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Digital Nudging in Social Media Disaster Communication

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Abstract

Social media has become an important channel of communication in emergency and disaster management. Emergency Management Agencies can distribute helpful and important information to the general public and also gather information to enrich their management efforts. This, however, remains challenging since several communication-related barriers occur. This study investigates how the concept of Nudging, a form of behaviour adjustment, can be applied to address these barriers. A Systematic Literature Review and qualitative social media data analysis methods were applied to explore the potential of digital nudges on social media. Twelve forms of digital nudges could be identified in the data that influenced the visibility of the messages they occurred in. The results suggest that Digital Nudging on Social Media is a promising approach to use in emergency and disaster communication.

Keywords Digital nudging · Social media · Disaster communication · Emergency management

1 Introduction

Social Media is an important communication channel during emergency and other crisis events. The general public use social media to share emergency updates and information (Abdullah et al., 2017; Shahbazi et al., 2018), or to seek information (Marx et al., 2018; Mirbabaie & Youn, 2018). As a consequence, emergency management agencies (EMA) have integrated social media into their emergency and disaster

management (EDM) efforts (Ehnis, 2017; Fosso Wamba & Edwards, 2014).

EMA use of social media underpins an enormous potential to support community safety and welfare by facilitating the spread of information in real-time with less effort (Ehnis, 2017). On the other hand, EMA face several challenges, including the need to ensure their messages reach everyone, so the community has trustworthy situational awareness to make the right decisions. As massive amounts of data are produced during and around an extreme event, different social media platforms and their associated accounts compete for a social media user's attention, which impedes the visibility of an account's own messages (Ross et al., 2018).

User-generated content produced in social media during and shortly after extreme events also presents another challenge. Both the high quantity and diverse quality of information that is generated on social media makes it hard for EMA, who often lack the resources and skills to process such large amounts of information (Stieglitz et al., 2018b), to identify, analyse, respond to and propagate reliable, trustworthy and accurate information. This, in turn, can hamper the development of situational awareness and subsequent decision-making, or, in case of misinformation, even lead to bad decisions, whereas devastating consequences can result (Fischer et al., 2016). Thus, it is undisputed that effective communication and goal-oriented decision-making is fundamental for the management of a crisis or disaster (Grebennik et al., 2019; Lazreg et al., 2018) and to ensure community safety and welfare.

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The concept of *digital nudging* has been applied by various disciplines to the theory of decision-making, and has led to promising results in offline as well as online decision environments (Henkel et al., 2019; Miesler et al., 2017; Yeomans & Reich, 2017). Within our study we therefore explore digital nudging as a possible communications design solution to EMA social media communications challenges and which is consistent with EDM goals.

The objective of our paper is to highlight initial insights into: (1) *how does and can digital nudging take place in user-generated content on social media platforms dealing with emergency and disaster communications (EDC)*; and (2) *how can digital nudging be used by EMA in EDC to support EDM efforts*.

To provide these insights our study qualitatively analyses Twitter communication during the first peak period (in 2019) of the Australian Bushfires (2019/2020) in New South Wales (NSW).

The paper is structured as follows. Firstly, an overview of the literature that focusses on social media in relation to EDC and EDM is outlined. The concept of nudging is then introduced by discussing digital nudging in information systems (IS) research. We then explain our research methods and the results of our data analysis. Our findings are then presented against the theoretical background of nudging. The paper concludes with contributions, limitations, and implications for further research.

2 Impact of Social Media on Emergency and Disaster Management

The literature is divided in two major sections. Firstly we outline the general use of social media in EDC as well as the different communication and interactions dynamics (Ahmed, 2011). We then, look at EMA social media usage for EDM in order to highlight the benefits and challenges to be overcome.

2.1 Emergency and Disaster Communication on Social Media

Social media platforms have become an important channel of communication for active stakeholders like EMA, the media, and the general public (Fischer et al., 2016; Shahbazi et al., 2018) to manage extreme events including natural disasters. According to Ahmed (2011) social media utilisation during emergency events can be separated into the communication and interaction (1) between EMA (A-A), (2) between EMA and the community (A-C), and (3) between members of the general public, such as between community (member) and community (member) (C-C) (Ahmed, 2011). In his framework, microblogging, image and video sharing platforms build the view on social media. From research conducted so

far much is known about the C-C interaction, which emerges in every major extreme event through the phenomenon of self-organising systems (Bunker et al., 2015). Communities use social media during extreme events for different purposes like gathering information (Fraustino et al., 2012), assessment of the situation (Mirbabaie & Youn, 2018; Stieglitz et al., 2017), checking with family and friends (Procopio & Procopio, 2007), emotional release and support (Imran et al., 2015), and coordination of spontaneous volunteer formations (Bunker et al., 2013; Reuter et al., 2013).

In trying to better understand the A-A interaction dimension, we find that research studies are few. Nevertheless, Ehnis (2017) found that social media is used for intra- rather than inter-organisational communication in EMA. Purposes of use for example are the dissemination of information within the organisations, or “to reduce the separation between the centralised (corporate) structure of the organisation in the headquarters with the volunteer-based brigades/units” (Ehnis, 2017, pp. 203–204).

Research investigating in the A-C interaction found that EMA use social media mostly to publish relevant information, provide guidance, and advice about the current status of an emergency situation and how the general public should act. EMA clearly have the role of information providers (Mirbabaie & Youn, 2018). One example of this type of interaction would be the use of social media by the Queensland police service during the Queensland floods of 2011, where they communicated with the general public as a part of their overall communication strategy and showed that social media was as useful additional channel (Bruns et al., 2012).

2.2 Social Media Utilisation by EMAs During Disasters

EMAs are central and influential actors in the emerging EDC (Mirbabaie et al., 2014). Research showed that EMA use social media channels especially during emergencies with the intent to communicate and interact with the general public. To achieve this objective they predominantly use social media as a “push” medium to distribute information and warnings as a one-way channel (Ehnis & Bunker, 2012; Potter, 2016). Information flows from EMA to the general public without a feedback loop. It was found, however, that the general public shares useful real-time information out of affected areas, sending requests for help and also offering their help to others, which could be used by EMA to improve their EDM (Nalluru et al., 2019).

