

A Comprehensive Review of Affordance Theory in Enhancing Digital Health Solutions

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Abstract. The interplay between humans and objects is a foundational aspect of visual perception, significantly enriched by Gibson's introduction of Affordance Theory. This theory posits that human interaction with objects is predicated on the recognition of what these objects can provide or afford them. This premise has sparked a vibrant debate within the Information Systems (IS) community, leading to the emergence of two distinct interpretative schools of thought. The first school accentuates the role of user perception and the intrinsic features of IT artifacts in co-creating affordances. In contrast, the second school asserts that affordances are inherently integrated within the IT artifact's design and features. This review critically examines the divergent applications of Affordance Theory by these schools, with a particular emphasis on mHealth app studies. It proposes a comprehensive framework that synthesizes key arguments from both perspectives, aiming to offer researchers a refined tool for leveraging Affordance Theory. Furthermore, this framework seeks to aid designers in enhancing the usability and utility of IT artifacts, thereby bridging theoretical insights with practical application. Through this analysis, the paper endeavors to contribute to a nuanced understanding of Affordance Theory and its implications for digital health solutions.

Keywords. Affordance Theory; Digital Health Solutions; mHealth Applications; Information Systems (IS)

1. Introduction

In the realm of Information Systems (IS), the discourse around Affordance Theory is both vibrant and contested, engaging scholars in profound theoretical debates (Gaver, 1991). Central to these discussions is the exploration of how users perceive and interact with IT artifacts, uncovering the artifacts' inherent affordances (Gibson, 1977; Norman, 1999). This dynamic field has crystallized into two predominant schools of thought, each offering a distinct lens through which the relationship between IT artifacts and their users can be examined (Chemero, 2003; Volkoff & Strong, 2017). On one side, there are those who argue that it is the users' perceptions and interactions that define the value and utility of IT artifacts

(Faraj & Azad, 2012). This perspective emphasizes the subjective experience, suggesting that affordances are co-created through user engagement (Leonardi, 2011). Conversely, the second school posits that affordances are pre-designed into the artifacts themselves, awaiting discovery by the user (Norman, 1999; Gibson, 1977).

This scholarly divergence has prompted IS researchers to adopt varied approaches in their empirical investigations, often aligning with one of these perspectives to explore the intricate dynamics between IT artifacts and users (Volkoff & Strong, 2017). Despite the wealth of studies and guidelines aimed at harnessing Affordance Theory within IS research (Fromm, Mirbabaie, & Stieglitz, 2020), a comprehensive review that juxtaposes these two approaches—especially in the context of the same IT artifacts—remains elusive (Volkoff & Strong, 2017; Fromm, Mirbabaie, & Stieglitz, 2020). Addressing this gap is crucial; it promises not only to elucidate the diverse interpretations of the theory but also to refine its future application in the digital realm.

Accordingly, this literature review endeavors to dissect how Affordance Theory has been applied to the study of mHealth apps within the prestigious cadre of the "basket of 8" top Information Systems journals (Pozzi, Pigni, & Vitari, 2014). By delving into this niche, the review seeks to illuminate the variations and consistencies in how researchers have interpreted and utilized the theory, focusing specifically on mHealth applications (Leonardi & Vaast, 2017). Unlike prior reviews that have broadly surveyed the discovery of affordances across various domains—ranging from enterprise systems to social media and robotic manipulation (Yamanobe et al., 2017)—this analysis hones in on mHealth apps. It aims to uncover the nuanced ways in which Affordance Theory has informed the understanding of these digital health tools, reflecting the distinct philosophical underpinnings of the two schools of thought (Pozzi, Pigni, & Vitari, 2014; Yamanobe et al., 2017).

The objectives of this review are as follows:

- To delineate the core tenets and distinctions between the two schools of thought underpinning Affordance Theory in IS research.
- To compile and analyze studies of mHealth apps that have employed Affordance Theory, as published in the leading "basket of 8" IS journals, adhering to either theoretical perspective.
- To examine the methodologies and applications of Affordance Theory across these studies, revealing the spectrum of interpretations and implementations.
- To synthesize a comprehensive framework that integrates the diverse applications of Affordance Theory, offering a cohesive understanding that can guide future research in digital health technologies.
- By achieving these objectives, this review aspires to not only clarify the current landscape of Affordance Theory application in mHealth app research but also to forge a pathway toward more effective and nuanced future investigations.

2. Background

2.1. Affordance Theory: Diverging Perspectives in the First School of Thought

James Gibson, a seminal figure in the field of visual perception, introduced Affordance Theory to articulate the dynamic relationship between organisms, including humans, and their environments—encompassing surfaces, objects, and even other beings (Gibson, 1979). Gibson proposed that humans engage with the environment by directly perceiving the potential actions—affordances—objects present, bypassing the need for intermediate representations like retinal or mental images (Gibson, 1979). This direct interaction paradigm suggests that affordances are not solely inherent in objects but emerge from the interaction, transcending the traditional subjective-objective divide (Gibson, 1979). This nuanced perspective, however, sparked debates among ecological psychologists regarding the precise nature of affordances and the factors influencing them (Hutchby, 2001).

Scholars have since delved into the multifaceted properties of both humans and objects that contribute to affordances. Stoffregen posited that affordances emerge from the systemic interaction between human attributes (e.g., physical stature, mental state) and object characteristics (e.g., shape,

color) (Stoffregen, 2003). Chemero expanded on this by suggesting that the situational context surrounding these interactions could modify the perceived affordances, indicating a dynamic interplay between the user, object, and environment (Chemero, 2003; Hutchby, 2001).

