A Framework for Digital Affordances

Nadine Kathrin Ostern
Chair for Digitization and Process Management, nadine.ostern@wiwi.uni-marburg.de

Michael Rosemann
Queensland University of Technology, m.rosemann@qut.edu.au

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A FRAMEWORK FOR DIGITAL AFFORDANCES

Research Paper

Nadine Ostern, Marburg University, Marburg, Germany, nadine.ostern@wiwi.uni-marburg.de
Michael Rosemann, Queensland University of Technology, Brisbane, Australia, m.rosemann@qut.edu.au

Abstract

Since its development in the field of ecological psychology, the concept ‘affordances’ has been prone to various adaptations. This is most evident in information systems (IS) research, where rapid developments and the generativity of today’s digital technologies require a fast advancement of affordances theorization. Frequent but stepwise progress has been made to the concept over the past few years through IS researchers. While those advancements are necessary for understanding IT-associated organizational change, they carry the risk of theoretical fragmentation hindering knowledge accumulation. Applying a systematic five-staged literature review and reintegrating the results into existing conceptualizations of affordances, this paper strives toward a meta-view on affordances, constituted in a descriptive affordances framework and an affordances lifecycle model. The former provides researchers a tool for better identifying and understanding the meta-characteristics of affordances, while the latter offers a lens to interpret the circumstances of affordance emergence, actualization, and their outcomes.

Keywords: Affordances, digital technology, grounded theory, systematic literature review.

1 Introduction

The concept of affordances was introduced roughly three decades ago, describing the action possibilities enabled by the material properties of objects (Gibson, 1977; Seidel et al., 2013). Originating from the field of ecological psychology, Gibson (1977, 1986) theorized affordances in a non-dualist way, arguing that every object has specific material properties offering possibilities for actions, but those are relative for the observer (Stendal et al., 2016). For instance, a chair (characterized by the properties of being horizontal, flat, knee-high, etc.) affords sitting to adults. Still, it does not offer the same action possibilities to children that might use the chair as a standing aid (Seidel et al., 2013). Therefore, affordances can be understood as co-evolution between actors and their environment, a view that fits well in the changing nature of technology-supported organizations – one of many study contexts in information systems (IS) research (Bernhard et al., 2013; Stendal et al., 2016).

IS literature has described affordances as emerging from the relation between IT systems and organization systems (Markus and Silver, 2008; Zammuto et al., 2007) and defines them as the potential for behaviors associated with achieving an immediate concrete outcome, arising from the relation between an object (e.g., an IT artifact) and a goal-oriented actor(s) (Volkoff and Strong, 2013). Acknowledging that affordances provide an appropriate lens for developing better theories of IT-associated organizational change (Leonardi, 2011; Markus and Silver, 2008; Volkoff and Strong, 2013), IS researchers have made significant advances in understanding affordances and their actualization in recent years. This includes progress in theorizing on how and why affordances emerge depending on specific user groups or technological materiality (Leonardi, 2011; Leonardi and Vaast, 2017), what influences their actualization by users (Bernhard et al., 2013; Strong et al., 2014), the differentiation between the emergence, perception, and actualization of affordances as distinct concepts (Bernhard et al., 2013; Stendal et al., 2016).
al., 2013; Leidner et al., 2018), as well as theoretically bridging affordances and critical realism, whereas the latter is proposed as theoretical underpinning assisting researchers in specifying affordances and generative mechanisms (Bygstad et al., 2015; Volkoff and Strong, 2013). Although IS researchers have made impressive progress in adapting and refining the concept and theory for studying affordances in different IS contexts, we hypothesize that the rapid and stepwise theoretical development of affordances in IS research simultaneously bears the risk of theoretical fragmentation that hinders knowledge accumulation and cross-relating research results. In particular, while researchers developed extensive frameworks for studying affordances in specific contexts, e.g., social media use (Karahanna et al., 2018), process modeling (Bernhard et al., 2013), or technology-involved practices (Majchrzak and Markus, 2013), IS research misses a comprehensive approach that brings together various aspects and advancements of IS-specific affordances theory able to reconcile the multiple advancements into one holistic theory.

To ensure that context-specific advances of the concept of affordances can actually contribute to the development of better IS theories, we propose a meta-view on affordances that abstracts from affordances in specific contexts. In particular, this paper identifies meta-characteristics of affordances and conceptualizes them in a descriptive affordances framework. We integrate meta-characteristics into an affordances lifecycle model, providing IS researchers with a tool for better identifying, understanding, and possibly designing for specific affordances. For this, we ask: What are the meta-characteristics of affordances in advanced IS theorization, and how can we transfer them into an integrated affordances meta-view?