As EMA are just starting to explore the many possibilities in which social media can be used, latest research is investigating their adoption of social media intending to explore the potential social media can have to improve EMA response to emergencies and disasters (Fischer et al., 2016; Lazreg et al., 2018; Stieglitz et al., 2018a). Researchers have identified several opportunities to support communication goals or simplify

EMA management during emergencies and disasters but also, to address the challenges and problems that occur in the utilisation of social media by EMA.

For example, it is crucial to distribute relevant information to EMA as soon as possible to enable them to make fast and effective decisions, save lives and resources and minimize damage (Fischer et al., 2016; Lazreg et al., 2018; Reuter & Kaufhold, 2018). The provision of this kind of information in real-time is possible through social media. The provision of data from the general public to EMA via social media can be of great value and represents a great chance to improve emergency management overall (Velev & Zlateva, 2016). The analysis of such social media data can then be used to improve decision-making for specific purposes (Stieglitz et al., 2018a).

However, research also highlights that 2-way provision and use of high quality and trustworthy information i.e. from EMA to the general public and back again, is difficult to establish, as several communication-related barriers arise. These barriers hinder improved emergency and disaster response and recovery (Fischer et al., 2016; Lazreg et al., 2018) and include:

- Large amounts of information are typically spread rapidly throughout social media communications networks during and after an extreme event which is hard to manage and as a consequence the identification as well as the analysis of trustworthy and reliable information under these conditions, is still one of the hardest challenges for emergency managers (Mirbabaie et al., 2019);
- As social media can be utilised by everyone from almost everywhere and at any time, it allows everybody to spread unverified information in any form. This leads to user-generated content that does not meet high information quality and trust standards that are expected from and by EMA (Stieglitz et al., 2018b).
- When considering the communication by EMA to the general public, an important point to consider is that extreme events come with situational uncertainty, high levels of threat as well as decision-making pressure, which all occur under time-constraints (Fraustino et al., 2012). This leads to the need for the early provision of accurate, immediate and trustworthy information, to fill the information vacuum. This kind of information provision is essential from government, experts or EMA (Fraustino et al., 2012; Stieglitz et al., 2017), but it remains challenging for the EMA to use social media for this purpose. On the one hand, EMA have to provide crucial and accurate information in quickly and ensure it reaches the right individuals and users (Hofeditz et al., 2019). On the other hand, EMA are expected to match the growing expectations of the general public, to respond directly to their call for help (Hofeditz et al., 2019; Reuter & Spielhofer, 2017). This makes it very difficult and complicated when

addressing the needs and requests of very heterogeneous communities (Hofeditz et al., 2019).

- When studying C-A interaction, the problem of social media data volume is also encountered in A-C interaction dimension. Since different information publishers on social media fight for a user's attention, EMAs face a challenge to make themselves and their valuable information visible due to increasing the prominence of their own postings (Bruns & Burgess, 2014; Ross et al., 2018).

It is the function and highest goal of an EMA to improve situational awareness and support and protect individuals and communities, this includes informing them, warning them and getting them to make the right decisions for their own safety (Koob, 1998). EMAs need to keep up with these social media communications challenges, therefore in order to exploit its full potential.

Researches are only just commencing investigations into the problems and challenges that occur in the A-C communications dimension. To overcome the high amount of data and to increase the own visibility in Twitter, EMA found that the use of the retweet function was a key mechanism (Bruns & Burgess, 2014). Therefore, it is imperative that EMA should investigate how to get as many retweets as possible. For instance a specific and clear sentence style was shown to positively impact how many users will see a Twitter post or retweet it and it was also shown that the reactions of Twitter users were influenced by the content itself (Ross et al., 2018). As well, Hughes et al. (2014) suggested that an EMA should follow a structured hashtag use and create new Twitter use features to better document information.

So, we have seen the first tentative approaches by EMA to boost the diffusion of key information on social media networks during emergencies and disasters to assist in the development of situational awareness. Highly effective social media communications to and from the general public are still elusive for EMA as very little is known about how to design their communications strategies and messaging for this purpose.

In this paper we advance the idea that *Digital Nudging* can be used to enhance the visibility of EMA social media accounts and postings in order to influence public decision-making and to improve the EDC and EDM.

3 Digital Nudging

Digital nudging is based on the concept of *nudging* advanced by Thaler and Sunstein (2008). Based on social-psychological and cognitive theories, they presented nudging as a concept of influencing human behaviour without enforcing a particular action. Therefore, nudging is “*any aspect of the choice*

architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives" (Thaler & Sunstein, 2008, p. 6). The aim of nudging is to influence decisions in an easy reversible way to achieve a positive outcome for the decision-maker without excluding alternatives or modifying their relative costs. Nudging follows the principle of *Libertarian Paternalism*, which is regarded as a soft version of paternalism, because the choice of decision options is not restricted and none of the options are subject to very strict conditions. All measures and actions that can be used by choice architects to steer human behaviour in a predictable way without excluding any choices or strongly change economic incentives is therefore defined as a nudge.

Adopted to digital environments, the user-interfaces of applications and websites can be seen as the choice architecture, whereas the designers of these user-interfaces are the choice architects. In general, everything that requires a choice or judgement of the user is regarded as part of the choice architecture (Weinmann et al., 2016). Recently, information systems researchers have recognised the potential of digital nudging for online decision-making environments. This has led to the intentional introduction of digital nudging techniques and methods into system design approaches. Lembcke et al. (2019) addressed the insufficient common understanding of nudges in digital choice environments and have proposed a comprehensive definition of digital nudging which considers the previous definitional shortcomings such as missing points like the necessary transparency or the pro-social- and pro-self-intention. They state that:

A digital nudge is any intended and goal-oriented intervention element (e.g. design, information or interaction elements) in digital or blended environments attempting to influence people's judgment, choice, or behaviour in a predictable way, that

- *Is made possible because of and works by making use of cognitive boundaries, biases, routines, and habits in individual and social decision-making,*
- *Works by making use of those cognitive boundaries, biases, routines, and habits as integral parts of such attempts,*
- *Preserves the full freedom of choice without forbidding or adding any rationally relevant choice options,*
- *Does not limit the choice set or making alternatives appreciably costlier in terms of time, trouble, social sanctions, and so forth,*
- *Nudges must be able to easily recognize when and where they are subject to being nudged (type-transparency), as well as what the nudger's goals of this intervention are, in addition to how and why the nudge is working (token-transparency) and*

- *Increases the private welfare of the nudged individual (pro-self) or the social welfare in general (pro social).* (Lembcke et al., 2019).

