



DIGITAL NUDGES AND EFFECTS ON
CONSUMER BEHAVIOR:
A LITERATURE REVIEW

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MARVIN MESSENZEHL

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Reviewer: Prof. Dr. Hartmut Höhle
Supervisor: Florian Pethig

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List of Abbreviations

AIS	Area of Information Systems
CCH	Consumer Choice
EDU	Education
FIN	Finance
GOV	Government
HCI	Human Computer Interaction
HEA	Health
Lab	Laboratory
MISC	Miscellaneous
PSB	Pro-social Behavior
SCP	Security and Privacy
SUS	Sustainability
TRA	Transportation
UI	User Interface
UT	University of Texas
UX	User Experience
VHB	Verband der Hochschullehrer für Betriebswirtschaft

Abstract

1 Introduction

It is a typical Sunday afternoon. John is sitting on the couch, watching the match of his favorite soccer club on TV. On his lap, he is holding his tablet while browsing the internet. John is looking for a good travel deal for his upcoming trip to Bali with his girlfriend. On a news site, a prominent and bright advertisement catches his attention: *Booking.com - From cozy country homes to funky city apartments*. That is precisely what John is looking for. He clicks the link and finds himself on a website full of amazing images of traveling people. Moreover, there is a search field, too. John enters his dream-destination, the travel time and clicks on "search." After some seconds a list of hotels shows up. The first one catches his eyes. A beautiful beach, a nice pool and cozy, big bedrooms. Perfect. He clicks on the details. However, John is starting to become nervous. A bright, red piece of information is saying to him that this room has been booked three times in the last twelve hours. Also, there are only seven rooms left! His heart beats faster. He needs to get that deal! John clicks on the reservation button. He just has been nudged¹.

Johnson (2012, p.488) states that "what is chosen often depends upon how the choice is presented." This representation describes as the term of choice architecture, which should "alter people's behavior in a predictable way" (Thaler and Sunstein 2009, p.6). In the age of digital transformation, digital environments are powerful tools where the choice architecture can be controlled in detail and therefore provide opportunities to influence user behavior in several ways with the help of user-interface design elements. This process is called "digital nudging" (Weinmann et al. 2016).

Digital nudging and the design of online choice architecture have recently gained interest in different research areas. Because of the complexity behind this concept, it is significant to understand how such nudges influence the decision-making of the user and how the cognitive biases behind this process are working. Especially in consumer choices, there are good and bad patterns of nudging when it comes to an ethical point of view (Sunstein 2015). To get a better understanding of how digital nudges influence consumer choice this paper presents a systematic literature review of the last ten years.

The goals of this paper are two-folded. The primary aim is to provide an overview of different research streams within the topic of digital nudges. The paper focuses here on digital nudges in the area of consumer choice and their specific design elements. Literature

¹A screenshot of the web page can be found in the appendix on Figure 1

in this domain shall be gathered, reviewed and analyzed. Different target groups can, such as product designers, managers and user interface designers, can use this knowledge to implement nudges in digital application more thoughtful and efficient. Furthermore, the correct use of nudges in combination with design elements can increase user experience, customer satisfaction and therefore conversion rates for digital products.

Secondary, a recommendation for future research is derived from the analysis to advance research in this particular subject. Because of its multidisciplinary nature, research on digital nudges may contribute to several scientific domains, such as information systems, psychology, and behavioral economics.

2 Conceptual Background

2.1 Birth of Nudges

With the release of the book "Nudge" in 2009, Thaler and Sunstein have laid the foundation for the concept of nudging. This concept was primarily a subject of research in behavioral economics. Because of the multifaceted meaning of the word *nudging*, a consistent understanding is essential. Further on, this paper uses the central definition of nudges from Thaler and Sunstein (2009, p.6): *"A nudge [...] is any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives."*

One central aspect of this definition is the economic incentive of the consumer, which should not be changed. This fundamental thought is the basis of a concept called *libertarian paternalism*. In this concept, choices are influenced in a way to make them easy for people and aligning them with their interests. One example of that would be "putting the fruit at eye level" (Thaler and Sunstein 2009, p.6). However, banning the food would not be a nudge. This principle is the foundation of nudges for a good reason. Influencing people's behavior can simply be exploited. So, the ethical viewpoint on nudges should always be kept in mind when implementing and using them to guide customer choices (Sunstein 2015).

The underlying foundation for nudging the cognitive limitation of human brains. Because the human brain only has a limited capacity to store and process information, the consumer often feels subconsciously overloaded. This results in greater difficulty and complexity when it comes to decisions and cognitively demanding tasks (Broniarczyk and Griffin 2014). Therefore "many decisions are based on beliefs concerning the likelihood of uncertain events (Tversky and Kahneman 1974). Based on this assumption Tversky and Kahneman 1974 formulated three heuristics and several biases that build the underlying foundation of human decision making. Those heuristics and biases can also be found acting as a guideline in the world of digital nudges.

Besides the cognitive foundation of decision making, also the principles of nudges play a major role in their application and implementation. Overall, there are five general principles of nudging (based on Thaler et al. 2010)

Incentive Those kinds of nudges aim to make incentives more salient to increase the effectiveness of the nudge. The focus lays on the motivation behind the decision. The nudge should always search for the right motivation for the right people. This motivation goes beyond monetary and material incentives.

Understanding mapping Making the consequence of a choice clear is an essential part of easing the decision-making. Mainly, this concerns complex information that is difficult to evaluate. For example, the number of megapixels of a camera. Frequently, customers cannot evaluate this information directly and only compare on a single number. A rational mapping would be to display the maximum printable size of a taken picture. This way, the product attribute can be compared efficiently.

Defaults The pre-selection of certain information has enormous power. By changing the default option, consumers are more likely to choose that near to the selected default or even is the default. One prominent example of such a nudge is the question if people want to consent to be an organ donor. Simply by changing the default option, in this case, can nearly double the percentage of organ donors (Johnson and Goldstein 2003).

Giving feedback By giving feedback during the decision-making, people can evaluate their performance and estimate the output or consequences of the decisions they face. Such an example can be found in an experiment for pre-ordering lunch in a school. Students arrange their lunch with different kind of foods. According to this arrangement they receive feedback about how balanced and healthy their food compilation is. Only based on this feedback, students selected significantly more fruits and vegetables in their meals (Miller et al. 2016).