This paper offers first steps toward developing an integrated view on affordances by reviewing, summarizing, and abstracting from IS theory on and concerned with affordances. We apply the five-staged literature review approach proposed by Wolfswinkel et al. (2013) to identify the meta-characteristics of affordances in IS theory by utilizing the principles of grounded theory (Corbin and Strauss, 1990; Wolfswinkel et al., 2013). Thereby, we build the static affordances framework to help IS researchers better identify and understand affordances of digital technologies and their properties. Next, we integrate the meta-characteristics into the established theory of affordance actualization to connect the identified meta-characteristics with the existing literature. Thereby, we develop a processual affordances model, which provides IS researchers a lens for interpreting and predicting the circumstances of the actualization and emergence of affordances in the context of technological adaptation. Both the static affordances framework and the processual model are constituting parts of the emerging meta-view on affordances. The meta-view aims at providing a lens for understanding and designing for affordances in various IS contexts while being especially capable of capturing and improving our understanding of the fast-paced nature of today's digital technologies (Gregor, 2006; Orlikowski and Robey, 1991). Thereby, we contribute to the literature by opening the black box of digital technologies' generativity by providing insights into the dynamic and sudden actualization of affordances in the context of pervasive combinatorial innovations (Eaton et al., 2011; Yoo et al., 2010).

The need for such a model is elucidated by the fast-paced nature of technological development and adaptations by various user groups (Fichman et al., 2014). In fact, technologies today are by far not solely developed and provided by tech-firms; recent trends like the maker movement (exploiting the possibilities opened up by 3D-printers) as well as various forms of distributed innovation, such as the emergence of distributed ledger technology, has shown the generative power of digital technologies fueled by an increasing digital literacy of its users (Fichman et al., 2014; Yoo et al., 2012). Even beyond this, we observe that technologies increasingly have 'smart' capabilities (such as the ability to learn from data autonomously or to be context-aware), which means that these technologies are not static, but can proactively and dynamically shape affordances offered to users (Knote et al., 2021). Because of these dynamics, foreign affordances and understanding future use of digital technologies are more challenging than ever for researchers. More importantly, we need further developments in the theorization of affordances and related concepts that address these dynamics, and new developments to give researchers the right tools to do so, as prevailing theories still often see technologies as static and exclusively reactive artifacts (Knote et al., 2021). To do so, we argue that IS research cannot rely on the
essential yet partial advancements of the concept of affordances for specific IS contexts but needs to commence to a holistic understanding capturing the fast-moving nature of today's digital technologies.

The remainder of this paper is structured as follows: We explain our research approach in the next section, describing a structured literature review on the concept of affordances. Simultaneously, we present the literature review results, i.e., existing conceptualizations and advancements of affordances. We commence in section 3 with the description of meta-characteristics, summarizing and reconciling different views and partial advancements of the concept into one coherent affordances framework and a processual model. We explain each element of the framework and exemplify its origin and use to better identify, understand, and possibly design affordances in the context of IS research. We discuss limitations and the contribution of our work to the state of the literature in section 4. Eventually, we provide a conclusion and outlook in section 5.

2 Research Method and Analysis

Figure 1 visualizes the data collection and analysis process, consisting of two stages. We first applied the five-step research approach of Wolfsink et al. (2013) to systematically identify and review relevant literature on affordances, resulting in a list of meta-characteristics and the descriptive affordances framework. Afterward, we integrated the results into established representations of the actualization of affordances in IS theory in stage 2. Especially, we engaged in the most recent discourse on affordance actualization, which views affordances as a process rather than as a state. By integrating our findings, we developed the affordances lifecycle model, which provides a meta-view and insights into the circumstances of emergence and adaptation of affordances. We describe the literature review supported by a grounded theory approach in this section. The process of integrating the results of the literature review into existing conceptualizations of affordances is explained together with the lifecycle model in section 3.

![Figure 1. Data collection and analysis procedure (loop symbols indicate an iterative approach)](image-url)
We started the literature review with the definition of criteria for the inclusion and exclusion of research articles (step 1). We reviewed the IS literature focusing on the AIS Senior Scholars' Basket of Journals, gathering insights into the concept of affordances, its use, and theoretical advances from research published in the leading journals in our field (Wolfswinkel et al., 2013). We used the keyword "afford*" to screen each of the AIS Senior Scholars' Basket Journals for corresponding publications over the past thirty years, resulting in a total of 1674 papers. In particular, we included research papers that considered or are focused on affordances; we excluded papers that were merely mentioning the concept of affordances, for instance, as an alternative examination or explanation approach. We do not applied further quality criteria for the inclusion or exclusion of papers as we focused on the top journals in the IS research field, already ensuring a high quality of research.

Afterward, literature was searched using an iterative approach, i.e., using forward and backward search as well as by moving from selective to theoretical sampling based on the results of initial codings (step 2) (Webster and Watson, 2002). The eventually resulting sample of 1674 research papers (step 3) was sequentially refined using the above-stated inclusion and exclusion criteria, first, for screening abstracts and titles and, second, for full-text screening. After two iterations, step 3 of the five-staged research approach finally left us with, in total, 98 IS research articles concerned with the concept of affordances. While this much smaller amount of resulting papers in contrast to the initial amount of 1674 research articles was quite surprising initially, we realized that most articles did not directly refer to the concept of affordances nor provide any definition or conceptualization. Instead, its use was frequently but indirectly indicated in the statements of goals, expectations, and perceptions associated with implementation and use of IT—an observation also recently made by Faik et al. (2020). Table 1 gives an overview of the screened journals and the number of resulting research papers related to the concept of affordances. The systematic approach for both, literature identification and analysis process is described below (Boell and Cecez-Kecmanovic, 2015).