Researchers in IS have investigated the design of strategies and guidelines for digital nudges (Meske & Potthoff, 2017; Mirsch et al., 2017, 2018; Schneider et al., 2018). They all highlight the importance for choice architects to understand the underlying psychological effects like heuristics and cognitive biases and their adequate addressing when developing digital nudges (Meske & Amojó, 2019). Mirsch et al. (2017) conducted a systematic literature review (SLR) to investigate the psychological mechanism that underlies digital nudging to give researchers and practitioners a valuable basis to study or design IS that assist decision-making. An overview of all mechanisms, their frequency of occurrence and a brief description is given in appendix A, Table 6. The concept of digital nudging has already been applied in various digital choice environments spanning several disciplines: It has been applied in digital environments to drive individuals towards better decisions regarding their health (Miesler et al., 2017), but also in the context of enterprises, for example, to influence the behaviour of employees and support them with their decisions (Kissmer et al., 2018). Other fields of application in which digital nudges were found to be significantly effective are Pro-Environmental Behaviour (Henkel et al., 2019), education (Yeomans & Reich, 2017), e-commerce (Eigenbrod & Janson, 2018), security, and privacy (Acquisti et al., 2017; Kroll & Stieglitz, 2019). In all of these environments nudges are embodied through the design choices taken when designing the user interface. However, in a social media environment the organisations and users who want to use a digital nudge have typically no power to make decisions about the design of the user interface. Therefore, digital nudging must be applied to influence user behaviour in different ways, i.e. users get nudged through presenting information and messages in a particular form (Kim & Dennis, 2019). Within our study we apply this concept of digital nudging to better understand:

RQ 1: How can digital nudging be used in social media during emergency events and disasters?

RQ 2: How can social media nudging be used in emergency and disaster communication to support emergency management agencies?

4 Methodology

In order to answer these research questions, we have applied two methods which include: (1) a systematic literature review to define and identify forms of digital nudging in social media; and (2) a qualitative Twitter data analysis to understand social

media nudging in the context of emergency and disaster management. The research approach is visualised in Fig. 1.

4.1 Systematic Literature Review

A systematic literature review helps to identify significant insights into a topic that previous researchers have gained (Fink, 2006). The analysis was conducted across the disciplines of psychology, economics and information systems. This analysis applies the guidelines provided by vom Brocke et al., (2009). Articles that focus on the effectiveness of digital nudges were of interest for this study. The conceptualisation of the term digital nudge is based on Lembcke et al. (2019): “goal-oriented design, information, and interaction elements in online environments attempting to influence people’s judgement, choice, or behaviour [...]” and was used to categorise each paper. The databases accessed for the systematic literature review included: (1) Science Direct, (2) Scopus, (3) Web of Science, (4) Springer Link, (5) Institute of Electrical and Electronic Engineers (IEEE), (6) Association for Information System Electronic Library (AISeL), and (7) Association for Computing Machinery (ACM). To get an overview of digital nudging that effectively steers users’ decisions (influence), the terms “Digital” AND “Nudge” OR “Nudging” AND “Effective” were combined for the paper search request. The number of extant works for each database is displayed in Table 1.

4.2 Social Media Data Collection and Analysis

Twitter data was collected and analysed that reflects communication on bushfires that raged in NSW, Australia,

during the 2019/2020 bushfire season. Our study was conducted in late 2019, so the peak Twitter communications occurred on the 11th and 12th of November 2019. As on 10th November, a catastrophic fire danger warning was declared for those particular days over wide areas of NSW. During this period, EMA, media, individuals and other stakeholders communicated actively through Twitter.

The data was accessed via the open Twitter API and collected with the help of a self-developed crawler which is based on the Social Media Analytics Framework (Stieglitz et al. 2018c). Tweets containing the hashtags “#australiafires”, “#australiabushfires”, “#nswbushfires”, “#bushfiresnsw”, and “#nswfires” were collected during the timeframe ranging from the 11th of November (0:00 UTC) to the 12th of November (23:59 UTC) 2019. The crawler was set to only collect data that was provided in English language settings.

Data tracking resulted in a dataset of 71,190 tweets authored by 31,433 unique users. The tweets were scanned for anomalies and duplicates were removed from the dataset as well as not commented retweets, since they did not provide new content to analyse qualitatively. These tweets were sorted from highest to lowest retweet count. After sorting, the first 5% of the resulting tweets were analysed for this study.

The qualitative content analysis was conducted based on the principles outlined by Mayring (2014). More specific the analysis approach of the *Parallel Procedure* was applied. Using this method, knowledge about already existing digital nudges derived from the systematic literature review were assigned to the tweet text, and in addition, new digital nudges were identified from this analysis.

