applicable both in an inter-organizational context as well as in the consumer domain. Thus, we hypothesize the following:

Hypothesis 2.5 *Trusting beliefs will negatively influence perceived risk.*

Antecedents of Perceived Information Quality

Nicolaou & McKnight (2006) studied control transparency and outcome feedback as antecedents of PIQ. They noted that it may be worthwhile to study other antecedents of PIQ such as information content depth (Agarwal & Venkatesh, 2002), information currency (Nielsen, 2000) and overall system reliability. We chose information source as the antecedent of PIQ because we intend to inform further artifact development of Travel Safety and because the role of the information source on system adoption poses an interesting research problem. Crowdsourced content has been found to not be perceived as credible (Kittur et al., 2008, Flanagin & Metzger, 2011) compared to content that is provided by known, established sources. Furthermore, previous research has investigated aspects of social media that warrant the role and benefits of official information sources (Jarvenpaa & Majchrzak, 2010). Inaccurate information in addition to accurate, useful information can be generated using crowdsourcing platforms, thereby spurring what is known as vigilant interactions. Official information sources might be perceived as safeguards for making wrong decision based on false information resulting from vigilant interactions. Three elements of vigilant interactions can surface on crowdsourcing and social media sites: trust asymmetry, deception and novelty (Jarvenpaa & Majchrzak, 2010). Furthermore, it has been shown that source credibility in addition to argument quality plays an important role in behaviors concerning the sharing of tweets (Ha & Ahn, 2011). The depicted information source of a tweet could influence perceived information quality (Anderson, 1981, Boritz, 2004, Lee et al., 2002), i.e., the PIQ of information provided by official information sources might be higher than the PIQ of information provided by unofficial information sources (i.e., crowdsourced content). In particular, in the case of travel risk information, the suitability of crowdsourced content seems questionable because of its ability to negatively affect personal safety (Löwenheim, 2007). Thus, we hypothesize the following:

Hypothesis 2.6 *Crowdsourced content will negatively influence PIQ compared to official information sources.*

Prior evidence indicates that the experience of a user on Twitter might affect the perception of any information that is presented as a tweet (Schultz et al., 2011). Users of the application might use Twitter more or less frequently than others. For instance, some users might be daily Twitter users, who are constantly exposed to Twitter content and are highly familiar with the system and the type of content that it provides. Others might have never used Twitter and might thus be completely unfamiliar with it. Because PIQ is judged using the criteria of accessibility and interpretability (Nicolaou & McKnight, 2006), it is important to note that these criteria can change over time and from individual to individual. In particular, some users might perceive official information as more accessible than crowdsourced content because they usually do not have access to Twitter and other social media and crowdsourcing platforms. In contrast, a frequent Twitter user might not notice the difference. Other users might experience problems interpreting the tweets because they were never or rarely exposed to crowdsourced content. In contrast, seasoned Twitter users might be used to making decisions based on information that they obtained from Twitter. Thus, we hypothesize the following:

Hypothesis 2.7 *The negative influence of crowdsourced content on PIQ will be moderated by regular Twitter usage.*

6.2 Research Design and Data Collection

To validate the model's constructs and test for the effects of the system design intervention, we conducted a combined online survey and experimental simulation. Participants were recruited via Facebook and a mailing list. All of the participants spoke German and English and were mostly from the university environment. In total, we collected 136 responses, of which 49 were only partial responses. We neglected the partial responses and used the sample of n=87 completed responses for our analysis. Participants were asked to imagine traveling to the fictional country "travel country" soon for the first time. We incorporated a fictional country so that participants would not be biased by previous travel experience (Sönmez & Graefe, 1998). To incorporate additional realism into the scenario and convey a somewhat clearer picture of "travel country", participants were informed that their flight to "travel country" would take approximately 12 hours, including waiting and transfer times. With the following scenario, we attempted to provide a somewhat realistic and substantial motivation for the participants' travel intent:

In two weeks, the wedding of your best friend will take place in "travel country". You are your best friend's witness at the marriage. On the next page, you will be presented with Twitter messages about "travel country". Please take a look at the page and answer the upcoming questions.

The applied experimental design is detailed in fig. 6.2. After being provided with general experimental instructions, participants were randomly assigned to either one of two treatment groups, A and B, in which we manipulated the information source of the presented travel-risk-related Twitter messages. One group of participants was presented with ten tweets from official information sources (namely, foreign offices of USA, UK, Canada, Switzerland, and Germany), and the other group was presented with tweets from individual fictional Twitter users mimicking crowdsourced content. Notably, except for the manipulation of the information source, all participants experienced identical conditions because the content of the Twitter messages in both groups was identical. Only author names and depicted avatars were replaced. To make the scenario more realistic, all presented information originated from actual tweets posted by foreign offices about Colombia after a volcano erupted in 2012. Fig. 6.3 shows a subset of the ten presented tweets for both treatment groups. In treatment group A, the depicted avatars were user profile images typical of social media sites.

Names and Twitter handles were randomly chosen. In treatment group B, the depicted avatars, names and Twitter handles originate from the original tweets about Colombia.