Expecting error Precisely because of the underlying complexity of the decision-making process, it is necessary to expect errors to be made. Such errors should be taken into account when designing a decision, and the environment should be as forgiving as possible. In complex choice environments, such as the food of healthy and balanced food, many people make mistakes. By giving direct feedback on those errors and providing information on how to improve the performance, this decision can be made easier (Guthrie et al. 2015).

Structure complex choices Another difficult task in decision-making is to compare different product alternatives. By listing all attributes, people can evaluate trade-offs and make better decisions, based on their interests. In a field experiment, researchers evaluated the effect of such a nudge in a bar, when it comes to craft beer choice. By listing product more product attributes that naturally describe the taste, people could decide easier what they want to order (Malone and Lusk 2017).

2.2 (Online) Choice Architectures

The concept of nudges builds on the assumption that decisions are made in choice architectures, which are designed by choice architects (Thaler and Sunstein 2009). In this case, the parallel to a "real" architect of a building is not far-fetched. Johnson et al. 2012 describes the power of such choice architects and how choice architects guide people's choices like other architects guide behavior through the design of the "placement of doors, hallways, staircases, and bathrooms. Just like in a hotel or building, "there is no neutral architecture" (Johnson et al. 2012) for choices. Even small things like a default choice affect the decision which is made by the user. The mobile payment app Square, for example, nudges people into giving tips only by setting a default value. This way, customers actively must select a "no tipping" option if they do not want to give a tip (Weinmann et al. 2016). "Because advances in technology and the user of the Internet also provide new ways of finding, creating and exchanging information [...]" (Broniarczyk and Griffin 2014) people automatically shifted a majority of their decisions in the online or digital world. However, those digital environments are not less complex. Just like in offline environments, there is no neutral way to present choices. Therefore, any user interface can be viewed as a digital choice environment (Schneider et al. 2018). This ranges from the positioning of elements, the colors in the interface, the language, even the design elements themselves and beyond.

To get a better understanding of how such choice architectures can be built up and what elements are available, Münscher et al. 2016 created a taxonomy of choice architecture categories and their techniques. Overall, there are three major categories with several associated techniques.

Decision information The first level of choice architectures targets the "presentation of decision-relevant information" (Münscher et al. 2016). One important aspect is that

this category only includes the presentation and no altering of the options itself. Techniques for that choice architecture category are the translation of information, visibility of information and the providence of social reference points

Decision structure Secondly, choice architects directly modify the available options of choice itself. This modification includes techniques like choice defaults, the related effort and consequences of an option and also the range of composition and options.

Decision assistance Lastly, choices can be designed in a way that consumers follow their intentions. Techniques for such assistance can be the fostering of a commitment or by providing reminders of the preferred behavior.

2.3 Nudging became digital

Because various choices we take today "involve some form of information technology" (Johnson et al. 2012), the concept of nudging recently gains interest in research of different disciplines. Thereby, the underlying concepts of "offline" nudges are transferred and adapted in digital environments. The result is digital nudges. According to Weinmann et al. 2016 digital nudges are defined as follows:

Digital nudging is the use of user-interface design elements to guide people's behaviors in digital choice environments.

Just like in the offline and analog environments, digital environments face multiple sources of decision difficulty such as task complexity, information load, information uncertainty, conflicts, emotional difficulty and preference uncertainty (Broniarczyk and Griffin 2014). To face those challenges in digital environments, the use of cognitive heuristics and biases can act as a baseline to design digital nudges. Different user-interface design elements facilitate different nudges. Table 1 gives an overview of the different biases, in which way they influence decision-making and how those are translated to specific design elements.

Even though nudges aim to influence behavior in digital environments, they should not be mistaken with persuasion. A persuasion is instead a form of human communication, that is also used in technology. The goal of this technique is also to influence user behavior, but more persistently, so that underlying attitudes are influenced (Oinas-Kukkonen and Harjumaa 2009). Although both concepts share similarities, this paper solely focuses

Heuristic / Bias	Example Design elements and mechanisms
Status quo bias	<ul style="list-style-type: none"> - Radio buttons - Checkboxes - Dropdown menus - Sliders with default position - Pre-filled inputs
Decoy effect	Presentation of options in: <ul style="list-style-type: none"> - Radio buttons - Checkboxes - Dropdown menus
Primacy and recency effect	Positioning of elements (earlier or later)
Middle-option bias	<ul style="list-style-type: none"> - Addition of higher- and lower-price alternatives around the preferred option. - Ordering of alternatives. - Modification of the option scale.
Anchoring and adjustments	<ul style="list-style-type: none"> - Variation of slider endpoints. - Use of default slider position. - Predefined values in text boxes for quantities.
Norms (moral / social)	<ul style="list-style-type: none"> - Display of popularity (social norms). - Display of honesty codes (moral norms)
Scarcity effect	<ul style="list-style-type: none"> - Use of default slider position. - Language and displaying additional information about quantity and availability

Table 1: Heuristics and Design elements of digital nudges (based on Schneider et al. 2018)

on digital nudges and the decision-making process. An ongoing influence on underlying behavior is still possible, but not directly part of a nudge and therefore not further evaluated.

3 Methodology

This literature review follows a systematic approach, that is well-established in the discipline of information systems (Webster and Watson 2002). It was done in a limited scope which means that it does not cover all papers and studies of the subject. Rather, this literature review targets a qualitative subset of literature and thereby tries to be as representative as possible. The focus lies on publications of academic journals. To get a qualitative representation of the current research a journal-wise analysis is preferable to a database-based analysis. The overall approach follows a known pattern in information systems literature reviews (Alavi and Carlson 1992).

1. Identifying, reviewing and analyzing existing literature in the field of digital nudges. This includes empirical, as well as non-empirical studies
2. Identifying theoretical and methodological approaches used to understand the use of nudges in consumer choice. This also includes the type of choices and the designed choice architecture.
3. Identifying a research gap within existing literature to guide future research.