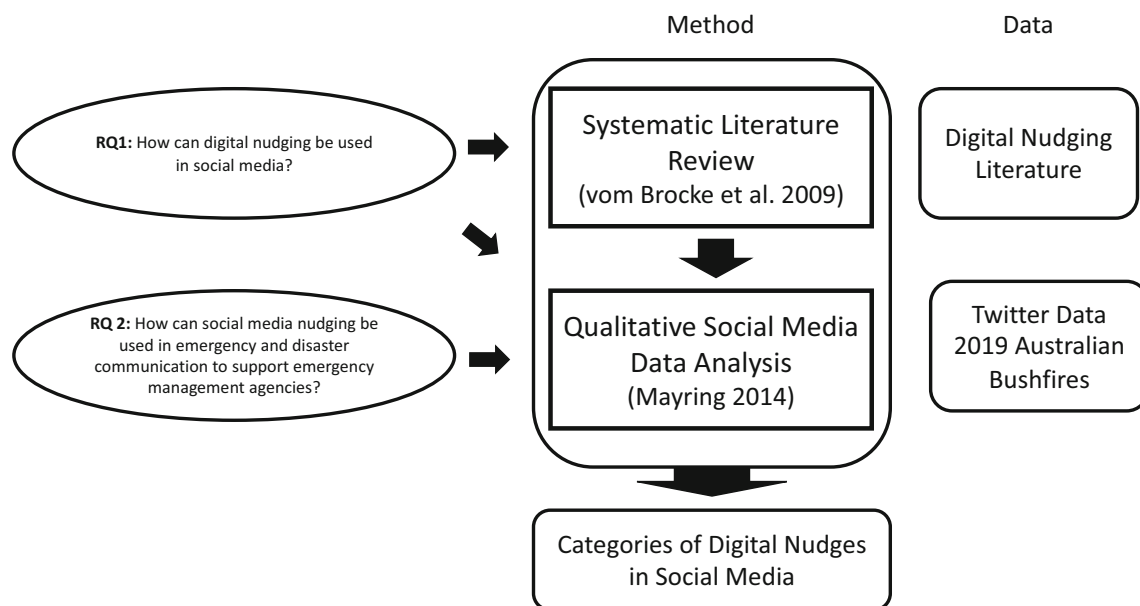


Fig. 1 Research approach

Table 1 Total and relevant number of works in each database

Database	Hits	Reviewed	Relevant	Sources
ACM	5	3	1	Ur et al. (2012)
AISel	10	9	5	Henkel et al. (2019), Huang et al. (2018), Schneider et al. (2017), Székely et al. (2016), Terres et al. (2019)
IEEE	1	1	0	
Scopus	10	4	2	Esposito et al. (2017), Niederberger and Champniss (2018)
Springer Link	256	4	1	Choe et al. (2018)
Science Direct	2	2	0	
Web of Science	53	14	7	Bergman et al. (2019), Dantzig et al. (2013), Furnell et al. (2018), Kim and Dennis (2019), Kretzer and Maedche (2018), Malhotra et al. (2016), Schneider and Graham (2017)
Total	337	37	16	

5 Findings

Our findings are split into two parts: firstly, we introduce the results of the systematic literature review and then secondly the findings of the qualitative Twitter dataset analysis are presented.

5.1 SLR Findings

After searching the databases with the keywords, a total number of 337 hits across all databases were found. The abstracts of all papers were reviewed to see whether the paper was relevant to our study. Thirty seven papers discussing effective digital nudging considered to be applicable. After reviewing the complete papers, some of them had to be excluded. Some were irrelevant or duplicates, while others did not refer to the nudging concept as defined by Thaler and Sunstein (2008). In the end, 15 relevant papers were left and their conceptual foundations were used to develop a concept-matrix of digital nudging, which is shown in Appendix B, Table 7.

Doing a backward search to ensure no relevant papers were missed, 13 more were identified and processed. One of these was relevant and further considered for inclusion in the matrix.

The finally selected papers were relevant to examining the use of digital nudges in various disciplinary fields such as consumer psychology, enterprises, gaming, health, Pro-Environmental Behaviour, online security and privacy, and social media. One quarter of the studies only focused on security and privacy; four on consumer psychology and marketing effects; two studies dealt with digital nudging in an enterprise context, in health, Pro-Environmental Behaviour and social media respectively, while only one examined digital nudging in gaming. The concept-matrix was used to develop a list of digital nudges which are named and described inclusively in Table 2.

5.2 Qualitative Social Media Data Analysis Findings

The 446 tweets were authored by 258 unique users. Each tweet was analysed regarding its author, the type of communication, and the topic of the tweet. In addition, every tweet was assigned one or more digital nudges, if nudges were used.

Twelve different categories of digital nudges or forms respectively, were found in the dataset. Seven of the digital nudging designs derived from the systematic literature review were identified in the tweets of the dataset. As well, five forms of digital nudging based on the psychological effects (Mirsch et al., 2017) were found. They were named after the effects they addressed. Only Striking Visuals was given as a new name since those digital nudges are a visualised form of Framing. Table 3 gives an overview of tweet distribution among the established digital nudging categories. Moreover, it shows how often all tweets per nudge were retweeted and provides the average retweet count for each tweet which included a respective nudge.

Of the analysed tweets, 201 included more than one digital nudge (182 retweets on average), 194 tweets included exactly one (118 retweets on average), and 51 tweets included no digital nudge at all (69 retweets on average). It became visible that the use of a digital nudge led to more retweets than using no nudge at all, while using more than one nudge led to the most retweets in relative comparison.

Also, there were notable differences between the communication and interaction dimensions regarding the usage of digital nudges. Looking at the A-A dimension, one of the two tweets that was shared in relation to A-A communication contained a Messenger Effect nudge and achieved 125 retweets. The other tweet contained the Messenger Effect nudge as well and also a Striking Visual digital nudge which achieved 31 retweets.

The occurrence of digital nudges in the other three dimensions, the total retweet count per nudging category and the average retweet frequency per one tweet are displayed in

Table 2 Digital nudges found in the SLR

Category	Anchor sample	Encoding rules
Emotive wording	“Avoid dissatisfaction by taking a time out here and then”	The emotions of the reader are directly or indirectly addressed
Position of crucial information	“A construction site at an intersection can lead to failures and delays in railway operations. See here if your railroad line is affected by disturbances: www. ...”	The important message is placed at the end of a tweet or visualised in an attached media
Score graphics	Energy saving score, donation score, ...	An attached media shows data in a scale/score
Complex/simple to process visualisations	Simple column diagrams/complex graphs with three axes	An attached media shows a data visualisation which is conspicuously simple or complex in its representation
Monetary incentives	“If you buy this chocolate bar, one dollar will be donated to X”	A call to action is made in combination with a monetary incentive
Relational capital/consensus	“Share this warning with you friends, they may find it helpful” “Get out of your chair! 95% of your friends already did a workout today”	A call to action is made in combination with calling the relational capital
Cognitive capital	“Share this with your friends, let them know your interests”	A call to action is made in combination with calling the cognitive capital
Commitment cues	“To fall in love with yourself takes time. Why don’t you start with a small challenge and give yourself a smile in the mirror every morning for 10 days?”	A call to action is made in combination with commitment cues
Visual cues	☺ → positive rating ☹ → negative rating	Commonly known and interpreted signs and colours are used to enrich the message on a visualisation
Relevance of information	“Please leave the area! It is important to make sure you stay safe and that the bomb disposal can begin in time”	Information about the relevance of something is added to the message
Messenger effect	The author of the tweet in which the reader is called to leave the area because of a bomb disposal is staff of the local fire service	The author of a tweet is in a position with more expertise compared to the reader regarding a specific situation
Scarcity cue	“Every day without eating fruits and vegetables is a missed chance to reach a healthier life”	Any hint of scarcity which affects the reader is added to a message

Table 4. Not every digital nudging category was used in every dimension.

In the A-C dimension (61 tweets), every tweet contained a Messenger Effect digital nudge. Visual Cues and Position of Crucial Information digital nudges are the second most frequently used nudges, followed by Simple to Process Visualisation and Striking Visual nudges with some distance. The average retweet frequency per tweet ranges between 129 and 174 retweets for every digital nudging category used.