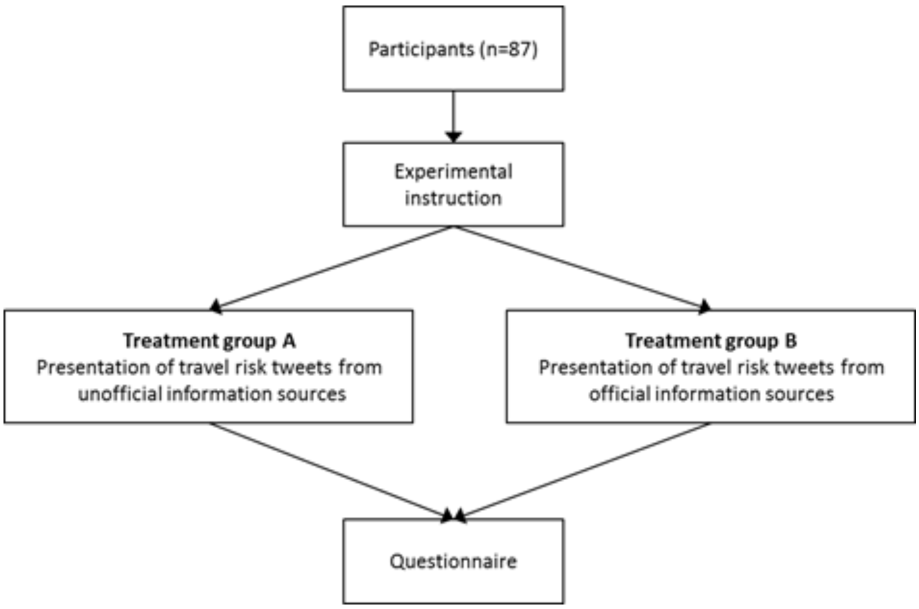
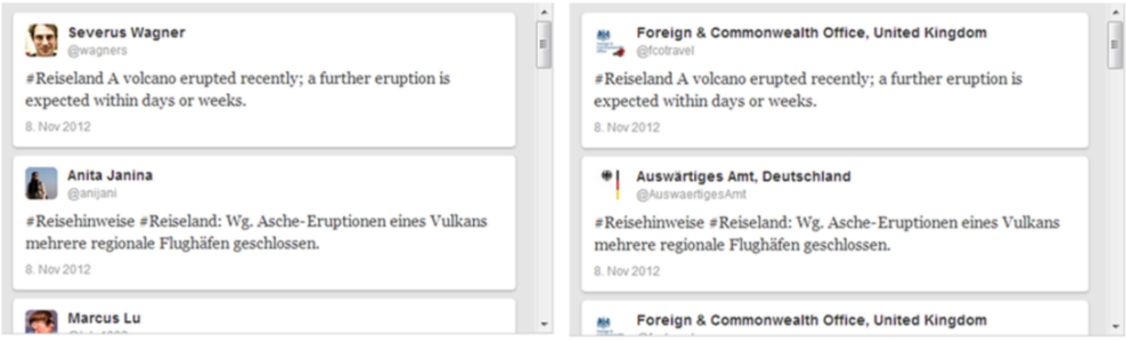


Figure 6.2: Experimental design

6.2.1 Measures

A subsequent item-based survey allowed us to measure participants' PIQ, RSK, TRU and ITU in both experimental groups. Furthermore, participants were asked how often they travel long distances (on a scale of 1 – 6, corresponding to rarely to often) and how often they use Twitter (on a scale of 1 – 6, corresponding to rarely to often)). The scale for assessing PIQ was adapted from Nicolaou & McKnight (2006) to the present context while preserving the underlying theoretical considerations of the scale (different information quality dimensions). TRU,



(a) Treatment group A: unofficial information sources

(b) Treatment group B: official information sources

Figure 6.3: Presentation of travel risk tweets from unofficial and official information sources

RSK and ITU also originate from Nicolaou & McKnight (2006). The scales were again adapted to maintain the underlying rationales. Only the original TRU scale could not be tuned well for the purposes of our work. Our experimental setup is limited in that it does not allow one to assess the benevolence of the solution provider. Hence, TRU only reflects honesty and competence as major aspects of trust. All items were adopted from the study by Nicolaou & McKnight (2006) when applicable and adapted to our context. To ensure the reliability of individual items, items with factor loadings on the corresponding latent constructs of below 0.8 were ignored (cf., e.g., Yoo & Alavi (2001)). Additionally, Twitter usage (USG) was measured on a five-point scale from never to daily (M=2.54, SD=0.86). 6.1 shows the item measures underlying our work along with corresponding descriptive information.

Table 6.1: Measurement items based on Nicolaou & McKnight (2006)

Construct	Item	Description	Scale
Perceived Information Quality (PIQ)	PIQ1	The presented information is sufficiently current to assess the travel risk. [dropped] (currency)	Strongly disagree / strongly agree; (seven-point)
	PIQ2	The presented information is sufficiently accurate to assess the travel risk. (accuracy)	
	PIQ3	The presented information is sufficiently relevant to assess the travel risk. (relevance)	
	PIQ4	The presented information is sufficiently complete to assess the travel risk. (completeness)	
	PIQ5	The presented information is sufficiently detailed to assess the travel risk. (detail)	
	PIQ6	The presented information is sufficiently reliable to assess the travel risk. (reliability)	
Perceived Risk (RSK)	RSK1	How would you rate the overall risk of making a bad decision based on the presented information? [dropped]	Extremely high / extremely low; (seven-point)
	RSK2	How would you characterize the possibility of using the portal for your travel decisions?	Significant threat / significant opportunity; (seven-point)
	RSK3	How would you characterize the possibility of using the portal for your travel decisions?	Potential for loss / potential for gain; (seven-point)
Trusting Beliefs (TRU)	TRU1	The portal is sincere and genuine. [dropped]	Strongly disagree / strongly agree; (seven-point)
	TRU2	The portal is competent in selecting, processing and presenting travel risk information.	
	TRU3	The portal performs its role of providing travel risk information very well.	
	TRU4	The portal is a very good source for travel risk information.	
Intention to Use (ITU)	ITU1	I would use this portal again for making travel decision to foreign countries.	Extremely unlikely / extremely likely; (seven points)
	ITU2	I would feel comfortable using the portal again in the future.	
	ITU3	I would recommend the portal to colleagues/friends.	

6.2.2 Demographics

Table 6.2 shows the demographic data for our sample. The sample consisted of 64.37% female and 34.48% male participants. One participant did not report their gender. A total of 73.56% of participants were between 25 and 34 years of age. A total of 21.84% of participants were between 18 and 24 years of age, and 4 participants were older than 34 years of age. We studied the effect of information source on the perceived information quality of the travel risk information and traveling in a broader sense. To ensure that our sample was suitable for this context, we asked participants to report the how often they traveled internationally with flight durations of less than and greater than six hours. A total of 89.66% of participants reported traveling to foreign countries with flight durations of less than six hours at least once every five years. A total of 44.83% of participants reported taking such trips multiple times per year. A total of 3.45% of participants did not report their travel frequency in this category. A total of 73.57% of participants reported traveling to foreign countries with flight durations of more than six hours at least once per five years. A total of 27.59% reported taking such trips multiple times per year. Finally, 5.75% of participants did not report their travel frequency in this category. The sample consisted of young participants who satisfied the requirements for the investigation of social media. The extensive travel activity that was reported suggests that the sample is also appropriate for our investigation in the context of travel and travel risk. Overall, we believe this sample constitutes a representative sample for our study.

