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Studying IT Effects via Functional Affordances

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Résumé

Les effets comportementaux et sociaux de l'utilisation des Technologie d'information (TI) constituent un sujet de recherche important ainsi qu'une composante importante de la recherche dans le domaine TI. Cependant, il n'existe que relativement peu de recherches ayant examiné l'artefact TI et leurs effets potentiels. Cette thèse se base sur le concept « d'affordances fonctionnelles » pour étudier l'artefact TI et son rôle dans l'obtention des résultats obtenus par son utilisation. Cette approche peut s'avérer utile aux concepteurs en les aidant à développer des systèmes qui pourront plus facilement les permettre, ainsi que leurs utilisateurs de ces artefacts TI, d'obtenir des résultats auxquels ils s'attendent. Dans cet objectif, notre recherche propose une conceptualisation « d'affordances fonctionnelle » qui peut en servir à étudier les utilisations et les effets des TI et l'examine dans deux études.

La première étude propose une approche méthodologique qui présente une vision intégrée de l'artefact TI, les comportements d'utilisation d'un groupe spécifié d'utilisateurs, de même que les conséquences de leurs utilisations. Spécifiquement, notre approche permet d'identifier des liens entre les caractéristiques de n'importe quelle TI et les conséquences de son utilisation, en plus de démontrer comment les aspects matériels de la TI peut déclencher ses effets potentiels. L'approche méthodologique que nous proposons adopte le concept « d'affordances fonctionnelles » afin d'identifier les caractéristiques d'une TI et les comportements d'utilisation d'un groupe d'utilisateurs (l'approche pourrait être appliquée à différentes TI, dépendamment du choix de l'analyste ou du chercheur). En combinant une approche empirique avec l'analyse des réseaux sociaux, la méthodologie permet d'identifier les affordances fonctionnelles d'une TI et de les catégoriser selon leur proximité soit à l'artefact ou aux objectifs de ses utilisateurs. Le réseau d'affordances fonctionnelles qui en résulte peut ensuite servir à étudier les effets d'une TI ainsi qu'à mieux comprendre son design et à

l'améliorer, de même que ses programmes de formation. La faisabilité et l'utilité de l'approche que nous proposons sont illustrées en l'appliquant à Facebook et en examinant les données collectées auprès d'un groupe d'utilisateurs.

L'utilisation des artefacts TI est souvent considérée comme étant un indicateur clé du succès de l'adoption et de l'implantation des TI ainsi qu'étant nécessaire pour réaliser les bénéfices de ces implantations. Pourtant, même si l'utilisation des TI peut constituer une bonne mesure du succès de leur adoption, elle ne veut pas nécessairement dire que des résultats voulus de cette utilisation seront obtenus, c'est-à-dire, les bénéfices que les utilisateurs des TI retireront et auxquels les concepteurs des TI s'y attendent. Le deuxième article de la thèse examine comment l'utilisation d'une TI peut mener aux résultats attendus par ses concepteurs. Afin de répondre à cette question, nous adoptons une perspective « d'affordances fonctionnelles ». En l'appliquant au niveau individuel d'analyse et en le conceptualisant selon les perceptions des utilisateurs, nous définissons le concept des dispositions fonctionnelles perçues ou « perceived functional affordances (PFA) » comme étant les possibilités d'action offertes par des TI telles que perçues par un utilisateur individuel. Par ailleurs, suite à l'approche méthodologique proposée par Eisenhardt (1989), et en étudiant l'utilisation d'un portail permettant des patients d'auto-gérer leur asthme, nous avons identifié quatre archétypes de PFA: "Facilitator", "Protector", "Imposer", et "Inhibitor". Afin d'illustrer la mise en pratique de ces archétypes, l'article examine comment et sous quelles conditions les PFAs des patients qui utilisent le portail ont influencé la qualité de gestion de leur maladie chronique.

Mots-clés: Recherche qualitative, Affordances fonctionnelles, Utilisation de TI, Les effets de TI, L'analyse des réseaux sociaux, Étude de cas, Auto gestion de l'asthme

Abstract

The behavioral and social effects of IT usage is an important research topic and constitutes a significant component of IS research. Yet, there exists relatively little research on IT artifacts and how their use leads to their effects. The present thesis follows up on the idea that using the concept of functional affordances to study IT effects can help researchers acquire a more in-depth knowledge of IT artifacts and their role in creating IT usage consequences. Such an approach can also help designers build IT artifacts that result in outcomes that are desirable for designers and users. Hence, this research is an effort to conceptualize the functional affordance concept and put it into practice in the study of IT usage and its effects. To do so, two studies were undertaken.

The first study develops a methodological approach that yields an integrated view of any IT artifact, the usage behaviors of a specified group of its users, and eventually the consequences of their usage. Specifically, the approach links the features-in-use of an IT to their possible consequences for the user group being analyzed (the proposed approach can be applied to different IT, depending on the choice of the analyst or researcher). To do so, the relational nature of the functional affordance concept is exploited. This approach also provides a way to link the functional affordances of an IT as a network which can then be analyzed via social network analysis methods. The first study illustrates the viability of the proposed approach based on data collected from a group of Facebook users.

IT usage is generally viewed as a key indicator of adoption success and a prerequisite for deriving benefits. Yet, while IT usage can provide a good measure of adoption success, it may not necessarily yield desirable outcomes, i.e., the individual benefits expected by its designers. The second study investigates how IT use can lead to its desirable outcomes. To answer this question we adopted a functional affordance perspective. Specifically, we define perceived functional affordances (PFA) as an IT's afforded possibilities for action as

perceived by an individual user. Further, by following Eisenhardt's (1989) approach of theory building from multiple cases, and by studying the usage of a portal designed to help asthma patients better self-manage their asthma, we identified four PFA archetypes: Facilitator, Protector, Imposer, and Inhibitor. Next, we used these archetypes to explain the conditions under which the PFA of the portal could be transformed into usage that is conducive to improved asthma self-management for a group of patients.

Keywords: Qualitative research, Functional affordances, IS use, IT impact, Social network analysis, Case study, Asthma-self-management.

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Chapter I - Introduction

The behavioral and social effects of IT usage is an important research topic and can be viewed as "…foundational to a large part of the information system research enterprise" (Markus and Silver 2008, p. 610). By studying the effects of IT, researchers examine the changes that IT bring to human and social behavior, thereby providing a better understanding of "…what technology impacts should we anticipate, and how can we interpret the changes that we observe?" (DeSanctis and Poole 1994, p. 122). Yet, the lack of research focus on the IT artifact and its role in producing outcomes is a widely cited concern (Markus and Silver 2008).

This lack of focus on the IT artifact is not only limited to IT effects studies. As Orlikowski and Iacono (2001) noted, "…information technology is not a major player on its own playing field" (p. 130) and "…the tendency to take IT artifacts for granted in IS studies has limited our ability as researchers to understand many of their critical implications…" (p. 133). While it is generally accepted that having such an understanding is important, past IS research has not adequately studied its core subject, the IT artifact (Benbasat and Zmud, 2003), which has been "…either absent, black boxed, abstracted from social life, or reduced to surrogate measures" (Orlikowski and Iacono 2001, p. 130). Although it has been more than a decade since the Orlikowski and Iacono paper, calls for deeper research engagement with the IT artifact remain unanswered (Akhlaghpour et al. 2013).

In a pioneering study that focused on the IT artifact to study IT effects, DeSanctis and Poole (1994) hypothesized a link between the properties of IT artifacts and outcomes. They noted that IT could be contributing causes of their usage patterns and thereby their consequences, i.e., technology can make a difference (Jasperson 2005). To characterize IT artifacts and to explain what it is about them that can contribute to behavioral and social outcomes of their usage, DeSanctis and Poole (1994) proposed the concepts of "structural features" and

"system spirit" as properties of IT.

Consistent with DeSanctis and Poole (1994), Markus and Silver (2008) also emphasized the materiality of IT and its role as a potential cause of social and behavioral outcomes. However, borrowing the concept of affordance from ecological psychology, Markus and Silver (2008) suggested a new approach to extend DeSanctis and Poole's conceptualization, address some of its shortcomings, such as the assumption that IT has embedded social structures, and revisit DeSanctis and Poole's positioning of spirit as an IT property. More specifically, they conceptualized "structural features" and "spirit" via three new constructs: technical objects (which represent the materiality of IT and refer to IT artifacts and their component parts), functional affordances (which refer to "…the possibilities for goal-oriented action afforded to specified user groups by technical objects", p. 622), and symbolic expressions (which refer to the "…communicative possibilities of a technical object for a specified user group", p. 623, which capture the intentions and values that a system supports for its users). Further, Markus and Silver (2008) noted that the affordance-based view of the IT artifact could "…explain action non deterministically … for which the properties of objects are seen as necessary, but not sufficient, conditions." (p. 620), and help researchers create hypotheses about the relations between certain IT properties with particular effects.

The origins of the notion of affordance can be found in ecological psychology where it has been used to describe the relationship of animals or human beings with objects (Gibson 1966). In this view, affordances primarily refer to the possibilities of action provided by the environment (Gibson 1966). For example, a child might perceive that a closet can afford her "hiding", while another might view it as affording "storage". Further, the "…affordance of an object refers to both the attributes of the object and the actor." (Gaver 1991, p. 79), and as such cannot be the same for all actors. For example, to a group that desires to make consensus-based decisions, a group support system may afford the opportunity to surface ideas anonymously. Yet, the same system may afford

nothing to a group with an autocratic leader (Markus and Silver 2008).

Several IS and HCI researchers have tried to more clearly define affordances and exploit their full potential (Kaptelinin and Nardi 2012). For example, Norman (1988) introduced affordances to HCI and described them as perceived or actual properties of objects, which determine how they can be used. Later, Gaver (1991) defined affordances as perceived possibilities for actions that objects provide, and which depend on people's needs.

Given that IT effects studies have largely ignored the IT artifact, and the potential usefulness of the concept of functional affordances in linking IT usage to their characteristics, this dissertation is an effort to conceptualize the functional affordance concept and put it into practice to study IT usage and effects in two different settings: 1- Social networks, 2- Health IT. More specifically this dissertation will attempt to answer the following research questions:

RQ1. How can IT features-in-use and their possible consequences be linked via the functional affordance concept for a specified user group?

RQ2. How and under what conditions can the functional affordances of an asthma self-management portal be transformed into usage that is conducive to high levels of self-management performance?

To answer these questions, this study adopts two different lenses toward the concept of functional affordances, i.e. a reductionist view to answer the first research question and a holistic view to answer the second research question. Adopting a reductionist view, the affordances of an IT artifact are viewed as decomposable entities. For example, Facebook affords "communication" with other users, which can be decomposed into "sending messages", "writing on walls", or "commenting on someone status". In a reductionist view, all of these components need to be identified and studied to create a detailed picture of an IT's functional affordances. On the other hand, a holistic view enables the creation of a broad picture of functional affordances. For example, adopting a holistic view, we can identify affordance archetypes without being concerned

about the IT's components.

This dissertation is composed of two papers to answer the above research questions. The objective and methodology of each paper are shown in Table 1 and described in more detail below.

Table 1. Summary of the two papers comprising the thesis

	Paper 1	Paper 2
Objective	To develop an approach to link IT features, usage behaviors, and their consequences for a specific group of users	Develop a categorization of functional affordances and show that the categorization can explain how different individuals who appear to use IT in similar ways may achieve very different outcomes
Methodology	Qualitative inductive approach, quantitative (social network analysis).	Qualitative theory building from multiple cases (Eisenhardt 1989)
Context	Facebook (preliminary test of the methodology)	A user-centric asthma self-management portal, used by 30 asthma patients for a period of six months
Contribution	A new approach (method)	A new categorization and theory

1.1. Summary of paper 1: Functional Affordance Networks: A Social Network Analysis Approach for Linking Information Technology Features-in-use to Their Effects

The first paper is an effort to include the IT artifact in IT effects research by linking the features-in-use of IT artifacts to their possible consequences. Typically, past research has tended to study IT and behaviors as two distinct phenomena. For example, according to Hevner et al. (2004), researchers have either focused on the design of the IT artifact "… to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts" (p. 75) (e.g., Albert et al 2004; Dey et al. 1998), or have mostly been concerned with theories that explain or predict human behavior, such as studies of how people use IT and the consequences of such usage (e.g., Burton Jones and Straub 2006;

Dennis et al. 2001; Goodhue and Thompson 1995). Yet, the absence of a clear linkage between IT designs and usage behaviors, and eventually their consequences makes it difficult to understand IT effects and whether IT designs have the impacts that their designers intended (Leonardi and Barley 2008). It is also important to note that "…technology and behavior are not dichotomous in an information system. They are inseparable." (Lee 2000, cited in Hevner et al. 2004, p. 77).

Although the presence of links between IT artifact properties, usage behaviors and their consequences is largely acknowledged, questions regarding how IT artifact properties can trigger long-term outcomes and what consequences can be anticipated from IT remain largely unanswered. Yet, exploring the linkages between IT features, their usage, and their potential effects can help us better understand how IT can achieve their acknowledged purposes, and which IT properties or features can produce desired or undesired outcomes. By assuming that the appropriations of an IT (i.e. how its features are brought into action (DeSanctis and Poole 1994)) result in desired or undesired outcomes of IT usage, the first paper attempts to answer the following question: How can IT features-in-use, their possible appropriations, and their possible consequences be linked via the functional affordance concept for a specified user group?

As Hevner (2004) noted, "… engaging the complementary research cycle between design science and behavioral-science …" (p. 77) provides IS researchers an important opportunity for making significant contributions. Eventually, the knowledge obtained from such research can also help us improve the design of IT artifacts and training programs (DeSanctis and Poole 1994). In order to answer the above research question, this study proposes an approach that links IT artifact features to their appropriations and possible consequences (Leonardi and Barley 2008) through a network structure. As such, by operationalizing and advancing Markus and Silver's (2008) functional affordances construct, and introducing two new concepts: (1) The individual network of functional affordances (INFA),

defined as an IT's afforded possibilities for action and their linkages as perceived by an individual user, and (2) The aggregate network of functional affordances (ANFA), defined as an IT's total afforded possibilities for action and their linkages as perceived by a specified user group, the approach proposed here provides a way to identify all possible appropriation moves of a group of users, and link them to IT features-in-use, which can eventually help open the left hand side of IS acceptance models (Benbasat and Barki 2007). It can also reveal how the usage of IT features can trigger designers' desired or undesired effects.

Individual networks of functional affordances (INFA) are similar to aggregate networks of functional affordances (ANFA) in that they both refer to the possibilities of action a specific IT artifact provides to users. Their difference lies in the fact that INFAs are the possibilities of action that are individually perceived, and potentially used. On the other hand, the ANFA includes the whole set of action possibilities an IT provides to a group of users. For example, an individual user might perceive "sending messages", "receiving messages", and "organizing tasks" as possible affordances of an e-mail application and act on them. As such, "sending messages", "receiving messages", and "organizing tasks" would be this user's INFA. On the other hand, another user might perceive and use the same tool not only as a way to send and receive messages, but also as a way to create personal reminders. In other words, the INFAs of the e-mail application for the second user would be "sending messages", "receiving messages", and "creating reminders". As such, different users can have different INFA for the same IT artifact. On the other hand, an overall, global view of the affordances of that e-mail system for a specific group of users (including both user1 and user2), i.e. its ANFA, would include "sending and receiving messages", "creating personal reminders", and "organizing tasks". Thus, the set of INFAs can be used to create the ANFA of a given IT.

The proposed approach views the functional affordances of an IT as a hierarchical network which links a specific IT's features-in-use to its appropriation

moves, i.e. different ways of appropriating a feature (DeSanctis and Poole 1994), and its possible consequences. To do so, an empirical technique adapted from psychology and Social Network Analysis (SNA) is proposed as a way to identify the INFAs and ANFAs of an IT and categorize them according to their distance from the IT artifact or possible consequences. The approach effectively creates a functional affordance hierarchy, with functional affordances that are the closest to the IT artifact (Low-level functional affordances) clustered at one end, and functional affordances that are closest to the consequences of using that IT (High-level functional affordances) clustered at the other end. For example, in studying Facebook's individual functional affordances, "Poking people", "Editing text", or "Sending/receiving friend request" can all be viewed as being very close to the IT artifact. On the other hand, "Expressing feeling or thoughts", "interfering in people's affairs", or "Learning", are basically users' appropriations of Facebook, and can be viewed as functional affordances that are very close to Facebook's usage consequences. As such, the proposed method can help to empirically derive a hierarchical functional affordance network of an IT, based on the perceptions of its users, as well as to exhaustively identify these users' appropriation moves and their possible consequences. To do so, the methodology provides a way to identify the INFA of an IT artifact and its network structure for each individual user. Then, the ANFA of the group is created by aggregating the INFIs the users in the group. Then, analyzing the ANFA enables the identification of the group's appropriation moves, which can then be linked to the eventual outcomes of usage.

Moreover, the network paths linking the IT artifact's features-in-use to possible consequences can also be used to identify which features trigger which appropriation moves. Doing so can be useful in the study and better understanding of that IT's effects, as well as help improve its design and training programs. In order to illustrate the viability of the proposed approach, Paper 1 describes a pilot study of a group of 17 young and educated users to identify Facebook's individual and aggregate functional affordances, the respondents' appropriation moves, as well as the Facebook features which triggered them.

Contributions: The approach proposed in the first study is an effort to put Markus and Silver's (2008) ideas into practice. As such, its key contributions lie in the practicality of the way in which an IT artifact can be accurately and reliably connected to its possible appropriations, as well as in helping explain why IT effects may vary across contexts. By empirically constructing such functional affordance networks for different IT artifacts, it is likely that a better understanding of their use can be achieved, which eventually can point designers to better artifact designs. As this method helps identify all possible appropriations of an IT artifact, it can also help improve the artifact's training programs by enabling them to better inform its future users.

1.2. Summary of Paper 2: Functional Affordance Archetypes: a New Perspective for Examining the Impact of Information Technology

The usage of IT artifacts is generally thought to be a prerequisite for deriving their benefits, and as such to provide a key indicator of IT implementation and adoption success (DeLone and McLean 1992; Lucas 1978; Petter et al. 2008). Yet, while IT usage can serve as an appropriate measure of IT adoption and success, it may not necessarily yield desirable outcomes, i.e., result in user benefits that IT designers expect, such as "improved decision-making" for a decision support system, or "improved quality of care" for e-health technologies. Based on a functional affordance (FA) perspective (Markus and Silver 2008), the second paper of the dissertation investigates how IT use can lead to its desirable outcomes. Specifically, applying the FA concept at the individual level of analysis, and also relying on the inductive analysis of our data, we extended existing definitions of functional affordances by specifying "who/what is perceived as the source of action" by defining PFA as perceived possibilities of action provided by an IT artifact to an individual user who could view either herself or the IT artifact as undertaking such possibilities. We then examined how PFAs influence the way people use IT, and thereby play a key role in determining whether or not their usage will lead to desirable outcomes.

Further, by following Eisenhardt's (1989) approach of theory building from multiple cases, we developed a PFA categorization of four PFA archetypes: Facilitator, Protector, Imposer, and Inhibitor. Next, we used these archetypes to explain the conditions under which the PFA of an e-health system can be transformed into usage that is conducive to the attainment of its desirable outcomes.