To realize this strategy, several variables are necessary to consider while identifying qualitative representative research articles. Digital nudging is a concept that spans across several fields of research. At the same time the understanding as well as implementation and studying differs widely. Therefore, this literature review aims to cooperate different research streams to build a common ground, by identifying and analyzing the most representative research articles in the domain. Thereby search variables are set journal- and paper-wise. A graphic of the screening process is available in the appendix (Figure 2).

3.1 Journal selection

Journal-wise variables are the journal domain and its rating. As suggested in existing literature, it is reasonable to not only look within the field of information systems research but also outside (Webster and Watson 2002). It is reasonable to examine academic journals with the most influence in the research domain. As already mentioned, nudging is a subject of several research streams. This includes research from the area of information

systems, management, marketing, behavioral economics, and psychology. Regarding research about information systems the *AIS Basket of 8* provides a good source (Alavi and Carlson 1992). This basket consists out of eight well-respected journals in the domain. After the AIS scholarly basket, academic journals about management and marketing were recorded in the research process. Thereby, the journal list of the *UT Dallas* was taken as a reference point. Overall, the journal list of the UT Dallas contributes with twelve journals to the research pool. This paper also includes academic journals from the domains of behavioral economics, decision making and psychology (with regards to human decision making) in the research process, to gain further insights into the concept of nudges. The relevant publications are identified by the *VHB* journal rating *JOURQUAL*². Journals with a rating of *B* or better are taken into account for the research. To finalize the list of sources for the upcoming analysis, conference publication from the AIS pool with a VHB rating of *B* or better were included, too. In total 36 journals were examined. A complete list of these journals is accessible in the appendix.

3.2 Paper selection

Paper-wise, only articles with a publication date older than 2010 are concerned. This literature review sets this date because nudging is a rather new concept that first was introduced under this definition in 2009 (Thaler and Sunstein 2009). To obtain relevant articles, a keyword-based search is conducted. The major keywords in this search are *nudg* AND digital*. A full-text search searches all journals. Because the term nudging is not always directly mentioned in the articles, additional keywords are added to the search query if the examined journal does not provide any necessary results with regards to the keyword *nudg**. Those additional keywords are *decision, choice, consumer*. Overall 87 journal articles were found that mentioned the term nudge or matched the described keywords. To extract the most relevant sources, articles were excluded to based on several criteria. This concerns journal papers that only embody offline nudges. Such articles were excluded from the final article list, as well as articles that focus on the topic of persuasion and long-term behavior change. In the end, the final concept matrix evaluates 37 research articles. The complete list of articles is available in the appendix.

²more information under <https://vhbonline.org/vhb4you/jourqual/vhb-jourqual-3/gesamtliste/>

3.3 Analysis approach

To guide the analysis, the research takes several questions into account. The structure of those questions is based on prior literature research. (Alavi and Carlson 1992).

- What is the type of choice?
- What is the research approach?
- What major theories, concepts, heuristics, and biases are used to study the effect of the evaluated nudge and how is the choice guided?
- What part of the choice architecture is influenced?

Concerning the in-depth analysis, a concept matrix codes the extracted articles. To answer the underlying research questions, this paper inspects different categories of the relevant articles. Those categories are

- General research information and metadata
- Influence on choice architecture
- Underlying concepts and theories

A complete version of the coding and concept matrix is available in the appendix.

4 Results

4.1 Overall research output

Since the release of the "Nudge" by Thaler and Sunstein in 2009, the concept of nudges gained more and more interest in several research streams and domains. Table 2 gives an overview of the overall research output. To get a better overview, the domain names are coded with abbreviations. The complete coding of the domain names is available in the appendix in table 8 as well as in the abbreviation section.

Considering the number of published articles, the overall research output increased since 2011. Especially in the last five years, the research has gained interest. On the one hand this can be explained by the increased adoption and knowledge of nudging. On the other hand, there are also more possibilities where digital nudges can be used. More and more domains face digitization. This change leads to an expansion of digital applications and their adoption. Digital nudges also gained awareness in across several domains. Thereby, the primary research within the last ten years is done in the area of consumer choice. Here a digital environment builds a typical buyer/seller relationship, where the application offers a good or service and the user takes the role of the consumer/buyer. One explanation for that is the economic interest behind the concept of nudging. If done right digital nudges are an excellent tool to increase conversion rates and overall revenue. However, the interest in digital nudging also spans across other domains. Especially complex domain, where typically some form of expert knowledge is needed in decision-making. Such an example is the health domain, where five of the overall 37 research articles evaluate the usage of digital nudges. Miller et al. 2016 study the effect of digital nudges within the MyPlate food recommendation systems. Through a feedback nudge during the pre-ordering process, they discover a significant positive effect on the meal composition of students. "Students who received the MyPlate nudge while pre-ordering selected statistically significantly more fruits, vegetables, and low-fat milk than students who pre-ordered without nudging" Miller et al. 2016. Another example of such a digital nudge in a complex field describes Székely and Weinmann 2016. With a nudge in a default choice, the amount of carbon offset payments could increase significantly. Finally, this leads to an environmentally friendly decision.

Publishing year	CCH	EDU	FIN	HEA	PSB	SUS	TRA	SCP	GOV	MISC
2011 (1)	1	0	0	0	0	0	0	0	0	0
2012 (1)	0	0	0	0	0	0	0	0	0	1
2013 (0)	0	0	0	0	0	0	0	0	0	0
2014 (5)	4	0	0	0	0	0	1	0	0	0
2015 (3)	0	0	1	2	0	0	0	0	0	0
2016 (7)	3	0	0	1	1	1	0	1	0	0
2017 (10)	6	0	0	0	2	1	0	1	0	0
2018 (9)	5	0	0	1	0	1	0	1	0	1
2019 (1)	1	0	0	0	0	0	0	0	0	0
Total (37)	20	0	1	4	3	3	1	3	0	2

Table 2: Overall research output across domains

4.2 Research type and methods

While the main focus of this paper is on nudges in consumer choice digital nudges are also used and researched in other domains and fields of application. The different research articles for this literature review use different research approaches and methods. Those articles should be categorized based on Alavi's and Carlson's research classification scheme (Alavi and Carlson 1992). A graphic of this classification approach is available in the appendix (3).