In C-A communication (10 tweets), Striking Visual, Visual Cues, Framing, and Emotive Wording Nudges were used. Also, one tweet contained no nudges at all. The average retweet count is 29 here, whereas it ranges from 122 to 411 for the tweets which include nudges.

All categories of digital nudges occur in C-C dimension (373 tweets). Framing and Striking Visual nudges were both found over 100 times in the dataset in this interaction dimension. Tweets containing Anchoring and Adjustment digital nudges achieved 272, the second highest average retweet frequency. Tweets with Commitment Cues, Monetary Incentive and Simple to Process Visualisation digital nudges on average reached the least retweet frequencies. This was even less than

tweets that did not contain any nudging category at all. Tweets missing nudges were retweeted 70 times on average.

Various topics were identified within our dataset. The main content of the analysed tweets dealt with warnings, advice, and crucial information regarding the bushfires (90 tweets), political topics (90 tweets), climate change (48 tweets), the firefighters (38 tweets), as well as calls for help, awareness and coverage (33 tweets) and animals (23 tweets). More specific topics were comparisons to other fires (9 tweets), and the budget cuts for the NSW Rural Fire Service (RFS) (8 tweets).

Information, Advice and Warnings were shared mostly in the form of official statements by the RFS or as articles by media services and governmental institutions. Tweets which included information, advice and warning were shared most often when they contained Messenger Effect (131 times on average), Striking Visual (144 times on average), Visual Cues (143 times on average), Position of Crucial Information (138 times on average), and/or Simple to Process Visualisation (120 times on average) digital nudges.

In tweets about *Politics and Government*, most used were Framing nudges (53 times). However, tweets about this topic which included Striking Visual (300 retweets on average) and

Table 3 Occurrence, retweet count and average retweet frequency of the digital nudging categories

Digital nudge in social media	Total frequency of occurrence	Absolute retweet count	Average retweet frequency per tweet
Anchoring & adjustment	16	4358	272
Striking visual	130	31,649	244
Status quo bias	5	1167	233
Visual cues	40	7232	181
Framing	191	28,409	149
Position of crucial information	61	8970	147
Social norms	12	1507	126
Messenger effect	105	13,043	124
Simple to process visualisation	22	2440	111
Emotive wording	61	6562	108
No nudge	51	3523	69
Monetary incentives	4	217	54
Commitment cues	3	136	45

Visual Cue (301 retweets on average) digital nudges were retweeted the most relatively to tweets which contained other digital nudges.

It was also dealt with missing awareness, coverage and virality of the NSW bushfires. This topic was covered in C-C communication, mostly by private persons or public

persons who could be identified as activists. Next to that, calls for help were made via Twitter. Tweets about these topics which contained Striking Visual (685 retweets on average) and Framing (435 retweets on average) nudges were retweeted most often on average, followed by the one tweet which contained a Visual Cue digital nudge (361 retweets on

Table 4 Occurrence, retweet count and average retweet frequency of the digital nudging categories in the communication and interaction dimensions

Digital nudge	Agency to community (A–C)			Community to agency (C–A)			Community to community C–C		
	Total frequency of occurrence	Absolute retweet count	Average retweet frequency per tweet	Total frequency of occurrence	Absolute retweet count	Average retweet frequency per tweet	Total frequency of occurrence	Absolute retweet count	Average retweet frequency per tweet
Anchoring & adjustment							16	4358	272
Striking visual	9	1516	168	6	734	122	114	29,250	256
Status quo bias							5	1167	233
Visual cues	31	5199	168	1	411	411	8	1622	203
Framing				4	647	161	187	27,760	148
Position of crucial info.	34	5929	174				27	3246	135
Social norms							12	1507	126
Simple to process vis.	16	2095	129				6	345	58
Messenger effect	61	9109	149				41	3715	90
Emotive wording				3	560	187	58	5698	98
No nudge				1	29	29	50	3492	70
Monetary incentives							4	217	54
Commitment cues							3	136	45

average) and tweets with Anchoring and Adjustment nudges (276 retweets on average).

Animals were also often the centre of attention in tweets. People asked other community members to provide help for animals, videos of koala hospitals were shared, numbers of animals that perished were shared, and awareness that the habitat of many species was being destroyed was spread. Tweets which contained Emotive Wording digital nudges were shared most often regarding this topic and were measured by the average retweet count which was 114 times on average.

6 Discussion

All in all, various digital nudges were found in the EDC of our Twitter dataset. Since it is difficult to identify to *what extent the nudges influenced the decision-making behaviour of the nudged users offline*, we analysed the number of *average retweets as a proxy measure for this behaviour*. Table 5 gives an overview on the digital nudges found in the user-generated content on Twitter inclusively the main intents with which they were used and potential use for future EDC.

6.1 How Is Digital Nudging Used in Social Media During Emergency Events and Disasters?

Looking at all data, tweets with Anchoring and Adjustment digital nudges were the most successful regarding the average retweet count. In such tweets, the anchors were the fire of Notre-Dame de Paris in 2019, the 2019 Amazonian rainforest wildfires, or the California fires in 2019. Against the background of asking for awareness and expressing desperation, these anchors seem to be effective in leading users towards making the decision to retweet the tweets along with providing awareness and visibility, at least in the digital environment. The second form, that was the most successful in terms of retweets, was the Striking Visual digital nudge. Usually, the contents referred to the degree of devastation, the helplessness of the animals, the efforts of the firefighters and desperation of affected individuals. Interestingly, the Status Quo Bias, although in theory being one of the most popular effects, only was found to be nudged in five tweets in total. However, it was the third most successfully used digital nudging form found in the dataset. *The Status Quo Bias digital nudge therefore seems to be a promising candidate for steering decisions in EDC.*

There were also 51 tweets found in the data which did not contain any nudge at all but counted on average 70 retweets. In contrast to previous research results (Suh et al., 2010), the number of followers does not seem to relate to the statistics of retweets here. The mostly shared tweets in this category were authored by Twitter users with a small number of followers and vice versa. An explanation might be due to the special

setting in which the digital nudges are designed in user-generated content on social media platforms. The tweets which have been assigned to include no nudges might contain nudges that were not identified yet. Possibly, new information, design and interaction elements have not been considered as this work draws on digital nudges and psychological effects that were already identified in other decision-making contexts and choice environments. Since current digital nudging definitions focus on user-interfaces as the choice-environment (Lembcke et al., 2019; Meske & Potthoff, 2017), they might have to be broadened in the social media context regarding user-generated content.