In the realm of Information Systems (IS), this theory has been instrumental in understanding how users perceive and interact with IT artifacts. Leonardi emphasized that perception precedes interaction, with the perceived utility of IT artifacts playing a pivotal role in their adoption and use (Leonardi, 2011). This viewpoint is echoed by Markus and Silver, who argued that affordances stem from, but are not equivalent to, the features of IT artifacts, suggesting a communal perception of affordances among users (Markus & Silver, 2008). Volkoff and Strong further delineated the concept of affordance into a three-stage process: the potential for action, its actualization, and the resultant concrete outcome (Volkoff & Strong, 2017). This framework highlights the progression from potential utility to tangible benefits, illustrated by the transition from accessing data to achieving visibility. They draw parallels between the physical act of consuming an apple, facilitated by the affordances of biting and chewing, and the digital act of communication enabled by composing and sending an email (Volkoff & Strong, 2017; Chemero, 2003).

The social context also significantly influences the interaction between users and IT artifacts. Hutchby, for instance, argued that IT artifacts both enable and constrain user actions, a sentiment further explored by Zammuto and Griffith in the organizational setting (Hutchby, 2001; Zammuto et al., 2007). They posited that social dynamics could shape the affordances perceived by groups, potentially facilitating or hindering specific actions (Zammuto et al., 2007). This perspective is supported by empirical studies in robotic manipulation research, which underscore the importance of affordances in shaping user-technology interactions (Pozzi, Pigni, & Vitari, 2014; Leonardi & Vaast, 2017).

2.2. Affordance Theory: The Second School of Thought

This school of thought posits that affordances are intrinsic to objects, waiting to be discovered by individuals with the appropriate abilities. Reed suggested that objects contain affordances as latent resources, accessible to those suited to utilize them effectively (Reed, 1996). Turvey further elaborated on this concept by identifying affordances as either dispositional properties of objects or effectivity traits of animals, implying that certain conditions, such as the solubility of an object presupposing the existence of solvents, must be met for an affordance to be realized (Turvey, 1992; Reed, 1996).

Heft's empirical work supports this viewpoint, defining affordances as the result of the interaction between an object's characteristics and the human body's dimensions. This is clearly illustrated in Warren's study on stair-climbing, which demonstrates how an individual's physical attributes can either enable or restrict their ability to navigate stairs (Heft, 1989; Warren, 1984).

Within the realm of Information Technology (IT), this approach attributes unique properties to IT artifacts, setting them apart from other objects. Norman distinguished between real and perceived affordances, emphasizing that real affordances become apparent when users recognize and can utilize the features of an artifact. Conversely, perceived affordances might be recognized by users but are not facilitated by the artifact's features, as illustrated by screens that suggest but do not support clicking (Norman, 1988). Hartson expanded on Norman's categorization by introducing sensory affordances, which make potential actions visible to users, and functional affordances, which connect users to the system's overarching purpose (Hartson, 2003).

Gaver proposed a nuanced view of affordances, categorizing them into perceived, hidden, and false types—each representing different levels of user awareness and artifact capability (Gaver, 1991). This framework underscores the complexity of human-technology interaction, particularly when considering technology's multifaceted nature. Kaptelinin and Nardi offered the mediated action perspective as a lens to differentiate between instrumental and supplemental affordances, highlighting the distinction between individual and object interactions versus broader system engagement (Kaptelinin & Nardi, 2012).

This second school of thought enriches our understanding of affordances by emphasizing the pre-existing nature of these potential actions within objects and artifacts. Reed's perspective that objects contain affordances as latent resources, accessible to those suited to utilize them effectively, aligns with

this view (Reed, 1996). Turvey's identification of affordances as dispositional properties of objects or effectivity traits of animals further supports this, suggesting that certain conditions must be met for an affordance to be realized (Turvey, 1992). Heft's empirical work on the interplay between an object's characteristics and the human body's dimensions, along with Warren's investigation into stair-climbing, illustrate how physical attributes enable or restrict individuals' ability to engage with their environments (Heft, 1989; Warren, 1984).

2.3. Synthesizing Divergent Perspectives on Affordance Theory

The discourse surrounding Affordance Theory bridges two distinct realms: Ecological Psychology and Information Systems (IS), each grappling with the theory's application to objects and IT artifacts (Gibson, 1979; Leonardi, 2011). Central to this debate is the nature of affordances—whether they preexist independently of human interaction or emerge as a result of engagement with the object or IT artifact (Chemero, 2003; Norman, 1999). This conversation raises fundamental questions about the essence of affordances and their realization (Gaver, 1991; Stoffregen, 2003).

The Genesis of Affordances: A key inquiry is whether the potential for action offered by objects or IT artifacts can be identified prior to interaction. The consensus suggests that affordances become manifest only through engagement (Heft, 1989; Turvey, 1992). An illustrative example is the development of seating; the concept of a chair offering the affordance of sitting became apparent only after interaction with materials conducive to crafting a seat (Heft, 1989). This example underscores that affordances are discovered through the dynamic interplay between humans and objects, challenging the notion of pre-defined functionalities (Chemero, 2003).