<table>
<thead>
<tr>
<th>Journal</th>
<th>Initial No. of Papers</th>
<th>No. of Paper (screening 1)</th>
<th>No. of Paper (screening 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Journal of Information Systems</td>
<td>244</td>
<td>27</td>
<td>24</td>
</tr>
<tr>
<td>Information Systems Journal</td>
<td>193</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Information Systems Research</td>
<td>213</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Journal of the AIS</td>
<td>167</td>
<td>25</td>
<td>23</td>
</tr>
<tr>
<td>Journal of Information Technology</td>
<td>211</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>Journal of MIS</td>
<td>161</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Journal of Strategic Information Systems</td>
<td>157</td>
<td>24</td>
<td>20</td>
</tr>
<tr>
<td>MIS Quarterly</td>
<td>328</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1674</strong></td>
<td><strong>118</strong></td>
<td><strong>98</strong></td>
</tr>
</tbody>
</table>

Table 1. AIS Senior Scholars' Basket Research Papers Concerned with Affordances

We commenced with step 4 of the five-staged research approach, which is concerned with analyzing the literature using open, axial, and selective coding performed in an iterative manner (Wolfswinkel et al., 2013). In particular, Wolfswinkel et al. (2013) proposed grounded theory as a method for rigorously reviewing the literature, which has the advantage of being inductive, meaning that salient concepts arise from the literature instead of being deductively derived beforehand (Wolfswinkel et al., 2013). This allows concepts to surface during the analytical process of substantive inquiry, aimed at logical grouping and presenting the key concepts, i.e., our meta-characteristics (Wolfswinkel et al., 2013).

We started analyzing the identified literature by reading and highlighting any findings and insights in the papers related to the concept of affordances or aimed to create a more comprehensive affordances theory in an IS context. By highlighting, we engaged in open coding, i.e., we highlighted words and text passages line-by-line that were subsequently differentiated by associating them to concepts, often well-
defined from earlier literature (e.g., technological affordances, spatial affordances) and relating them to meta-insights often pertained to the methodological or theoretical parts of research articles (such as the applied research method or the focus of studies, i.e., whether papers were concerned with the materiality of technology or the timely or logical conditions of their emergence). Open coding left us with 33 emerging themes, leading us to the second analytical step, i.e., axial coding (Wolfswinkel et al., 2013). Through constant comparison of themes, data collected, and their codings we identified interrelations between the first set of concepts and terms to detect and merge concepts into broader categories, representing the main themes or patterns of affordances theorization. For instance, we build the category of drivers, used to indicate the reason of affordances actualization which might be actualized due to desirability, e.g., the use of wearable technology to self-monitor and increase one own health (Benbunan-Fich, 2019), or due to responsibility, i.e., investigating how information systems can contribute to the creation of environmentally sustainable organizations (Seidel et al., 2013). In particular, analyzing the data using axial coding, merged open codes into 19 categories. Eventually, we engaged in selective coding by integrating and refining the identified categories (Wolfswinkel et al., 2013). Selective coding was performed until theoretical saturation was reached, i.e. the stage where no new concepts, properties, and interesting links arise (Corbin and Strauss, 1990; Wolfswinkel et al., 2013). Selective coding was performed by both authors until both determined theoretical saturation. As a result, a final set of meta-characteristics was determined resulting in a set of 6 selective themes. We recorded all decisions and results generated in the course of the literature identification and analysis stage in a dated codebook to recall the logic of earlier review decisions accurately as well as for retrospective comprehension.

The last step of Wolfswinkel's et al.'s (2013) five-staged literature review approach is to present and compile the review's insights. In this paper, we start delivering first insights utilizing table 2, summarizing the identified meta-characteristic and nineteen sub-categories that emerged from the literature analysis, their definition, as well as references to seminal papers for each meta-characteristic. Apparent from Table 2, the identified meta-characteristics differ in terms of their quality and relation to the concept of affordances, and hitherto do not allow any conclusion on the compounds between the meta-characteristics. To progress toward the generation of an affordances framework and meta-view, we, therefore, start in the next section to provide deeper insights into the meaning and relationship of concepts and explain the meta-characteristic in detail. Eventually, we interpret the results reflecting on and integrating our results into existing IS literature on affordances (Wolfswinkel et al., 2013).