Looking at the usage of nudging in different dimensions of interaction and communication according to Ahmed (2011), the most used digital nudges in C-C dimension were Framing nudges. Compared to other digital nudges in C-C dimension, Framing nudges were moderately effective with regard to the number of retweets. The already discussed Striking Visual nudges, in contrast, were second most used after Framing digital nudges. With 256 retweets on average, they were the most successful following the Anchoring and Adjustment nudges.

The Messenger Effect nudges in the C-C dimension were found in tweets authored by famous public persons like celebrities or bloggers. Next to that, politicians and users who are highly engaged to activities of climate change were identified. In the C-C dimension, the tweets with Messenger Effect digital nudges led to 90 retweets on average. In A-C dimension those tweets led to 149 retweets on average. The difference in the average retweet count between the interaction dimensions might be explained due to the central role the NSW RFS plays in bushfire disasters as they are the first response combat agency and this would match previous findings by Mirbabaie et al. (2014). The RFS authored most of the tweets found in A-C dimension which include a Messenger Effect nudge. All in all, the Messenger Effect digital nudge can be seen as an effective nudge, however, it is a nudge authors do not have influence on: An author is either or is not central to a certain topic or is respectively famous or popular so that their message has an impact on the receivers.

The two nudges with a lower average retweet count were only used in the C-C communication dimension. Monetary Incentive digital nudges occurred in two ways: by offering free access to their articles, users were provided the opportunity to save money and users were encouraged to donate voluntarily. Although Monetary Incentive digital nudges did not lead to a high average number of retweets, it might be possible that these nudges affected the users decision-making behaviour apart from their social media involvement. The same assumption comes up for the Commitment Cue digital nudged tweets. An example for these types of nudges was the demand to give shelter to cats and dogs. The realisation of this appeal does not depend on a tweet or retweet. Therefore, both nudges

Table 5 Digital nudges found in the user-generated social media content, intent in use and potential use for future EDC

Digital nudge in social media	Intent in use	Known/new from this study	Potential use for future EDC
Anchoring & adjustment	Highlight the devastation on the bushfires	New	Anchors as best practice examples to get people to make certain decisions, e.g. leave early enough
Striking visual	Get attention; underline statements	New	To distribute information, advice, warning; nudge media organisations towards sharing
Status quo bias	Get people to make certain decisions, e.g. leave the area	New	To get people to make decisions, to get people to give feedback
Visual cues	Enable a quick understanding of what the message is all about	Known	To distribute information, advice, warning
Framing	Draw attention to specific aspects, arouse interest in more information	New	Highlight special information to get people to make certain decisions; nudge media organisations towards sharing
Position of crucial information	Bring important information into the focus	Known	To distribute information, advice, warning
Social norms	Get people to help other people and animals	New	Get people to act in solidarity, e.g. help their neighbours
Messenger effect	/	Known	Distribute important messages
Simple to process visualisation	Make complex contents easily and quickly understandable	Known	To distribute information, advice, warning
Emotive wording	Evoke sympathy, compassion, understanding	Known	Make things more comprehensible and steer people towards certain decisions, e.g. leave the area
Monetary incentives	Collect donations	Known	Get people to donate to preferable organisations
Commitment cues	Make people rethink their behaviour; get them to help others	New	Get people to make the right decisions, e.g. help animals

could be suitable for EMA EDC, but this would need further examination.

Looking at the different topics dealt with in the tweets, some features became noticeable regarding digital nudging usage and its effectiveness. *It would seem that different types of digital nudges are more suitable for specific topics.*

Tweets that included information, advice and warning, were most often tweeted by EMAs, therefore primarily containing a Messenger Effect digital nudge. Tweets with this nudge led to 131 retweets on average. Next to that, 35 of the tweets also included Position of Crucial Information digital nudges which led to 138 retweets on average. Twenty eight tweets contained Visual Cue digital nudges that led to 143 retweets on average. The Striking Visual digital nudge was only used ten times in tweets dealing with information, advice and warning, but these also count 144 retweets on average. These nudges therefore seem to be promising in order to affect other user's decision making when it comes to information, advice and warnings, at least in terms of spreading the message, however, *the correlation between nudging and users' decisions made offline still remains unclear.*

Tweets in which the authors called for awareness, coverage and help were most successful regarding their average retweet count when they contained Striking Visual and Framing digital nudges, whereas both led to over 500 retweets on average. The high retweet count can perhaps also be explained by the fact that the decision to pay attention and provide coverage

was nudged. This behaviour is shown in the context of Twitter through retweets.

6.2 How Can Digital Nudging be Used in Emergency and Disaster Communication in Social Media to Support Emergency Management Agencies Goals?

In regard to the provision of information, advice and warnings in tweets, Position of Crucial Information, Visual Cue and Striking Visual digital nudges have shown to positively impact the decision-making process in terms of retweeting. These nudges were frequently used by the NSW RFS through commonly interpreted signal colours, ratings, comprehensible maps and eye-catching visuals to support the messages they were about to spread. Additionally, they highlighted the most crucial information of their message. This consistent usage of stylistic elements led to overall high retweet counts. Therefore, the use of these digital nudges can be seen as effective.

However, even if the people do get the message through the use of these nudges, they often do not feel unsafe or endangered if they do not see the effects of the crisis directly, so their tendency to act cautiously may be low and they may hesitate to make a decision or take an action that is appropriate to the situation. In order to resolve this problem, the Status Quo Bias nudge might be a good choice to use, as this nudge aims to overcome the inertia that goes with the path of least resistance

(Balz et al., 2014). As nudges which address the Status Quo Bias have been shown to be effective many times in offline context, the usage of such nudges seems to be promising, not only to nudge the decision to retweet, but also to take offline action and to (for example) evacuate. Moreover, emotions have been shown to impact the retweet count (Berger & Milkman, 2010) and Emotive Wording nudges are effective when used in combination with a mentioned concrete decision (Esposito et al., 2017). Thus, this nudge could also be suitable to steer people towards better decisions if attached to information, advice and warning. Another nudge possibility to apply might be the Relevance of Information digital nudge. This nudge was not found in the dataset but adding the importance to take action to the message could possibly nudge users. It has been shown to impact decisions effectively when advice is added with an explanation of why it was relevant, in case of a natural disaster (for example) to evacuate (Furnell et al., 2018).