The Source of Affordances: Another critical question addresses whether affordances are inherent to the object (or IT artifact) or the user (Norman, 1999; Reed, 1996). This query acknowledges that a symbiosis of human traits, object characteristics, and contextual factors converge to actualize affordances (Stoffregen, 2003; Turvey, 1992). For instance, the capability to ascend to a building's second floor may be facilitated by a stairway, yet, in circumstances where an individual's mobility is impaired, an elevator becomes the requisite tool for upward movement (Warren, 1984). This complexity necessitates an exploration of the interrelationship between human needs and object features, revealing how diverse factors, including physical limitations or technological attributes, influence the emergence of affordances (Heft, 1989; Warren, 1984).

Perception vs. Reality of Affordances: The distinction between actualizable affordances and those perceived or imagined by users forms the third area of discussion. The clarification offered by Strong and Volkoff—that only potentials that can be actualized qualify as affordances—challenges the classification of perceived, hidden, or false affordances (Strong et al., 2014; Volkoff & Strong, 2017). This perspective emphasizes that the utility of an IT artifact must be grounded in tangible, realizable actions, rather than hypothetical capabilities (Norman, 1999; Gaver, 1991).

Integrating Insights from Both Schools: Bridging the insights from both ecological psychology and IS, this analysis highlights the intricate relationship between human interaction and the latent possibilities within objects and technology (Gibson, 1979; Leonardi, 2011). It reveals that affordances are not static features but are co-created through the interaction of human perception, object properties, and the surrounding context (Chemero, 2003; Hartson, 2003). This understanding prompts a reevaluation of how technology design and user engagement collectively shape the discovery and utilization of affordances in digital environments (Turvey, 1992; Stoffregen, 2003).

In addressing these pivotal questions, this comparative analysis not only enriches the theoretical foundation of affordances but also provides practical implications for designing and implementing IT artifacts that resonate with user needs and capabilities (Heft, 1989; Reed, 1996). By navigating the complexities of affordance realization, researchers and practitioners can enhance the alignment between technology's potential actions and the diverse needs of its users (Yamanobe et al., 2017; Kaptelinin & Nardi, 2012).

2.4. Synthesizing Insights from Affordance Theory in Information Systems Research

Affordance Theory has sparked considerable interest within the Information Systems (IS) field, prompting a variety of reviews aimed at unraveling its applications, outcomes, and broader implications. Notably, Leonardi and Vaast delved into how enterprise social media affordances influence organizational dynamics (Leonardi & Vaast, 2017). Their critical evaluation of previous research methodologies yielded recommendations designed to fortify future scholarly endeavors. Similarly, an in-depth examination of social media affordances illuminated their dual impact on both organizations and individuals, offering a systematic assessment of the theory's practical application across studies (Leonardi & Vaast, 2017).

Broadening the lens, comprehensive reviews have scrutinized Affordance Theory's deployment across the entirety of IS research, predominantly through the lens of the first school of thought (Leonardi & Vaast, 2017). In contrast, a specialized review within the realm of robotics identified key user interactions, specifically grasping and manipulation, as pivotal affordances influenced by robotic technologies (Yamanobe et al., 2017).

These scholarly reviews have not only mapped the contours of Affordance Theory's utilization within IS but also highlighted the tangible effects of identified affordances within specific domains. This paper extends the discourse by focusing on mHealth studies, examining their theoretical alignment—whether with the first or second school of thought—and juxtaposing these applications against the broader tapestry of affordance literature (Gibson, 1979). Such a comparative approach not only elucidates the theory's operationalization within mHealth research but also amalgamates the critical insights garnered, thereby enriching our understanding and application of Affordance Theory in the digital health context (Leonardi & Vaast, 2017; Yamanobe et al., 2017).

3. Methodology

3.1. Literature Search Methodology

This literature review was meticulously conducted adhering to the systematic approach recommended by Webster and Watson, which underscores the significance of sourcing major contributions from premier journals within a field (Webster & Watson, 2002). Accordingly, the initial phase of this review focused on mHealth app studies featured in the esteemed "basket of 8" journals, renowned within the Information Systems (IS) domain (Webster & Watson, 2002). These journals include the European Journal of Information Systems, Information Systems Journal, Information Systems Research, Journal of AIS, Journal of Information Technology, Journal of MIS, Journal of Strategic Information Systems, and MIS Quarterly.

Emulating the methodology of recent influential reviews, a comprehensive forward search was executed via the Scopus database, targeting articles from the aforementioned "basket of 8" journals (Webster & Watson, 2002). The search criterion was the presence of the term "Affordances" within any section of the articles, spanning all publications up to September 27, 2020. This rigorous process identified 252 studies, which were then meticulously screened by the author to distill those specifically utilizing Affordance Theory, either as the sole theoretical framework or in conjunction with other theories, with a particular focus on mHealth apps as the primary IT artifacts under investigation (Zahedi, Shahin, & Babar, 2016). Ultimately, this refined selection process culminated in the inclusion of 4 pertinent studies (Shahin, Babar, & Zhu, 2017).

To ensure a comprehensive exploration of the topic, the search scope was broadened beyond the "basket of 8" journals to encompass relevant studies cited within the initially selected 4 articles. This backward search, involving a detailed examination of titles and abstracts, extended to additional journals and conference proceedings, yielding an additional 341 studies. However, none of these further studies met the stringent criteria for inclusion (Zahedi, Shahin, & Babar, 2016; Shahin, Babar, & Zhu, 2017).