Demographic	Value	Frequency	Percentage
Gender	Female	56	64.37
	Male	30	34.48
	n/a	1	1.15
Age	18-24	19	21.84
	25-34	64	73.56
	35-54	2	2.30
	55+	2	2.30
	n/a	0	0.00
Foreign travel (<6 hour flight)	Rarely	3	3.45
	Every 4-6 years	3	3.45
	Every 1-5 years	39	44.83
	Multiple times per year	37	42.53
	Multiple times per month	2	2.30
	n/a	3	3.45
Foreign travel (>6 hour flight)	Rarely	5	5.75
	Every 4-6 years	13	14.94
	Every 1-5 years	40	45.98
	Multiple times per year	23	26.44
	Multiple times per month	1	1.15
	n/a	5	5.75

Table 6.2: Demographic data of the sample (n=87)

To verify the clarity of the experimental instructions, accuracy of the formatting and wording of the questionnaire and consistency of the research design, we conducted a pre-test with three participants. No problems were found other than minor problems with the formatting of the questionnaire, which were corrected in the final version. Data from the pre-test were not included in the final sample.

6.3 Analysis and Results

To test the psychometric properties of the constructs, we used Partial Least Squares (PLS) analysis using the SmartPLS software, version 2.0 (Ringle et al., 2005). PLS is a regression-based technique that allows for estimating and testing relationships between constructs (Chin, 1998). The PLS technique was chosen for the analyses due to its ability to handle a wide range of sample sizes and constructs with fewer items (Hair & Black, 2009).

We applied PLS modeling to validate the constructs of perceived information quality, perceived risk, trust and intention to use and to test our hypotheses. Following the criteria of (Jarvis et al., 2003), all variables in the research model were modeled as reflective constructs. To determine the quality of the reflective measurement model, internal consistency (construct reliability), convergent validity, and discriminant validity were assessed (Straub et al., 2004). Validity statistics are presented in table 6.3. Regarding the internal consistency of the constructs, the Composite Reliability (CR) values were at least 0.88, and Cronbach's alpha was greater than 0.72 for all constructs. These values exceed the required threshold of 0.70 and thus demonstrate the reliability of the five scales. Convergent validity can be examined in terms of item loadings and Average Variance Extracted (AVE) (Fornell & Larcker, 1981). In general, item loadings greater than 0.70 are considered acceptable (Fornell & Larcker, 1981). As table 6.4 shows, all items meet these requirements. Furthermore, all items were significant at $p<0.001$, and all AVE exceeded 0.50, thus establishing convergent va-

Table 6.3: Descriptives and validity statistics

Construct	CR	AVE	Cronbach's Alpha	Item	M	SD
Perceived Information Quality (PIQ)	0.91	0.68	0.88	PIQ2	3.78	1.60
				PIQ3	4.70	1.51
				PIQ4	3.28	1.40
				PIQ5	2.97	1.73
				PIQ6	4.02	1.76
Perceived Risk (RSK)	0.88	0.78	0.72	RSK2	3.11	1.39
				RSK3	3.25	1.12
Trusting Beliefs (TRU)	0.92	0.78	0.86	TRU2	4.11	1.63
				TRU3	4.37	1.53
				TRU4	4.41	1.66
Intention to Use (ITU)	0.96	0.89	0.94	ITU1	4.53	1.63
				ITU2	4.48	1.68
				ITU3	4.60	1.71

lidity. To assess discriminant validity, the square root of AVE for each construct should be larger than their corresponding inter-construct correlation coefficients. In addition, individual items should load higher than 0.50 on their associated construct and load more strongly on their associated construct than on any other constructs in the model (Chin, 2010). Each square root of AVE is much larger than the corresponding inter-construct correlations (table 6.5). Furthermore, items have greater loadings on their own construct than on other constructs (table 6.4). Thus, the results provide evidence for the discriminant validity of the model.

	PIQ	RSK	TRU	ITU
PIQ2	0.83	-0.41	0.22	0.4
PIQ3	0.83	-0.43	0.31	0.46
PIQ4	0.85	-0.34	0.3	0.43
PIQ5	0.81	-0.35	0.22	0.42
PIQ6	0.81	-0.41	0.38	0.48
RSK2	-0.4	0.87	-0.4	-0.6
RSK3	-0.44	0.9	-0.46	-0.65
TRU2	0.27	-0.34	0.86	0.46
TRU3	0.34	-0.44	0.91	0.51
TRU4	0.33	-0.5	0.89	0.5
ITU1	0.47	-0.73	0.55	0.95
ITU2	0.53	-0.61	0.47	0.93
ITU3	0.52	-0.65	0.55	0.95

Table 6.4: PLS loadings and cross-loadings of the measurement model items

After establishing the validity and reliability of the measurements, the next step is to test the structural model for the hypothesized paths. The primary evaluation criteria for this purpose are the R^2 measures as well as the magnitude and significance of the path coefficients (Hair et al., 2011). The R^2 values indicate the amount of variance of a dependent variable explained by the model (Chin, 2010). Path coefficients indicate the strengths of the relationships between the dependent and independent variables. Following Chin (2010), we performed bootstrapping to generate 200 samples to estimate the significance of the path coefficients. Fig. 6.4 shows the path coefficients for each hypothesized path along with the corresponding t-statistics and R^2 values.