Our contextual focus was a web-based user-centric self-management system designed to promote asthma self-management for asthma patients. Asthma self-management is mainly concerned with the systematic education of asthma patients in order to engage their active participation in controlling their asthma by avoiding its triggers and reducing its symptoms (Kotses and Creer 2010). Information technology can provide opportunities to improve self-management support for chronic illnesses like asthma by integrating it with ongoing medical care. The system examined here was My Asthma Portal (MAP), developed in 2010 by the McGill Clinical and Health Informatics research group. To examine its effectiveness in asthma self-management, a preliminary study (Ahmed et al. 2011) examined its use over six months by 30 patients (between 18 and 60 years of age) and a supervising nurse. At the end of the six-month period, we were able to interview 16 of these patients and the nurse. We also collected patient activity log data and their e-mail exchanges with the nurse during the six-month usage period. In order to benefit from data-triangulation (Patton 2002) we also collected health insurance data from the provincial health ministry (RAMQ).

Our research design is a multiple-case approach where each individual user, i.e., asthma patient, was treated as a case, and the results were based on an analysis of the 16 cases. Adopting a multiple case-study approach (Eisenhardt 1989), we examined how and under what conditions the observed patients' PFA of the portal influenced their asthma self-management performance. To do so, we first followed an inductive strategy to develop a categorization of PFA. Then

we developed several propositions concerning how and under what conditions IT use can lead to high versus low levels of desirable outcomes. We elected to use this strategy in view of a lack of prior theory and research regarding the role of affordances as determinants of IT usage outcomes.

To analyze the data, each interview was first transcribed and the transcripts were codified according to the study concepts. Then we inductively looked for new concepts and relationships between concepts. The analysis of the interview transcripts yielded an inductive identification of four PFA archetypes: Facilitator, Protector, Inhibitor, and Imposer. Then, following Eisenhardt (1989) approach of theory building from contrasting cases, we categorized each patient as high or low in terms of their self-management performance (SMP). A comparison between high and low level SMP cases helped us to inductively develop propositions and then to replicate them across other pairs of cases.

Contribution: One of the main contributions of this research is to extend the existing definitions of affordances, and to show how the construct of PFA can be applied to IT effects studies. Also, the proposed archetypes provide a new lens that can help researchers better explain human-IT interactions. Moreover, our data suggests that patients' perceptions of the portal's functional affordances in terms of the four archetypes played an important role in determining how they used the portal and the asthma self-management outcomes that they achieved.

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Chapter II - Article #1

Functional Affordance Networks: A Social Network Analysis Approach for Linking Information Technology Features-in-Use to Their Effects

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2.1. Abstract

Responding to calls to include the IT artifact in IT effects research, the present study proposes an approach that links IT features to their usage, and shows how IT features can trigger its potential effects. To do so, the proposed approach adopts Markus and Silver's (2008) concept of "functional affordance" as a key property of IT and their view of IT as a potential cause of behavioral outcomes. Combining an inductive approach with Social Network Analysis (SNA), the functional affordances of an IT are thus identified and categorized according to their closeness to the IT artifact or its users' goal oriented behavior. The resulting functional affordance network can then be used to study and better understand that IT's features-in-use, the IT's effects, as well as help improve its design and training programs. The viability and potential usefulness of the proposed methodology is illustrated by providing a preliminary application to Facebook.

Keywords: IT effects, functional affordances, social network analysis, IT use

2.2. Introduction

Studying the behavioral and social effects of IT usage is thought to be "…foundational to a large part of the information system research enterprise" (Markus and Silver 2008, p. 610). By studying the effects of IT, researchers examine the changes that IT bring to human and social behavior, thereby providing a better understanding of "…what technology impacts should we anticipate, and how can we interpret the changes that we observe?" (DeSanctis and Poole 1994, p. 122). Yet, the lack of research focus on the IT artifact and its

role in producing outcomes is a widely cited concern (Markus and Silver 2008). Typically, past IS research has tended to study IT and behaviors as two distinct phenomena. For example, according to Hevner et al. (2004), researchers have either focused on the design of the IT artifact "…to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts" (p. 75) (e.g., Albert et al. 2004 ; Dey et al. 1998), or have mostly been concerned with theories that explain or predict human behavior, such as studies of how people use a technology and the consequences of such usage (e.g., Burton-Jones and Straub 2006; Dennis et al. 2001; Goodhue and Thompson 1995). However, exploring the linkages between the features and effects of technology can help us better understand how its acknowledged purposes can be achieved, and what technology properties or features can produce designers' desired or undesired outcomes. As Hevner (2004) noted, "…engaging the complementary research cycle between design science and behavioral-science …" (p. 77) provides IS researchers an important opportunity to make significant contributions. Eventually, the knowledge obtained from such research can also help us improve the design of IT artifacts and training programs (DeSanctis and Poole 1994). While researchers generally acknowledge the existence of links between IT features, usage behaviors, and their consequences, many questions remain largely unanswered about how IT artifact features can trigger long-term outcomes and their anticipated consequences (Leonardi and Barley 2008).

The objective of this research is to explore the linkage between IT features, usage behavior, and its possible outcomes through the concept of functional affordances. Borrowing the concept of affordance from ecological psychology, Markus and Silver (2008) defined functional affordances as "…the possibilities for goal-oriented action afforded to specified user groups by technical objects" (p. 622). Since affordance is a relational concept that refers to both objects and individuals, it can be used to link IT artifacts with their usage and the potential consequences of that usage. The present paper views IT and behavior as two complementary, but inseparable pieces, and following Markus

and Silver (2008), that technology is not "the only, or even the most important, contributor to IT effects, but merely that it may matter." (p. 610) and can trigger such effects (DeSanctis and Poole 1994). Based on these ideas and by using the concept of functional affordances, the present paper proposes an approach to link IT artifact features-in-use to possible appropriation moves (i.e. users' deliberate choices in how to use a technology, DeSanctis and Poole, 1994) which are aligned with individuals' high-level goals, thus helping openg the left hand side of IS acceptance models (Benbasat and Barki 2007). The proposed approach is also expected to help reveal how IT features can trigger the desired effects intended by their designers and/or the undesired effects they had not intended.

The proposed approach views the functional affordances of a given IT as a hierarchical network that links that IT's features to its possible outcomes. To derive this network, an empirical technique adapted from psychology and Social Network Analysis (SNA) is used to identify the functional affordances of an IT and categorize them according to their distance from the IT artifact or possible consequences. The approach effectively creates an affordance hierarchy, with functional affordances that are the closest to the IT artifact clustered at one end, and functional affordances that are closest to the IT's consequences clustered at the other end. In other words, the proposed method serves to empirically derive a hierarchical, functional affordance network for an IT, based on the perceptions of its users, as well as to exhaustively identify the consequences of using that IT. Moreover, the network paths linking the IT artifact's features to users' possible appropriations also reveal how the IT's features can be interpreted in users' minds in the occurrence of desired and/or undesired outcomes from the perspective of the designers.

In order to illustrate the viability of the proposed approach, we describe a pilot study of a group of 17 young and educated users that was conducted to identify Facebook's functional affordances, the respondents' appropriation moves, as well as the Facebook features that triggered them.

2.3. Theory

2.3.1. The concept of functional affordance: a new concept to study IT effects

Defining them as "…the possibilities for goal oriented action afforded to specified user groups by technical objects" (p. 622), Markus and Silver (2008) suggested functional affordances as an appropriate construct for studying IT effects. Based on affordance theory, they also noted that the concept of functional affordances could represent the likely uses and effects of IT.

The origins of the notion of affordance can be found in ecological psychology where it has been used to describe the relationship of animals or human beings with their environment (Gibson 1966). According to Gibson, the way people or animals interact with an object is related to the possibilities which the object affords for their action. In other words, "An affordance perspective recognizes how the materiality of an object favors, shapes, or invites and at the same time constrains a set of specific uses" (Zammuto et al. 2007). For example, a chair affords sitting and a door handle affords grasping for human beings.

The concept of affordance also points to both an actor and an environment (Gibson 1986). In other words, the "…affordance of an object refers to both the attributes of the object and the actor." (Gaver 1991, p.79) Thus, an object's affordances "…exist relative to the action capabilities of a particular actor." (McGrenere and Ho 2000, p. 179), and hence cannot be the same for all actors. For example, a small chair which affords a child to sit will usually not afford the same to an adult. Similarly, a car which affords driving to adults does not do so for a child. Moreover, according to the Gibsonian view, affordances are not imagined; they are real and their existence does not depend on people's perceptions. For example, while a mobile phone affords users to manage their contacts, some users may be unaware of the existence of such an affordance. In addition, in the Gibsonian view, affordances are not dependent on people's current needs, goals, or cultural and social settings.

Gibson's theory of affordances has gone through different interpretations in the literature. For example, Gaver (1991) viewed affordances as independent of people's perception, but dependent on their needs. That is, affordances "… exist whether the perceiver cares for them or not […], or whether there is perceptual information for them or not" (Gaver 2001, p. 80). However, contrary to the Gibsonian view of affordances, Gaver emphasized the role of culture, social setting, experience, and intention as highlighting certain affordances. Hutchby (2001) also noted that affordances and constraints are not independent of people. As people often approach technology with diverse goals, they tend to perceive it as affording different action possibilities. Thus, in this view, affordances are subjective and depend on perceptions: "People may perceive that a technology offers no affordances for action, perceiving instead that it constraints their ability to carry out their goals" (Leonardi 2011, p. 153). Moreover, Strong et al. (2013) distinguish between affordances as action potentials and actualization as actions undertaken by individuals to realize those potentials.

Following this line of thinking, Markus and Silver (2008) emphasized individuals' interpretation of the technology through their goals for action. To clarify the affordance concept, Markus and Silver (2008) provided an example from group support systems (GSS): a GSS may afford the opportunity to surface ideas anonymously for a group that desires to make consensus-based decisions. But the same system may afford nothing to a group with an autocratic leader. Here, the functional affordances of the GSS are what the user group may be able to do with it given their objectives and capabilities.

The IS literature has also examined affordances at the organizational level. For example, Zammuto et. al (2007) used affordances to explain the IT-organization relationship. In addition, Volkoff and Strong (2014) used the concept of affordance to build theories of the effects of introducing new systems into organizations.

The relational nature of the functional affordance concept helps address

many of the concerns raised in extant research regarding IT effects studies. For example, according to Markus and Silver (2008), an affordance approach encourages the adoption of a non-deterministic view of IT impacts, and as such IT properties are unlikely to be viewed as the only cause of change: "Conditions other than technology may play key roles in causal explanations" (Markus and Silver 2008, p. 627). This perspective is also consistent with the non-deterministic view of IT advocated in past research (e.g., DeSanctis and Poole 1994). Moreover, according to Orlikowski and Iacono (2001), IT are socio-technical phenomena embedded in a larger social context. The functional affordance concept is consistent with this view that sees IT as socio-technical artifacts and functional affordances as bridges between objects and the people who use them. In other words, the concept of functional affordance "…approaches the study of IT effects from a broader social or behavioral standpoint, inquiring about second-order effects or why system effects may differ across contexts" (Markus and Silver 2008, p. 627). In addition, Orlikowski and Iacono (2001) urged researchers to see IT not as objects that are discrete and independent, but rather as objects that "…are always and already implicated in action and effect" (p.131). Such a perspective is also consistent with the action-based nature of objects in ecological psychology.

Following Markus and Silver (2008), we conceptualize affordances as being dependent on people's objectives and needs. Further, we view culture and social setting as being influential in how people perceive affordances. We also view affordances as real with their existence being independent of individuals' perceptions. However, we also think that each person may perceive them differently and decide whether to actualize them or not (Strong et al. 2014).

2.3.2. The Hierarchical Nature of Functional Affordances

A hierarchy can be defined as a "system of superordinate and subordinate concepts that fall in nested ranks" (Suter 2011, p. 356). A key premise of the present study is that functional affordances are inherently hierarchical and

decomposable because human activities are goal oriented, and goals are hierarchical and decomposable. That is, since a given user group's goals in using an IT can be decomposed into lower-level or "smaller" goals (or be components of higher level objectives), the functional affordances that correspond to the activities underlying such goals can also be decomposed into sub-affordances (or be components of higher level functional affordances). For example, as depicted in Figure 1-1, an email system may afford a group of users an easy way to "collaborate with colleagues" and "create a higher social status in the workplace". The relatively "high-level" goal of "collaborating with colleagues" and its concomitant functional affordance can be decomposed into a series of sub-goals and sub-affordances, respectively, such as "sending messages", and "receiving messages". In turn, "sending messages" can be further decomposed into several lower level functional affordances such as "replying to messages", "forwarding messages", and so on. Thus, any IT can be viewed as consisting of a hierarchy of chains of functional affordances and sub-functional affordances, paralleling the hierarchy of goals and sub-goals of its users.

Moreover, as the above example illustrates, the functional affordances of a given IT can usually be structured in terms of multiple hierarchies with many possible linkages likely to exist between different hierarchical chains. For example, an email system may afford a user group the possibility of engaging in "task management", "collaboration on a project", "send and receive messages", "communicating with potential clients" etc., all of which are likely to be interrelated in some network pattern, such as that shown in Figure 1-1.

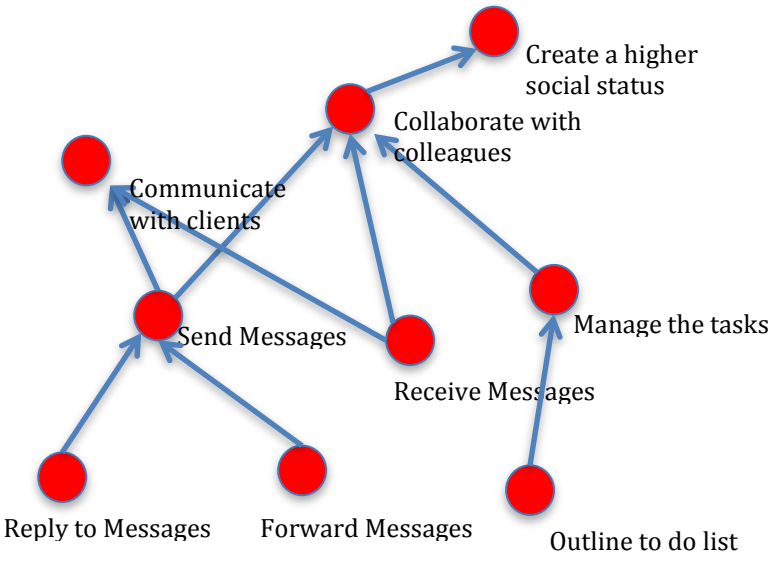

Figure 1-1. Illustrative example- Interrelation of functional affordance hierarchies in email for a group of users

In the email example above, some functional affordances such as "forwarding messages", "replying messages", or "outline to do list" which occupy the lower levels of the affordance hierarchy, can provide triggers to functional affordances such as "communicate with potential clients", "create higher social status", or "collaborate with colleagues", which occupy the higher levels of this network. In other words, perceived low-level affordances can be interpreted in users' minds as creating high-level affordances. For example, while users may perceive the "forwarding messages" affordance of an email system, they might also create a bigger picture of that affordance in their minds and interpret that capability as a lower level component of "sending messages". In turn, they can link "sending messages" into a higher level purpose of "collaborating with colleagues", or ultimately view it as an opportunity to "create a higher social status". Provided that the functional affordance hierarchy of an IT is sufficiently exhaustive, then the lower level functional affordances will tend to be very close to the IT artifact's features. On the other hand, the higher-level functional affordances of the network will tend to be closer to appropriation

moves which serve the long-term goals of the IT's users, which in turn are likely be related to the consequences of using that technology.

Building on the above ideas, and based on the hierarchical nature of functional affordances, a key premise of the present research is that an IT artifact's decomposed functional affordances can be depicted as a network by interconnecting them through means-ends linkages and analyzing them via network methods. For example, as shown in Figure 1-2, functional affordance Y is decomposed into functional affordances X and Z which are connected to functional affordance Y because they both are means to the end of Y. In other words, each functional affordance can be viewed as a node[1] in a network and the hierarchy between them can be viewed as the ties[2] of the network.

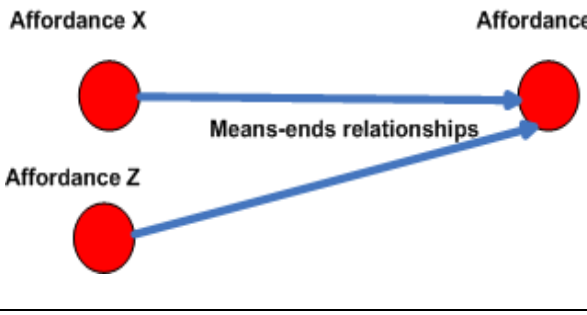

Figure 1-2. The linkage between two functional affordances

Continuing the email example above, the functional affordance of "send messages" can be decomposed into sub-affordances, such as "reply to messages" and "forward messages". In other words, "reply to messages" and "forward messages" provide the means by which the functional affordance of "send messages" can be achieved, and the latter can in turn be seen to provide a means to "collaborate with colleagues". That is, "reply to messages" and "forward messages" are subordinate functional affordances that enable the achievement of

[1] In a network, each "node" is a discrete individual or event that links to others (Kilduff and Tsai 2003).
[2] "Nodes" are linked to each other by "ties" (Wasserman and Faust 1994)

the superordinate functional affordance of "easy collaboration with colleagues".

It is important to note that identifying an IT's network of functional affordances for a user group can be useful for identifying the appropriation moves and eventually possible consequences of using that IT in that group, as well as the IT artifact features-in-use which could trigger them. The consequences of using an IT depends highly on how people appropriate that technology based on their goals and needs which are "…internal representations of desired states, where states are broadly constructed as outcomes, events, or processes." (Austin and Vancouver 1996, p. 338)

Further, the relational nature of functional affordances provides a context-dependent image of IT usage. Hence, depending on users' work environments, as well as their goals and capabilities, different usage outcomes will be likely. For example, in the functional affordance network of Figure 1-1, the central capability of "sending messages" might help some users raise their social status among their colleagues, but it may also trigger communications with potential clients. Moreover, based on users' work environment, goals and capabilities, one, both, or none of these consequences could occur. Thus, by deriving such functional affordance networks it becomes possible to link an IT artifact's features-in-use to its potential consequences or effects. Doing so can also help to more clearly identify and understand the potential consequences of IT in their specific contexts, some of which might not even have been intended by its designers, and help improve IT artifact designs and training programs.

2.3.3. Functional affordance networks are multilevel

In addition to the hierarchical structure of functional affordances, another key premise of the present study is that affordance networks are inherently multilevel: at the individual level, each person can be viewed as having a particular network of affordances based on his/her perceptions, which may or may not be the same as someone else's network; aggregating all individual

networks of a group of individual would then yield the network of that group. We define the "individual network of functional affordances" (INFA) as a given IT's afforded possibilities for action and their linkages as perceived by an individual user. We also define the "aggregate network of functional affordances" (ANFA) as *an IT's total afforded possibilities for action and their linkages as perceived by a specified user group*. The two networks are similar in that they both refer to the possibilities of action provided to users by a specific IT artifact. Their difference lies in the fact that INFAs are IT's possibilities of action for each individual whereas the ANFA incorporates the whole set of action possibilities an IT provides to a group of users. An INFA is the set of functional affordances as perceived and possibly used by an individual user. For example, an individual user might perceive and act on "sending messages", "receiving messages", and "organizing tasks" as possible affordances of an email system. Therefore "sending messages", "receiving messages", and "organizing tasks" are her perceived functional affordances that she has eventually acted upon. On the other hand, another user might perceive and use an email system not only as a way to send and receive messages, but also as a way to create personal reminders. In other words, the INFAs of an email system for the second user may be "sending messages", "receiving messages", and "creating reminders". As such, the INFA of an IT artifact might vary from one user to another. On the other hand, an overall, global view of the affordances of that email system for a specific group of users (including both user1 and user2), i.e. its ANFA, would include "sending and receiving messages", "creating personal reminders", and "organizing tasks".