<table>
<thead>
<tr>
<th>Meta-Characteristic</th>
<th>Sub-Categories</th>
<th>Definition</th>
<th>Seminal Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
<td>Canonical</td>
<td>State of existence and perceptibility of an affordance(s)</td>
<td>(Burton-Jones and Volkoff, 2017; Chan et al., 2019; Mettler et al., 2017; Seidel et al., 2018)</td>
</tr>
<tr>
<td></td>
<td>Relational</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hidden</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>False</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level</td>
<td>Business</td>
<td>Anticipated or actual scope of enactment of an affordance(s) within existing structures</td>
<td>(Bygstad et al., 2015; Leidner et al., 2018; Niemimaa and Niemimaa, 2019; Volkoff and Strong, 2013)</td>
</tr>
<tr>
<td></td>
<td>Design</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Technology</td>
<td></td>
<td></td>
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<tr>
<td>Driver</td>
<td>Feasibility</td>
<td>Measurable resource that triggers the actualization of or design for a specific affordance(s)</td>
<td>(Chaterjee et al., 2020; Faik et al., 2020; Goh et al., 2011; Lehrer et al., 2018; Seidel et al., 2013; Tilson et al., 2010)</td>
</tr>
<tr>
<td></td>
<td>Viability</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Responsibility</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Desirability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Functional</td>
<td>Anticipated or actual effect of an actualized affordance(s) on actor(s) experiences</td>
<td>(Benbunan-Fich, 2019; Faik et al., 2020; Goh et al., 2011; Karahanna et al., 2018; Lehrer et al., 2018)</td>
</tr>
<tr>
<td></td>
<td>Emotional</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Personal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Social</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3 Theory Development

We use the insights generated by the literature review to progress toward a descriptive affordances framework and a processual affordances model. The first provides IS researchers an exploratory tool for identifying and understanding affordances in various IS contexts more throughout. The latter offers a lens for interpreting and predicting the circumstances of the actualization and emergence of affordances in the context of technological adaptation. We describe the affordances framework and the holistic affordances model in this section by first explaining meta-characteristics in more detail, and second, integrating meta-characteristics into previous literature of IS theory. Whereas the first increases the understanding of meta-characteristics, the second enables utilization of those for research concerned with the emergence and actualization of affordances. Both the static affordances framework and the processual model are constituting parts of the emerging meta-theory on affordances, providing a lens for viewing, understanding, and designing for affordances in various IS contexts while being especially capable of capturing and improving our understanding of the fast-paced nature of today’s digital technologies (Gregor, 2006; Orlikowski and Robey, 1991).

3.1 Understanding Meta-Characteristics: The Affordances Framework

Figure 2 depicts the static affordances framework, summarizing, and offering a conceptualization of the meta-characteristics found in the analytical phase of the conducted five-staged literature review (Wolfswinkel et al., 2013). In line with the aim of descriptive theory, the affordances framework seeks to provide a comprehensive description of the phenomena of affordances and its boundaries within IS theory, which are characterized by a high degree of generalizability due to the level of abstraction achieved in the course of the analytical phase of the literature review (Gregor, 2006).

While IS researchers may start anywhere in the model when trying to identify and understand meta-characteristics of affordances in the context of IS studies, we begin describing the affordances framework with the meta-characteristic property. The meta-characteristic property summarizes different states of existence and perceivability of an affordance, whereby, firstly, affordances might be canonical or relational. IS researchers overall acknowledge that affordances are relational in nature, meaning that affordances are determined by the relation between actors and an object emerging from the perception of the object’s properties, such as their material or functional characteristics (Burton-Jones and Volkoff, 2017; Bygstad et al., 2015; Chan et al., 2019). Others, however, also acknowledge the existence of canonical affordances, assuming that primarily social conventions determine the meaning and perception of affordances. This might be the case with keyboards used for typing; neither the end-user nor the designer established this meaning, socio-cultural and/or organizational influences shaped this meaning over time (Mettler et al., 2017). We might conclude that due to the increased complexity and modular structures of today’s digital technologies, affordances are both canonical (i.e., perceived and understood the same way by everyone) and non-canonical (i.e., relational and dependent on the actor(s)-object relationship). For instance, many use cases for the applicability of blockchain arise from the action possibilities offered by blockchain’s properties to a specific user or user group (Ostern et al.,
Blockchains, however, are a combination of well-known technological components, whose meaning has been shaped by socio-cultural and organizational influences over time. For instance, time-stamps are used for several years in organizational contexts, and their meaning, as such, is likely to be perceived similarly by a large user group.

Figure 2. Descriptive Affordances Framework

Also, affordances can be characterized by being hidden or false (Gaver, 1991). The notion of hidden refers to the fact that an object’s properties offer action possibilities that are not yet perceived by actors; nevertheless, they exist independent of their recognizability for a user. The affordance’s property of being false, in contrast, is typically the result of design attempts that aim at making specific affordances of a designed object particularly salient for an actor or a group of actors (Seidel et al., 2018). In some cases, however, the enactment of those intentionally designed-for affordances differs from the intended practice, given the non-deterministic nature of affordances (Fayard and Weeks, 2014).

The meta-characteristic level describes the anticipated or actual scope of the emergence of an affordance within or beyond the structure it is enacted. Thereby, IS researchers have paid close attention to affordances' outcomes through their enactment at different levels and cross-level effects. For instance, IS researchers have described how technology’s affordances enacted at an infrastructure level might be implemented within an organization's installed IT base, therefore triggering technological and organizational change (Niemimaa and Niemimaa, 2019). The notion of the meta-characteristic level is thereby closely related to the conceptual differentiation between an object’s use, its affordance, and the outcome of an affordance that has been recently discussed in the IS literature (Du et al., 2019; Leidner et al., 2018). The characteristic level relates to the latter, i.e., the anticipated or actual outcome of an affordance, but instead characterizes the extent than the result of affordance’s outcome.