	PIQ	RSK	TRU	ITU
PIQ	0.82			
RSK	-0.47	0.88		
TRU	0.36	-0.49	0.88	
ITU	0.53	-0.7	0.56	0.94

Table 6.5: Correlation of latent constructs (Diagonal elements are the square root of the AVE)

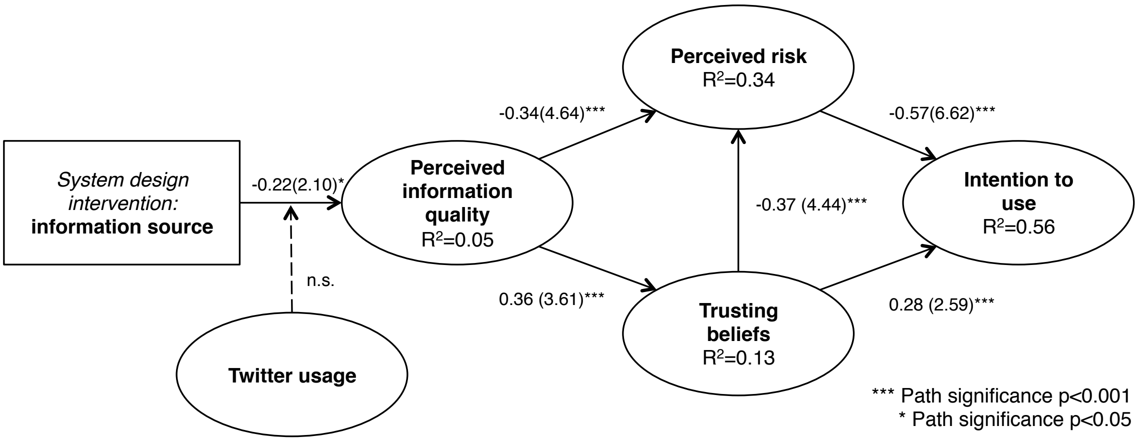


Figure 6.4: Results of structural model analysis

The research model explained 56% of the variance in the dependent variable ITU, 34% in the variable RSK and 13% in the variable TRU. As seen in fig. 6.4, all hypothesized paths in the model adopted from Nicolaou & McKnight (2006) were found to be significant at $p<0.001$.

Furthermore, the directionality of all significant paths was confirmed as hypothesized in the proposed model. In terms of hypothesis tests, the results support hypothesis 2.1, namely, PIQ positively influences TRU ($t=0.36$; $p<0.001$). For hypothesis 2.2, we found that PIQ negatively influences RSK ($t=-0.34$; $p<0.001$). Hypothesis 2.3 is supported, namely, RSK negatively influences ITU ($t=-0.57$; $p<0.001$). We also found that TRU positively influences ITU, thus supporting hypothesis 2.4 ($t=0.28$; $p<0.001$). The results further support hypothesis 2.5, namely,TRU negatively influences RSK ($t=-0.37$, $p<0.001$). Our intervention whereby we manipulated the information source yielded a significant effect on PIQ, thus providing support for hypothesis 2.6, namely, crowdsourced content negatively influences PIQ relative to official information sources ($t=-0.22$; $p<0.05$). However, the effect was small because the experimental manipulation of the information source only explains 5% of the variance in PIQ. The hypothesized moderating effect of Twitter usage on the relationship between information source and PIQ was found not to be significant; thus, there was no support for hypothesis 2.7.

6.4 Contributions and Conclusion

The design artifact motivating our research is the mobile crowdsourcing application Travel Safety. The primary objective of our research was to investigate how crowdsourced content affects the usage intentions of the application. Building upon a research model by Nicolaou & McKnight (2006), which was originally applied to the context of

B2B data exchanges, we conducted a study that included a lab experiment. In this experiment, we manipulated the information source of presented tweets to either be depicted as official (foreign offices) or unofficial (crowdsourced). Because our findings provided support for hypotheses 2.1 to 2.5, we successfully adapted the research model of Nicolaou & McKnight (2006) to our research context. We found that the information source had a significant negative effect on PIQ, thus providing support for 2.6. Therefore, our findings suggest that despite the great potential of crowdsourcing for providing up-to-date first-hand information, crowdsourced content should be used with care. However, because the manipulation only accounted for 5% of the variance in PIQ, our findings do not provide conclusive evidence that crowdsourced content would substantially harm usage intentions of Travel Safety. Furthermore, we have not found support for hypothesis 2.7. There was no significant moderating effect of Twitter usage on the relationship between information source and PIQ. Although this is a surprising result, one possible explanation could be that the presentation of tweets is generally highly intuitive. In this case, higher Twitter usage would not lead to higher familiarity with Twitter content.

6.4.1 Contribution to the Research Literature

We extended previous research in two ways. First, specifically following their call to research, we successfully adapted the research model of Nicolaou & McKnight (2006) to the consumer domain. By identifying and adapting the research model from its B2B context and validating it in a consumer context, we add to the IS literature by providing a possible research framework for use by other consumer platforms. Second, we contributed to better understanding the PIQ construct in the context of user-generated content and crowdsourcing (Kittur et al., 2008, Flanagin & Metzger, 2011) because we found that crowdsourced content significantly but weakly decreased PIQ relative to the official information sources in our study. Although our evidence is based on travel risk information content, our findings might be limited to the travel risk domain. However, one could argue that because of its importance to personal safety, the PIQ of travel risk content may be particularly sensitive. Therefore, our findings may allow for a conservative generalization to other domains.

6.4.2 Contribution to Practice

On the practical side, our findings have several implications. First, as it becomes increasingly important for corporations, individuals and governments (Wasko & Faraj, 2005), practitioners should be informed about the implications of crowdsourced content. In that sense, our study, which enhances the understanding of the role of crowdsourced content, is timely. Second, as could be expected, official information was perceived as being more reliable and made the overall system appear to be more sincere. However, we found no substantial evidence that crowdsourcing per se would be unsuitable as an information source in our context. These findings suggest that practitioners should leverage the high potential of crowdsourcing but integrate it with caution; moreover, they may want to carefully monitor its performance. Third, addressing further artifact development for Travel Safety, our findings suggest that crowdsourced travel risk information may be integrated alongside existing official information sources such that users can clearly differentiate between the two. In this way, official information sources would be complemented by up-to-date first-hand information, although with the potential negative influence of crowdsourced content based on perceptions of information quality and usage intentions.

6.5 Limitations and Future Research Directions

Various limitations should be considered when assessing our contribution. First, researchers are aware of an intention-behavior gap in many fields of behavior (Ajzen et al., 2004). It remains unclear whether the dynamics observed in intention-focused studies apply well in real environments. Our research was conducted in an artificial experimental environment; therefore, our findings could be biased because they are related to participant intentions and not the actual behavior of people. Second, as noted above, our study was conducted by incorporating travel risk information. This might limit the applicability of our findings to this specific domain. Future research could consider crowdsourced content from other domains. Second, the sample used in this study is rather small (n=87). Future research should use large sample sizes to validate and extend the model, especially in the context of an online platform, where large numbers of users are common. Third, the sample is quite homogeneous, focusing on young participants. Although we believe that our sample represents a suitable target audience for a mobile crowdsourcing application, more diverse samples could lead to a greater generalizability of the findings. Finally, despite yielding significant effects, our experimental manipulation of the information source only explained 5 % of the variance in the perceived information source variable. To explain more of the variance in perceived information quality, future research should consider evaluating more constructs and further extending the research model.