4.2.1 Non-empirical

Non-empirical research	CCH	SCP	MISC
Literature review (1)	1	0	0
Conceptual (2)	1	1	0
Literature review and conceptual (4)	3	0	1
Total (7)	5	1	1

Table 3: Non-empirical research across domains

Non-empirical research includes articles based on the subjective opinions of the authors and literature reviews. They do not include empirically collected data Alavi and Carlson 1992. In the identified basket of literature, there is only one exception, where Gamliel and Peer 2017 which creates a theoretical concept based on a survey. Overall, seven articles can be classified as non-empirical research. This makes ca. 19% of the

findings. Those papers use in particular two different, non-empirical research approaches, namely literature reviews and conceptual studies. The literature reviews are present literature in the field, and their findings, here as conceptual studies describe theories, models or frameworks for the application of (digital) nudges. Four research articles do follow both approaches. Broniarczyk and Griffin 2014, for example, reviews different literature and creates a model that describes which techniques can aid in the decision-making process.

As described in 3 the area of consumer choice contributes the most non-empirical research. Lades 2014, for example, evaluates the theoretical effect of nudges in intertemporal choices and the context of ethical usage. Thereby, he concludes that "self-imposed nudges should be preferred to nudges by third parties." Furthermore, impulsive nudges should be reduced to allow more humane handling of nudges in consumer choice.

4.2.2 Empirical

Empirical research	CCH	EDU	FIN	HEA	PSB	SUS	TRA	SCP	GOV	MISC
Lab experiment (15)	10	0	0	2	1	1	0	0	0	1
Field experiment (5)	2	0	0	1	1	1	0	0	0	0
Lab experiment and field experiment (1)	0	0	0	0	1	0	0	0	0	0
Lab experiment and survey (3)	2	0	0	0	0	0	0	1	0	0
Survey (5)	2	0	1	0	0	0	1	1	0	0
Case Study (1)	0	0	0	1	0	0	0	0	0	0
Case Study, survey and lab experiment (1)	0	0	0	0	1	0	0	0	0	0
Total (31)	16	0	1	4	4	2	1	2	0	1

Table 4: Empirical research across domains

Empirical articles are classified as articles that rely on observation and capture data through different research techniques such as survey, case studies or laboratory experiments Alavi and Carlson 1992. Overall 31 articles emphasize empirical methods and capture or work with some form of data.

Given the context of use, the location is one important aspect to keep in mind. The identified literature shows a clear focus on research in the USA and Europe. Only two studies take place in Asia. This aspect is critical to bear in mind because of different

Empirical research	Decision Information	Decision structure	Decision assistance	Combination
Lab experiment (15)	9	5	1	0
Field experiment (5)	0	1	1	3
Lab experiment and field experiment (1)	0	1	0	0
Lab experiment and survey (3)	1	2	0	0
Survey (5)	2	0	0	3
Case Study (1)	1	0	0	0
Case Study, survey and lab experiment (1)	1	0	0	0
Total (31)	12	9	2	6

Table 5: Empirical research across parts of the choice architecture

underlying mental models and mindsets. Those mindsets demand diverse requirements on the application as well as on the ethical perspective Sunstein 2015.

Laboratory experiments In the findings of the literature, the majority (48%) uses laboratory experiments to evaluate the efficiency and use of digital nudges. A lab experiment describes an artificial setting in which researches can control several variables, manipulate them and evaluate the impact of that manipulation. This kind of research is ideally as a research method for digital nudging. As can be seen from previous parts of analysis, most lab experiments take place in the field of consumer choice. For example, Lee et al. 2014 study the effect of colorful versus monochrome product pictures. The finding of this study is that colorful images impact the product choice in several ways and act as a kind of "psychological nudge." On the one hand, color can pull attention and highlight certain product features. On the other hand, colorful product images can create some abstraction that makes it harder to compare different products. Lee et al. 2014 state that markets have to choose carefully whether to use black-and-white versus colorful imagery in advertisements and online shops. Furthermore, lab experiments with regards to health (Laran et al. 2018; Langley et al. 2015), as well as sustainability (Bruns et al. 2018) and pro-social behavior (Zarghamee et al. 2017) are part of the findings. Focusing on the underlying evaluation of the choice architecture design most lab experiments study the use of nudges concerning decision information, which typically takes place as the first step right

before the decision. Such an experiment is designed by Kretzer and Maedche 2018. This study uses digital nudging in the context of enterprise recommendation agents. A precisely targeted recommendation through a social nudge allows employees to reuse existing document resources more effectively which saves time and costs. This recommendation is a typical influence on the decision information of the choice architecture and nudges the user right at the beginning of the decision-making process. Another vast part of lab experiments shapes the decision structure of the choice architecture. Here, the choice architect manipulates the decision itself, often through the change of choice options. In this part the usage of specific heuristics and biases is common Tversky and Kahneman 1974. One downside of laboratory experiments is the isolated view on the decision-making process. Because of the artificial setting and variables set in advance, those studies only evaluate the effect of a nudge on only one part of the overall decision-making. There is no measurement concerning the digital nudge influence on the whole process.

Field experiment Field experiments provide exactly this natural consideration of the application. In a field experiment, there is only limited or no control on research variables. This problem leads to a realistic view of the evaluation and how the user perceives a nudge. This literature review identifies five field experiments within the findings. The research article of Goswami and Urminsky 2016 combines a laboratory experiment with a field experiment while studying the effects of default effects in donations. Surprisingly, the most optimistic prediction, the significant increase of funds, is not supported. Rather, the study discovers two other effects can. The "scale-back" and "lower-bar" effect. Concerning the influence on the choice architecture, field experiments grant a broad view of the whole decision-making process. Three out of the five field experiments take a look at a combination of choice architecture elements (Miller et al. 2016; Cosmo and O'Hara 2017; Mazar et al. 2018). Cosmo and O'Hara 2017 study the effect of time-of-use pricing models for electricity consumption in households. Thereby, a little, standalone display acts as the UI. This display gives feedback, information, and reminders about the electricity consumption of the user. With this digital nudge that effects all three categories of choice architectures. The finding of the study shows that informational displays cause a reduction in costs.

Survey Survey make only a small part of the research on the topic of digital nudges. This can be explained because of the experimental nature of nudges and survey data is not current. The five surveys in the findings spread across different domains. Additionally, three surveys are done together with a lab experiment. Those experiments take the survey data as a base and further examine the findings. The survey of Hilton et al. 2014 investigates the effect of bonus-malus taxes. In combination with a social guidance nudge, users are drawn towards more sustainable transportation options. Surveys typically evaluate the decision information as well as a combination of choice architecture categories.