However, when decisions are executed, they will not necessarily be reported. As a consequence, EMA are lacking an instrument to measure their impact. EMA assume that their impact is based on users' reactions such as comments. Again, the Relevance of Information nudge might be suitable to address this problem. With the help of this tool the importance of a measurable response could be stressed. Users could inform EMA about their actions using comments or direct messages, thus required feedback is ensured.

A further opportunity arises with the utilisation of social media during emergencies and disasters for EMA. We know that the general public shares useful real-time information. EMAs could make use of this information to make fast and accurate decisions about crisis situations and thus improve their EDM (Nalluru et al., 2019; Nikolova & Zlateva, 2018).

To ensure that they make the right decisions on time, the identification and analysis of trustworthy and reliable information is crucial but it also still one of the hardest challenges for emergency managers (Hofeditz et al., 2019).

As described in Section 2.2, the diverse quality of the user-generated content on social media platforms is a barrier here (Lazreg et al., 2018; Stieglitz et al., 2018b). User-generated content that is not meeting the high standards of information sources that are expected by EMAs are problematic (Stieglitz et al., 2018b). The same applies for unreliable and false information and rumours which are likely to be spread throughout networks and which have led to increasing concern during the last few years (Hofeditz et al., 2019; Lazreg et al., 2018). Digital nudges might help one step further to avoid the production and spreading of false information as well as help to alter the shared information generated by the general public so that by EMAs required standards for information quality and trust are matched. Again, the Importance of the Relevant Information digital nudge seems to be suitable to ask the general public for accurate, reliable and trustworthy information.

As Twitter has been found to be a channel that EMA communicate on not only with the general public but also with media institutions (Marx et al., 2018), they could also directly nudge media and news agencies to use and spread their critical information about the situation as well as prepared additional material. Striking Visual digital nudges seem suitable for this purpose, as media and news agencies work a lot with them and Framing techniques as our findings have shown.

In conclusion, the results show that digital nudges can contribute to more effective EDC in that EMA can use them to increase the visibility of their own tweets. Thus, the crucial information they need to communicate can reach more people and their decision behaviour impacted and influenced. Moreover, content-related requirements of EMA as well as decisions to be made offline can be possibly nudged in a social media context. This could be further investigated in future research.

7 Conclusion

This work investigated how digital nudging take place in user-generated content on Twitter during a natural disaster. Our motivation was to examine the potential that digital nudges have for EMA EDM efforts. A qualitative content analysis on social media Twitter data of EDC during the Australian bushfires in November 2019 was conducted. The aim was to provide first insights into the usage of digital nudges in user-generated content on social media as well as to identify problems in social media EDC by EMA.

Overall, 12 categories of nudges have been identified in our dataset. The effectiveness of the nudges was analysed using the average retweet count as a proxy measure. The usage and effectiveness were analysed regarding the different interaction and communication dimensions according to Ahmed (2011). It was shown that specific nudges were predominantly used or not used at all in different dimensions. Lastly, it was also found that various digital nudges were used and were also distinctly effective regarding specific topics which were communicated in the tweets.

The digital nudges found in this work with their effectivity depending on content and purpose can be used by EMAs to (1) increase the visibility of their messages, (2) nudge people to give them feedback about the decisions they made, (3) nudge them to provide valid and important information, (4) make faster and more effective decisions themselves, and (5) improve their EDC.

7.1 Theoretical and Practical Contributions and Implications

One major theoretical contribution is the provision of additional knowledge about digital nudging in the area of disasters

and emergencies. Before our study, digital nudges have only been examined in the user-interface, where choice architects had the possibility to design and change them. Definitions, guidelines and tests regarding the effectiveness on the decision-making process have been created in the assumption that the user-interface builds the choice architecture which can be influenced by the choice architect. However, in social media settings normal users do not have any possibility to change the user-interface. Their choice architecture is the posting function i.e. the tweeting function in this study. Therefore, this study adds to knowledge as it is one of the first to explore a new choice architecture and digital nudges in user-generated content on social media.

In conducting this study, five digital nudging forms have been identified next to those found in the SLR on digital nudges, namely (1) Anchoring & Adjustment, (2) Striking Visuals, (3) Status Quo Bias, (4) Framing, and (5) Social Norms. These forms have been shown to successfully nudge users towards the decision of retweeting content. Moreover, digital nudging has been applied to a new field and is examined in the context of EDC for the first time. The findings provide initial insights into what nudges seem to effectively tempt people, in extreme situations, to make decisions in the interest of their own and others' safety as well as how they can be applied in a social media context.

Also, this work contributes to IS research as it adds to the body of knowledge in EDC and the use of technologies in EDM. Previous research focused on how EMA communicate with the general public and which role they have (e.g. Hughes et al., 2014; Mirbabaie et al., 2014). Others have analysed social media data to infer certain aspects of user behaviour (e.g. Marx et al., 2018; Mirbabaie & Youn, 2018). Further research emphasis was placed on information and data aspects and how EMA can use such information (e.g. Ehnis, 2017; Stieglitz et al. 2018c), and finally our study highlights the challenges the EMA face, but also which opportunities social media brings to their EDC (e.g. Fischer et al., 2016; Lazreg et al., 2018; Stieglitz et al., 2018b).

Until the completion of our study, however, nothing was known about the potential of digital nudges in EMA EDC and how the problems they face can be addressed by nudges to support the EMA goals. Our work provides the first insights into nudging usage in social media EDC as it shows; (1) what forms of digital nudging were used in the our dataset; (2) the communication and interaction dimensions in which digital nudges are used; and (3) in relation to what type of content the digital nudges were used.

Looking at all tweets in our dataset, and without considering any other variable, it was found that Anchoring and Adjustment, Striking Visual, and Status Quo Bias digital nudges were most effective. Each of those nudges led to between 230 and 272 retweets on average, however, the most used nudge was Framing with 191 occurrences, followed by

Striking Visual nudges with 130 uses. Our analysis also revealed that the usage of some digital nudges in combination with each other leads to more retweets on average than using only one nudge. In general, the usage of nudges is more effective regarding the retweet frequency than using no nudges at all.