7

Discussion and Conclusion

7.1 Key Findings

The transition into a connected, digital environment produces many challenges for businesses that want to stay current with IT innovation to remain relevant and profitable. To address this challenge, many businesses need to transform and integrate their traditional products into innovative digital services (Christensen, 1997). One such IT innovation is the concept of crowdsourcing, which has been shown to be highly successful in various fields, thereby creating new opportunities for businesses and providing significant benefits to individuals and society as whole (Howe, 2008). The starting point of this thesis was the development of Travel Safety, a mobile crowdsourcing application for travel risk information that leverages voluntary user contribution. Motivating the research in this thesis, the development of Travel Safety was initiated by research partners from the insurance industry. Recognizing the digital transformation of their environment, the main objective of the partnership was to gradually develop a sustainable mobile crowdsourcing application to build a platform that engages existing customers and attracts new ones.

We found that the content generation and consumption cycle (Kumar, 2009, Zhang & Zhu, 2011, Shriver et al., 2013, Ahn et al., 2011) is a determining factor for the success of voluntary crowdsourcing applications. The small set of initial users typically does not generate sufficient content to sustain the application's initial user base and to make it valuable for new users. This leads to the generation of even less content, making the application less valuable and ultimately rendering it obsolete. This downward spiral can be particularly drastic because the vast majority of users are typically free-riders, i.e., they are using the platform but do not contribute (Huberman et al., 2009). In contrast, a large contributing user base leads to the generation of sufficient amounts of content to attract new users, who might contribute even more content, thus attracting even more users and ultimately leading to the type of success experienced by many established crowdsourcing platforms (Hendler & Golbeck, 2008). Therefore, the implicit content generation and consumption dynamics of voluntary crowdsourcing applications pose an interesting research problem. We focused on two specific aspects of this problem by addressing both the behavioral mechanics of content generation and consumption. Our research approach used the design science fundamentals of Hevner et al. (2004) and Peffers et al. (2007). With Travel Safety, we built an innovative, purposeful artifact to investigate a design problem in the above problem domain (Hevner et al., 2004). The design artifact was assessed (Hevner et al., 2004) through two evaluation steps that addressed the respective research questions of this thesis. Our research yielded various interesting findings, which we outline in the following section.

First, starting with a general perspective on the performance of Travel Safety as an innovative IT artifact, there are certain lessons that can be learned based on our investigations. Our results provide no rigorous benchmark to evaluate the performance of Travel Safety in this role, but we can draw tentative conclusions from the field study based on our impressions and those of our research partner. Naturally, overall usage of the application and how well it is received by the users is of utmost importance for building a platform from which the research partner can benefit. Specifically considering that participants in the field study were not incentivized to use the application on a continuous basis, usage of the application throughout the entire study was higher than expected. Another rather strong indicator that Travel Safety provided value for the participants of the field study was its actual usage during travel. Although all participants were Swiss residents, the integrated Analytics solution showed that Travel Safety was used in more than

15 countries on every continent. Furthermore, positive feedback from many participants indicated that Travel Safety and its functionality were well received overall. Therefore, both the travel theme and the functional implementation of Travel Safety show potential and should be further pursued to establish a platform to engage existing and new customers.

Second, the design process and evaluation of Travel Safety provided various interesting insights concerning the challenge of creating a voluntary crowdsourcing application from the ground up and, in particular, establishing a sustainable content generation and consumption cycle. Although the main idea behind Travel Safety always included sourcing original travel risk information from its users, it was decided to first obtain external content from foreign offices on Twitter and to let users contribute by improving the content via an integrated HCS. This design decision was made to mitigate the risk of an unsustainable content generation and consumption cycle. It was unclear whether users would contribute sufficient content to make Travel Safety valuable to other users. In addition, it seemed questionable whether the crowdsourced travel risk information would be suitable; if not, it could inhibit the usage of Travel Safety. Because we could observe the contribution behavior of Travel Safety users via the integrated HCS, our first concern that the initial users of Travel Safety would not contribute sufficient travel risk content to make the application valuable to other users seems to have been warranted. Only a small fraction of Travel Safety users were active contributors in the HCS. Accordingly, our findings are in agreement with previous studies that observed free-riding behavior in voluntary contribution-based applications (Adar &

Huberman, 2000, Huberman et al., 2009, Jain & Parkes, 2009). However, the integration of external content ensured that Travel Safety provided value to all users, even though only a few users contributed. In addition to providing support for our design decision, our findings further emphasize the importance of our first research question. It seems to be very important to actively encourage contribution in voluntary crowdsourcing applications.

Third, addressing the first research question, our investigation of how to foster sustainable contribution behavior in voluntary crowdsourcing applications yielded various interesting findings. The first research question focused on the content generation aspect of the content generation and consumption cycle. In particular, we proposed SNF (Cialdini et al., 1991), which is known as one of the most powerful levers of behavioral change (Loock et al., 2011), as a catalyst to foster user contribution in Travel Safety's integrated HCS. In accordance with the design science research fundamentals described by Hevner et al. (2004) and Peffers et al. (2007), we conducted a field experiment with a total of 768 participants to evaluate SNF as a method of fostering user contribution while focusing on free-riders, i.e., those users who exhibited low contribution behavior. At first glance, our proposal to foster user contribution by SNF was successful; our results provided evidence that SNF has a strong positive effect on short-term user contribution. This finding is in agreement with existing SNF intervention studies (Cialdini et al., 1991, Flüchter et al., 2014, Loock et al., 2011). However, consistent with motivation crowding theory (Frey & Jegen, 2001), we also found that SNF reduced individuals' intrinsic motivation, which is known to be a key antecedent of voluntary contribution (Yang &

Lai, 2010, Nov, 2007, Prasarnphanich & Wagner, 2009) and behavior in general (Ryan & Deci, 2000b). Accordingly, the results from our field study suggest that SNF interventions might harm longer term contribution behavior.