Case Study The results of the research identify only one case study. Guthrie et al. 2015 the usage of digital nudges in the form of recommendations. Those recommendations should nudge people towards healthier food choices. Findings conclude that such a nudge works digitally in a better way than non-digital nudges do. Furthermore, the overall food choice is perceived as healthier, whereas the understanding of the information still is an intricate part.

4.3 Theories and concepts used to study nudges

4.3.1 Conceptual Background

Overall, it is difficult to evaluate the conceptual background of the found literature. Digital nudging is a concept that is based on research across several research streams and domains. That is why underlying concepts, theories, and models also spread across different domains. Within the total findings, 29 research articles mention one or more theoretical background concepts they refer to during their studies. All in all, those papers mention 25 different theories. From those 25 theories, models and frameworks the majority is only named once.

The most mentioned theories are the libertarian paternalism (Thaler and Sunstein 2009) with seven mentions, the bounded rationality, a important basic theory for decision making, with five mentions (Simon 1955), the model of judgment under uncertainty with six mentions (Tversky and Kahneman 1974) and the prospect theory with eight mentions (Kahneman and Tversky 1979). All those theories and models have their origin in behavioral economic research and focus on decision making.

For social nudges, the theory of social influence (Cialdini and Goldstein 2004) is

named three times in the findings. The social influence theory "emphasizes the way in which [...] goals interact with external forces". This kind of influence is subtle, indirect and outside of awareness.

Research articles that lay a focus on psychological factors, reference among other things the reactance theory (Brehm 1966), the general evaluability theory (Hsee and Zhang 2010) and the construal level theory (Trope and Liberman 2010). Every single theory is mentioned two times. Brehm 1966 states that the theory of psychological reactance shows "that individuals have certain freedoms concerning their behavior. If these behavioral freedoms are reduced or threatened with reduction, the individual will be motivationally aroused to regain them." This theory provides an important insight into how far nudges should take influence in decision-making and what their boundaries are. The general evaluability theory, on the other hand, focuses on the value system of individuals. It specifies "when people are value sensitive and when people mispredict their own or others' value sensitivity" (Hsee and Zhang 2010). Those insights have important meanings for the design of social nudges. The construal level theory emphasizes cognitive and mental processes with regards to similarity and comparisons (Trope and Liberman 2010).

Furthermore, the majority of research articles in the domain of health mentions the health belief model (Rosenstock 1974). This model evaluates three categories of preventive health behavior. With a focus on mental states, it describes a model with "states which help to account for behavior" in the domain of health. Such insights in behavioral psychology provide essential guidelines for the efficient design of health nudges.

4.3.2 Heuristics and biases

To design a successful digital nudge, some heuristics should be used. Those heuristics as a "rule of thumb" for guiding a choice in cognitive loaded environments (Thaler and Sunstein 2009). In the 37 identified papers, 21 articles reference or use a heuristic in the design and implementation of a digital nudge. Zarghamee et al. 2017 executes the only study that relates to the status quo bias as well as social and mental norms. In this study, two implemented nudges increase the donation to charitable giving about 25%. This gain is achieved with a set default and an additional social nudge that provides a social reference point. The most used form of heuristics are norms which describes the effect that people tend to be influenced by the behavior of others (Schneider et al. 2018).

Heuristic / Bias	Decision information	Decision structure	Decisions assistance	Combination
Status quo bias (5)	0	5	0	0
Decoy effect (1)	0	1	0	0
Primacy and recency effect (1)	0	1	0	0
Middle-option bias (0)	0	0	0	0
Anchoring and adjustments (1)	1	0	0	0
Norms (12)	8	1	2	1
Status quo bias and norms (1)	0	1	0	0
Scarcity effect (0)	0	0	0	0
Total (21)	9	9	2	1

Table 6: Heuristics used across parts of choice architectures

Choice architects can implement nudges that use norms in two way. Social norms and moral norms. Where social norms nudge users towards a social reference point (Wang et al. 2018) and moral norms which tend to emphasize value-based decisions, in a field experiment of 2017 a "pay what you want" pricing model was changed to nudge users to a higher pricing decision at a books store. The result shows that member, who are reminded of their club membership right before the decision, significantly adjust their pricing decision upwards (Gravert 2017).

Five of the 21 research articles that use heuristics and biases in a certain way referred to the status quo bias which is some form of default. Defaults are one of the most efficient forms of nudging (Johnson and Goldstein 2003). The status quo bias shows that people tend to "favor the status quo, so they are less inclined to change default options" (Schneider et al. 2018). One interesting finding of the identified literature is shown by Steffel et al. 2016. In this study, the researchers try to de-bias the effect of a default choice by communicating the nudge transparently. The result shows that it is not entirely possible to de-bias a default choice and that the user is still nudged towards the default value. This result shows the cognitive strength of the status quo bias.

Other heuristics and biases are used less. Such an example is the decoy effect, which has a likely influence on online choice architectures. The decoy effect is, in theory, a perfect technique for digital nudges. By showing an unattractive option besides an attractive one, the user is nudged towards the attractive option (Schneider et al. 2018). Only one

research article studies the effect of this decoy effect. The target environment is a crowd-sourcing platform where users can donate money to an upcoming project. Here, the user has the choice between different "donation-packages" that include some reward for trust and support. With the help of the decoy effect, the study shows that donations can increase by 11% (Tietz et al. 2016).

Another less used heuristic and bias is the primacy and recency effect which describes the effect of the positioning of choice options and interface elements. One research article studies the effect of choice positioning across different sides of the screen. For food choices, the researchers find out that it is more likely to choose a healthy option when it is located on the left side of the screen. Overall, several visual cues play an important role in influencing choices (Romero and Biswas 2016).