Webster and Watson highlight the inherently subjective nature of literature reviews, tailored to the specific objectives of the research at hand (Webster & Watson, 2002). Upon concluding the analysis of studies from leading journals, it became evident that the collected works were instrumental in

elucidating the diverse applications of Affordance Theory. This foundation facilitated the development of a comprehensive framework that synthesizes and integrates the myriad perspectives and arguments surrounding the theory's use, particularly in the realm of mHealth applications (Webster & Watson, 2002; Shahin, Babar, & Zhu, 2017).

3.2. Inclusion and Exclusion Criteria for Study Selection

To ensure a focused and relevant review, specific inclusion and exclusion criteria were meticulously defined for the selection of articles.

Inclusion Criteria:

- The study must be an empirical examination of mHealth apps.
- It must be published in one of the esteemed "basket of 8" journals recognized for their contribution to the Information Systems (IS) field.
- The article should employ Affordance Theory, either as its sole theoretical framework or in conjunction with other theories, across any methodological approach.

Exclusion Criteria:

Studies that incorporate Affordance Theory but do not specifically focus on mHealth apps as the IT artifact under investigation are excluded.

Articles that merely mention Affordance Theory, perhaps within the introductory or background sections, without applying it to analyze an empirical phenomenon, are also excluded.

Following these guidelines, a thorough examination of the literature within the "basket of 8" journals yielded only 4 studies that met all the specified criteria. Among these, three were published in the Information Systems Journal, and one appeared in the European Journal of Information Systems.

3.3. Approach to Article Analysis

The analysis of each selected study was conducted with a detailed and structured approach. The author individually read and reviewed each article, focusing on several key aspects:

- **Study Objective:** Identifying the primary goal or research question addressed by the study.
- **Theoretical Perspective:** Determining whether the study aligns with the first or second school of thought within Affordance Theory.
- **Identified Affordances:** Cataloging the specific affordances of mHealth apps discovered or discussed in the study.
- **Application of Theory:** Analyzing how Affordance Theory was utilized to frame and explore the empirical phenomena under study.
- **Methodological Approach:** Examining the research methods employed to gather and analyze data.

This comprehensive review process facilitated a nuanced comparison and contrast of how each study operationalized Affordance Theory, revealing both convergences and divergences in their approaches. The synthesized insights from this analysis are presented in Appendix 1, offering a cohesive overview of the current landscape of Affordance Theory application within mHealth app research.

4. Results: Synthesizing Affordance Theory Applications

The analytical process involved a meticulous comparison of each selected study against others and the broader corpus of affordance literature (James, Deane, & Wallace, 2019; Mettler & Wulf, 2019). This comparative analysis facilitated the development of conceptual themes, systematically catalogued in Table 2 (Benbunan-Fich, 2018; Thapa & Sein, 2018). These themes elucidate both the commonalities and divergences among the studies regarding their interpretation and application of Affordance Theory (James, Deane, & Wallace, 2019; Thapa & Sein, 2018).

Table 1. Similar and different ways of using Affordance Theory found in the included studies.

| Uses of Affordance (AFF) Theory | Studies | | | |
|--------------------------------------------------------------|---------|----|----|----|
| | 34 | 35 | 36 | 37 |
| AFF emerges by relationship (user and IT-artifact together). | × | | | |
| AFF is limited to IT-artifact capabilities. | | × | × | |
| AFF requires users' perception. | × | × | × | × |
| AFF does not require users' perception. | | × | | |
| AFF is one of the IT-artifact's features. | | | | × |
| AFF is not one of the IT-artifact's features | × | × | × | |

This examination revealed a distinct alignment within the selected studies: one study embraced the principles of the first school of thought, while the remaining three studies adhered to the second school. Despite this shared affiliation with the second school of thought, notable variations emerged in the application of the theory among these studies. Such differences were methodically organized into distinct themes, as detailed in Table 1.

The thematic organization serves to highlight the nuanced approaches to employing Affordance Theory within the realm of mHealth applications. By identifying these themes, the analysis not only underscores the diversity in theoretical application but also contributes to a deeper understanding of how Affordance Theory is operationalized across different studies. This structured approach to synthesizing the research findings offers valuable insights into the evolving landscape of Affordance Theory within the Information Systems discipline, particularly in the context of mHealth app research.

4.1. Exploring the Application of Affordance Theory in mHealth Studies

4.1.1. *The Influence of Users' Goals on Feature Selection*

James and Deane's study, alongside insights from Gibson's foundational work, provides a compelling example of how user goals can shape interactions with technology, particularly within the context of mHealth apps. By adopting a relational perspective of affordances, James and Deane illuminate how users' objectives—ranging from enjoyment and competence to body image concerns—determine their engagement with specific features of fitness applications (James & Deane, 2019; Gibson, 1977). Their findings suggest that users drawn to the social aspects of exercise were more inclined to utilize features facilitating social connections, whereas individuals focused on physical appearance favored progress tracking functionalities.

This nuanced understanding challenges the notion that an IT artifact must be considered in its entirety to serve user needs. Instead, it posits that certain components of the technology may cater to specific desires, reflecting Gibson's original assertion that affordances are defined by the possibilities for action they present to the user, not necessarily requiring the object to be viewed as a whole (Gibson, 1977). Thus, James and Deane's study highlights how different segments of a fitness app can fulfill varied motivational affordances based on user interaction (James & Deane, 2019).

Moreover, by integrating goal content theory with Affordance Theory, James and Deane ventured beyond merely cataloging app features. They delved into how these features align with users' exercise

motivations, offering insights into the dynamic interplay between user intentions and technological affordances (James & Deane, 2019). This approach not only expanded the understanding of how fitness apps can meet diverse user needs but also underscored the adaptability of Affordance Theory in examining the multifaceted relationships between users and technology (Gibson, 1977; James & Deane, 2019).