This study provides insights into how digital nudges are used in social media EDC, highlighting which of them are effective in what context, and therefore how social media users can be influenced in their decisions during emergencies and disasters. Furthermore, this work reveals how social media as a technology can be used to impact people's decisions during an extreme event. The knowledge about digital nudging usage in social media EDC also expands the understanding of EDC in general as some behaviours are more comprehensible against the background of digital nudging. For example, the missing application of Visual Cue or Position of Crucial Information nudges could explain why some tweets are retweeted less than others, although they contain crucial information.

In addition, this work also adds to the interdisciplinary body of knowledge as it extends the comprehension of digital nudging specifically in IS. This work is one of the first to examine digital nudges in social media domain, but also in terms of user-generated content. Next to that, as concrete design principles for digital nudges are still missing in IS as well, this study provides insights into how digital nudges can be designed when the choice architecture is not a user-interface but a posting function. It has also identified new forms of digital nudging which may effective when creating design guidelines.

The knowledge about digital nudges gained through this work also has implications for practitioners, since it shows how social media can be used by EMA in order to support the emergency management goals through digital nudging. Previous research has focused on the analytics and tools to face the problems of quality and quantity of data to be identified and analysed during emergencies and disasters (e.g. Nalluru et al., 2019; Purohit et al., 2013; Stieglitz et al., 2018b). The findings of our study, however, explain how EMA can address this problem through the application of content nudges. Digital nudges can be used by them to influence social media users; (1) towards sharing relevant, reliable information that matches their requirements; (2) towards telling the EMA about the decisions they are making; and, of course, (3) towards spreading the message or downloading important applications to spread EMA messages. For example, Visual Cue and Position of Crucial Information digital nudges have been shown to be effective – measured on the average retweet count – when it comes to distributing information and warnings. Next to that, Status Quo Bias digital nudges could be a promising approach to get people to download relevant emergency management phone applications so that they always get crucial information on time.

7.2 Limitations and Implications for Further Research

This study gives valuable insights into the use of digital nudges both within user-generated content and in EDC. Nonetheless, this work has inherent limitations and suggestions for further research. This study outlines an initial qualitative study from a small Twitter dataset over a two-day peak communications period. Since such peak periods require fast and effective decision making, the results of this work are highly relevant, but boundary conditions like the timeframe, have to be taken into account and should be addressed in future research. Moreover, it remains in question if digital nudges in social media EDC also effectively nudge decisions which require actions apart from retweeting i.e. physical activities. Future research needs to consider other

variables to measure decision-making and the effectiveness of the digital nudges which might include observing and studying individual and groups of social media users in experimental and live settings.

Apart from the inherent limitations mentioned, this work provides valuable insights into how digital nudging takes place in social media and how it can be used by EMA in order to enrich their EDC. With this knowledge, further opportunities for research have been identified. In future, not only the users who nudge, but also the users who get nudged should be studied to gain more insights into the effectiveness of the digital nudges used in social media settings.

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Appendix A

Table 6 Underlying psychological effects of digital nudges (Mirsch et al., 2017)

Psychological effect	Description	Frequency
Framing	Design of decision-making problems with framing methods: To frame is to select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described. Different formulations of a message – with the same content – influence the behaviour of the recipient differently	34
Status quo bias	Strong tendency to remain with status quo	30
Social norms	Rules and standards that control people's behaviour without the power of laws	15
Loss aversion	Losses/disadvantages have bigger impact on choice preferences than gains/advantages	13
Anchoring & adjustment	Anchor = a specific piece of information; the information may be formed by the person concerned from the circumstances or obtained from another person, or it may be present purely by chance. It is crucial for assessing a situation and making decisions. It is irrelevant whether the information is actually relevant and useful for rational decision-making	7
Hyperbolic discounting	People act inconsistent in time, value presence more than future	7
Decoupling	Costs for choice are included in the decision but maybe not straightforward, credit e.g. more difficult than cash, because payment is decoupled from consumption	6
Priming	Influencing the processing of a stimulus. Mostly, a preceding stimulus activates implicit memory content Affective priming: processing of subsequent stimuli is influenced because emotional states were activated by preceding, "priming" stimulus semantic priming: activation of conceptual associations, for example word fields	6
Availability heuristic	Tendency to assess the probability of events based on how easily something can be accessed	5
Commitment	Persons act in a self-committed manner if they are firmly in favour of action or decision; willingness to behave increases	4
Mental accounting	People divide their financial transactions in different accounts and treat all of them differently	4
Optimism & over-confidence	Tendency to believe that one is less at risk for something than others Trust of a person in their abilities is greater than objective accuracy	4
Attentional collapse	Tendency to imagine the future wrong because of mental comparisons made. In the end different experience than expected because there is no time to think about alternatives	3
Messenger effect	The messenger and their social position affect the decision-making process	3
Image motivation		2
Intertemporal choice	The process of deciding what and how much to do at different times when decisions made at one point in time affect opportunities at other points in time. These decisions are influenced by the relative value attached to two or more payouts at different points in time	2
Representativeness & stereotypes	The degree of familiarity with a structure or selectable option influences decisions: on the basis of ideas and thought patterns that are firmly anchored in the brain and are no longer questioned in our daily thinking, perception and decision-making processes	2
Endowment effect	Tendency to value a good more when one owns it	1
Spotlight effect	Tendency to believe that people pay much more attention to you than they do	1

Table 7 Concept-matrix of the systematic literature review

Database	Article	Field of application							Digital nudge		
		Consumer psychology	Enterprise	Gaming	Health	Pro-envir. behaviour	Security and privacy	Social media	Design	Information	Interaction element
Web of Science	Bergman et al. (2019)		X								X
SpringerLink	Choe et al. (2018)						X		X		
Web of Science	Dantzig et al. (2013)				X				X		
Scopus	Esposito et al. (2017)	X							X	X	
Web of Science	Furnell et al. (2018)						X		X	X	
AISel	Henkel et al. (2019)					X				X	X
AISel	Huang et al. (2018)							X	X		X
Web of Science	Kim and Dennis (2019)							X	X	X	
Web of Science	Kretzer and Maedche (2018)	X							X		
Web of Science	Malhotra et al. (2016)	X							X		X
Scopus	Niederberger and Champniss (2018)	X								X	
Web of Science	Schneider and Graham (2017)			X					X		X
AISel	Schneider et al. (2017)						X		X		
AISel	Székely et al. (2016)					X			X		X
AISel	Terres et al. (2019)		X						X		
ACM	Ur et al. (2012)						X		X		

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