Surprisingly, two heuristics often implemented in non-digital nudges are not present in the findings of the identified literature. First, this includes the middle-option bias, which explains that people fronted with three options are most likely to choose the middle-option considering the price. In an offline environment, one can observe this effect in several coffee-shops. Here, the customer typically has a choice between three options in size. Because of the middle-option bias, it is most likely that the customer will choose the medium-sized coffee. Such a bias is also transferable to digital environments, for example in a scenario where the user has to choose between different pricing models or product configurations. Furthermore, none of the research articles studies the implementation of nudge that is based on the scarcity effect. This effect shows that people tend to perceive rare items as more attractive and desirable (Fromkin and Snyder 1980). One crucial aspect of the scarcity effect is a difficult implementation. Users often perceive nudges that build on top of this effect unethical (Sunstein 2015), while at the same time they are instrumental in forcing certain choices. An example of this nudge is described in the introduction chapter.

By mapping those heuristics to categories of the choice architecture, several insights can be made. The first observation is that norms are typically used for decision information. In eight out of twelve cases, norms are used in nudges that provide decision information. At the same time, norms are also efficient when it comes to long term decision and decision assistance. Such a social reference point makes it easier for users to have some orientation. In complex environments, this makes choices more accessible. Other heuris-

tics are more efficient in decision-making when it comes to the decision structure itself. Researchers use all of the five times the status quo bias; it affects the decision structure. Other techniques like the decoy effect and the primacy and recency effect are also used in decision structure. Those techniques influence choices directly when the decision is taken by manipulation the choice option, their outcomes and efforts (Münscher et al. 2016).

4.4 Influence on the choice architecture and decision making

Choice Architecture	CCH	EDU	FIN	HEA	PSB	SUS	TRA	SCP	GOV	MISC
Decision information (15)	10	0	1	2	1	0	0	0	0	1
Decision structure (10)	4	0	0	0	2	2	0	2	0	0
Decision assistance (3)	2	0	0	1	0	0	0	0	0	0
Combination (6)	2	0	0	1	0	1	1	1	0	0
Total (34)	18	0	1	4	3	3	1	3	0	1

Table 7: Choice architecture parts used across the domains

Another important aspect is the influence of the nudge design on the choice architecture. Münscher et al. 2016 classify these parts of decision making in a taxonomy consisting out of decision information, structure and assistance. To guide choices efficient, different parts of the choice architecture according to the part of the decision-making process, For example, it is not perceived as useful to design a nudge for decision information, when the user is directly in the decision process. Such nudges should always be implemented beforehand. Because those decision steps have different requirements, the use of the right heuristics and biases is essential. Table 6 shows the heuristics and biases used to guide decisions in different categories of the choice architecture. Here, the status quo bias is solely implemented in nudges which influence the decision structure. The same holds for heuristics and biases concerning the decision information. Besides the heuristics, several other possibilities to influence the choice architecture to exist. This can be plain informational text and the visibility of information (used by twelve research articles). Also, the translation of information (used by eight research articles) is a simple decision that designers can make to guide choices.

Across the domains, there is no real pattern to be recognized. The vast majority of the research articles explores the impact of choice information on consumer choice. In

this decision environment consumers typically decide on their own, with no need for expert knowledge. Many consumers nowadays use technology to compare different choices and products. Accurate decision information is a powerful tool to guide those choices. However, the simplification of decision information proves to be beneficial in other domains, too. Such an example is the health domain. Langley et al. 2015 studies the effect of decision information in an online forum to nudge users towards a vaccination decision. The finding shows that the decision information provides helpful advice for users, but at the same time demonstrates that vaccination decisions are not taken in social isolation. This experiment implements a very hard nudge, by targeting the user in a digital environment, whereas the decision has to be made in a non-digital environment. For such specific nudges, no literature to date is identified. In terms of decision structure, heuristics such as the status quo bias, the primacy and recency effect, and the decoy effect have proved to be effective. As well as for decision information, research articles use also other choice architecture techniques to implement nudges. With six research articles, the majority manipulates choice defaults to nudge users towards certain decisions. Like mentioned before, defaults provide a valid form of nudging. Other techniques used to design effective nudges are about the choice options, their position, effort and also consequences (Münscher et al. 2016). One of the studies explores the framing effects of intertemporal choices (Faralla et al. 2017). Here the authors try to nudge users towards a more future-oriented decision. Participants of the study have the option between two amounts of money such as "55€ today or 75€ in 60 days". The experiment additionally gives information about an explicit penalty if participants take the money now. This gentle nudge leads towards a more future-oriented decision by changing only the consequences of the choice. Concerning domains, no real pattern can be recognized for the category of decision structure.

A minor part of the research articles studies nudges with regards to decision assistance. Decision assistance can be achieved by providing reminders or facilitate commitment for a choice (Münscher et al. 2016). In a study of 2018 customers were nudged with the help of planning prompts. Those prompts asked for a specified timeframe for paying credit card debts. Within the help of this particular nudge the likelihood for following the set intentions increases significantly. Research articles that emphasize a longer decision-making process or intertemporal decisions often use nudges in the category of decisions assistance.

One crucial finding is that only six research articles use a combination of choice architecture techniques. An effective nudging can only happen if the entire decision-making process is taken into scope of the nudge (Miller et al. 2016; Hilton et al. 2014; Cosmo and O’Hora 2017; Mazar et al. 2018; Basu and Savani 2017; Schneider et al. 2017).

5 Conclusion

5.1 Summary of Findings

The results of this literature review are multifaceted. As shown previously, the vast majority of identified research articles studies nudging in the consumer choice area. Additionally, the superior part deals with empirical research. In summary the studies with a focus on provider overall better information and contributions to the concept of nudging. Empirical studies usually build a useful way of studying the effect of nudges and furnish ways to understand the use of them. With a clear focus on laboratory experiments, researchers limit on an isolated view on the decision-making process and the nudge implementation. Furthermore, it is important to mention, that also other factors than the nudge itself have an important influence on the decision environment so that other variables that do not directly have an impact on the decision should also be taken into account. Dong et al. 2019.

Considering the type of digital nudges, research articles lay a clear focus on default effect and social nudges. With the status quo bias and the norms as most used heuristics and biases in the nudge design, support this observation. Moreover, the current research targets mainly the choice architecture categories of decision information and decision structure. The category of decision assistance is less pronounced. One of the underlying reasons for that might be the psychological background and complex implementation of nudges. Decision assistance often goes beyond the boundaries of digital environments so that a digital nudge should affect a decision in a non-digital environment.