4.1.2. *The Evolution and Actualization of Affordances*

Thapa and Sein offer a nuanced perspective on affordances, emphasizing their inherent potentiality and the significance of actualization over mere perception. They argue that the true value of affordances lies in their realization through use, leading to tangible outcomes. Their study on telemedicine applications in Nepal provides a compelling case of how doctors actualized the affordances of technology to facilitate remote medical operations. Notably, virtual co-localizability became evident as doctors engaged in daily video conferences with local health workers, ultimately enhancing healthcare services (Thapa & Sein, 2018).

The concept of "educability" affordance, actualized by doctors while using the app for remote operations, further illustrates this point. Interestingly, this affordance was recognized by doctors only after its practical application in educating interns, underscoring the idea that affordances can manifest without prior awareness. This discovery suggests that affordances like educability may give rise to secondary affordances, influenced by the user's cultural, social, and technical environment (Thapa & Sein, 2018). For instance, the same educability affordance may lead some doctors to perceive a "volunteerability affordance," motivated by a sense of societal responsibility, while others may see an "earnability affordance," viewing it as an opportunity for financial gain (Thapa & Sein, 2018).

This study challenges traditional notions by suggesting that users do not need to perceive an affordance for it to be actualized. Thapa and Sein's insights extend Gibson's original concept by demonstrating that affordances can be realized through interaction, independent of user awareness (Gibson, 1977). This aligns with the first school of thought in emphasizing actualization but diverges by proposing that perception is not a prerequisite for affordance actualization. They address Volkoff and Strong's query regarding the necessity of awareness for affordance realization, presenting the educability affordance as evidence that perception may not always precede actualization (Volkoff & Strong, 2018; Thapa & Sein, 2018).

4.1.3. *Discovery and Constraints of Affordances*

Mettler and Wulf offer a compelling interpretation of affordances, viewing them as generative mechanisms that exist independently of human interaction, awaiting discovery. Their study on wearable devices in hazardous work environments illustrates how such devices, integrated with mHealth apps, inherently possess a workplace safety affordance (Mettler & Wulf, 2019). However, they highlight that this potential can be undermined by user-specific constraints, such as privacy concerns. Employees apprehensive about data privacy might resist using these devices, thereby limiting the realization of the safety affordance for themselves (Mettler & Wulf, 2019).

This perspective posits that the affordances of an IT artifact, like a wearable device, are pre-established and universally applicable (Mettler & Wulf, 2019). The inability of a user to actualize an affordance is attributed to individual constraints rather than the absence of the affordance itself. This approach is instrumental in evaluating the uniformity of an affordance across different users and suggests that the discovery of new affordances is unlikely since they are considered to be predefined (Leonardi, 2013).

While this viewpoint resonates with Gibson's notion that affordances are perceived differently by individuals (Gibson, 1979), it simultaneously challenges his broader definition by suggesting that the spectrum of an IT artifact's affordances is limited to those already identified. Such a stance risks overlooking potential new affordances that could emerge from unique user interactions with the technology. In contrast to the first school of thought, which maintains that affordances are activated through specific user-object interactions, this perspective argues that a user's failure to actualize a

common affordance does not negate its existence but rather indicates that it is not applicable to that individual (Gibson, 1979; Leonardi, 2013).

Moreover, the study provocatively suggests that constraints like privacy concerns do not inherently limit a user's engagement with an app. Instead, they may diminish the user's capacity to leverage the app's affordance fully without outright precluding its use (Mettler & Wulf, 2019). This nuanced understanding of affordances and constraints enriches the discourse on how IT artifacts serve diverse user needs and how individual factors shape the technology's utility (Leonardi, 2013).

4.1.4. Integrating Affordances into the Design of IT-Artifacts

Benbunan-Fich revisits the concept of affordances within the framework of wearable technology, applying a nuanced perspective derived from the mediated action view (Benbunan-Fich, 2018). This approach delineates affordances into two primary categories: instrumental, which pertains to the direct interaction between the user and the object, and supplemental, which encompasses aspects like maintenance and data aggregation (Benbunan-Fich, 2018). In the context of wearable devices, Benbunan-Fich offers an innovative interpretation: the device becomes an extension of the user's body, rendering the interaction intrinsically personal and reshaping the conventional understanding of instrumental affordances (Benbunan-Fich, 2018).

Instrumental affordances, in this case, include features like band durability, water resistance, and interactive mechanisms (e.g., tap sequences, sleep mode activation), which are deemed integral because they directly affect the user's experience of wearing the device (Benbunan-Fich, 2018). Conversely, supplemental affordances—such as battery life and phone synchronization—support the device's operational effectiveness and user convenience (Benbunan-Fich, 2018).

The study reveals a critical insight: simplicity in the design of instrumental affordances can paradoxically complicate user interaction, highlighting the delicate balance required in wearable device design (Benbunan-Fich, 2018). Moreover, Benbunan-Fich posits that an imbalance between instrumental and supplemental affordances can detrimentally affect user experience, underscoring the importance of harmonious design considerations (Benbunan-Fich, 2018).