Fourth, addressing the second research question, our investigation of how crowdsourced content affects the usage intentions of the application bore certain valuable insights. To address the second research question, we focused on the content consumption aspect of the content generation and consumption cycle. Because crowdsourced content is generally not perceived as credible and trustworthy (Kittur et al., 2008, Flanagin & Metzger, 2011) compared to content provided by known, established sources, it was unclear how such content might affect the usage intentions of the application. Specifically, in the case of travel risk information, it seemed reasonable to assume that the suitability of crowdsourced content is at least questionable. In accordance with the design science research fundamentals described by Hevner et al. (2004) and Peffers et al. (2007), we conducted a lab experiment with 87 participants to investigate the effect of crowdsourced content on usage intentions. In the experiment, we manipulated the information source to either represent official or crowdsourced content. To base our analysis on existing research, we successfully adapted a research model by Nicolaou & McKnight (2006) from the B2B domain to our context, positioning PIQ as a determinant construct to predict usage intentions. We found that our experimental manipulation had a significant negative effect on PIQ. Therefore, despite the great potential of crowdsourcing for providing up-to-date first-hand information, crowdsourced content should be used with care. However, because the effect was relatively small, the inherent advantages of crowdsourced travel risk content may be utilized if precautions are taken to mitigate potential negative effects.

7.2 Contributions to the Research Literature and Practice

Various contributions to the research literature have resulted from the above findings. In accordance with the design science fundamentals discussed by Hevner et al. (2004) and Peffers et al. (2007), this thesis attempted to add to the knowledge base by contributing to the research fields of IS, social psychology, user-generated content, and in particular crowdsourcing and HCS. First, we extended the IS, user-generated content and crowdsourcing literature by addressing two specific aspects of the content generation and consumption cycle in Web 2.0 applications (Kumar, 2009, Zhang & Zhu, 2011, Shriver et al., 2013, Ahn et al., 2011). Furthermore, our strategy of sourcing external content instead of relying on user contribution may be generalized in the context of design science research (Hevner et al., 2004, Peffers et al., 2007). By breaking down the instantiation of an innovative design artifact to a state in which it is not affected by the underlying design problem yet still has utility in the original sense, we can investigate particular aspects of the problem that would otherwise not be observable. Guided by our two research questions, we advanced the understanding of how to foster content generation and how content is consumed. Second, based on our investigation of SNF toward fostering user contribution, we followed the call for research by Sidorova & Evangelopoulos (2008), who suggested intensified investigation of psychological interventions in IS. To the best of our knowledge, our study is the first to investigate SNF interventions in the context of crowdsourcing and HCSs. In addition, we have tested the concept of SNF and investigated the effect of extrinsic feedback on intrinsic motivation in a real-world setting. Furthermore, by studying social norms and their direct and reproducible implications for IS, our research is in line with Davis et al. (1992) and Gerow et al. (2012), who called for a deeper understanding of the effects of extrinsic motivation and the sources of intrinsic motivation. Third, we followed the call for research by Nicolaou & McKnight (2006). Because we adapted their research model from the B2B to the consumer domain, we added to the IS literature by extending the existing model by contributing to a deeper understanding of the PIQ construct and by providing a possible research framework for other consumer platforms. Furthermore, we extended the literature by investigating the trust and credibility of user-generated content (Kittur et al., 2008, Flanagin & Metzger, 2011) by providing evidence generated from the case of travel risk information.

The findings of this study have implications for practitioners. Based on the design science fundamentals described by Hevner et al. (2004) and Peffers et al. (2007), the findings of this thesis can guide further artifact development and inform other practitioners. Our strategy of sourcing external content instead of relying on user contributions proved to be a viable approach for mitigating the risk of an initially unsustainable content generation and consumption cycle. Therefore, practitioners might want to consider using a similar approach to introducing new mobile crowdsourcing applications. They should be aware of potential external content sources and consider if and when these could be integrated into the application. In addition, summarizing the findings of our investigation of SNF as a means to foster user contribution, we find that SNF is a very powerful tool. However, as with all powerful tools, practitioners should use it with great care. We found that SNF is highly effective for encouraging short-term contribution behavior, but our evidence also indicates that it significantly reduces the intrinsic motivation of users and may harm longer term contribution behavior. Therefore, practitioners should carefully consider to what end, under which circumstances and in what form they use SNF interventions. For example, SNF interventions may be implemented if practitioners are interested in short-term activity, e.g., to address pressing workload peaks. Applications that rely on longer term contribution behavior may be less suited for SNF interventions compared to applications that, e.g., only require one input from each user. Generally, and particularly for the further development of Travel Safety, SNF may be less intrusive than an SMS message for mitigating the negative effects on longer term contribution. Finally, in light of our findings regarding the second research question, we confirmed our initial apprehension that crowdsourced content could affect the usage intentions of Travel Safety. However, because we only found a relatively small effect, the potential of crowdsourced content to broaden the information base and provide more detailed first-hand information may still be realized. A potential next step in the development of Travel Safety could be to gradually integrate crowdsourced risk information along with externally sourced official content to mitigate the risk of an unsustainable content generation and consumption cycle.

7.3 Limitations

The contributions of this thesis are subject to a number of limitations in terms of the generalizability of the findings and the applied research methods. First, addressing the general scope of this thesis, we focused on two specific aspects of the content contribution and consumption cycle. Therefore, we draw only tentative conclusions regarding the implicit dynamics of the cycle. Furthermore, we derived all results based on studies using the mobile travel risk application Travel Safety or an experimental simulation of Travel Safety. As a consequence, our findings may be specific to travel risk and closely related applications. Second, because both of the presented studies rely at least partially on self-reported measures, our results might be biased by an intention-behavior gap (Ajzen et al., 2004). Therefore, it remains unclear whether our findings are applicable to real environments. Third, both of our samples were relatively small compared to the extremely large user bases of established applications. In particular, because users showed low contribution behavior, as expected, our analysis of the longer term effects of SNF is based on only a few participants from the field study. Additionally, because both of our samples were geographically confined, our results may have been affected by demographic bias. Fourth, in our study investigating the effects of SNF on user contribution, the measurement period was limited to a restricted time frame, which could have further limited the generalizability of our findings. Additionally, the contribution of classifying content in an HCS may not be generalizable to the contribution of original content, e.g., because of a higher workload. Therefore, the corresponding findings may be limited to HCSs and might not be generalizable to voluntary crowdsourcing applications. Finally, even though there was no direct monetary incentive to contribute within the application, participants received small monetary rewards for trying out the application at their own discretion and for completing the survey. It is unclear whether and how this might have influenced the results.