ANFA is a collective concept that emerges by aggregating the individual networks of functional affordances (INFA) of all the users of an IT. According to multilevel theory (Klein and Kozlowski, 2000), a concept is considered collective when it represents the aggregate influence of individuals. In other words, a collective concept has its theoretical foundations in the characteristics of

individuals, which has emergent properties that manifest at higher levels. Therefore we can argue that, ANFA (i.e. the emergent phenomenon) has its origin in the INFAs (i.e. lower levels) which are basically the individual elements contributing to the emergence of the ANFA. According to multilevel theory (Klein and Kozlowski, 2000), if the elemental contributions are not identical for all the individuals in the collective, then the emergent process is a compilation.

Here, INFA basically represents each user's mental model and shows how they each see a system's functionalities and how they might appropriate them. According to affordance theory, individual users have somewhat different mental representations of a system's functionalities. However, these different mental models "… fit together in a complementary way, like the pieces of a puzzle, to create the whole" (Klein and Kozlowski, 2000, p. 59). Moreover, the elemental contributions (i.e. INFAs) to the ANFA are not similar in type or amount. Hence, we can argue that the ANFA is created through the emergent process of "compilation" (Klein and Kozlowski, 2000). That is, the ANFA for a user group emerges from the aggregation of INFAs, and can be considered to be a multilevel concept[3]. According to Klein and Kozlowski (2000) compilation "describes phenomena that comprise a common domain but are distinctively different as they emerge across levels", and that "compilation processes describe the combination of related but different lower-level properties-that is, the configuration of different lower-level characteristics to yield a higher-level property that is functionally equivalent to its constituent elements." (p. 59)

2.3.4. An Approach to Develop and Analyze a Network[4] of Functional Affordances

[3] It is important to note that the multilevel nature of the network of functional affordances discussed here differs from the hierarchical structure of functional affordances discussed earlier. The hierarchical structure categorizes functional affordances as being in higher or lower levels in terms of their means-ends sequences. On the other hand, the multilevel aspect of affordance networks views the group-level network emerging from the aggregation of individual networks.

[4] Similar to a network of motives (Baggozi et al. 2003), a network of affordances has also a weak hierarchical structure, because in this network "…the direction of relationships is not limited to vertical arrangements but can include horizontal connections, and the course of paths is not restricted to one direction but can be bidirectional and exhibit circular feedback in principle" (p. 931)

As explained earlier, a key premise of the present research is that an IT artifact's decomposed functional affordances can be depicted as a network by interconnecting them through means-ends linkages and then analyzed via network methods. We describe below an approach which helps derive the functional affordance networks of any IT and categorize its functional affordances. The resulting functional affordance network and categories links the IT artifact's features-in-use to their potential effects and captures how individuals' perceptions of these features-in-use can result in perceived behavioral outcomes.

In general, SNA examines the ties (relationships) within the nodes (actors) of a network, as well as the patterns and implications of these relationships (Wasserman & Faust 1994). Initially, SNA has been used in behavioral and social sciences to investigate economic, political or affective relationships among social entities such as individuals, groups, or organizations (Wasserman and Faust 1994). However, the nodes of a network need not be limited to social entities. For example, viewing the interconnections between people's ideas or perceptions as a network, some researchers have used SNA methods to study the structuring of people's ideas, goals and motives (e.g. Bagozzi et al. 1996; Bagozzi and Dabholkar 2000; Bagozzi et al. 2003). Applying SNA procedures to a study of consumer attitudes toward recycling, Bagozzi et al. (1996) found that some recycling goals, such as saving resources, were actually customers' means to achieve more abstract goals, such as providing for future generations. Linking different goals associated with recycling by the means-ends relations between them, Bagozzi et al. (1996) created a network, which could in turn be analyzed by network methods. More recently, Bagozzi et al. (2003) developed a methodology inspired by Toulmin (1958) for extracting officers' motivations for volunteering to join the army. Applying SNA, Bagozzi et al. (2003) derived a hierarchical structure of officers' motives, showing that individuals' motives in goal setting can be connected through means-ends linkages and represented via schemas (i.e. as a set of motives and perceived relationships among them). An approach

similar to the motive extraction procedure described in Bagozzi et al. (2003) can be used to extract the network structure of an IT's functional affordances for a specified user group. Our proposed approach follows the following three steps: 1-Inductively extracting affordances and their linkages to create each individual's network. 2-Aggregating individuals' networks to create an aggregate network of affordances 3-Analyzing the network.

Step 1: Inductively extracting affordances and their linkages to create each individual's network

Since the affordances of an IT artifact can be interconnected through means-ends linkages, a means-ends chain logic (based on a How-What-Why triad) can be used to extract affordance hierarchies. Using a HOW-WHAT-WHY logic, a specified group of IT users can be queried to identify the functional affordances they perceive in that artifact and also their linkages. That is, each individual can be asked to list every activity they perform when using the IT artifact (i.e. a list of actualized functional affordances), and for each functional affordance to identify its subordinate and superordinate functional affordances, as they perceive them (by answering HOW and WHY they perform each activity). In doing so, a general inductive approach is followed since the data are allowed to speak for themselves via the emergence of conceptual functional affordances. It is recommended that the data collection continue until a saturation point is reached, i.e. no new functional affordances are identified.

In essence, the above procedure helps extract all the "actualized" functional affordances (Strong et al. 2014) for each individual user. According to Strong et al. (2014), affordances are basically potentials for action, and individuals can realize or actualize them. Extracting the actualized affordances for each user provides an opportunity to identify all features-in-use.[5]

Continuing the above email example, a user might identify "sending

[5] It is important to note that it is also possible to extract all perceived potentials for action. To do so, individuals can be asked to list all the activities they can perform by using the IT artifact in question, even if they have not yet done so.

messages" as a functional affordance. By then answering the question "why do you send messages via the email system?" he/she might identify superordinate functional affordances such as "to easily collaborate with my colleagues" or "as a fast way of communicating". On the other hand, by answering the question "how do you use the email system to send messages?" he/she might identify subordinate functional affordances such as "reply messages" and "forward messages". Thus, via such a How–What–Why question triad, the different nodes of an IT's functional affordance network can be identified, as perceived by a specified user group. By then linking the nodes that have been thus identified, a network of functional affordances can be constructed for the IT, providing a reliable hierarchical map of its functional affordances. It should be mentioned that the proposed procedure for extracting an IT's functional affordances does not depend on where in their minds respondents start the functional affordance hierarchy. While each person may start the hierarchy at a different level of abstraction, linking the multiple how-what-why triads results in the same hierarchical chain that would have resulted wherever they started.

It is interesting to note that a similar procedure is often used in software requirement engineering to link software objectives to their requirements. Typically, after identifying a system's high-level objectives from initial requirement documents, software analysts repeatedly ask themselves HOW questions in order to decompose these objectives into low-level system requirements. In addition, by repeatedly asking themselves WHY questions about operational descriptions that are available, software analysts clarify a system's objectives to avoid irrelevant requirements and detect conflicting requirements (Lamsweerde 2001).

Step 2: ***Aggregating individuals' networks***

Combining all the individual networks (INFA) of a specified group of users yields their aggregate network (ANFA). Figure 1-3 is an illustrative example of the aggregation process: User 1's INFA has five perceived

affordances (i.e. A, B, C, D, E) and four relationships; User 2's INFA has six perceived affordances (i.e. A, B, C, D, F, G) and five relationships. The ANFA network of Figure 1-3 includes all functional affordances identified by both users (represented by letters A to G), as well as all the relationships they identified.

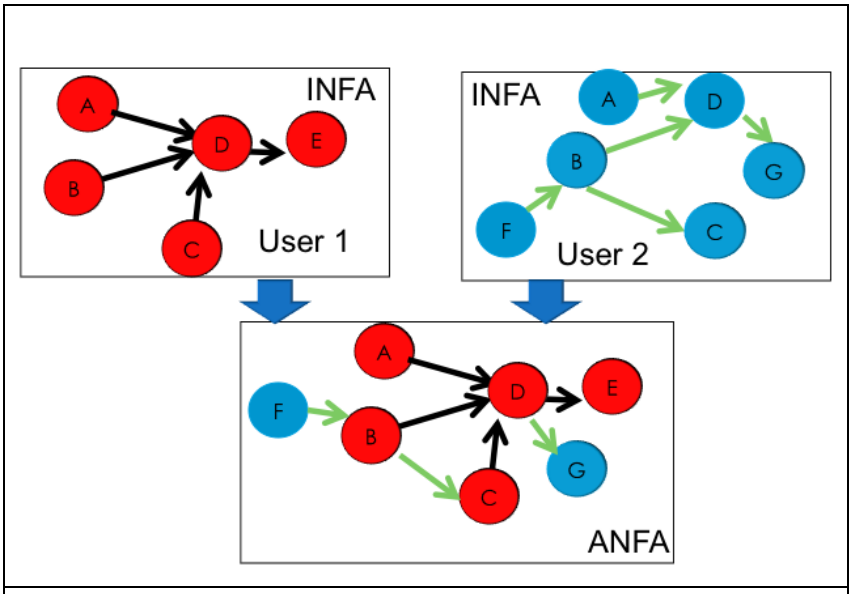

Figure 1-3. Aggregating individual networks

Since a particular individual's usage of an IT can also be a future or potential functional affordance for another person, the ANFA of that IT captures all potential affordances of a specified user group. For example, while a knowledge worker might use an email system to manage her tasks, her colleague might not. Yet, "manage tasks" is always available as a potential functional affordance to the latter. In other words, the actualized affordance of one user can provide novel functional affordances of that IT to other users. Thus, the ANFA identifies an IT's set of functional affordances, i.e. that IT's potential uses, as perceived by a specified user group.

Step 3*: Analyzing the network*

Functional affordance networks can be analyzed both quantitatively, as well as qualitatively.

Quantitative analysis

In order to quantitatively analyze the data, we can rely on SNA indices. As noted above, a network is made up of some nodes connected by a set of directed or undirected ties. A tie is directional if it is oriented from one node to another (e.g., exporting goods from one country to another in a social network that might represent trade among countries) (Wasserman and Faust 1994). On the other hand, a tie is undirected if the connection between two nodes is not oriented (e.g. being physically proximate, Borgatti and Foster, 2003). Moreover, a network can be dichotomous or valued. In dichotomous networks ties are present or absent (e.g., in a friendship network two people are either friends or not). In valued networks, ties are measured on a scale (e.g., the strength of friendship between two people) (Borgatti and Foster 2003), and the value of a tie (i.e., its weight or strength) can be defined as the sum of the frequency of direct interactions between two nodes. As such, a hierarchical network of functional affordances consists of directed and valued ties between nodes, with each node representing a functional affordance. The directed nature of ties stems from the means-ends relations between functional affordances. A tie is always oriented from means (i.e., functional affordances at lower levels) toward ends (i.e., functional affordances at higher levels). In addition, the value (weight or strength) of each tie in the network can be calculated by the number of respondents in a sample who have identified that tie.

Also, an important decision in deriving a network of functional affordances is to select the appropriate indices with which to analyze the network. In order to classify functional affordances according to their hierarchical level, the "degree" index seems a plausible choice. The "degree" of a network measures the network activity of a node, and refers to the number of ties (connections) that a node has in a network (Kilduff and Tsai 2003). Two types of degrees appear particularly useful: "in-degree", represented by the number of ties oriented toward a node (i.e., the number of nodes terminating at it), and "out-degree"

which is the number of ties oriented from a node (i.e., the number of nodes originating from it). For example, in an advice network, the number of people who ask a specific individual (i.e., a node) for advice would be that node's in-degree, and the number of people the individual asks for advice would be its out-degree (Kilduff and Tsai 2003).

Based on the above, and following Bagozzi et al. (2003), the nodes of an IT's aggregate network of affordances can be classified according to their in-degrees and out-degrees. A functional affordance whose in-degree is zero is never an end in itself because no other functional affordance node is oriented toward it. However, a zero in-degree functional affordance is instrumental in achieving other functional affordances (e.g., "forward a message" or "reply to a message" in the email example). Thus, a node with a zero in-degree can be viewed as occupying the lowest level in the functional affordance hierarchy of that IT, i.e., lower than any functional affordance having a non-zero in-degree. Further, a zero out-degree node can be viewed as being at the highest hierarchical level, i.e., higher than any functional affordance which is oriented towards it (e.g., "easy collaboration with colleagues" in the email example). The intermediate-level functional affordances (i.e., those having non-zero in- and out-degrees) are more difficult to categorize since they can sometimes be seen as ends, and at other times they can be viewed as means. A plausible approach to establishing the hierarchical level of intermediate nodes in a functional affordance network would be to use the abstractness index (Bagozzi et al. 2003) which is the node's in-degrees divided by the sum of its in-degrees plus out-degrees:

$$A(n_i) = \frac{d_{in}(n_i)}{d_{in}(n_i) + d_{out}(n_i)}$$

Here $A(n_i)$ represents the abstractness score of functional affordance i, $d_{in}(n_i)$ is its in-degree, and $d_{out}(n_i)$ is its out-degree. Abstractness scores can range from zero to one, with values close to zero indicating a relatively low level in the functional affordance hierarchy, and values close to one indicating a

relatively high level. Calculating the abstractness of intermediate functional affordances in this way can yield a relatively objective empirical classification of an IT's functional affordances, with functional affordances having zero in-degrees occupying the lowest level, those with zero out-degrees occupying the highest level (with functional affordances having many in-degrees being more important than those having fewer in-degrees), and the intermediate ones ranked according to their abstractness scores as per the above formula.

Qualitative analysis

Affordance networks can also be analyzed qualitatively. To do so, we can look into chains of relationships between a set of affordances and interpret how each low-level affordance (i.e. features-in-use) leads to a high-level one (i.e. a possible outcome). Examples of such a qualitative analysis are provided in the empirical illustration described below.

2.4. An empirical illustration of the proposed approach

2.4.1. Data collection

In order to illustrate the viability of the proposed SNA approach for linking IT features-in-use to their effects, a pilot study based on a small set of respondents was undertaken. The objective of the pilot study was to identify Facebook's affordances for a group of users and to analyze them quantitatively and qualitatively. To do so, an open format questionnaire (shown in Appendix 1) was developed based on the How-What-Why triad of the means-ends logic chain. More specifically, the three columns of the questionnaire were used for the "how", "what", and "why" questions, respectively. Respondents were first asked to list in column two up to 15 activities they normally did with Facebook. Then, for each activity a respondent entered, he/she was asked to explain how they typically went about doing that activity in Facebook (thereby identifying the lower level affordances) and to enter them in the first column. Next, each respondent was asked to explain the purposes for which they performed each activity (thus identifying the higher level affordances) and to enter them at the

corresponding appropriate place in the third column. As noted above, by asking a group of Facebook users about what they did with it, their actualized affordances were extracted, which in turn were aggregated to identify the use potential of Facebook for that group.

The survey instrument was refined and improved through informal interviews with five PhD students. Some minor modifications were made to the instructions and question wording to improve their clarity. The final version of the questionnaire was sent by email to a group of 24 active Facebook users who were invited to participate in the pilot study, and 17 returned completed questionnaires via email. It is important to note that the purpose of this study is not to generalize the identified network of affordances to the complete population of Facebook users, but to essentially show the viability of the proposed SNA approach. In order to use the approach in a real setting, it would no doubt be advisable to continue data collection until a point of saturation is reached, i.e., when new data no longer reveal new functional affordances and only confirm those that have already been identified.

The maximum number of rows filled in by respondents was 11, indicating that the questionnaire's table of 15 rows was adequate for capturing all possible affordances. It is important to note that, depending on how complex an IT is, the number of rows can be different. For less complex IT (i.e. less features), fewer rows might be sufficient.

The returned questionnaires were next codified to create a list of all the affordances identified by the respondents, regardless of their level in the affordance hierarchy. Each cell of the table that had an entry included one or more affordances.

2.4.2. Data analysis

First, all affordances were extracted from the responses by asking two judges to independently identify the affordances noted in the responses to questionnaires. The inter-coder reliability of the two coders was 91%, calculated

as the number of agreements divided by the sum of the number of agreements and disagreements (Miles and Huberman, 1994). All disagreements were subsequently discussed by the judges and resolved (Larsson 1993), and yielded a total of 591 affordances.

Next, the 591 affordances were content analyzed in order to identify those that were similar. For example, “write on wall page”, “put status”, and “post on a wall” were all grouped into the same category under the label “writing on walls”. This analysis was performed by one of the authors in an inductive fashion by placing affordances into categories based on their meaning and by maintaining maximal within-group similarity and between-group dissimilarity. This step helped compact the set of 591 initial affordances extracted from the questionnaires into a final set of 48 final affordances listed in Appendix 2. The higher or lower level affordances adjacent to each cell in the table were also helpful in reaching a better understanding of the respondents’ perception of the affordances that were entered in that cell.

Then, a validity check was performed by asking a second coder to assign one of the 48 affordances to each of the 591 initial affordances. Inter-coder reliability in this step was 81%, indicating that the final set of 48 affordances had an acceptable level of reliability. Once again, disagreements were resolved by discussion and each of the 591 initial affordances was categorized into one of the 48 final affordance categories (i.e. A1 to A48).

Finally, a socio matrix (adjacency matrix) was created for each respondent and summed to generate the aggregate matrix. A socio matrix is a square matrix with as many rows and columns as there are nodes in the data set. The scores in the cells of the matrix record information about the ties between each pair of nodes. For example, as shown in Table 1-1, one row from a respondent listed five affordances (A1, A5, A16, A21, and A36). The linkages between them were derived based on the position of each affordance in the cells of the table. As shown in Figure 1-4, “writing on walls” (A5) and “creating, accessing, editing

messages" (A5) were linked to "sending and receiving messages" (A1), indicating that A36 and A5 are sub-affordances of A1. Then, "sending and receiving messages" (A1) was connected to "communicating" (A16) and "spreading and receiving news, info, and events" (A21), to reflect the fact that A1 is a sub-affordance of A16 and A21.