5.2 Limitations

Despite the promising results and insights concerning digital nudging, the identified research papers, as well as the overall literature review have some limitations. First of all, it is important to mention that not every that of the research articles does not directly specify the studied concept as nudging. One possible explanation for this is the novelty of the concept of nudging. With the first research in the late 2000s, nudging itself is known less than ten years. Additionally, nudging has its roots in the area of behavioral economics. Other research streams might study the same concept but do not label it as nudge directly. If nudging research continues, this problem will fade away with the broader adoption of the

term "nudging" across research streams. At the moment many research articles, specifically about digital nudging, is in the review process and will probably be released in the near future. Those articles in review are not part of this literature review.

Moreover, there is only a limited amount of articles that mentions specific interface design elements of digital nudges. Design elements are the building stones of every user interface and therefore have a significant influence on the choice architecture presented to the user. Unfortunately, those design elements are rarely specified in current studies. Studies with a focus on digital nudges barely included screenshots of the digital environment and the user interface of the experiment. Such additional information can have a significant impact on the understanding of digital nudges.

In the end, this literature review was carried out in a limited time and scope. It is important to mention that not every article in the domain is included in this literature review. Moreover, a qualitative part of the literature is identified trying to be as representative as possible.

5.3 Recommendations for future research

Based on the limitations and findings of this literature review, one can derive several recommendations for future research. One of those recommendations includes the use of other heuristics. As described in the review of the literature, no research article uses the scarcity effect, as well as the middle-option bias. Both techniques successfully support nudging in non-digital environments. Therefore, a transfer to digital choice environments might provide promising results.

Another implication for future research is the connection to the domain of HCI. Here, further research on how design elements influence digital nudges can be conducted. This can provide useful information for product designers and managers, to build efficient choice architectures.

Finally, future research should place more emphasis on other domains than consumer choice. Especially domains where complex decisions are taken. Such a domain is the finance and insurance sector. Here, users face complex decisions without being knowing domain experts. In the past, a lot of financial services and insurances were sold with the help of a consultant in the sales department. Nowadays, more and more self-services allow users to act by themselves and independently. Such an example is the online bank

N26 that provides full banking functionalities and services without a physical bank in the background. The only interfaces between bank and user are the mobile app and the web dashboard. In finance and insurance, decisions typically have a long term effect and usually are locked-in for an extended time. That is why it is critical to make good decisions and to provide a natural choice architecture for users. Besides the likely possibilities, nudging is very critical in this domain, because of the importance of the ethical aspect of nudging. If done wrong, a company can quickly lose the trust of users and conversions might go down.

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Appendix

Booking.com

€ 

List Your Property

Register

Sign in

Accommodations

Flights


Flight + Hotel


Car Rentals

Airport Taxis

Search



Destination/Property Name:
Bali


Check-in Date
 Monday, April 22, 2019

Check-out Date
 Sunday, April 28, 2019

6-night stay

2 adults


No children  1 room 

☐ I'm traveling for work 

Search

Bali: 6,417 properties found – including 1629 with great value today!


3 reasons to visit: relaxation, beaches & food



Our Top Picks

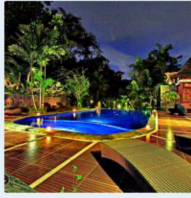
Price (lowest first)



Review Score & Price


Stars 

Star rating and price

Top Reviewed




Dewangga Bungalow  

 Downtown Ubud, Ubud - [Show on map](#)


3 people are looking right now

Booked 3 times in the last 12 hours on our site

Double or Twin Cottage 

Only 7 rooms left on our site!

Risk Free: You can cancel later, so lock in this great price today!