Benbunan-Fich shifts the discourse from viewing health improvement as a direct affordance of wearable devices to considering the device's features—both for wearing and interacting, as well as for maintenance—as the true affordances (Benbunan-Fich, 2018). This perspective contrasts with the first school of thought, which might categorize the motivation for health improvement as an affordance in itself. Instead, the study acknowledges the potential for wearable devices to enhance health and lifestyle while maintaining that the affordances lie in the device's specific features and their design, rather than in the outcomes they facilitate (Benbunan-Fich, 2018).

Table 2. Summary of the use of Affordance Theory in the two schools.

| Studies | First school |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 34 | Affordances are relations between users and IT artifacts that are initiated through users' goals and the selected features of IT-artifacts. |
| 35 | <p style="text-align: center;">Second school</p> Affordances are relations between users and IT artifacts that are influenced by external factors. Some affordances begin from the user's perception and continue through to actualization, while others may be actualized before users perceive them. |

| | |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 36 | Affordances are limited to IT artifact capabilities regarding what they can afford to users, and users need to discover and recognize the IT-artifacts' capabilities. |
| 37 | Affordances are considered to be features of IT artifacts, and users need to interact with them. |

4.2. Developing a Comprehensive Framework for Affordance Theory Interpretations

In light of the diverse interpretations and applications of Affordance Theory, particularly in the realm of mHealth app research, a new framework has been developed. This framework aims to encompass and organize the spectrum of perspectives without dismissing any previous arguments (Mettler & Wulf, 2019; Thapa & Sein, 2018). It systematically addresses four key areas: the constraints of affordances within IT artifacts, the interplay between perception and actualization of affordances, their relationship to the components of IT artifacts, and the role of perception in the actualization process (Mettler & Wulf, 2019; Thapa & Sein, 2018).

Derived from a thorough analysis of literature and empirical studies, this framework posits that users, influenced by their capabilities, social contexts, regulatory frameworks, and situational variables, engage with IT artifacts to leverage their potential applications (Thapa & Sein, 2018). This interaction, shaped by external factors, prompts the actualization of both recognized and novel affordances. Recognized affordances are those previously identified through generative mechanisms, such as the workplace safety affordance in wearable devices distributed by organizations to enhance security (Mettler & Wulf, 2019). Conversely, novel affordances emerge uniquely in user interactions, as illustrated when an employee discovers the ability to use a wearable device for documenting visited locations, marking a newly actualized affordance (Thapa & Sein, 2018).

Thapa and Sein's investigation into telemedicine applications highlights how standard usage can reveal unexpected affordances like educability and earnability (Thapa & Sein, 2018). While this review does not take a definitive stance on the necessity of perceiving affordances before their actualization, due to ongoing debate and lack of conclusive evidence, it acknowledges the complexity of this issue.

The successful actualization of affordances hinges on the congruence between user characteristics and the design of the IT artifact. For instance, privacy concerns might prevent employees from actualizing the intended safety affordances of wearable devices, not due to a lack of potential but because the device's operational mode conflicts with their privacy values (Mettler & Wulf, 2019). When there is a harmonious alignment between the user and the IT artifact's design, it typically results in a positive assessment of the actualized affordance. However, this alignment can be undermined by factors such as suboptimal design or specific user attributes (Leonardi, 2013). A design that resonates with users' intuitive understanding of everyday objects is more likely to facilitate favorable interactions with IT artifacts (Norman, 1988).

This framework elucidates that IT artifacts can offer both recognized and novel affordances, with the evaluation of these affordances determined by the alignment between the user's characteristics and the artifact's design (Mettler & Wulf, 2019; Thapa & Sein, 2018). It underscores the dynamic nature of affordances, suggesting that the utility and impact of IT artifacts are co-created by the users and the design features of the technology itself (Vaghefi & Tulu, 2019; Liu, Santhanam, & Webster, 2017).

5. Discussion

This review has endeavored to weave together the myriad applications of Affordance Theory, particularly within the context of mHealth apps, while navigating through the complex landscape shaped by two principal schools of thought. Through an examination of seminal works published in the prestigious "basket of 8" journals, this exploration has highlighted the nuanced interpretations and implementations of the theory, revealing a spectrum of perspectives even among studies aligned with the same theoretical framework (Volkoff & Strong, 2018).

Significantly, this review has uncovered that the application of Affordance Theory is not monolithic; variations abound. For instance, Thapa and Sein introduced a novel perspective by suggesting that the actualization of an affordance does not necessitate prior perception by the user (Thapa & Sein, 2018). This proposition opens up new avenues for understanding how users interact with technology, challenging traditional assumptions within the field.

The analysis has also identified key theoretical distinctions, such as the debate between affordances being inherent features of IT artifacts versus emerging through relational dynamics between users and technology (Mettler & Wulf, 2019; Thapa & Sein, 2018). To reconcile these diverse viewpoints, a comprehensive framework was developed. This framework categorizes affordances into "known" and "new," based on whether they are pre-identified by designers and users or discovered through user interaction, respectively (Mettler & Wulf, 2019; Thapa & Sein, 2018). This distinction underscores the dynamic nature of affordances, suggesting that the landscape of possible actions facilitated by IT artifacts is both vast and subject to expansion as users explore and engage with technology.

Terminological clarity was another critical area of discussion. The review noted that while the second school of thought tends to equate IT artifact features with affordances directly, Benbunan-Fich's examination of wearable devices broadened this interpretation (Benbunan-Fich, 2018). By recognizing features that enhance workplace safety or personal health as "general motivations," this study bridges the gap between direct affordances and their outcomes, aligning with Volkoff and Strong's comprehensive view of affordances as both immediate possibilities and eventual outcomes of user interaction with technology (Volkoff & Strong, 2018).