The meaning of the meta-characteristics level gets more apparent when delaminating it from the meta-characteristic impact. While the characteristic impact is as well concerned with the anticipated or actual outcome of an affordance, it qualifies its impact rather than determining its scope. More precisely, independent from the level the affordance is enacted, it can affect an actor differently. From the literature, we identified four different types of impact of an affordance, i.e., functional, emotional,
personal, and social. Thereby, functional impact was most commonly observed in the context of IS studies (e.g., Du et al. 2019; Strong et al. 2014), indicating what an object (in the IS context: an IT/IS artifact) provides for actors to accomplish a specific goal. Also, we were able to identify motivational impact characterizing a relationship between an actor, and an IT/IS artifact that supports a motivational need (e.g., Holzer et al. 2020) and personal impact, supporting a personal need such as self-monitoring and tracking through wearables or self-presentation in the context of social networking sites (e.g., Benbunan-Fich 2019; Karahanna et al. 2018). Eventually, we identified social impact as one sub-category of the meta-characteristic impact, i.e., an object-actor relationship aimed at supporting or constraining societal goals (e.g., Faik et al. 2020; Seidel et al. 2013). Hence, while the meta-characteristics property and level determine the perceived or actual granularity of the outcome of an object-actor relationship, the meta-characteristic impact specifies the perceived or actual outcome of an affordance(s).

Another category identified through the literature review is described by the meta-characteristic driver, defined as the measurable resource that triggers the actualization of or the design for a specific affordance. Thereby, feasibility, viability, responsibility, and desirability of a resulting object-actor relationship were identified as sub-categories constituting the meta-characteristic drivers. IS researchers concerned with IT-driven organizational change view a major driver for the actualization of affordances in increasing organizations’ viability by signifying new opportunities and rethinking organizational command and control (Chaterjee et al., 2020; Tilson et al., 2010). For instance, Goh et al. (2011) investigated the implementation of medical technology as a means to trigger the disruption of inefficient routines in a hospital to improve care delivery and, eventually, the hospital's profitability. Similarly, Lehrer et al. (2018) analyzed how the actualization of the affordance ‘offering individualized service to customers provided by big data analytics helps organizations from the insurance, baking, telecommunication, and e-commerce industry to increase profits by providing better services.

While feasibility, i.e., the actualization of affordances to achieve a particular organizational or personal goal, such as easing the way we interact or accomplish tasks (e.g., Steffen et al. 2019), and desirability, i.e., the actualization of affordances to satisfy certain needs (e.g., Benbunan-Fich 2019; Karahanna et al. 2018), are as well frequently observed within the IS literature, we observed that responsibility recently plays an increasingly important role as a driver for the actualization of an object’s affordance, for example, such as for the realization of sustainable work practices (e.g., Faik et al. 2020; Seidel et al. 2013). Apparent from these descriptions, driver and impact of affordances are in theory similar to each other as the impact reflects the driver and, thus, the intended impact of an affordance. In practice, however, we see that with an increasing likelihood, this is no longer the case. We observe the growing digital literacy of users of modern ISs and digital technologies and their ability to adapt functionalities of digital technologies to their personalized use cases. This justifies the presentation of drivers and impact as separate categories particularly.

Having elaborated on drivers and impact constituting two meta-characteristics of affordances, we commence with the meta-characteristic value, describing how a specific output emerges dependent or independent from other actor(s). Individual value emerges when someone enacts and solely benefits from an affordance, meaning that this affordance is not available to others, e.g., personalized technology. In contrast, synchronized value emerges for one or more actors that might perceive an affordance. Synchronized value can either be homogenous, i.e., the value is enacted and similarly benefits all actors. In contrast, heterogeneous value enactment implies that an affordance can only be enacted in a group but benefits actors in divergent ways, e.g., a pooled individualized affordance (Leonardi, 2013). Notably, this description of value of an object-actor relationship partly reflects the way how IS research looks at affordances. In particular, while IS research was traditionally considered individual use and, thus, value emerging from the actualization of an affordance, more recently, researchers started to focus on group enactment of affordances, e.g., in the context of organizations or organizational units (Leonardi and Barley, 2010; Strong et al., 2014).

Eventually, we identified the meta-characteristic type, reflecting how affordances and their output emerges dependent or independent from other affordances. Autonomous affordances are thereby
independent of the actualization of other affordances, i.e., an object's material properties can be directly perceived by an actor without further prerequisites. Given the increasing modularity of technologies, however, we can assume affordances to evolve as modular structures as well. IS scholars have recently started to differentiate so-called composite affordances according to their structure, i.e., they distinguished between the actualization of basic and higher-level affordances (Strong et al., 2014; Volkoff and Strong, 2013). The actualization of basic affordances serves as generative mechanisms to unlock new action potentials offered by higher-level affordances. Importantly, the existence and perceivability of higher-level affordances' action potentials are determined by the actualization of basic affordances. Thus, basic affordances may exist with or without higher-level affordances, but higher-level affordances prerequisite the actualization of basic affordances (Bygstad et al., 2015).