Table 1-1. One row from a respondent answer		
A	B	C
Creating, accessing, editing messages (A36) Writing on walls (A5)	Sending and receiving messages (A1)	Communicating (A16) Spreading/ receiving news, Info, events (A21)

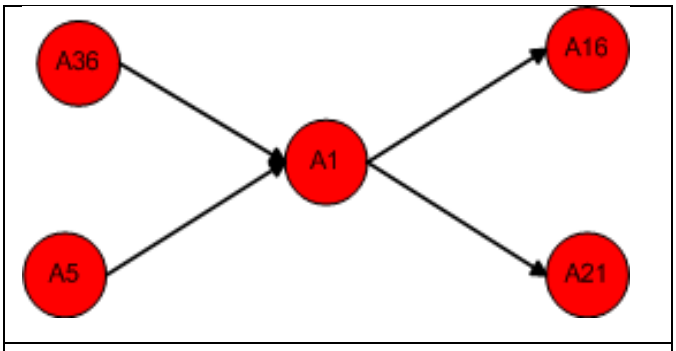

Figure 1- 4.The linkages between the affordances of Table 1-1

The dichotomous ties in the 48x48 socio matrix of each respondent show the presence or absence of a connection between two affordances (1 or 0). Table 1-2 shows the socio matrix of the network in Figure 1-4, with rows representing the source of directed ties and columns representing the targets. For example, as there is no arrow going from A1 to A5, the corresponding cell has the value of 0, but because an arrow goes from A5 to A1, the related cell has a 1.

Table 1-2 – Socio matrix of the network shown in figure 1-4										
	A1	…	A5	…	A16	…	A21	…	A36	…	A48
A1	0		0		1		1		0		⋮
⋮											
A5	1		0		0		0		0		
⋮											
A16	1		0		0		0		0		
⋮											
A21	0		0		0		0		0		
⋮											
A36	1		0		0		0		0		
⋮											
A48	…										

2.4.3. Findings

As mentioned above, the 48X48 socio matrix created for each respondent corresponds to the network of affordances of each individual and captures the affordances of Facebook as they each perceive them. Figures 1-5 to 1-8 depict example INFA of four respondents.

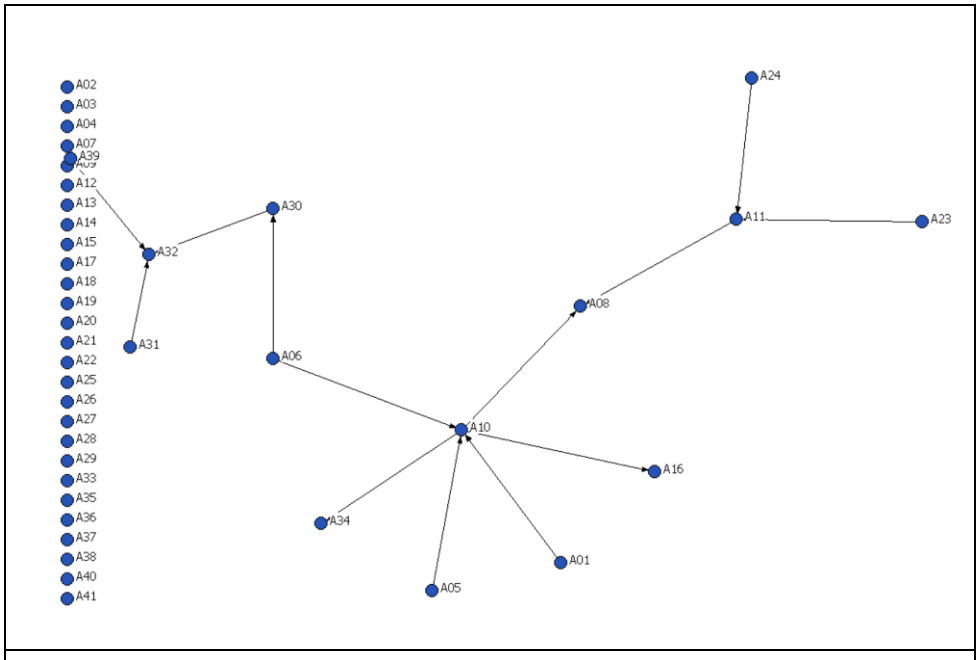

Figure 1-5. Visualization of the individual affordance network for respondent 1

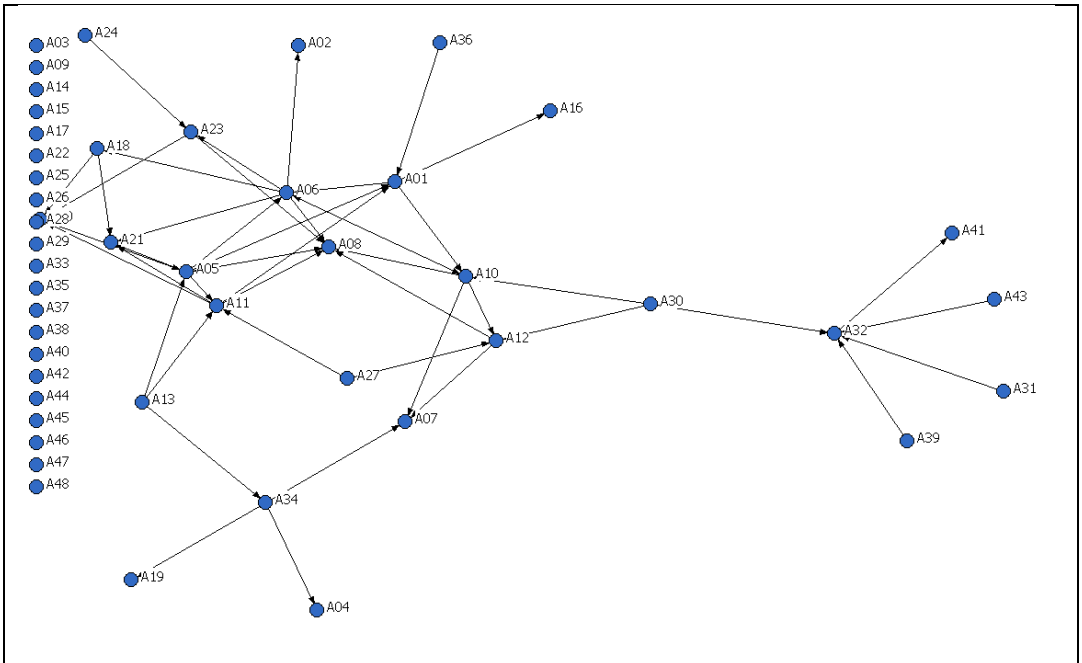

Figure 1-6.Visualization of the individual affordance network for respondent 2

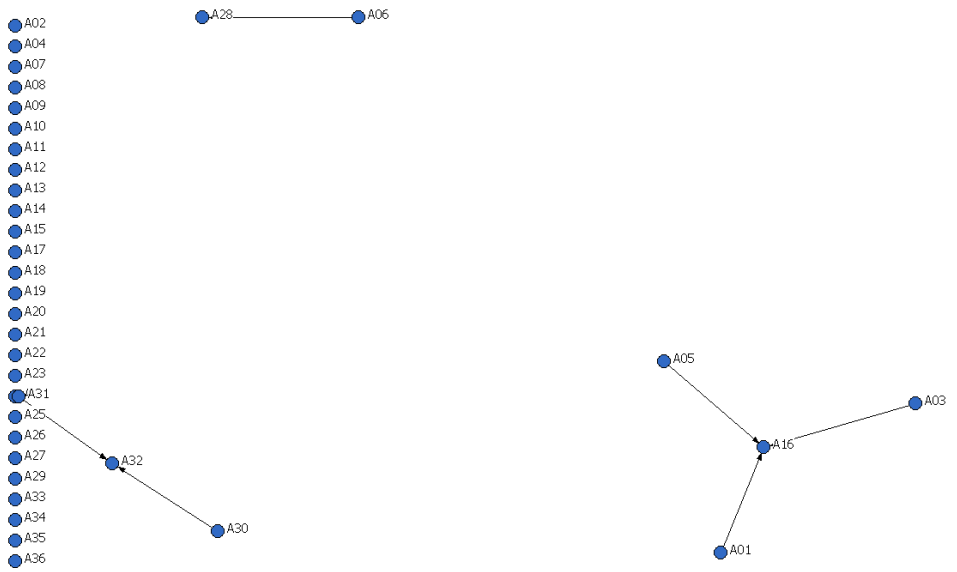

Figure 1-7. Visualization of the individual affordance network for respondent 3

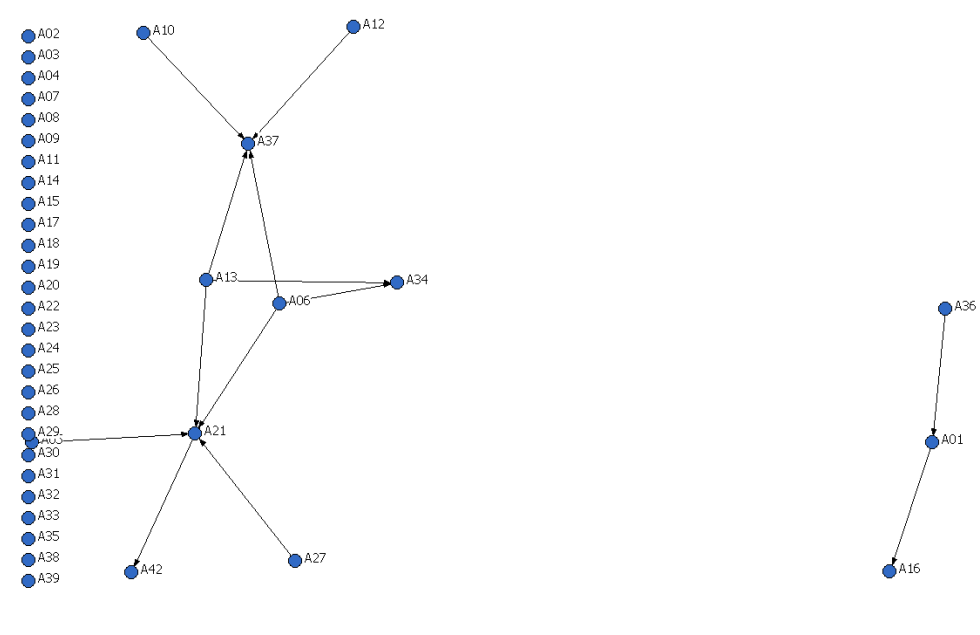

Figure 1-8. Visualization of the individual affordance network for respondent 4

As shown in Figures 1-5 to 1-8, the four respondents perceived and used Facebook's affordances in specific ways, with some using it in greater detail (e.g. Figure 1-5), while some viewed Facebook's functionalities as being more interrelated (e.g. Figure 1-5 and Figure 1-6). On the other hand, some perceived or realized a limited number of Facebook affordances (e.g. Figure 1-7) and viewed it as a bunch of unrelated functionalities (e.g. Figure 1-7 and Figure 1-8).

To create a picture of all the perceived or realized functional affordances of Facebook and their possible interrelations among the respondents, the 17 INFA were aggregated. The aggregate matrix displays the number of times each affordance connects to every other affordance for the 17 respondents. It is a square matrix A whose elements (a_{ij}) record how often the respondents identified affordance i as connecting to affordance j, based on an aggregation across the sample. The aggregate matrix was created by adding the socio matrices of the 17 respondents. Thus, the strength of each tie is the sum of the frequency of direct interactions between two affordances. For example affordance A5 (write on walls) was considered to be a sub affordance of A8 (Expressing/receiving feelings or thoughts) for eight respondents, which corresponds to a strength of 8 between these two nodes (Appendix 3).

UCINET Version 6.303 (Borgatti et al. 2002) was used to analyze the data. Figure 1-9 provides a visual representation of the aggregate affordance network, where each node represents a Facebook affordance. As can be seen, some affordances are the starting points of relations (e.g. A39- "Using Facebook suggestions" or A31- "Searching through friends of friends"), and as a result their in-degree centrality scores are zero. On the other hand, some affordances only receive arrows (e.g. A38-"Recruiting people", A41- "Reconnecting to old friends"), and hence their out-degree centrality scores are zero.

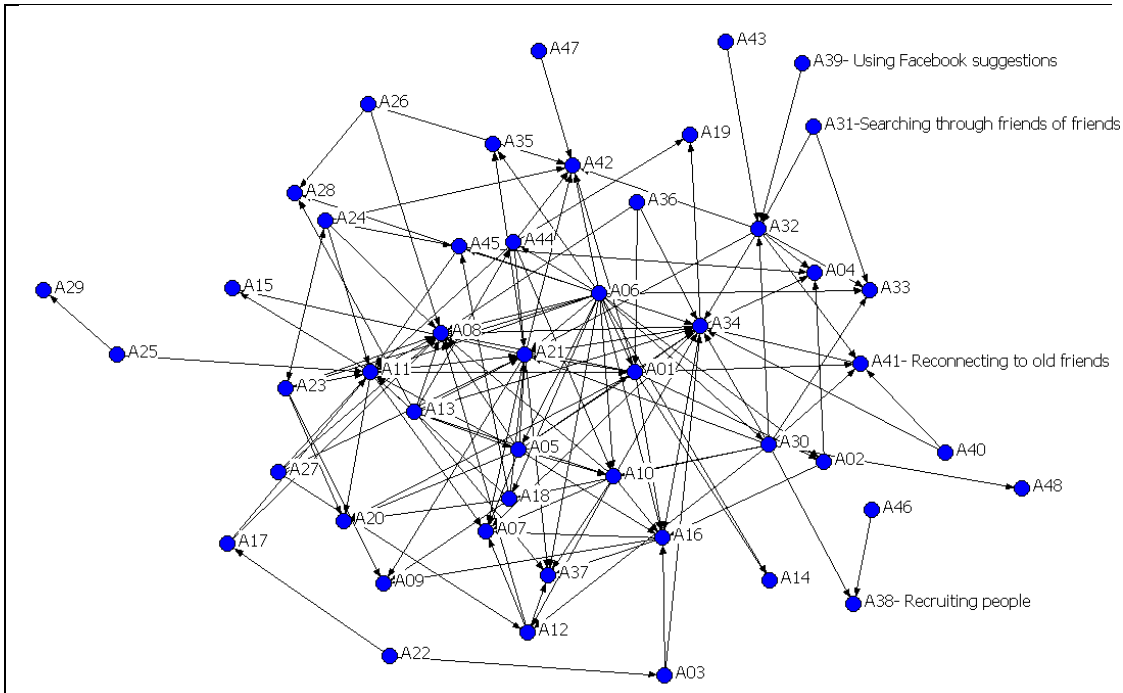

Figure 1-9. Visualization of the aggregate network of affordances in the Pilot Study

As can be seen in Table 1-3, the set of 48 functional affordances can also be ranked according to their abstractness score. As noted earlier, abstractness is the ratio of in-degrees to the sum of in-degrees plus out-degrees, and can be used to classify functional affordances according to their level in the decomposition hierarchy. In the present example, 13 functional affordances had an abstractness score of zero, and were thus identified as being the most concrete in the set of 48 (e.g., "accessing news feeds", "editing texts" or "poking people"). These affordances are very close to the IT artifact and are instrumental in achieving other functional affordances. That is, they are features-in-use by that group. On the other hand, 16 functional affordances had an abstractness score of one (e.g., "making new friends", "doing business", or "expressing feelings or thoughts"), and represent functional affordances associated with potential appropriation moves that can be helpful for achieving higher-level goals of Facebook users. They can also be viewed as leading to potential consequences of using Facebook.

Finally, 19 functional affordances had abstractness scores greater than zero and less than one (e.g., "organizing meetings/events", "organizing photos"), and were classified as intermediate-level functional affordances.

Table 1-3. In-degree, out-degree, and abstractness indices of Facebook's functional affordances in the Pilot Study

Code	*Functional affordance*	*Out Degree*	*In Degree*	*Abstractness*
A06	Create/ access/edit profile, photos, pages, events, groups	40	0	0
A13	Access news feeds	13	0	0
A22	Edit text	2	0	0
A25	Set privacy	3	0	0
A26	Play games, use applications	6	0	0
A27	Receive notifications	4	0	0
A31	Search through friends of friends	8	0	0
A36	Create/access/edit messages	7	0	0
A39	Use Facebook suggestions	3	0	0
A40	Send/receive friend request	2	0	0
A43	Search through groups and communities	2	0	0
A46	Access adds	1	0	0
A47	Poke people	1	0	0
A24	Create albums	8	1	0.111
A30	Search/find info	23	3	0.115
A05	Write on walls	26	4	0.133
A03	Chat	5	1	0.166
A18	Tag	7	3	0.300
A17	Read or write a note	2	1	0.333
A23	Upload files	10	6	0.375

A44	Access pictures/videos	5	3	0.375
A01	Send and receive private/public messages	16	11	0.407
A10	Add/read comments	9	7	0.437
A12	Like an item/check who likes an item	3	3	0.500
A11	Distribute access to a file or link	14	16	0.533
A32	Find/add actual, lost, or new friends	20	25	0.555
A45	Organize photos	2	3	0.600
A21	Spread and receive news/info/events	9	24	0.727
A34	Keep in touch with friends/people	8	22	0.733
A02	Organize events and meetings	2	6	0.750
A16	Communicate offline/online	3	17	0.850
A41	Reconnect to old friends	1	9	0.900
A04	Save time, money, space	0	4	1.000
A07	Give and receive feedback help and support	0	9	1.000
A08	Express/receive feelings/thoughts	0	32	1.000
A09	Do business	0	5	1.000
A14	Track people	0	3	1.000
A15	Reach a large number of people	0	3	1.000
A19	Interfere in people's affaires	0	3	1.000
A20	Let others know about you or your friends' activities	0	7	1.000
A28	Kill time	0	3	1.000
A29	Control privacy	0	2	1.000
A33	Make new friends	0	6	1.000
A35	Do social activities	0	2	1.000
A37	Know people	0	6	1.000
A38	Recruit people	0	3	1.000
A42	Have fun	0	11	1.000

A48	Learn	0	1	1.000

A hierarchical representation of the above functional affordances, based on their abstractness scores, is provided in Figure 1-10. While affordances located at the bottom of Figure 1-10 are close to the IT artifact and represent features-in-use, those located at the top are close to the possible effects of using Facebook. That is, functional affordances with an abstractness score of zero are closer to Facebook's material features and properties. On the other hand, functional affordances with an abstractness score of one are closer to the consequences of using Facebook, e.g., people use news feeds, poke each other, or write on each others' walls to make new friends, kill time, or do business. In sum, the functional affordance hierarchy derived with the proposed approach provides a broad, yet fine grained map of an IT's capabilities and its important consequences for a set of users, e.g., in the present case, for Facebook and a group of young and educated users living in North America who daily use it.