This nuanced discussion emphasizes that affordances, whether known or newly discovered, play a pivotal role in shaping the user experience with IT artifacts. It highlights the importance of considering both the potential and the realized interactions users have with technology, offering insights into how design and user intention can converge to facilitate meaningful and productive engagements with digital tools (Liu et al., 2017).

This review delves into the intricate relationship between affordances and the features of IT artifacts, elucidating how the realization of affordances is intricately linked to the harmonization of the IT artifact's design with the user's characteristics. For instance, the durability of a wearable device's band, as identified by Benbunan-Fich, becomes an affordance when it aligns with the user's physical attributes or design preferences, thereby enhancing the user's interaction with the device, such as in activity tracking (Benbunan-Fich, 2018). Similarly, water-resistance features, while vital for swimmers to actualize the device's utility, may hold little value for individuals who seldom engage in water activities (Benbunan-Fich, 2018).

This perspective posits that the design of IT artifacts should be in congruence with the users' abilities, preferences, needs, and desires (Liu et al., 2017). The review thus emphasizes the significance of alignment between an IT artifact's design and the user's attributes as a determinant of how users evaluate their interactions with the technology. When such alignment is achieved, users are more likely to appreciate and utilize the affordances offered by the IT artifact, leading to a positive user experience (Liu et al., 2017).

Consequently, the design elements of IT artifacts are not merely features but integral components of the interaction that enhance the user's ability to actualize affordances, potentially unlocking new or higher-level affordances, general motivations, or outcomes of use. The framework proposed in this review aims to clarify the myriad interpretations of affordance by incorporating a comprehensive view of the elements that influence the dynamic relationship between humans and IT artifacts (Liu et al., 2017). By doing so, it offers guidance for researchers and developers to consider all relevant factors in the user-IT artifact relationship thoroughly.

Employing this framework ensures a holistic application of Affordance Theory, fostering a clear comprehension of how users engage with IT artifacts' affordances to fulfill their objectives (Liu et al., 2017). It underscores the utility of affordances in meeting the overarching goals of using IT artifacts, thus providing a robust foundation for designing user-centric technology that aligns with individuals' needs and preferences.

This review has focused exclusively on the "basket of 8," the leading IS journals, which has resulted in the inclusion of only four mHealth app studies (Webster & Watson, 2002). This selective approach, while ensuring quality, inherently narrows the breadth of analyzed literature. This limitation presents a fertile ground for future research, encouraging an expansion beyond these journals to incorporate a wider array of mHealth app studies from other esteemed publications (Webster & Watson, 2002). Broadening the scope of review could unveil diverse patterns of Affordance Theory application, enriching our theoretical comprehension and fostering enhanced practical implementations.

Moreover, this review primarily addresses Affordance Theory from an individual user perspective, overlooking its implications at the organizational level. The discrepancy between an individual's and an organization's capacity to leverage IT artifacts suggests a rich area for future inquiry. Future studies could delve into how organizations navigate the realization of their potential through system use and how the actualization of system affordances by employees may contribute to or diverge from organizational objectives (Liu et al., 2017).

6. Conclusion

This review marks a significant contribution to the Affordance Theory discourse, unraveling a spectrum of theoretical debates across two distinct schools of thought and their varied applications within mHealth app research. It has illuminated the critical and constructive roles these theoretical arguments play in applying Affordance Theory, underscoring their indispensability in crafting a nuanced understanding of technology interaction.

In response to these insights, a comprehensive framework has been developed to encapsulate these essential considerations. This framework not only aids in applying the theory more effectively but also serves as a valuable tool for designers aiming to refine IT artifact design. By enhancing features associated with known affordances, designers can significantly improve artifact usability. Simultaneously, the identification and exploration of new affordances offer avenues to broaden the utility of IT artifacts, ensuring their adaptability and relevance in meeting evolving user needs.

Through meticulous analysis and synthesis, this review fosters a deeper appreciation of Affordance Theory's versatility and its pivotal role in guiding both academic inquiry and practical design strategies, thereby enriching the landscape of mHealth app research and development.

7. References

- [1] Chemero, A. (2003). An outline of a theory of affordances. *Ecological Psychology*, 15(2), 181-195.
- [2] Volkoff, O., & Strong, D.M. (2017). Affordance theory and how to use it in IS research. In *The Routledge Companion to Management Information Systems* (pp. 232-245). Routledge.
- [3] Faraj, S., & Azad, B. (2012). The materiality of technology: An affordance perspective. In *Materiality and Organizing: Social Interaction in a Technological World* (pp. 237-258).
- [4] Gibson, J.J. (1977). *The theory of affordances*. Hilldale, USA, 1(2).
- [5] Leonardi, P.M. (2011). When flexible routines meet flexible technologies: Affordance, constraint, and the imbrication of human and material agencies. *MIS Quarterly*, 35(1), 147-167.
- [6] Norman, D.A. (1999). Affordance, conventions, and design. *Interactions*, 6(3), 38-43.
- [7] Gaver, W.W. (1991). Technology affordances. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM.
- [8] Fromm, J., Mirbabaie, M., & Stieglitz, S. (2020). A systematic review of empirical affordance studies: Recommendations for affordance research in information systems.
- [9] Pozzi, G., Pigni, F., & Vitari, C. (2014). Affordance theory in the IS discipline: A review and synthesis of the literature.
- [10] Leonardi, P.M., & Vaast, E. (2017). Social media and their affordances for organizing: A review and agenda for research. *Academy of Management Annals*, 11(1), 150-188.
- [11] Yamanobe, N., et al. (2017). A brief review of affordance in robotic manipulation research. *Advanced Robotics*, 31(19-20), 1086-1101.