7.4 Future Research Directions

The findings discussed above and their limitations may serve as a basis for future research in the fields of IS, social psychology, user-generated content, and, in particular, crowdsourcing and HCS. First, revisiting the challenge of creating a voluntary crowdsourcing application from the ground up, performing an in-depth investigation of the inherent dynamics of voluntary crowdsourcing and, in particular, establishing a sustainable content generation and consumption cycle may lead to valuable insights. Second, as noted above, the relatively small sample sizes of our studies obviously limit the generalizability of our results and require further research and repetition on a larger scale. Third, future research should continue to investigate the potential of SNF in crowdsourcing applications and HCSs. We explored the effects of SNF in applications based on voluntary contribution, but it seems promising to further investigate the role of SNF in crowdsourcing applications and HCSs that incentivize contributions with monetary rewards. For instance, it is quite possible that paid workers' performance could be improved with SNF. Additionally, future research on how the internalization of extrinsic motivation might be achieved appears highly relevant. It also seems necessary to conduct lab experiments to better understand cognitive processes and to carefully disentangle countervailing longer term effects of SNF in general. Fourth, building on our research on the effects of crowdsourced content on usage intentions in a travel risk context, researchers may want to address crowdsourced content from other domains to generalize our findings. Finally, because our experimental manipulation only explained a relatively small part of the variation in PIQ, further research should be conducted to extend the research model of Nicolaou & McKnight (2006) by evaluating more constructs.

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Appendix

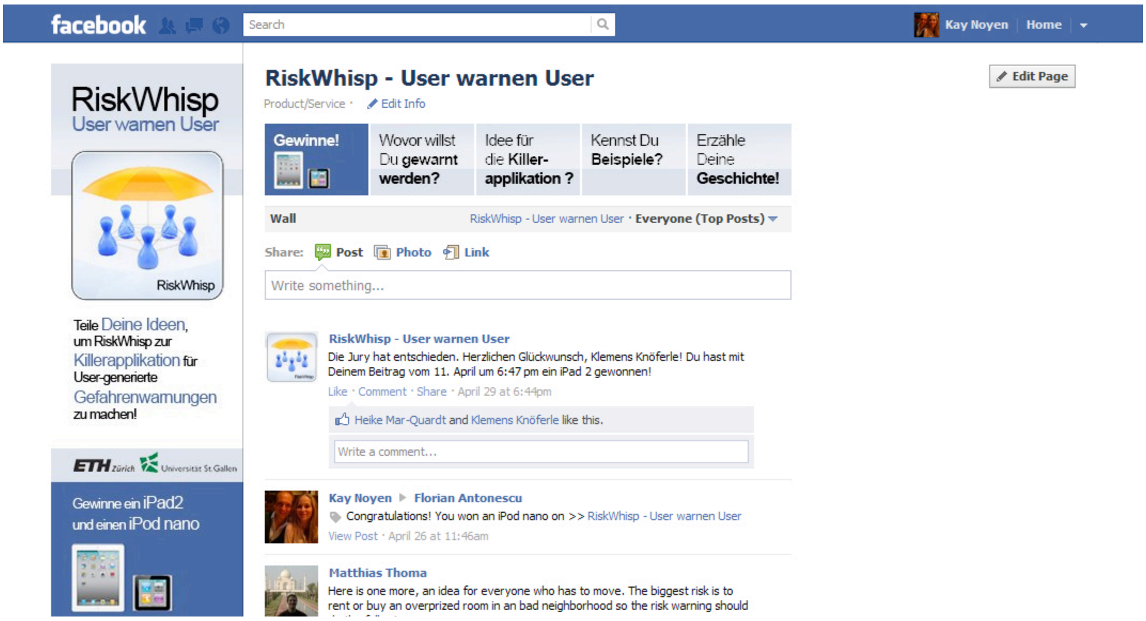
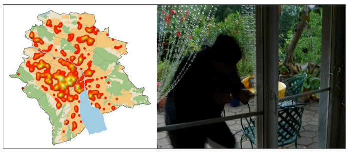
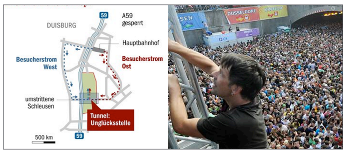
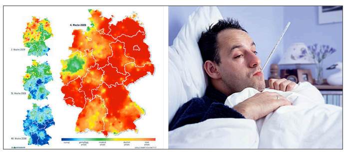
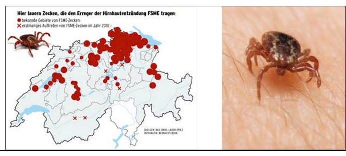
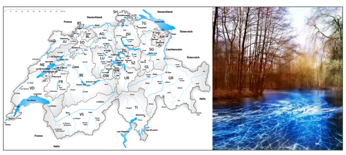


Figure 1: Facebook crowdsourcing page "RiskWhisp"

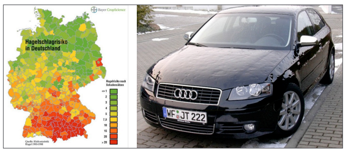
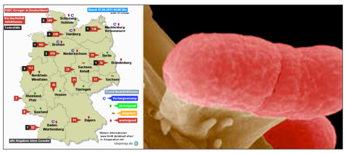
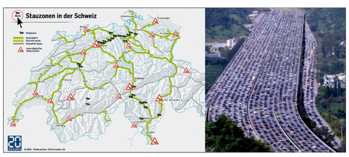
Table 1: Proposed use cases for mobile crowdsourcing application

No	Use Case	Illustration	Description
1	Safe navigation		The navigation system in your car easily finds the fastest and cheapest route. The new application also suggests the safest route.