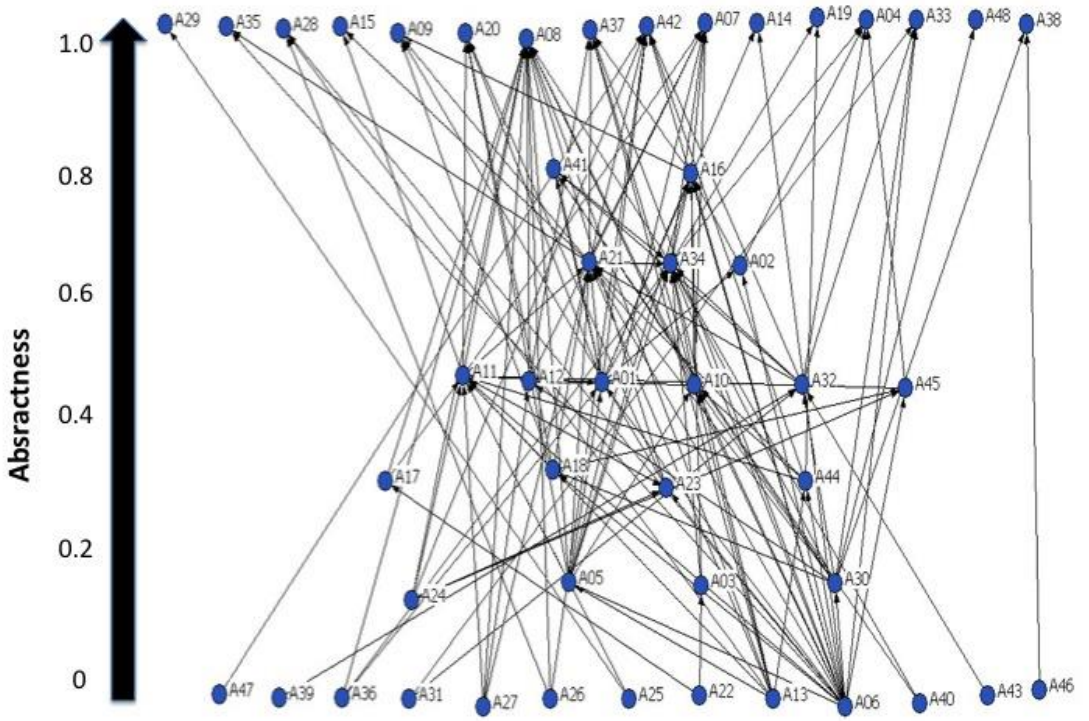

Figure 1-10[6]. A hierarchical representation of Facebook's functional affordances

As noted earlier, it is also possible to analyze affordance networks qualitatively. In addition to yielding an overall view of the important consequences of using an IT artifact, the proposed approach can also clarify how the utilization of each IT feature might trigger certain outcomes which may not have been intended by the IT's designers. In other words, the proposed approach can help identify users' appropriations of an IT, i.e., a "… user's choices in terms of how to utilize the artifact" (Al-Natour and Benbasat, 2009, p. 665). For example, as shown in Figure 1-11, access to Facebook newsfeeds can trigger the usage of Facebook walls, which initially can help people keep in touch with others. However, examining this affordance network also reveals that being in touch with others can also create conflicts in terms of interfering in others'

[6] Nodes that appear to lie on the same line may not have the same abstractness scores.

affairs. In other words, specific chains of the affordance network can also indicate how certain functionalities can be appropriated to create certain unexpected effects from the designers' point of view.

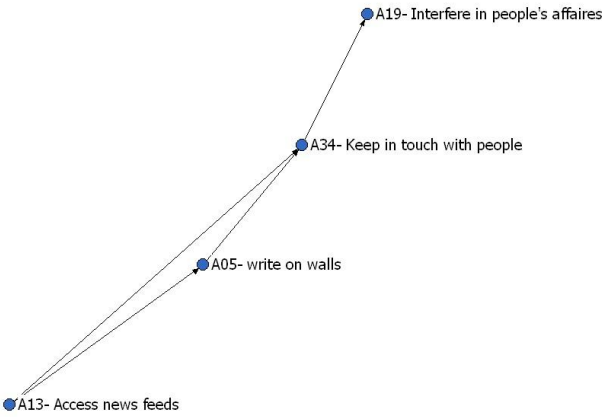

Figure 1-11. An example appropriation of a functional affordance (A13)

In another example, some respondents appropriated Facebook's "tag" in a way that had not been intended by its designers. Tagging is provided by Web 2.0 technologies "… to add explicit meaning to the information or object [people] are consuming" (Anderson 2007, cited in Angus et al. 2008, p. 90), in order to help the classification, self-reference and identification process (Angus et al. 2008). However, as the arrow from A18 to A21 in Figure 1-12 shows, this particular respondent saw "tag" (A18) as a means to "Spread and receive news/info/events" (A21). Clearly, such a functional affordance was not intended by Facebook's designers who added the tag feature to let a user tag his/her friends on a photo in order to identify them: "A tag will link to the tagged friend and cause the photo to display in the friends' photos section"(Facebook Help Center 2011). Moreover, when someone is tagged, he or she will receive a notification, which then encourages him/her to follow the link to see the picture. However, in contrast to

this usage intended by Facebook's designers, some respondents tagged their friends' names on advertisements and on social or political event posters, not for the purpose of, for example identifying those who appear in the picture, but to encourage them to look at the poster so as to more quickly spread news or information. Hence, these users appropriated Facebook's "tag" for a different purpose than what its designers had intended. And, though "tag" and "spread and receive news/info/events" appear as two obvious functional affordances of Facebook, it is only by examining the functional affordance networks of individual respondents that it became possible to more closely see each user's "appropriation moves" (DeSanctis and Poole 1994).

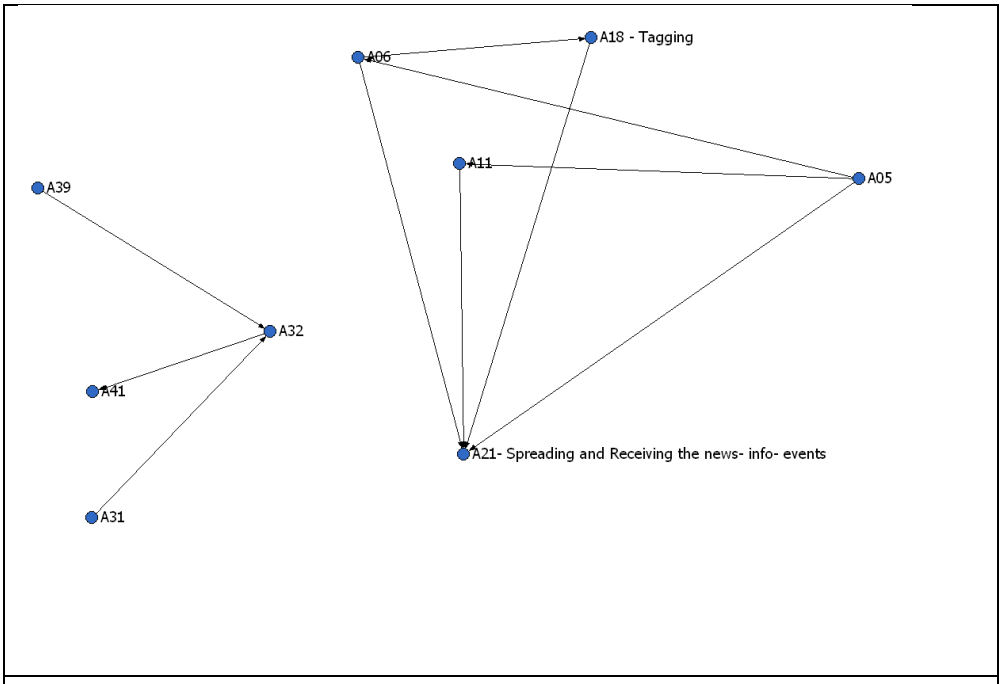

Figure 1-12. Part of one respondent's network of Facebook individual functional affordances

The qualitative analysis of Facebook's emergent network also suggested three types of means-ends relationships between affordances: 1- Conceptual relationship, 2- Componential relationship, and 3- Sequential relationship.

Conceptual relationship (Attribute: Each lower level is sufficient[7] for achieving the higher level)

The first type of relationship between two affordance nodes was labeled "conceptual". In this form of relationship, the superordinate affordance is basically a representation of the subordinate one. That is, when one accomplishes the lower level affordance, s/he also accomplishes the higher-level one (i.e. the lower level is sufficient for achieving the higher level). Moreover, both connected nodes are actualized simultaneously during the usage of the IT artifact. For example, as shown in Figure 1-13, "chat" or "post on someone's wall" are subordinate affordances linked to "communicate". Chatting or posting on someone's wall are basically two forms of communication via Facebook: they both represent "communication", and accomplishing each accomplishes the higher-level affordance, i.e. "communication". Therefore, if a user chats with someone or posts on someone's wall, s/he actualizes the "communication" affordance as well. In this situation, the user sees the affordance of "post on someone's wall", or "chat" as nested within the affordance of "communicate".

[7] Sufficiency means accomplishing the lower level also accomplishes the higher level.

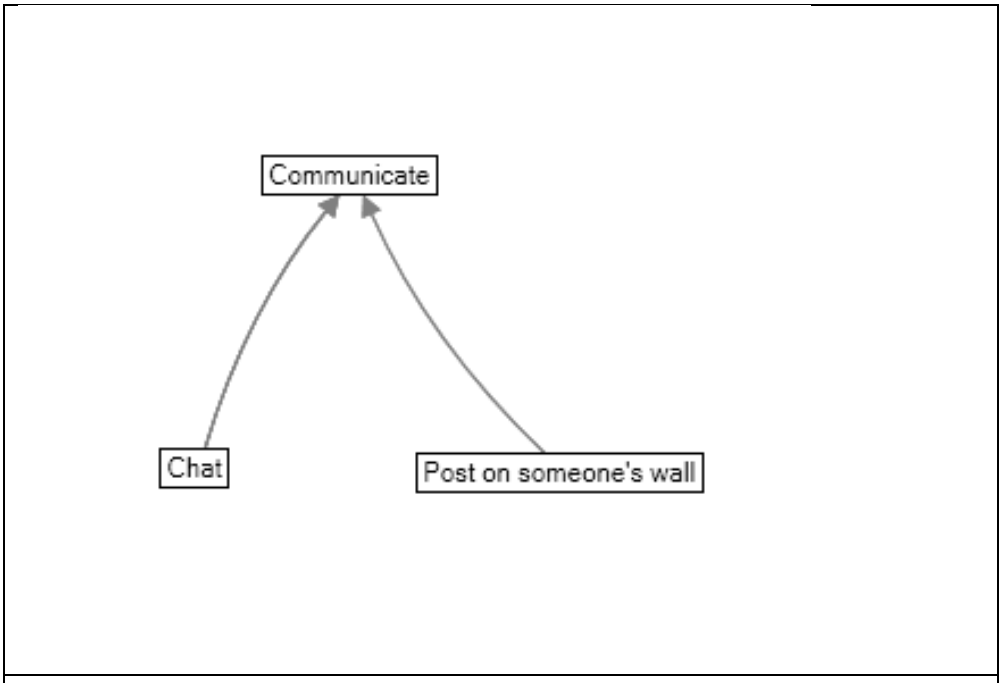

Figure 1-13. Conceptual relationship

Componential relationship (Attributes: 1- Each lower level is a potential component of the higher level; 2- Each lower level is not sufficient to achieve the higher level.

The second type of means-ends relationship was labeled "componential". Here, the subordinate affordance is a potential component of the superordinate affordance. Moreover, each subordinate affordance is not sufficient to achieve the superordinate one. For example, as shown in Figure 1-14, "organize photos" have three components of "create photos", "access photos", and "edit photos". All or some of these components need to be acted upon in order to consider the affordance "organize photos" as being actualized. For example, when users organize their photos, they need to access them, add some new photos or delete others. Thus, each subordinate affordance alone might not be sufficient for actualizing the superordinate affordance, i.e., "organize photo". It is important to note that we do not expect all the components of a superordinate affordance to be present in order to label the relationship "componential".

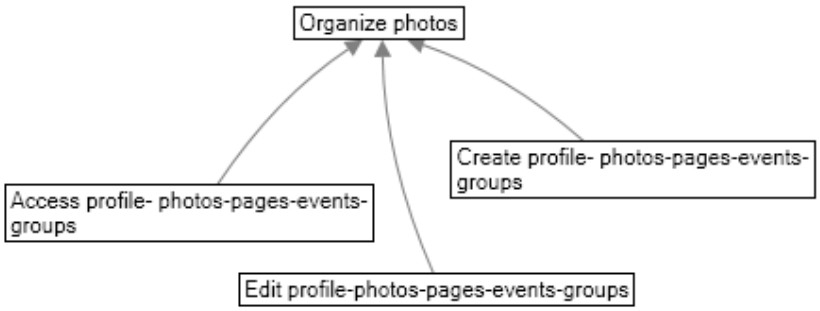

Figure 1-14. Componential relationship

Sequential relationship (Attributes: 1- The higher level is done after the lower level; 2 - Each lower level is not sufficient to achieve the higher level; 3- Each lower level is a potential enabler of the higher level)

The last type of means-ends relationship we observed was labeled "sequential". In this form, the superordinate affordance is accomplished after the actualization of the subordinate affordance. That is, the two related affordances are actualized at different points in time. Moreover, the actualization of each subordinate affordance is not sufficient to actualize the higher-level affordance: the subordinate affordance is only a potential enabler of the higher-level affordance. For example, as shown in Figure 1-15, users can update their Facebook status after accessing the newsfeed. However, "accessing newsfeed" by itself does not imply that "update status" will necessarily be actualized. The sequential relationship between affordances has been noted by Gaver (1991),

according to whom there might be situations where actualizing an affordance leads to information indicating new affordances.

Figure 1-15. Sequential relationship

The aggregate network of functional affordances we identified for Facebook based on the 17 users of our pilot study suggests that the SNA approach proposed here can be applied to any IT in the same way. Doing so can help identify all perceived functional affordances of a given IT for a given user group and to hierarchically structure them. This hierarchy can then be used as a functional affordance continuum, with one end occupied by functional affordances that are close to the IT artifact, such as edit text, access news feeds, or receive notifications. These low level affordances will basically be the features-in-use of that user group. At the other end will be functional affordances that are close to that group's appropriations of that IT to achieve their high-level goals and needs, such as having fun, learning, or interfere in people's affairs.

2.5. Discussion and conclusions

In extending the concepts of DeSanctis and Poole (1994), one objective of Markus and Silver (2008) was to develop a foundation for studying IT effects, and to emphasize the role of IT as a potential cause for social and behavioral outcomes, which can explain why IT effects may differ across contexts. The SNA approach proposed here for linking IT features-in-use to their effects is an effort to put these ideas into practice. As such, a first contribution of this research is to provide an approach to create a context-dependent picture of IT use and its effects.

The usage of IT is very dependent on its context of use (Burton Jones and Straub 2006, Burton Jones and Grange 2013). Although a technology's features remain the same in different contexts, the way they are perceived by users can be very different. Depending on the cultural characteristics of the social context, norms, values, and individual characteristics of users, some technology features might be perceived as more valuable and some of them might get totally ignored. Moreover, depending on the design of the technology, or users' experience with other technologies, some features might become very visible to users' eyes, while other features may remain completely hidden. Since our proposed approach is based on the perceived affordances of each IT artifact, it can be useful for identifying which features of an IT have been visible to a user group, and hence used by them (features-in-use).

Moreover the proposed SNA approach can help identify the potential outcomes of using an IT for a specified group of users. While an IT artifact may afford the same actions at a lower level (e.g., at a low level that is close to the artifact, Facebook affords "sending messages"), at higher levels it may afford different outcomes for different groups of users. For example, at higher levels, Facebook affords the organizing of social or political movements for some communities, while it affords marketing activities for others, with both

communities using the same lower level affordance of "sending messages". As such, based on the long term goals and desires of user groups, Facebook can be a facilitator for organizing social movements, as well as being a facilitator for reaching potential customers. In other words, by considering both the higher and lower level functional affordances of an IT, a better understanding of the big picture of its effects across contexts becomes possible. It is important to note that, by itself, the SNA approach is unlikely to be sufficient to identify and study the affordances of a given IT artifact. As suggested by the findings of the qualitative approach described in the present paper, conducting a qualitative examination is likely to complement SNA's quantitative approach, allowing a richer and broader understanding of an IT's usage and possible effects.

The above observations also re-iterate Markus and Silver's (2008) and DeSanctis and Poole's (1994) assumption that IT properties are not the only cause of change, but they might matter: if Facebook did not provide the possibility of sharing information, "political movements" or "marketing" might not have appeared as possible consequences of its usage. By enabling the derivation of a complete picture of an IT's functional affordances for specific user groups, the approach proposed here provides an important step in this understanding.

A second contribution of this research is to provide an approach to study affordances from a multilevel perspective. The individual level network of affordances (INFA) represents actualized affordances of an IT for each individual user and the aggregate level network of affordance (ANFA) represents affordances (i.e. potentials for actions) of that IT for a specified user group. According to Strong et al (2014), affordances are basically potentials for action and affordance actualizations are actions taken by individuals to realize those potentials. Therefore, a particular individual's usage of an IT can also be a future or potential functional affordance for another person. For example, while a knowledge worker might use an email system to manage her tasks, her colleague

might not. Yet, "manage tasks" is always available as a potential functional affordance to the latter. In other words, the actualizations of one user can provide novel functional affordances of that IT to other users. Thus, in addition to the aggregate functional affordance network which reveals the overall functional affordances of an IT (i.e. the potential uses of that IT), the functional affordance networks of individual users (INFA) provide the benefit of revealing their specific appropriation moves, i.e., how each individual actualized functional affordances.

A third contribution of this research is in the practicality of the way in which an IT's affordances can be connected to each other, as well as to the IT's potential effects. As several IS researchers have noted, multiple affordances can exist for each artifact, and these can be related to each other. Hence, understanding the nature of this relationship is important (Volkoff and Strong 2013). The present research provides an approach that helps identify the relationship between affordances through means-ends linkages. Moreover we identified three types of means-ends relations that appear to exist in affordance networks, i.e., relationships that are conceptual, componential, and sequential. Such a relational view of an IT artifact's functional affordances is helpful for seeing why and how IT can trigger intended or unintended outcomes, and how IT materiality can be interpreted in users' minds to help create appropriation moves which can lead to different outcomes. The proposed approach enables us to look at IT and behaviors as two complementary phenomena which are studied together so as to achieve a better understanding of the usage of IT and its effects.

It is also important to note that, while an abstractness score is applicable to all three types of means-ends relationships we identified, its interpretation is not the same for all three relational types. For example, for "conceptual" or "componential" nodes, the abstractness score can be interpreted as the node's (or the affordance's) closeness to the IT's features-in-use (i.e. IT materiality). On the other hand, for "sequential" nodes, the abstractness score can be viewed as the

node's (or affordance's) closeness to the triggering features in a sequential chain of actions, i.e., representing whether that affordance is actualized earlier than the other affordances of the network.

A fourth contribution of this research is to suggest a reasonable approach to address the Repeating Decomposition Problem (RDP). RDP arises when a phenomenon or characteristic can be decomposed into ever-smaller units with no obvious way to limit the decomposition. For example, in discussing the feature-centric view of IT, Griffith (1999) observed that "It is possible to examine some technology features at increasingly smaller (or larger) units of analysis. For instance, the personal digital assistant may take input from a stylus, the stylus may be plastic or metal, and the plastic may be hard or soft, ad infinitum" (p. 476). DeSanctis et al. (1994) identified the RDP as a potential difficulty when evaluating the features of a technology: "Feature at-a-time evaluation is not only tedious to conduct, it is conceptually inconsequential because "features" have the repeating decomposition problem; there are features within one feature (e.g., menus within menus, or icons within icons), making it difficult to isolate one system "feature" from another." (p. 333). As another example, "…a personal computer may be a small node on an internal intranet and/or an even smaller node on the Internet" (Griffith 1999, p. 476). Thus, it is not at all obvious "…how far must the analysis go to bring consistent, meaningful results?" (DeSanctis and Poole 1994, p. 124).