3.2 Theoretical Integration: The Processual Affordances Model

As already indicated in the description of the meta-characteristics, those correspond to different states and progresses regarding the actualization of affordances through actors. To reveal connections between the identified meta-characteristics and prior literature, we integrate our results into established representations of the actualization of affordances in IS theory. Especially, we engage in the most recent discourse on affordance actualization, viewed as a process rather than as a state, where researchers distinguish the existence, perception, actualization, and effect phase of affordance actualization (Anderson and Robey, 2017; Bernhard et al., 2013; Du et al., 2019; Leidner et al., 2018).

Bernhard et al. (2013) and Leidner et al. (2018) propose the theoretical differentiation between the existence of affordances, i.e., affordances that are offered by an object to an actor(s), but not necessarily have to be perceived by the user, and their perception. The perception of affordances thereby does not question whether affordances exist but whether information is perceivable and sufficiently clear for perceiving them (Bernhard et al., 2013; Gibson, 1977; McGrenere and Ho, 2000). Affordance actualization is then the degree of (cognitive) effort and actions an actor puts and exerts into the actualization of an affordance, which emerges as a continuum, meaning that affordance actualization is not binary (e.g., possible or impossible) but, instead, afflicted with different degrees of difficulty (Bernhard et al., 2013). IS researchers recently draw increasing attention to the importance of differentiating between the actualization of non-deterministic affordances and their outcome or effect that result from affordance actualization (Du et al., 2019; Leidner et al., 2018).

We extend those views by modeling the different phases of affordance emergence and actualization as a continuous perception-action feedback loop (Franchak et al., 2010; Gibson, 1986), indicating that the relationship between perception of affordances and actions are not one-sided (Leonardi, 2011). In particular, every effort and action taken toward actualizing the affordances as well as the actual actualization are expected to increase the accuracy in perceiving affordances and may give rise to composite affordances, i.e., affordances that prerequisite the perception and actualization of other affordances (Franchak et al., 2010; Volkoff and Strong, 2013). Figure 2 depicts the perception-action feedback loop for the emergence and actualization of affordances while combining the phases with the meta-characteristics and insides forged within the five-staged literature review. We commence by describing the affordances model shown in Figure 2, thereby emphasizing our model's contribution to existing conceptualizations and models of affordances perception and actualization.

We start by describing Figure 2 by looking at perceived affordances that are mainly characterized by the anticipated meta-characteristics type, impact, and level, i.e., the anticipated scope of effects and impact of a possible affordance actualization as well as their perceivability by other actors. We thereby extend and specify Bernhard et al.'s (2013) notion of the construct 'information about affordance', i.e., the expressions and messages that an artifact communicates to its user(s) (Markus and Silver, 2008) that influence the perception of an affordance. In particular, the anticipated type, level, and impact of perceived affordances are expected to provide actor(s) with information with which they decide whether or not to actualize an affordance based on the scope, and anticipated effect of affordances on the actor and the systems within the affordance is enacted.
The meta-characteristic value relates to affordance actualization, where actors exert effort to realize an affordance to unleash the anticipated effects (Bernhard et al., 2013; Smith and Pepping, 2010). Notably, value signals how the worth of an affordance emerges. This notion is in line with Leonardi's (2013) conceptualization of individual, collective, and shared (i.e., synergic) affordances, whose actualization and, thus, value happens and emerges at different structural levels, e.g., group-level networks.

Effects of affordances in the perception-action feedback loop are influenced by the meta-characteristics impact, type, and level; however, here, we refer to the actual outcome and not the anticipated effect of affordance actualization as in the phase of affordance perception. The theoretical differentiation between anticipated and actual type, impact, and level of affordances and the meta-characteristic value helps us conceptualize further the differentiation of the three phases of perception, actualization, and effect of affordances as recently emphasized by Leidner et al. (2018). In particular, while Leidner et al. (2018) provides a striking practical example of the differentiation of these phases, a theoretically substantiated explanation and conceptualization of this differentiation has so far been lacking. The meta-characteristics interwoven into the perception-action feedback loop offer a first starting point, assisting researchers by offering meta-characteristics to define the different phases in future studies. In particular, several researchers have pointed to the ambiguities that resulted from the lack of conceptual distinction between the perception, actualization, and effect of affordances (Du et al., 2019; Leidner et al., 2018), highlighting the need for a conceptualization of the different phases of affordance emergence and actualization.