Proposed use cases for mobile crowdsourcing application

No	Use Case	Illustration	Description
2	Travel safety		When traveling to foreign countries you are oftentimes not sufficiently informed about the local safety conditions. The new application provides you with the most important information.
3	Pickpocketing		Pickpocketers oftentimes strike in large crowds. The new application puts a stop to pocket picker activities by quickly warning one another.
4	Burglary		Only few people know how high the risk for burglary in their area or street actually is. With the new application, residents can share information about incidents and warn each other.
5	Mass panic		During mass panic incidents people are in great danger to be physically harmed. With the new application people in large crowds are warned about critical areas.
6	Contagious diseases		Every year there is a danger of a flue epidemic. The new application provides a contagion risk map to help users avoiding the flue.
7	Dangerous animals		Animal bites can be highly infectious. The new application warns about areas with dangerous animals.
8	Ice thickness		Over-frozen lakes oftentimes seem to be a solid ground. However, to set foot on thin ice can be life-endangering. The new application warns about thin ice.

Proposed use cases for mobile crowdsourcing application

No	Use Case	Illustration	Description
9	Thunder-storm		Weather forecasts are oftentimes inaccurate. Hailstorms however can seriously harm your car. The new application warns about dangerous weather incidents.
10	Dangerous urban areas		Some urban areas can be dangerous for your personal safety. The new application shows what areas you should avoid.
11	Contaminated food		Contaminated food can be a serious danger to you health. The new application tracks food poisoning incidents and warns others.
12	Slippery roads		Car drivers are oftentimes surprised by the sudden emergence of slippery roads. The new application tracks slippery roads and warns drivers in time.
13	Traffic accidents		Accident scenes should be avoided whenever possible. With the new application, witnesses of car accidents tag them on a map and warn other drivers.
14	Vandalism		Vandals destroying private property oftentimes get away. The new application allows to track incidents of vandalism and makes people aware.
15	Traffic jam		Drivers would like to know about traffic jams before they get in the car. The new applications allows drivers to report traffic jams and warn others in time.

Reisewarnung

Bei Einreise in ein unbekanntes Land, ist der Reisende oft nicht über die genauen Zustände im Land seiner Destination informiert. Offizielle Reisewarnungen und von anderen Nutzern beigetragene Informationen über Sicherheit, Hygiene etc. werden mit der neuen Basler Warn-Applikation automatisch bei der Einreise in ein beliebiges Land auf das Smartphone des Reisenden übermittelt. So fühlt sich der Basler Kunde sicherer und kann sich im Reiseland freier bewegen.

Illustration

Die mit einem roten Stern * versehenen Fragen zu Bewertung und Neuheit der "Use Cases" sind **zwingend** zu beantworten. Überlegen Sie nicht zu lange und lassen Sie neben Ihrer Erfahrung auch Ihr Bauchgefühl entscheiden: Welche der Ideen wären für Ihr Unternehmen interessant? Welche Idee macht den Basler Kunden wirklich sicherer? Wo sehen Sie echtes Potential?

Bei der Beantwortung der **optionalen** Fragen bezüglich der Stärken und Schwächen der "Use Cases", möchten wir Sie bitten, hier ganz besonders Ihr persönliches Expertenwissen einfliessen zu lassen.

13. Was halten Sie von dieser Idee? *

	Reisewarnung
Wertung *	★★★★★★★☆☆☆

14. Ist Ihnen diese Idee neu? *

- (●) Ja
- ( ) Nein

Figure 2: Exemplary use case from online survey

Country	Twitter handle	Tweet language(s)	# Followers	# Tweets	Verified	Rating	Integrated
Argentina	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Australia	dfat	English	11709	1658	no	3	yes
Brazil	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Canada	DFAIT_MAECI	English	10106	2711	yes	3	yes
China	n/a	n/a	n/a	n/a	n/a	n/a	n/a
France	francediplo_EN	English	3337	1591	no	3	yes
Germany	AuswaertigesAmt	German	28639	1651	yes	3	yes
India	IndianDiplomacy	English	64686	2833	yes	2	no
Indonesia	MoFA_Indonesia	English	404	196	no	1	no
Italy	FarnesinaPress	Italian	1352	374	no	2	no
Japan	MofaJapan_en	English	5695	1434	yes	3	yes
Mexico	SRE_mx	Spanish	85152	5470	yes	2	no
Russia	MFA_Russia	English	12925	4156	no	2	no
Saudi Arabia	KSAMOFA	Arabic	46727	838	yes	1	no
South Africa	n/a	n/a	n/a	n/a	n/a	n/a	n/a
South Korea	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Spain	MAECgob	Spanish	276	0	no	1	no
Turkey	MFATurkey	English	5219	2812	no	1	no
United Kingdom	fcotravel	English	33265	5615	yes	4	yes
United States	TravelGov	English	295834	2171	yes	4	yes

Table 2: G-20 states foreign office representation on Twitter as of 06.06.2013

Country	Twitter handle	Tweet language(s)	# Followers	# Tweets	Verified	Rating	Integrated
Austria	Minoritenplatz8	German	2703	1169	no	3	yes
Belgium	MFABelgiumMedia	French / Dutch / English	785	223	no	2	no
Bulgaria	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Croatia	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cyprus	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Czech Republic	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Denmark	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Estonia	estonia_eu	English	1812	540	no	2	no
Finland	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Greece	GreeceMFA	English	17163	1680	yes	2	no
Hungary	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ireland	dfatirl	English	2408	1125	yes	2	no
Israel	IsraelMFA	English	20693	4849	yes	3	yes
Latvia	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lithuania	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Luxemburg	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Malta	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Netherlands	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Norway	NorwayMFA	English	318	92	no	2	no
Poland	PolandMFA	English	5782	3261	no	2	no
Portugal	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Portugal	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Romania	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Slovakia	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Slovenia	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Sweden	SweMFA	English	1251	361	yes	2	no
Switzerland	travel_edadfae	German / French / Italian	877	721	no	4	yes

Table 3: EU states and Switzerland foreign office representation on Twitter as of 06.06.2013 (excluding G-20 states)

Instirution	Twitter handle	Tweet language(s)	# Followers	# Tweets	Verified	Rating	Integrated
Amnesty International	amnesty	English	569777	8232	yes	3	no
Human Rights Watch	hrw	English	527050	8539	yes	3	no
Red Cross	ICRC	English	134321	2776	yes	3	no
Unicef	UNICEF	English	1557476	7045	yes	3	no
United Nations	UN	English	1269148	18477	yes	3	no
World Health Organization	WHO	English	675700	5027	yes	3	no

Table 4: Selected international organizations representation on Twitter as of 06.06.2013

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