The RDP can also be found in the domain of task modeling and analysis. Task analysis and models employed in design science provide methods for analyzing and describing how users may interact with an interface to accomplish a task (Limbourg and Vanderdonckt 2002). These methods are also used "…to identify useful abstractions highlighting the main aspects that should be considered when designing effective interactive applications" (Mori et al. 2002, p. 797). Some task modeling techniques use hierarchical patterns to show the structure of a task. For example, Hierarchical Task Analysis (HTA, Shepherd

1989; 1995) decomposes an information system into goals and subordinate goals to show which actions or cognitive processes an operator needs to perform to achieve a system goal (Salmon et al. 2010). Unfortunately, the RDP is also present in such methods. According to Garcia et al. (2008), one of the challenges of task modeling is the lack of consistency between models. A task analyst or modeler "…may produce task models with different levels of detail depending on the design problem; even more, a same person can produce different task models for the same design problem over time" (García et al. 2008, p. 8). Moreover, analysts often have difficulty in knowing where to start and stop their decomposition since it is not at all obvious "…until when should [the analysts] proceed with task modeling such as decomposition and refinement" (García et al. 2008, p. 8). In sum, there is currently no objective rule for determining when to stop the decomposition process.

The SNA approach proposes here overcomes this problem via the identification of an IT artifact's functional affordances as perceived by its users. The premise of the approach is to rely on users' perceived affordances and therefore stop the decomposition of affordances at a level that is no longer perceived by the users.

Some limitations of the present study need to be acknowledged. The abstractness scores calculated here only take into account the in-degrees and out-degrees of the nodes that are adjacent to a given node. This approach to calculating an abstractness score assumes that the more abstract nodes will have more incoming than outgoing arrows. Hence, dividing the number of in-degrees by the sum of in-degrees and out-degrees of a given node provides an estimate of its location in the hierarchical network. However, this score can has limitations because it only takes into account the immediate ties of a given node, without taking into account how all other nodes of the network are connected to it. Future research can study ways of improving the calculation of the abstractness score by using the in- and out-degrees of all other nodes that are indirectly connected to a

given node. It is possible that, using other centrality indexes, such as closeness centrality, could yield a more accurate abstractness score.

Practical implications

This research also provides some practical implications. By revealing how people appropriate an IT, the proposed SNA method can be useful for technology designers. As noted above, users often appropriate IT in ways that are different from what their designers intended, which can eventually limit the functionalities of a system. Hence, by deriving an IT's network of functional affordances and by following the means-ends functional affordance chains, designers can, for example, more readily identify which features involve workarounds or misusages of the IT, and modify its design accordingly. In the Facebook example above, disabling the notification feature of tagging would result in users not being immediately notified when they are tagged, which in turn might make them less likely to immediately check the link to the photo, thereby diminishing the use of tags for sending bulk messages. On the other hand, designers would also be able to make more informed choices regarding which appropriations they wish to promote, and how to train users to more effectively use the IT. The SNA approach proposed here and the calculation of abstractness scores can be useful for managers as well. For example, the abstractness score can be used to reliably identify the IT features-in-use in an organization, as well as the possible consequences of using them. Having access to this information can enable managers to more accurately observe whether the employees of the organization are using an IT according to the designers' expectations or wishes. This in turn can enable them to orient usage patterns of the IT via the introduction of new rules or by providing the necessary training to the users.

The proposed SNA approach can also be helpful for training purposes. As each individual appropriates a given technology in a unique way, these appropriations can be taught to other users of the same community or other

communities of users. That is, the proposed approach can also help improve an IT artifact's training programs by enabling its designers to better inform its future users.

In sum, the proposed SNA approach provides a rigorous and theoretically sound technique for deriving the hierarchical structure of an IT's functional affordances for a group of users and to classify them according to the abstractness of their goal. By empirically constructing such functional affordance networks for different IT, it is likely that a better understanding of the uses of IT artifacts can be gained by helping generate fruitful research hypotheses linking different functional affordance categories to different IT constructs, and via the development of better conceptualizations of important IS constructs.

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2.7. Appendices

2.7.1. Appendix 1 : An instrument to identify individual functional affordances

Questions about your activities on Facebook

We would like to know about the activities Facebook offers you. Therefore, we would like you to fill out the table you will find below as follows:

1- Please think of the things you do on Facebook, and list them in Column B of the table

2- For each item identified in Column B, please think of how you go about doing it in Facebook. In other words, please think of different ways of accomplishing that item in Facebook, and enter them in Column A.

3- For each item listed in Column B, please think of why you do it (For what purposes you do it) and enter your answer in Column C.

A	**B**	**C**

A	B	C

2.7.2. Appendix 2: A list of Facebook functional affordances

Code	Affordance	Code	Affordance
A01	Send and receive private- public messages	A25	Set privacy
A02	Organize events and meetings	A26	Play games- use applications
A03	Chat	A27	Receive notifications
A04	Save time, money, space	A28	Kill time
A05	Write on walls	A29	Control privacy
A06	Create/ access/ edition of pages (profile- photos-events-groups)	A30	Search/find info
A07	Give and receive feedback help and support	A31	Search through friends of friends
A08	Express/receive feelings- thoughts	A32	Find-add friends
A09	Do business	A33	Make new friends
A10	Add/read comments	A34	Keep in touch with friends/people
A11	Distribute access to a file or link	A35	Do social activities
A12	Like an item/ check who likes an item	A36	Create/access/edition of messages
A13	Access news feeds	A37	Know people
A14	Track people	A38	Recruit people
A15	Reach a large number of people	A39	Use FB suggestions

A16	Communicate-offline/online	A40	Send- receive friend request
A17	Read or write a note	A41	Reconnect to old friends
A18	Tagging	A42	Have fun
A19	Interfere in people affaires	A43	Search through groups and communities
A20	Let others know about-you or your friends activities- mood	A44	Access pictures-videos
A21	Spread and receive the news-info-events	A45	Organize photos
A22	Edit text	A46	Access adds
A23	Upload files	A47	Poke people
A24	Create albums	A48	Learning

2.7.3. Appendix 3: The aggregate matrix

	A01	A02	A03	A04	A05	A06	A07	A08	A09	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	A24
A01	0	2	0	0	0	0	0	1	0	0	0	0	0	2	0	5	0	0	0	1	2	0	0	0
A02	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
A03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
A04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A05	4	0	0	0	0	0	2	8	0	1	2	0	0	0	0	2	0	0	0	1	4	0	0	0
A06	1	4	0	0	1	0	0	5	0	3	1	0	0	1	0	2	0	2	0	0	5	0	2	0
A07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A10	0	0	0	0	0	0	1	3	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
A11	1	0	0	0	0	0	1	4	0	0	0	0	0	0	1	0	0	0	0	1	5	0	1	0
A12	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A13	0	0	0	0	3	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	2	0	0	0
A14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A16	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A17	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
A18	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2	2	0	0	0
A19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A21	0	0	0	0	0	0	1	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
A22	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
A23	0	0	0	0	0	0	0	2	1	0	4	0	0	0	0	0	0	0	0	2	0	0	0	1
A24	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3	0
A25	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
A26	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A27	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0
A28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A30	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	1	0	0	0
A31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A32	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
A33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A34	0	0	0	1	0	0	2	1	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0
A35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A36	5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A44	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	0	0
A45	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
A46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(Appendix continues)

	A25	A26	A27	A28	A29	A30	A31	A32	A33	A34	A35	A36	A37	A38	A39	A40	A41	A42	A43	A44	A45	A46	A47	A48
A01	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0
A02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A03	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A05	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A06	0	0	0	1	0	3	0	0	1	2	1	0	1	0	0	0	0	1	0	2	1	0	0	0
A07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A10	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0
A11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A12	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
A13	0	0	0	1	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	1	0	0	0	0
A14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A16	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
A17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
A19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A21	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	1	0	0	0	0	0	0
A22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
A25	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A26	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
A27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A30	0	0	0	0	0	0	0	13	1	1	0	0	0	2	0	0	1	0	0	0	0	0	0	1
A31	0	0	0	0	0	0	0	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A32	0	0	0	0	0	0	0	0	3	7	0	0	0	0	0	0	6	2	0	0	0	0	0	0
A33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A36	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A39	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A40	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
A41	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A43	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
A45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A46	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
A47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
A48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Chapter III - Article # 2

Functional Affordance Archetypes: a New Perspective for Examining the Impact of Information Technology

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3.1. Abstract

IT usage is generally viewed as a key indicator of adoption success and a prerequisite for deriving its benefits. Yet, while IT usage can provide a good measure of adoption success, it does not necessarily yield desirable outcomes, i.e., the individual benefits expected by its designers. This paper investigates how IT use can lead to its desirable outcomes based on a functional affordance (FA) perspective (Markus and Silver 2008). Specifically, we define perceived functional affordances (PFA) as an IT's afforded possibilities for action as perceived by an individual user. Further, by following Eisenhardt's (1989) approach of theory building from multiple cases, we develop a PFA categorization and introduce four PFA archetypes: i.e. Facilitator, Protector, Imposer, and Inhibitor. Subsequently, we use these archetypes to explain the conditions under which the PFA of an e-health system can be transformed into usage that is conducive to the attainment of its desirable outcomes.

Keywords: IS usage, Functional affordance archetypes, Asthma self-management performance

3.2. Introduction

The usage of IT artifacts is generally thought to be a prerequisite for deriving their benefits, and as such to provide a key indicator of IT implementation and adoption success (DeLone and McLean 1992; Lucas 1978; Petter et al. 2008). Yet, while IT usage can serve as an appropriate measure of IT adoption and success, it may not necessarily yield desirable outcomes, i.e., result in user benefits that IT designers expect, such as "improved decision-making" for a decision support system, or "improved quality of care" for e-health technologies. Based on a functional affordance (FA) perspective (Markus and Silver 2008), this paper investigates how IT use can lead to its desirable outcomes. Specifically, applying the FA concept at the individual level of analysis, and also relying on the inductive analysis of our data, we extend existing definitions of functional affordances by specifying "who/what is perceived as the source of action" by defining Perceived Functional Affordances (PFA) as *perceived possibilities of action provided by an IT artifact to an individual user who could view either herself or the IT artifact as undertaking such possibilities*. We then will examine how PFAs influence the way people use IT, and thereby play a key role in determining whether their usage will lead to desirable outcomes.

Our contextual focus is a web-based user-centric self-management system designed to promote asthma self-management for asthma patients. Asthma self-management is mainly concerned with the systematic education of asthma patients in order to engage their active participation in controlling their asthma by avoiding its triggers and reducing its symptoms (Kotses and Creer 2010). Our research design is a multiple-case approach where each individual user, i.e., asthma patient, is treated as a case, and our results are based on an analysis of the 16 cases. Adopting a multiple case-study approach (Eisenhardt 1989), we examine how and under what conditions the observed patients' PFA of the portal has influenced their asthma self-management performance. To do so, we

followed an inductive strategy to develop a categorization of four PFA archetypes: Facilitator, Protector, Imposer, and Inhibitor. Next, we used these archetypes to explain the conditions under which the PFA of the asthma self-management system can be transformed into usage that is conducive to the attainment of the portal's desirable outcomes. This was achieved by following Eisenhardt (1989) approach of theory building from contrasting cases to categorize each patient as high or low in terms of their self-management performance (SMP). Comparing the two categories of cases helped us to inductively develop propositions, which were subsequently replicated across other pairs of cases.

3.3. Literature Review

While the use of an IT can be viewed to provide a good indicator of its adoption or implementation success, the use of an IT does not necessarily imply that the IT in question will yield the impacts intended by its designers or the organizations that implemented them. As can be seen from the examples provided in Table 2-1, past research has observed mixed results concerning the link between IT usage and desirable outcomes, such as individual performance or user satisfaction (Burton-Jones and Straub 2006; Petter et al. 2008). Based on extant literature, two plausible explanations can be provided for these results[8]: 1- Poor conceptualization and operationalization of the usage construct (Burton-Jones and Straub 2006; DeLone and McLean 2003; Petter et al. 2008) 2- The emergent nature of the outcomes of using IT (Barley 1986; DeSanctis and Poole 1994; Markus and Robey 1988; Orlikowski 1992).

[8] Other explanations are also possible, such as poor quality of design.

Table 2-1. Examples of Mixed Results Regarding the Individual Level Use of IT	
Link between usage and the desirable outcome	Study
Strongly positive	Burton-Jones and Straub (2006), Doll and Torkzadeh (1998)
Positive	Chiu et al. (2007), Halawi et al. (2007)
Weakly positive	Goodhue and Thompson (1995), Igbaria and Tan (1997), Vlahos et al., (2004), Yuthas and Young (1998)
Negative	Szaina (1993)
Not significant	McGill et al. (2003), Seddon and Kiew (1996), Vlahos and Ferratt (1995)

The first explanation argues that a key reason why past research has not consistently observed a direct and significant link between IT usage and its desirable outcomes stems from the poor conceptualization and operationalization of the usage construct. An underlying assumption of this perspective is that IT usage always generates the outcomes intended by their designers. However, without valid measures of IT usage, the empirical results are bound to be inconsistent. In other words, this perspective argues that the mixed results between individual system use and its desired effects can be due to how researchers have conceptualized and operationalized system use (DeLone and McLean, 2003, Burton-Jones and Straub, 2006, Petter et al., 2008) which has largely been limited to measures of frequency, duration and system functions used (Barki et al. 2007), or discrete elements of usage (e.g., individual cognition and technology characteristics) (Nan 2011). Thus, this view suggests that a rich conceptualization of IS use which encompasses the individual, the IT artifact, and

the task would be likely to better explain usage outcomes.

According to the second explanation, the inconsistency between IS usage and desired outcomes stems from the fact that the consequences of IS use are the result of an emergent process. Adopting such a perspective, some researchers have argued that usage and its consequences "… emerge unpredictably from complex social interactions" (Markus and Robey 1988, p. 588). For example, DeSanctis and Poole (1994) and Orlikowski (1992) "… developed structurational models of technology to account for the mutually shaping yet indeterministic interactions between IT features, human actions, and institutional properties in addition to the time-dependent nature of the structuration process." (Nan 2011, p. 506). Consequently, they have recognized the social and organizational context as an important factor in creating usage outcomes.

Although a poor conceptualization and measurement of IS usage might also help explain the mixed results observed in past research, consistent with Orlikowski (1992) and DeSanctis and Poole (1994) (i.e. the second perspective), we believe that the usage of IT artifacts does not always lead to the occurrence of desirable outcomes. In line with past research, we argue that individual capabilities, the social and organizational contexts, or the interaction between human, IT and institutional properties can shape individual usage outcomes. Consistent with this view, this study proposes that the concept of perceived functional affordances can be useful in explaining how and why desirable outcomes tend to occur. The concept of functional affordances views IT as socio-technical artifacts and perceives functional affordances as bridges between these artifacts and the people who use them. In other words, the concept of functional affordance "…approaches the study of IT effects from a broader social or behavioral standpoint, inquiring about second-order effects or why system effects may differ across contexts" (Markus and Silver 2008, p. 627). Moreover, as they can adequately capture how individuals perceive the capabilities and constraints of IT artifacts, the notion of functional affordances can provide a powerful lens to

help explain why and how desirable outcomes of usage can be achieved.

3.4. Theoretical Background

The origins of the notion of affordance can be found in ecological psychology where it has been used to describe the relationship of animals or human beings with objects (Gibson 1966). In this view, affordances primarily refer to the possibilities of action provided by the environment (Gibson 1966). In the Gibsonian view, affordances are not imagined; they are real and their existence does not depend on people's perceptions. For example, while a mobile phone affords users to manage their contacts, some users may be unaware of the existence of such an affordance.

Further, the "…affordance of an object refers to both the attributes of the object and the actor." (Gaver 1991, p. 79), and as such cannot be the same for all actors. For example, a child might perceive that a closet can afford her "hiding", while another might view it as affording "storage". In another example, to a group that desires to make consensus-based decisions, a group support system may afford the opportunity to surface ideas anonymously. Yet, the same system may afford nothing to a group with an autocratic leader (Markus and Silver 2008).

Numerous efforts in the IS and HCI literatures have tried to more clearly define affordances and exploit their full potential (Kaptelinin and Nardi 2012). For example, Norman (1988) introduced affordances to HCI and described them as perceived or actual properties of objects, which determine how they can be used. Later, Gaver (1991) defined affordances as perceived possibilities for actions that objects provide, and which depend on people's needs. Depending on the relationship between the availability of perceptual information about an affordance and the actual existence of that affordance, Gaver (1991) labeled affordances as visible, hidden, and false. A more recent effort is that of Van Osch and Mendelson (2011) who proposed a categorization of affordances based on the interactions between developers, users and artifacts: 1- Designed affordances that

are perceived and recognized only by developers and might not necessarily be recognized and enacted by users; 2- Improvised affordances that are recognized by users during usage; 3- Emergent affordances that are neither expected by developers nor improvised by users during usage.

Affordances have also been discussed in IS literature. According to Leonardi (2011) "as people attempt to reconcile their own goals with the materiality of a technology, they actively construct perceptual affordances and constraints." In addition, Volkoff and Strong (2013) have defined affordances as "the potential for behaviors associated with achieving an immediate concrete outcome and arising from the relation between an object (e.g., an IT artifact) and a goal-oriented actor or actors" (p. 823). Moreover, Strong et al. (2013) distinguished between affordances as action potentials and actualization as actions taken by individuals to realize those potentials, emphasizing that affordances do not only enable actions, but that they also constrain them.

One of the underleveraged views of affordances in IS research is that of Markus and Silver (2008). They introduced the concept of functional affordance (FA) and defined it as "…the possibilities for goal oriented action afforded to specified user groups by technical objects" (p. 622). They also suggested that functional affordances[9] provide an appropriate construct for studying IT effects as it encourages the adoption of a non-deterministic view of IT impacts, making IT properties unlikely to be viewed as the only cause of change. In the present study, we further specified Markus and Silver's (2008) concept of FA by introducing the notion of perceived functional affordances (PFA), defined as individuals' perceptions of an IT's afforded possibilities for action. It is important to note that FAs as defined by Markus and Silver (2008) are not necessarily perceived[10]. According to Markus and Silver (2008), FA "refers to potential usage of an IT

[9] The concept of "functional affordance" is different from the Gibsonian account of the "affordance" concept, as the latter does not depend on users' objectives and needs. According to Gibson (1986), the affordance of an object does not change even if the needs of the user change.
[10] Confirmed by M.S. Silver in a personal communication with one of the authors.

artifact" (p. 622). Thus, in their view, usage potentials exist for any user who has the goal and capability of taking advantage of the IT artifact, even though s/he may not be aware of all usage potentials of an IT. For example, a smart phone can provide the possibility of taking photos to a user who is capable of, and willing to take pictures, even though s/he may not see this possibility. In the present study, we limit the concept of PFA only to FAs that are perceived by each individual user. Our key premise is that when users interact with an IT, they develop a mental image of its capabilities and constraints (i.e. an IT's PFA for a particular user), and then they act based on that image. As such, each user's PFA influence that user's actions, which in turn determine the outcome(s) they each ultimately derive from their usage of a given IT. Thus, PFA can either facilitate or inhibit the occurrence of desirable outcomes.