Eventually, we arrive at affordance existence, that is, at the same time, the start and endpoint of the perception-action feedback loop. The meta-characteristics property and driver characterize affordance existence. A driver of affordances determines which cues that are offered by an object are possibly perceived by an actor, indicating that an affordance actually exists (Bernhard et al., 2013). As indicated by the notion of individual and synergic value, actors can perceive a shared affordance or only individually perceive an affordance, offering them personal or professional advantages. This is strongly determined by the drivers of a group of actors that may perceive an affordance as similar, different,
not at all, depending on whether they share the same drivers responsible for the emergence and actualization of affordances.

As presented in Figure 2, the processual affordances model provides a comprehensive model to understand the circumstances and reasoning of affordance actualization by integrating the identified meta-characteristics of affordances into the context of affordance emergence and actualization. Therefore, we consolidated previous IS literature on affordances and built the foundation for ongoing knowledge accumulation and a synthesized meta-theory on affordances for understanding today’s digital technologies. In the next section, we elaborate on the contribution and importance of this meta-theory to the existing state of the literature.

4 Contribution, Limitations, and Outlook

We see theoretical and practical contributions emerging from the affordances framework and the affordance lifecycle, both providing constituting parts of a holistic affordances theory for the age of today’s digital technologies. As we have presented the framework and model in the previous section, we now elaborate on their theoretical and practical contribution. In particular, we exemplify how the proposed theory on affordances may help IS researchers cope with the challenges that the rapid technological advancement bears to a comprehensive understanding and foreseeing of the effects of digital technologies and their appropriation by various user groups.

4.1 Theoretical Contribution and Practical Implication

This paper, first, provides a framework, easing the identification of meta-characteristics of affordances; second, we develop an affordances lifecycle model, incorporating a perception-action feedback loop, which does justice to the complexity of affordance emergence and actualization, and third we conceptualize and specify characteristics that support researchers in understanding and assessing the differences between the conceptually different phases of affordances existence, perception, actualization, and effects of affordance. By this, we are confident that our research results contribute to a better understanding of affordances in IS theorization. This is especially true since transferring and fully understanding the concept of affordances from ecological psychology is an ongoing challenge for IS researchers (Fromm et al., 2020). Challenges especially arise from the traits of digital technologies, that possess the capability to unleash so-called combinatorial innovation. Thereby, actors, e.g., companies or users of digital technologies, create new products or services by ‘mashing-up’ software-based digital modules that follow the same standards. This creates nearly limitless generative power (Arthur, 2009; Eaton et al., 2011; Yoo et al., 2010). The challenges that are posed to IS researchers are that we need to understand the pervasiveness of digital technology enhancement and adaptation through various actor groups. Also, we need to seek insights into the why and how of users and organizations rapidly adopting those technologies that, at the same time, fundamentally reshape them (Yoo et al., 2010). For this purpose, the existing literature on affordances must be consolidated and the theory expanded. We contribute to this endeavor by substantiating the IS literature in three ways:

1) Relational nature of affordances: Volkoff and Strong (2013) emphasize the relational nature of affordances that arise from a relation between an IT artifact and perceptions thereof by goal-oriented actor(s). Thus, affordances are frequently studied by either mapping them to specific IT features or by linking them to actor(s) goals and characteristics (e.g., user groups) (Fromm et al., 2020). Consequently, establishing measurement instruments or generalizing results of such studies is hardly feasible leading to the fact that affordances need to be identified for each new combination of IT artifact and user group under study (Grgecic et al., 2015). While this is still the case, the meta-characteristics allow us to identify and better understand affordances of IT artifacts and digital technologies on a more abstract level. In particular, it shows that affordances can be mapped to the phases of affordance existence, perception, and actualization, and outcomes that take into account the dynamic nature of rapidly evolving digital technologies and can be discussed accordingly. This
helps to ensure that the discussion on the evolvement of specific affordances is not at the expense of the underlying dynamics of generativity.

(2) **Interrelations and interactions between different affordances**: Several researchers point to the need to clarify interrelations between different types of affordances as well as for discussing facilitators for their actualization to fully understand action potentials of IT artifacts, especially in organizational contexts (Bygstad et al., 2015; Strong et al., 2014; Thapa and Sein, 2017). For instance, researchers suggest the use of affordance dependency diagrams or affordances networks to understand concrete outcomes of individual affordances actualization in organizational contexts (Burton-Jones and Volkoff, 2017; Strong et al., 2014). While these are all important approaches, they do not yet fully consider a temporal component of affordance actualization and interactions of the underlying action-perception feedback loop. We, therefore, propose a temporal view on affordance actualization and its outcomes, for instance, in the context of long-term observations.

(3) **Reusability of identified affordances**: Rarely do researchers use and analyze affordances from existing literature due to the relational nature of affordances (Fromm et al., 2020). An exception is Karahanna et al. (2018), who conduct a systematic literature review of social media affordances and describe a process for consolidating similar affordances. While this approach is emphasized by Fromm et al. (2020) as a suitable approach for generalizing and reusing affordances, our meta-characteristics contribute even more to this, by making results actionable. In particular, the framework invites researchers to assign identified affordances meta-characteristics of digital technologies to these meta-categories and thus to arrive at a portfolio of affordances of digital technologies in the long run.