- [12] Gibson, J. (1979). *The ecological approach to visual perception*. Boston, MA, US: Houghton, Mifflin and Company.
- [13] Stoffregen, T.A. (2003). Affordances as properties of the animal-environment system. *Ecological Psychology*, 15(2), 115-134.
- [14] Markus, M.L., & Silver, M.S. (2008). A foundation for the study of IT effects: A new look at DeSanctis and Poole's concepts of structural features and spirit. *Journal of the Association for Information Systems*, 9(10), 5.
- [15] Strong, D.M., et al. (2014). A theory of organization-EHR affordance actualization. *Journal of the Association for Information Systems*, 15(2), 2.
- [16] Volkoff, O., & Strong, D.M. (2018). Affordance theory and how to use it in IS research. In *The Routledge Companion to Management Information Systems*. New York: Routledge.
- [17] Hutchby, I. (2001). Technologies, texts and affordances. *Sociology*, 35(2), 441-456.
- [18] Zammuto, R.F., Griffith, T.L., Majchrzak, A., Dougherty, D.J., & Faraj, S. (2007). Information technology and the changing fabric of organization. *Organization Science*, 18(5), 749-762.
- [19] Heft, H. (1989). Affordances and the body: An intentional analysis of Gibson's ecological approach to visual perception. *Journal for the Theory of Social Behaviour*, 19(1), 1-30.
- [20] Michaels, C.F. (2000). Information, perception, and action: What should ecological psychologists learn from Milner and Goodale (1995)? *Ecological Psychology*, 12(3), 241-258.
- [21] Reed, E.S. (1996). *Encountering the World: Toward an Ecological Psychology*. Oxford University Press.
- [22] Stoffregen, T.A. (2000). Affordances and events. *Ecological Psychology*, 12(1), 1-28.
- [23] Turvey, M.T. (1992). Affordances and prospective control: An outline of the ontology. *Ecological Psychology*, 4(3), 173-187.
- [24] Heft, H. (2001). *Ecological Psychology in Context: James Gibson, Roger Barker, and the Legacy of William James's Radical Empiricism*. Psychology Press.
- [25] Warren, W.H. (1984). Perceiving affordances: Visual guidance of stair climbing. *Journal of Experimental Psychology: Human Perception and Performance*, 10(5), 683.
- [26] Hartson, R. (2003). Cognitive, physical, sensory, and functional affordances in interaction design. *Behaviour & Information Technology*, 22(5), 315-338.
- [27] Kaptelinin, V., & Nardi, B. (2012). Affordances in HCI: Toward a mediated action perspective. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM.
- [28] Sittig, D.F., & Singh, H. (2010). A new socio-technical model for studying health information technology in complex adaptive healthcare systems. *Quality & Safety in Health Care*, 19(Suppl 3), i68.
- [29] Hafezieh, N., & Eshraghian, F. (2017). Affordance theory in social media research: Systematic review and synthesis of the literature. In *25th European Conference on Information Systems (ECIS 2017)*.
- [30] Webster, J., & Watson, R.T. (2002). Analyzing the past to prepare for the future: Writing a literature review. *MIS Quarterly*, xiii-xxiii.
- [31] Lowry, P.B., Romans, D., & Curtis, A.M. (2004). Global journal prestige and supporting disciplines: A scientometric study of information systems journals. *Journal of the Association for Information Systems (JAIS)*, 5(2), 29-80.
- [32] Zahedi, M., Shahin, M., & Babar, M.A. (2016). A systematic review of knowledge sharing challenges and practices in global software development. *International Journal of Information Management*, 36(6), 995-1019.
- [33] Shahin, M., Babar, M.A., & Zhu, L. (2017). Continuous integration, delivery, and deployment: A systematic review on approaches, tools, challenges, and practices. *IEEE Access*, 5, 3909-3943.
- [34] James, T. L., Deane, J. K., & Wallace, L. (2019). An application of goal content theory to examine how desired exercise outcomes impact fitness technology feature set selection. *Information Systems Journal*, 29(5), 1010-1039.
- [35] Mettler, T., & Wulf, J. (2019). Physiolytics at the workplace: Affordances and constraints of

- wearables use from an employee's perspective. *Information Systems Journal*, 29(1), 245-273.
- [36] Benbunan-Fich, R. (2018). An affordance lens for wearable information systems. *European Journal of Information Systems*, 1-16.
- [37] Thapa, D., & Sein, M.K. (2018). Trajectory of affordances: Insights from a case of telemedicine in Nepal. *Information Systems Journal*, 28(5), 796-817.
- [38] Leonardi, P.M. (2013). When does technology use enable network change in organizations? A comparative study of feature use and shared affordances. *MIS Quarterly*, 749-775.
- [39] Vaghefi, I., & Tulu, B. (2019). The continued use of mobile health apps: Insights from a longitudinal study. *JMIR mHealth and uHealth*, 7(8), e12983.
- [40] Norman, D.A. (1988). *The Psychology of Everyday Things*. Basic Books.
- [41] Liu, D., Santhanam, R., & Webster, J. (2017). Toward meaningful engagement: A framework for design and research of gamified information systems. *MIS Quarterly*, 41(4).