3.5. Research Design and Method

3.5.1. Methodology

Our methodology basically consists of two main steps. In the first step, we followed an inductive strategy to develop a categorization of PFA. To do so, we employed a multiple-case approach whereby each individual user, i.e., asthma patient, was treated as a case. The results we report here are based on an analysis of interviews with 16 patients. In the second step, we followed Eisenhardt's (1989) approach of "building theory from case studies" to develop several propositions concerning how and under what conditions IT use can lead to high versus low levels of asthma self-management performance. To do so, we employed the "polar types" theoretical sampling approach (Eisenhardt 1989; Eisenhardt and Graebner 2007), in order to more readily observe contrasting patterns in the data, i.e., by identifying contrasting cases in terms of self-management performance. A comparison between contrasting cases helped us to inductively develop propositions and then to replicate them across other pairs of cases. We elected to use this strategy in view of a lack of prior theory and research regarding the role of affordances as determinants of IT usage outcomes.

3.5.2. Context of the study

Our contextual focus was the My Asthma Portal (MAP), a user-centric self-management system designed to promote asthma self-management for asthma patients. Asthma self-management is mainly concerned with the systematic education of asthma patients in order to engage their active participation in controlling their asthma by avoiding its triggers and reducing its symptoms (Kotses and Creer 2010). As such, it promotes patient ability to manage the symptoms, treatments, and the physical, as well as psychosocial consequences and lifestyle changes inherent in living with an asthmatic condition. The integration of self-management into daily life requires patients to master skills related to medical self-management, and to develop problem solving and coping skills that deal with emotions that arise from living with asthma and its exacerbations (Holman and Lorig 2004).

Information technology can provide opportunities to improve self-management support for chronic illnesses like asthma by integrating it with ongoing medical care. Web-based and patient-focused tools provide one form of health information technologies that help increase patient participation in disease prevention and management (Polomano et al. 2007). Such tools have the potential to improve self-management because they are available at home or at work, at the convenience of the patient, and they provide information when needed most. The use of web-based tools also allows for the management of the intense anxiety that often accompany living with a chronic disease such as asthma by allowing the patient to communicate with a care provider and by reassuring them that they will receive support when they need it. As well, web-based tools have the capacity to allow patients to modify the way information is presented to them and to receive information that is specifically pertinent to their own condition.

The system examined in the present study, My Asthma Portal (MAP) (Figure 2-1) is a web-based self-management-system developed in 2010 by the McGill Clinical and Health Informatics research group. To examine its

effectiveness in the management of asthma, a preliminary study (Ahmed et al. 2011) examined its use over six months by 30 patients (between 18 and 60 years of age) and a supervising nurse. MAP's patient interface required that, approximately twice a week, each patient answer pre-determined questions about their health status and medication-adherence. Further, a nurse case manager used the nurse interface of the portal during the same period to monitor each patient's asthma status and to provide him or her with individual feedback via e-mail.

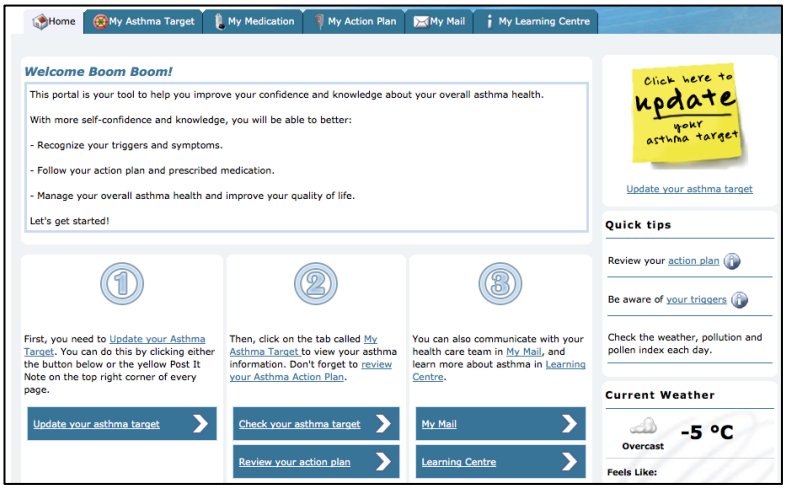


Figure 2-1. My Asthma Portal Homepage

At the time of initial login to MAP, each patient was asked to set-up an individual profile which consisted of their 1) language preferences 2) name and contact information, and individual asthma health goal stated in textual format, and 3) allergies and asthma triggers. Moreover, MAP required each patient to answer several questions about their symptoms, medication adherence, use and understanding of the action plan, and weekly physical activity. Each time, after answering the questions (Figure 2-2), a graphical feedback mechanism (Asthma Diagram) (Figure 2-3) and a graph of medication, exercise and symptoms (Figure 2-4) informed each patient about the status of their asthma control.

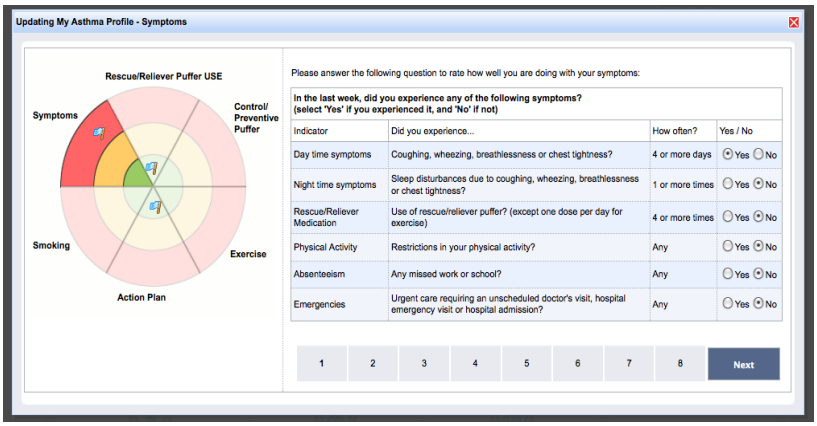


Figure 2-2. Asthma questionnaire

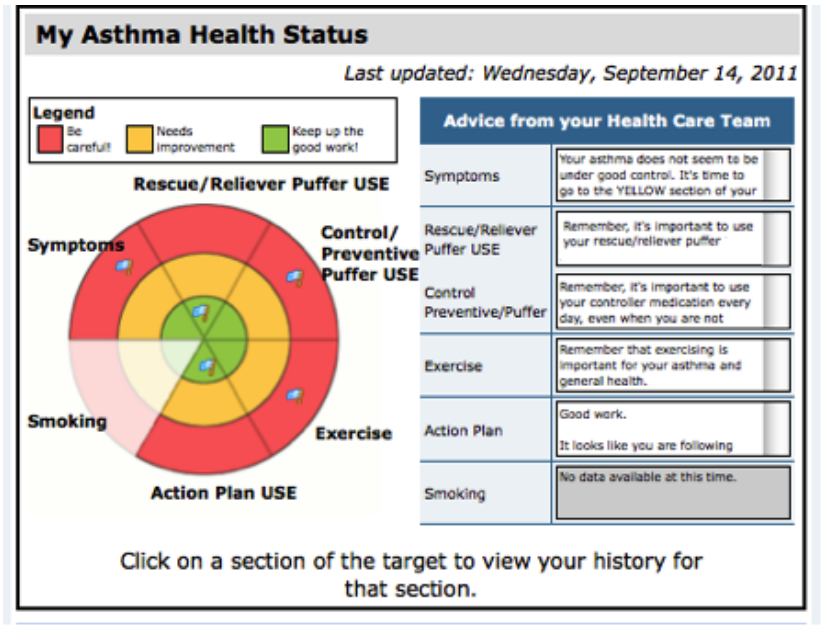


Figure 2-3. Asthma diagram

Figure 2-4. Feedback graph (historical graph)

The weekly questionnaire and the graphical feedback mechanism were devised to enable patients to self-monitor their symptoms, medication adherence and physical activity. MAP also advised patients about what to do (i.e. Action Plan) if their asthma was not under control. The e-mail section of the interface enabled them to exchange messages with the nurse. If the nurse noticed any problems, such as ambiguous data or an out-of-control asthma status, she e-mailed the patient. The patient could also e-mail the nurse to ask questions or share information. The homepage of the nurse interface contained a list of patient names that were color-coded and ordered according to each patient's weekly health-status. Patients whose asthma was out of control or those who had not started their action plan had a higher priority in the list. Table 2-2 summarizes MAP's patient interface features.

Table 2-2. MAP functions, features and their descriptions		
Function	Feature	Description
Updating health status	Asthma questionnaire	A series of questions that ask the patient to report on his/her health status since the last data entry.
Alerts and advice	Asthma diagram	A feedback mechanism that assigns a color (red, yellow, green) to mark the patient's health status.
Feedback	Historical Graphs	Includes a symptoms graph, a medication graph, as well as a physical activity graph. They provide a history of the patient's symptoms, medication usage, and number of steps taken from the beginning of the study.
Self-learning	Information page (links)	Provides links to educational material about asthma.
Messaging	E-Mail	Provides the possibility to have ongoing e-mail communication between a patient and the nurse case manager.

3.6. Data Collection

The McGill research group recruited 30 asthma patients from the Jewish General Hospital in Montreal and the Montreal Chest Institute and asked them to use MAP for a period of six months. The recruited patients had been in poor control of their asthma despite being prescribed appropriate therapy and a written action plan. Patients with serious medical diagnoses such as lung cancer, or those who had severely limited mobility that prevented them from leaving home were excluded from the study. A McGill University research coordinator provided about two hours of training to the participants in how to use MAP. Patients were encouraged to access MAP at least twice a week for six months, a period the research group deemed necessary to reinforce self-management. Patients were sent automated e-mail messages to encourage them to log on to MAP and to promote their continued participation. A nurse was also recruited from the Montreal Chest Institute as the case manager with access to the nurse interface of MAP which enabled her to monitor the patients' health status. She contacted the patients if their situation was deteriorating or if she felt that the patient required

urgent care. At the end of the six-month MAP usage period we interviewed the nurse and 16 patients out of 30 who agreed to participate in our study (Appendix 1). We also collected patient activity log data and their e-mail exchanges with the nurse during throughout the six-month usage period. In order to benefit from data-triangulation we also collected health insurance data from the provincial health ministry (RAMQ[11]).

Two interview protocols were developed (Appendix 2 and Appendix 3). The first contained a series of open-ended questions that allowed the patients to describe how they used MAP, their perceptions of its capabilities and constraints, as well as their asthma self-management behavior with or without MAP. The second protocol also contained a series of open-ended questions that allowed the nurse to describe her activities on MAP. During the interview with the nurse we also asked her to assess each patient's self-management performance at the end of his or her six-month MAP usage. The interviews with patients were conducted at one point of time (cross sectional) and shortly after this usage period. During the interviews, all respondents had access to MAP. Table 2-3 summarizes our data sources and the study concepts extracted from the data.

Table 2-3. Data sources

Data source	Concepts
Semi structured interviews with 16 patients (around one hour each)	PFA, Asthma self-management behavior
Semi structured interview with the nurse (around one hour)	Asthma self-management performance
MAP activity log for six months	Usage
E-mail exchanges between the asthma nurse and the patients	Asthma self-management performance
RAMQ data (from the Quebec Health Insurance Plan)	Asthma self-management performance

[11] Regie de l'Assurance Maladie du Québec (Quebec Health Insurance Plan)

3.7. Analysis

Step 1: Inductive identification of affordance archetypes

Each interview was transcribed and the transcripts were codified according to the study concepts which initially consisted of "perceived functional affordances", "self-management performance", "technology features", "IS usage", "user desires", and "user attitudes towards the system". Then, we inductively looked for new concepts and relationships between concepts. N'vivo (ver. 9) was used to facilitate the coding process. As we were interested in creating a categorization of functional affordances across all cases, in the first step we organized all transcripts into a single file to facilitate the comparison of codes through the data. A constant comparison of the data, codes and categories was central during this process, and yielded a categorization of PFA. In examining PFA and identifying the dominant archetype of each patient-user, their interaction with each MAP function/feature was the primary unit of analysis, and their interaction with the system as a whole was the secondary unit of analysis.

Step 2: Developing propositions

In the second step, we categorized each patient as being either high or low in terms of his/her self-management performance (SMP). It is important to note that our categorization was only based on each patient's SMP that resulted from using MAP. In doing so, we relied on RAMQ data, the nurse interview and her evaluation of each patient's performance, the e-mail exchanges, and also the patients' self-reported self-management (SM) behaviors. This enabled the identification of contrasting cases (i.e. low versus high SMP). Then, the PFAs and usage behaviors of high performing cases were compared to the PFAs and usage behaviors of low performing cases.

Each patient's usage log had been recorded during their six-month usage period (i.e. 24 weeks) and served as the basis for identifying their individual usage patterns. The logs provided each patient's weekly usage of five MAP

features, i.e., for each of the 24 weeks, the logs indicate the number of times each patient: 1- updated the asthma questionnaire, 2- visited the asthma target and historical graph pages, 3- visited the information page, 4- sent an e-mail to the nurse 5- received an e-mail from the nurse.

The bar graph of Figure 2-5 shows an example of one patient's usage pattern. The vertical axis shows usage frequency (number of times) and the horizontal axis shows the weeks. Week one is the first week of usage, and week 24 is the last week of usage[12]. The bars depict the weekly usage frequency of different MAP features as indicated by their colors. For example as shown in Figure 2-5, patient 13 updated the portal three times during the first week of her usage. She also visited the asthma target page four times during the same week (Appendix 4 provides the list of all usage patterns).

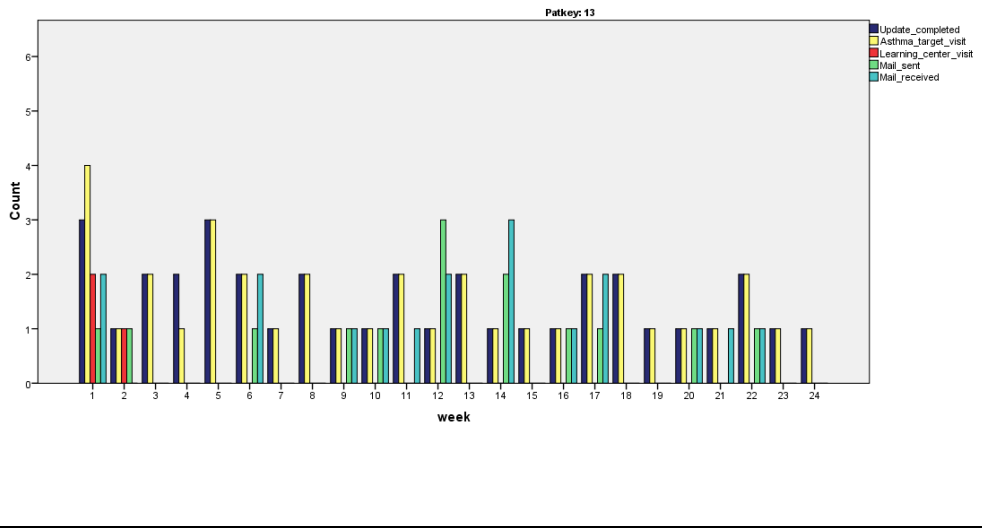


Figure 2-5. Example usage pattern (P13)

To compare usage patterns, we examined correlations and did t-tests to show that low or high SMP could occur from usage patterns that were not significantly different from each other.

[12] A high usage in first two or three weeks of usage can be seen for most of the cases, which is due to their learning process.

To facilitate the comparison of cases, the interview transcripts, the RAMQ data, and patient-nurse e-mail exchanges were synthesized into individual case histories. These are 1-2 double-spaced pages of narrative, selected quotes from the participants, as well as tables that summarize each patient's asthma self-management performance, his/her PFA, and other key facts (e.g. their attitude toward MAP). We also created a table to summarize each patient's usage, SMP, and PFA, to provide a general overview of the cases, and to help compare the cases and generate propositions. The case histories were used both for within-case, and cross-case analyses (Miles and Huberman 1994).

Finally we developed propositions by looking for patterns and relationships between existing and emerging concepts across the cases, and then by deductively looking for replications across other cases. Following Eisenhardt (1989), we compared the patterns and relationships between the concepts in contrasting cases (i.e. high versus low SMP) to develop initial propositions and then to examine whether they could be replicated across other pairs of cases.

3.8. Results

The analysis of the interview transcripts led to an inductive identification of four PFA archetypes. PFA is a relational concept that is dependent on both the users and the IT's properties. That is, different individuals can perceive the capabilities and constraints of an IT artifact differently. This phenomenon was well observed in the interview data: although all patients were using the same IT artifact, i.e. MAP, they each perceived the portal's capabilities and constraints in unique ways. For example, one of the main features of the portal, labeled "Asthma Target" is part of MAP's electronic health record system which tracks and monitors the patients' asthma health. Depending on the patients' answers to a series of questions about their symptoms, it gives them feedback on their health status. Yet, patient perceptions of the Asthma Target were very diverse. While some of them perceived it as something which "rewards them if they take care of themselves", others saw it as something which "reassures them that they are

healthy", and still others viewed it as something which "helps them to keep track of their symptoms". The diversity of how patients perceived MAP's affordances encouraged us to look for similarities and differences between their PFA, and enabled us to identify the four archetypes described below

3.8.1. A Categorization of Perceived Functional Affordances (PFA)

As shown in Figure 2-6, based on how participants perceived their relationship with the portal, four PFA archetypes emerged from the interview data, labeled Facilitator, Inhibitor, Imposer, and Protector. The data also indicated that when using MAP, the patients always seemed to assign a role to themselves and a role to the portal (i.e., MAP). That is, while some of them saw themselves as actors (i.e. someone who does an action) and MAP as a tool, others saw MAP as the actor and themselves as subjects who followed its actions. That is, while the former saw themselves as using MAP to achieve their own objectives, those who had the latter perspective tended to see MAP as something that did something either for or against them. As depicted in Figure 2-6, casting these perspectives as the axes of a 2X2 table yielded four PFA archetypes.

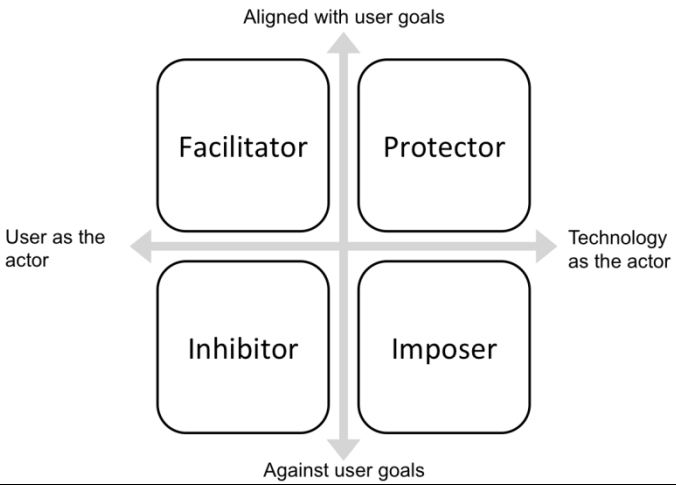


Figure 2-6. Four PFA Archetypes Based on the Actor and the Alignment Between IT and User Goals

Facilitator PFA

Some patients perceived themselves as actors who performed an action by means of MAP, that is, they saw MAP as a tool which facilitated their activities. For example, patient #1 (P1) referred to MAP's "historical graphs" as something she could use to analyze her symptoms: "*I could pretty much look at that information [graphs] at a glance and realize oh, okay, this combination of factors makes my asthma worse or better"(P1).*

Note that, P1 perceived herself as the one managing her asthma and MAP as a tool which facilitated this action. Thus, for P1, "analyzing symptoms" can be viewed as MAP's afforded action and MAP as a "Facilitator" of that action. As such, we labeled this PFA archetype "Facilitator". Note that, this archetype involves a relationship where users perceive the IT as allowing them to perform an action that is aligned with their goals and desires. Thus, in the above example, P1 was willing to use MAP's graphs as an analysis tool and the IT allowed her to do so.