Excellent 
759 reviews

Location 9.5

Price for 6 nights

€ 282

includes taxes and charges

FREE cancellation

No prepayment needed

See availability >

Figure 1: Digital nudging example - booking.com

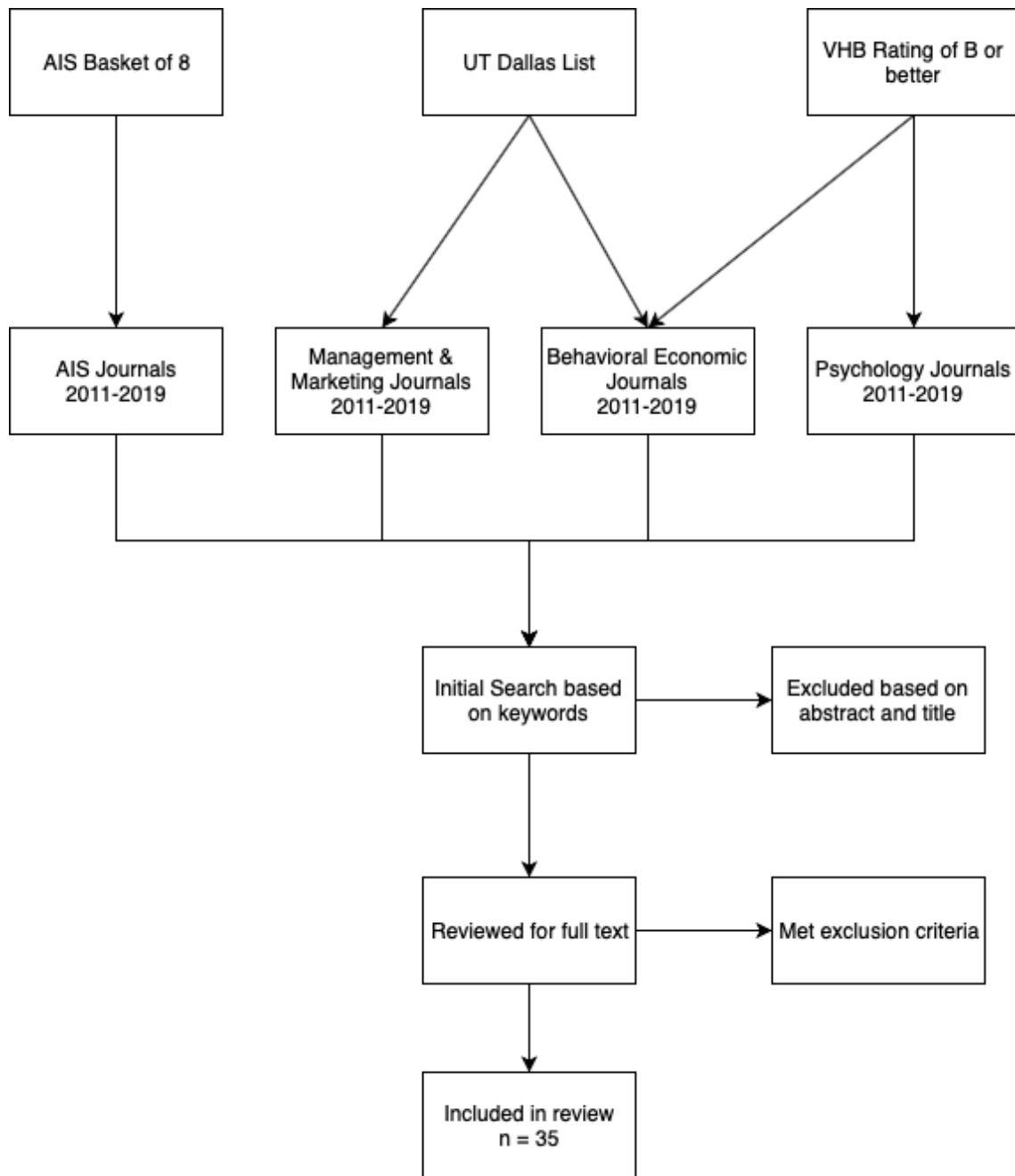


Figure 2: Information flow of the screening process

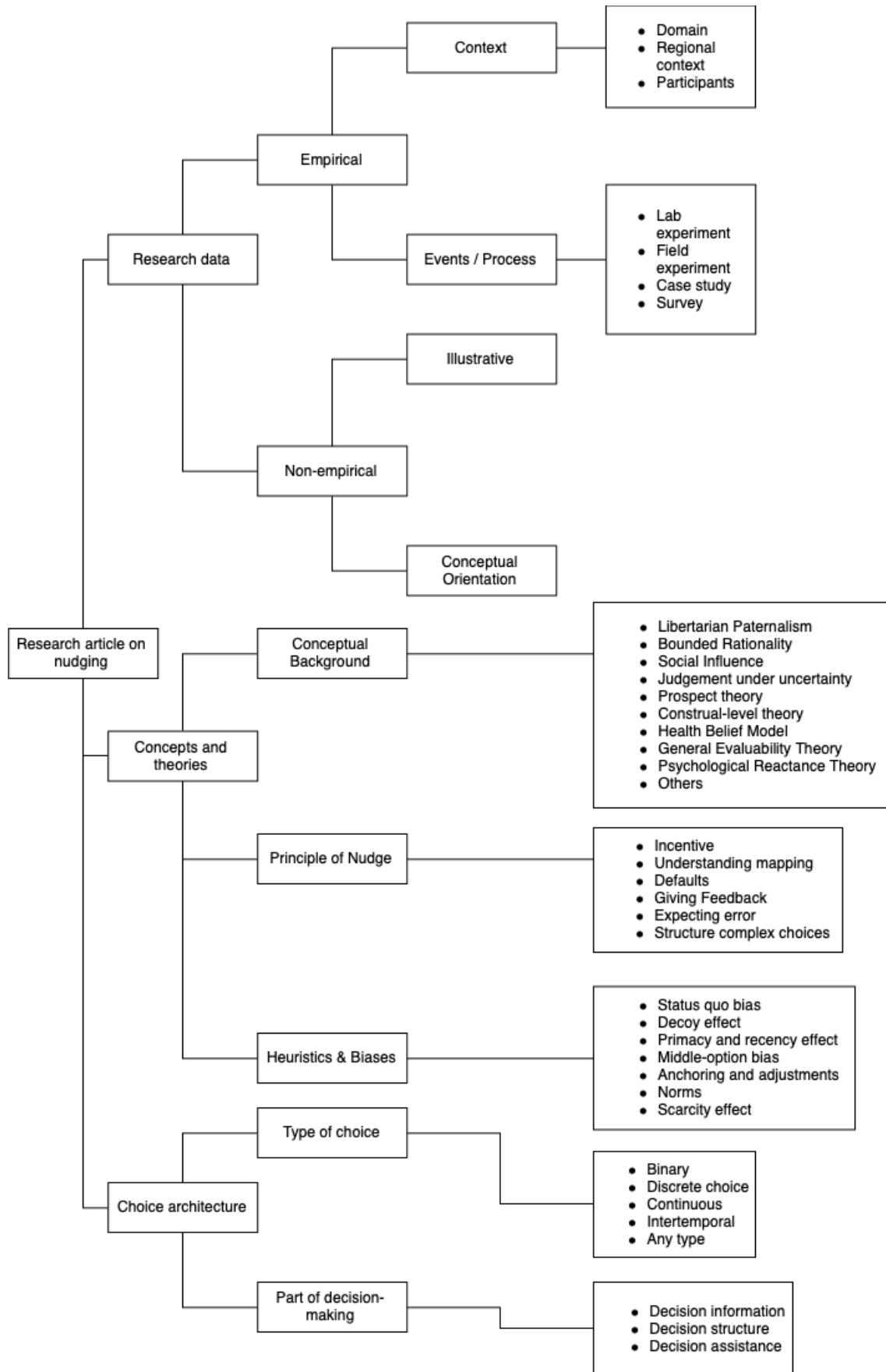


Figure 3: Classification of findings-detailed

Domain	Coding
Consumer Choice	CCH
Education	EDU
Finance	FIN
Health	HEA
Prosocial Behavior	PSB
Sustainability	SUS
Transportation	TRA
Security & Privacy	SCP
Government	GOV
Other	MISC

Table 8: List of domain codings

Affidavit

I hereby declare that I have developed and written the enclosed seminar thesis entirely on my own and have not used outside sources without declaration in the text. Any concepts or quotations applicable to these sources are clearly attributed to them.

This seminar thesis has not been submitted in the same or substantially similar version, not even in part, to any other authority for grading and has not been published elsewhere. I am aware of the fact that a misstatement may have serious legal consequences.

Mannheim, 3. April 2019

Marvin Messenzehl