Besides theoretical contribution, we see practical implications arising from the static affordances framework and the affordances lifecycle model. In particular, we expect both the framework and the model to support the deliberate design of affordances and foresee the appropriation of digital technologies by increasingly understanding how meta-characteristics determine the perception and actualization of affordances through various actors. In fact, various scholars already proposed the more throughout use of affordances and the knowledge thereof for purposefully user experience design, e.g., by describing human-product interactions using the affordances (Pucillo and Cascini, 2014). The framework, thus, can be applied to anticipate how affordances are perceived and potentially enacted within the structures they affect. Thereby, companies may understand the use and appropriation of new technologies through their employees and assess possible effects across employees and organizational units, which may go beyond the initial technology’s use. For instance, companies might start thinking about what possibilities for needs are performed by an IT artifact, e.g., supporting a simple task or providing an explicit invitation to an experience, and commence with how they might use another IT artifact or how they can intentionally design for similar perceptions on other artifacts (Pucillo and Cascini, 2014). The affordances model also helps capture the evolution of affordances when considering the introduction or usage of modular IT or IS systems. The perception-action feedback loop leads companies to think about the sequential triggering of perceiving newly emerging combinatorial affordances.

### 4.2 Limitations and Future Work

The results of the literature study and the theory development described in this paper need to be interpreted in light of their limitations. First of all, the literature review focused on AIS Senior Scholars’ Basket Journals guaranteeing a high quality of papers screened to develop the affordances framework and the processual affordances model. At the same time, we exclude numerous papers from other journals, conferences, and insights from different research fields. While our proceeding ensures that the developed framework and model include insights from top journals in our field, indeed, we need to assess the completeness and exhaustiveness of identified meta-characteristics as well as their incorporation into the processual affordances model. To this end, we want to screen and check emerging meta-characteristics against those already placed in future work.
Second, we use the five-staged literature review approach proposed by Wolfswinkel et al. (2013) to identify, analyze and forge connections between identified concepts within the literature, by which we use the principles of grounded theory. While Wolfswinkel et al. (2013) provide a detailed explanation of the five steps and guidance on analyzing the literature, grounded theory, as such rather proposes various reflexive strategies than providing concrete steps on how to interpret the literature. While we avoided arbitrariness and ensure the rigor of our literature review and analysis, we used the principles of open, axial, and selective coding and recorded each decision taken in a separate logbook to ensure the traceability of codings and decisions taken during the analytical phase of the literature review.

To avoid any issue that may result from the proceeding, we thus suggest improving the models' rigorousness by comparing the results of this study using further literature and ensuring the relevance of the identified meta-characteristics and their incorporation into the static framework and combinational affordances model. Applicability checks may be conducted with organizations that experienced the appropriation of IT or IS systems through their employees or other actors contributing to the emergence of combinatorial innovation. Checks thereby provide a means to ensure the importance, accessibility, and suitability of identified meta-characteristics as well as the integration into the affordances model (Rosemann and Vessey, 2008). By commencing with these steps, we want to head toward developing a two-sided holistic affordances theory that comprises extensively proved versions of the static affordances framework as well as the processual affordances model. Together, these should explain the properties and meta-characteristics of affordances of digital technologies and open up the black box of combinational innovation resulting from the perception of newly and subsequently emerging affordances of today’s digital technologies (Yoo et al., 2010).

5 Conclusion

This paper presents a comprehensive literature review of research articles concerned with affordances to develop a meta-view on affordances, capturing the dynamic nature of today’s digital technology. In fact, technologies are increasingly characterized by generativity. Their modular structure enables the (re-)combination of technological features and resulting affordances in previously unknown and almost infinite dimensions. Thus, IS researchers are frequently confronted with the unpredictability of appropriations and different use patterns of digital technologies through their users, making it hard to understand and foreseeing IT-associated organizational change. This situation is even more complex when considering that today's digital technologies increasingly embed smart capabilities, such as the ability to learn and be context-aware, whereby technologies can proactively and dynamically shape affordances offered to their users (Knote et al., 2021).

To catch up with those developments, we screen the literature to condense meta-characteristics of affordances whose existence, perception, and actualization circumstances have been hitherto discussed in our field's most prestigious journals. Based on a five-staged literature review approach that builds upon the foundation of grounded theory (Wolfswinkel et al., 2013), we identified meta-characteristics of affordances. We progressed toward a meta-view on affordances comprising a descriptive affordances framework as well as an affordances lifecycle model. The first provides IS researchers a tool for identifying and understanding affordances in various IS contexts through knowing and being able to identify and interpret their meta-characteristics. The latter offers a lens for analyzing and predicting the circumstances of the emergence and actualization of affordances while considering the ever-developing nature of technological advancements and the associated actualization of affordances by modeling affordances actualization as an infinite perception-action feedback loop. In doing so, we open the black box of continuous and combinational innovation by linking the meta-characteristics to the phases of affordance emergence, perception, and updating, while providing a theoretical underpinning for the differentiation between affordance emergence, perception, updating, and their outcomes that has often been called for recently (Bernhard et al., 2013; Leidner et al., 2018).
References


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