Inhibitor PFA

A second category of PFA that we labeled "Inhibitor" is similar to the "Facilitator" archetype in that patients who held this view also perceived themselves as actors and the IT artifact as a tool. However, in contrast to the "Facilitator" perspective, in this case they felt that MAP did not allow them to perform the actions they wanted to execute. For example, one patient saw MAP as inhibiting some of her possible self-management actions. More specifically, to prevent misinterpretation of her data, this patient liked to provide to MAP and the health care team additional information about her asthma condition. However, in her view, MAP did not provide her adequate space for expressing herself. She perceived the portal as an inhibitor because she tended to see it as a constraint that did not provide her the affordances she wanted to have. Thus, "giving extra information about her asthma condition" was a system constraint (Leonardi 2011) for her and she viewed MAP to be acting as an "inhibitor" of that action.

Similarly, another participant was not a typical asthma patient and used medication that MAP's database did not include. When she tried to enter the quantity of all medications she was taking, MAP refused to accept the one that was not in its database. This situation was a limitation for the patient, as she could not enter the correct values of her medications into the portal. Thus, "entering the value of one of his medications" became a system constraint for this patient who viewed MAP's asthma diagrams as acting like an "inhibitor". *"I wanted to use it [the asthma diagram] as a tracking tool and it wasn't able to do that for me."* (P37)

Imposer PFA

Some patients perceived MAP as an actor who acted against them. For example, one patient felt that MAP treated him like a kid, telling him what to do and what not to do. *« It's like taking a child by the hand, and saying - Look, you're not able to feel yourself. We'll show you ... we will tell you that you are fine. Because you responded to this question, or to that question » (P122)*

In essence, P122 perceived MAP as something which acted against his desire of being independent in taking care of himself. Thus, "Treating the patient as a kid" was MAP's afforded action and the patient perceived it as acting like an "imposer" of this action. As such, we labeled this archetype "Imposer".

Protector PFA

Some patients perceived MAP as an actor, but themselves as subjects who underwent an action that was for their own good, i.e., aligned with their goals. As such, we labeled this archetype "Protector".

For example, one patient viewed the portal as a mother who takes care of her sick child. *"... it's like somebody is looking in on you. It's like when you're sick and you're a kid and your mother comes to look in on you. She's not going to make you any better, but if she looks in on you at night before you go to sleep you feel better. So someone's looking in. That's what I feel." (P14).* This patient also

described MAP as someone who monitored him "*somebody is actually watching and taking care to monitor what I'm feeding in. So if I'm feeding in information that goes outside of my personal profile, someone's going to pick up on it."*

Thus, for P14, "looking after the patient" was the afforded action, which suggests that the system acted like a "protector". When users' perceptions of IT capabilities were aligned with their desires and goals, and the IT was perceived as the actor, they tended to see the system as a "protector". That is, the system basically did some actions for them that they liked, approved of, or appreciated.

3.8.2. Function level and System level archetypes

When asked about MAP's affordances, patients sometimes referred to MAP's features/functions (e.g. asthma diagram, e-mail, etc.), and at other times they referred to the system as a whole. For example, when asked about MAP's capabilities and constraints, P12 stated, "… *using that [MAP] reinforces medications and I don't want to do that*". In this case P12 was referring to MAP as a whole. However, at other times he referred to MAP's specific features: *"... graphs just bang me on the head that I'm not doing enough*". As many patients viewed some PFA at the function level and others at the system level, we coded and analyzed PFA at these two levels.

Further, each patient's function and system level PFA were not always of the same archetype. For example, P101 did not see any affordances in the graphs and information pages of MAP: *"I never dealt with graphs. They don't mean anything to me … I never went onto it [the learning center]… Basically I never knew how to get onto different things and everything."* However, when describing MAP as a whole, he saw it as an Imposer: *"MAP would always say, "Start your action plan. Start your action plan." But my nurse would always say, "If you're hesitating when to start it, come in and see us and we'll either put you on your action plan, or… my doctor saying one thing and the machine is saying something else"* (P101).

Similarly, P14 viewed MAP's asthma questionnaire as a Protector *"... if I*

made mistakes in my medication, someone [referring to MAP] was there to send me a signal… by updating the questionnaire, yeah I was giving the people in MAP my data … so that they could see that I was doing what I was supposed to be doing." However, when describing MAP's messaging function, he pictured it as a Facilitator: "*But if I had sort of questions about this or that, I'm not going to call her [the nurse]. But on the portal I would be able to do" (P14).*[13]

Table 2-4. Archetypes as seen by P126

Function (feature)	Function level PFA Archetype	Quote
Updating health status (Asthma questionnaire)	Inhibitor	"I found it a little frustrating that many of the multiple choice questions did not have the answer that I wanted to give… I felt more that it was me providing data as supposed to it providing it to me."
Alerts and advice (Asthma diagram)	Imposer	"If you didn't know what your asthma was and you needed somebody to say "okay, go to plan A, B or C" like yellow, red or green, that's fine. But I know what my asthma was like. I didn't need them to tell me I was in the yellow."
Feedback (Historical graphs)	-	"… the graphs [were] not accurate for me"
Self-learning (Information page)	-	"… there wasn't anything particularly that stood out to me."
Messaging (Email)	Protector	"Because it was someone at the other end of the line you could ask a question to and get a response within a couple of days. You know, it felt like I had support…. it relieved the frustration that I was able to contact the asthma nurse and get some feedback and get an appointment with an asthma doctor"

A system level archetype basically represents a patient's overall view of the whole system. This view appeared to have been strongly influenced by function level PFA of the same archetype. For example, P126's system level comment *"... but I know what my asthma was like. I didn't need them to tell me I*

[13] Appendix 5 provides a list of representative quotes for the function and system levels of each category for all patients.

was in the yellow. I knew I was in the yellow", suggested that he viewed MAP as an Imposer. However, as can be seen in Table 2-4, the only function that acted like an imposer for P126 was "Alerts and Advice", while other functions either had no affordances or reflected the Protector or Inhibitor archetypes. Thus, for P126, alerts and advice (of the Asthma diagram) played a key role by strongly affecting his dominant, system level Imposer archetype, i.e., the Asthma diagram was an "instigating feature" that shaped P126's system level archetype. Instigating features for each patient are those that seemed to strongly influence each patient's system level archetype.

The data suggested that most patients viewed one of the four archetypes as dominant, and the dominant archetype eventually determined how they interacted with MAP. However, for two of the patients, two system level archetypes seemed to exist: P37 and P20 saw MAP as being both a Protector and a Facilitator. Figure 2-7 shows the distribution of the 16 patients into the four PFA archetypes.

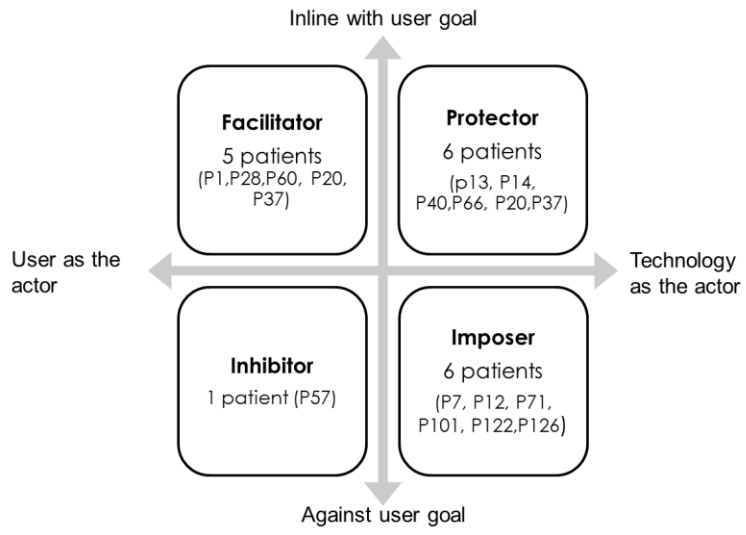


Figure 2-7. Distribution of Patients into PFA Archetypes

3.8.3. Extending PFAs: Who/What is the Source of Action

It is important to note that, past definitions of affordances have invariably viewed users as actors and the object (e.g. the IT artifact) as a thing that users act upon. For example, a door handle affords pulling (Norman 1988), i.e., users perceive themselves as actors who pull the door handle, or a group support system affords anonymous voting to a group of users (Markus and Silver 2008), i.e., users are actors who vote anonymously by using the group support system. Our analysis strongly suggests that people's perceptions of an IT's affordances go beyond existing definitions which only consider the user as the one who performs the action. As suggested by our analysis, in many cases, individuals tend to see the IT artifact as an actor as well (e.g. a health record system which provides feedback to its users). We believe that this is mainly due the fact that past research has not clearly distinguished between the IT artifact and other objects. From the perspective of many individuals, IT have the capability to perform actions on their own (even if they have been programmed to do so). Hence, users sometimes assign the source of actions to the IT artifact and perceive it as something that acts for or against their will. Such a characteristic is less likely to be seen in static objects, such as chairs or closets, given that they do not act or react automatically. This view is also consistent with social response theory (Moon 2000; Nass et al. 1997) according to which people tend to treat computers as social actors although they know that computers do not possess feelings or "selves".

Among the four identified archetypes, the Facilitator seems to reflect the dominant view of affordances in extant literature, as it assigns the source of actions to users. This archetype is also consistent with the idea of reflectivity and intentionality of human actors (Pickering, 1993). In this view, people with specific goals, desires or needs interact with IT materiality. Thus, they perceive the functionalities of an IT artifact based on what they plan to do with it or based on what they desire or need to do. According to Hutchby (2001), "people come to materiality with diverse goals, they perceive a technology as affording distinct possibilities for action" (cited in Leonardi 2011, p. 153). While the Inhibitor

archetype also assigns the source of action to the user, users are basically seen as incapable of performing their desired actions because the IT artifact inhibits them. Thus, the Inhibitor archetype can be viewed as reflecting the constraints of the IT artifact. In contrast to these two archetypes, the Protector and Imposer archetypes assign the source of the action to the IT artifact and represent PFA types that have not yet been considered in the affordance literature. There is also a related literature which partially informs the agency of artifacts. For example, Actor Network Theory (Latour 2005) assumes a "generalized symmetry" between humans and an object. It proposes a flat ontology where all actors and entities are placed at the same level of agency. In addition, Knappett and Malafouris (2008) also discuss material agency and emphasize what the material does to humans rather than how humans deal with things. The "Protector" and "Imposer" archetypes highlight the fact that individual users can perceive artifacts as agents who have free will to act in line with, or against their desires. The agency of the artifacts can be a real agency due to the automatized nature of IT or it can be a perceived agency, which might not be necessarily real. As such, our research aims to extend existing definitions of functional affordances by specifying "who/what is perceived as the source of action" by defining PFA as

Perceived possibilities of action provided by an IT artifact to an individual user who could view either herself or the IT artifact as undertaking such possibilities.

3.8.4. Identifying contrasting cases

As explained earlier, our research method relied on inductive theory building using multiple cases (Eisenhardt 1989). To do so, we categorized each patient according to his or her self-management performance (SMP) with the MAP portal. A comparison between high and low level SMP cases helped in our theory building effort. To identify contrasting cases (in terms of their SMP), we used the ministry's RAMQ data, the patients' self-management behavior, and the nurse's evaluation of patients' SMP.

RAMQ data: The Quebec provincial health insurance (RAMQ) database includes information about the medications prescribed by physicians to their asthma patients, the dispensed drugs, as well as patient emergency visits and hospitalization records. To assess the asthma SMP of each patient, we used the McGill health group asthma control score (Ahmed et al. 2011). According to Ahmed et al. (2011), asthma control can be evaluated by examining patient overuse of rescue fast acting bronchodilators (FABA) in the last six months, combined with the number of their hospital emergency visits for respiratory problems. The dosages of dispensed medication were calculated based on the quantities noted in the prescriptions recorded in RAMQ. A patient's asthma was considered to be out of control (OOC) if any of the following conditions applied, otherwise the patient's asthma was considered in control:

- The patient had one or more emergency room visits for respiratory problems in the 3 to 9 months before using the portal and in the 3 to 9 months after starting to use the portal. The RAMQ billing records were consulted to obtain asthma patients' emergency room visits for respiratory problems.

- The total FABA dispensed to the patient exceeded 500 doses in the 6 months before using MAP and 6 months after using MAP.

If a patient's asthma control score was OOC before and after using MAP, we concluded that MAP did not improve their SMP, i.e. the patient was categorized as a low SMP case. On the other hand, if the RAMQ data showed in control status before and after using the portal, we could not attribute the patient's SMP to MAP usage. In such cases we relied on other data sources to identify the patient's SMP level. For example, the asthma control score of P12 was "In control" before and after using MAP. Being in control in this case means the patient did not have any emergency visits to hospitals for respiratory problems and his FABA medication dosage was not above 500 either before or after using MAP. However, P12's SMP could not be assessed as high because he might have been controlling his asthma through means other than MAP. As we did not have

to any information to that effect, P12's SMP could not be linked to MAP usage.

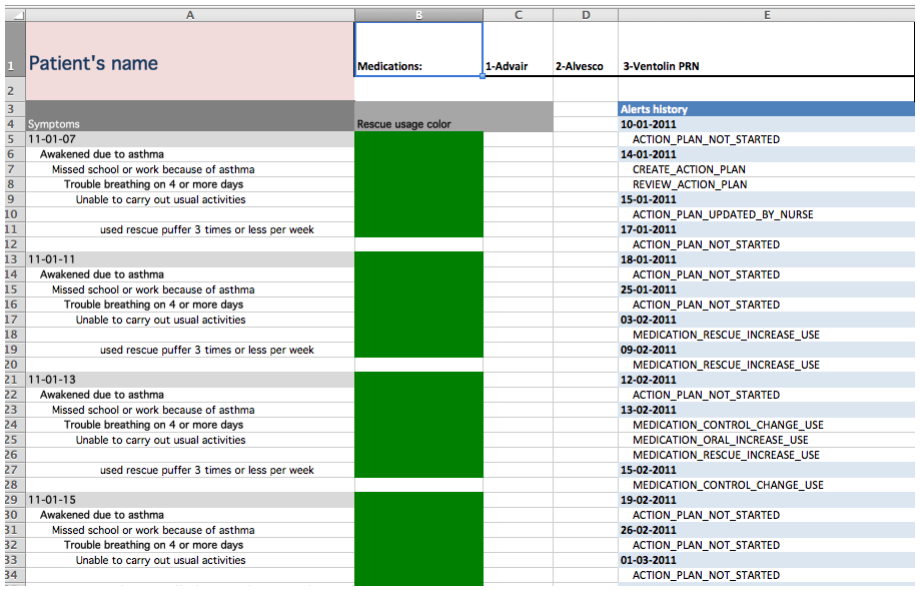
Asthma self-management behavior: In the interviews, patients were asked to describe their asthma self-management behaviors, with or without using MAP. We also consulted the emails they had exchanged with the nurse during the six months of their MAP usage. As the content and frequency of e-mail exchanges between the nurse and the patients could sometimes be useful in explaining their SM behavior, we categorized them into cases of low and high SMP. For example, when asked about her asthma self-management activities, P7 noted: "*I would ask my questions directly to [my doctor] … I would go on Google for searching information about asthma … My asthma pretty much manages itself by its own. So I don't need to do anything for it*." (P7). Thus, P7 was reluctant to self-manage her asthma, and when she needed support, she relied on sources other than MAP. Moreover, during the first week of her MAP usage, P7 exchanged several e-mails with the nurse, but after that, their communication became unidirectional, with the nurse trying to contact her, and P7 not even reading the nurse's messages (whether patients read their e-mails is also recorded in MAP's usage logs). The content of the nurse's messages also show that P7 did not properly update MAP.

The nurse's assessment of patients' SMP: At the end of the six-month usage period, we asked the nurse to assess how well each patient self-managed their asthma with MAP. To help the nurse evaluate the patients, upon her request, we extracted information from the usage logs of all 16 patients and presented them in tabular format using Excel pivot tables (Figure 2-8). This information included histories of patient symptoms, medication usage, and MAP alerts, and showed how patients used MAP to self-manage their asthma. As shown in Figure 2-9, the nurse also had access to patient records via MAP's "nurse interface".

As noted above, we determined each patient's overall SMP level based on data from three sources. Table 2-5 summarizes the asthma control status of patients before and after using MAP, their self-management behavior, and the nurse's evaluation of their SMP. RAMQ data for patients P1, P7, P20, P122, and

P126 were not available (indicated as NA in Table 2-5). Also, the nurse could not evaluate P7, P40, P57, P60, P66, P122, and P126 because of insufficient data which was due either to the fact that these patients had not systematically updated their profile or because the nurse thought the available data was unreliable (e.g., a patient who reported taking high levels of medication but not reporting any asthma symptoms).

In order to assign an overall SMP level to each patient, we consulted all three data sources: the patient's asthma control score before and after MAP usage, the nurse's evaluation, and the patient's SM behavior. As can be seen in Table 2-5, the nurse's SMP evaluation and the asthma self-management behavior of nine patients were consistent. The nurse was unable to assess the SMP of the remaining seven patients. The absence of nurse evaluation data can be interpreted as reflecting either patients who were not willing to update MAP, or as patients who entered incorrect information that rendered the data unreliable. Hence, the SMP level of these seven patients were categorized as low (because they did not use the portal to manage their asthma), which was also consistent with their self-management behavior. Moreover, for one patient (P40), all three data sources were consistent. Comparing our categorization and patients' SM behaviors provides further support for our categorization.



	A	B	C	D	E
1	Patient's name	Medications:	1-Advair	2-Alvesco	3-Ventolin PRN
2					
3					Alerts history
4	Symptoms	Rescue usage color			10-01-2011
5	11-01-07				ACTION_PLAN_NOT_STARTED
6	Awakened due to asthma				14-01-2011
7	Missed school or work because of asthma				CREATE_ACTION_PLAN
8	Trouble breathing on 4 or more days				REVIEW_ACTION_PLAN
9	Unable to carry out usual activities				15-01-2011
10					ACTION_PLAN_UPDATED_BY_NURSE
11	used rescue puffer 3 times or less per week				17-01-2011
12					ACTION_PLAN_NOT_STARTED
13	11-01-11				18-01-2011
14	Awakened due to asthma				ACTION_PLAN_NOT_STARTED
15	Missed school or work because of asthma				25-01-2011
16	Trouble breathing on 4 or more days				ACTION_PLAN_NOT_STARTED
17	Unable to carry out usual activities				03-02-2011
18					MEDICATION_RESCUE_INCREASE_USE
19	used rescue puffer 3 times or less per week				09-02-2011
20					MEDICATION_RESCUE_INCREASE_USE
21	11-01-13				12-02-2011
22	Awakened due to asthma				ACTION_PLAN_NOT_STARTED
23	Missed school or work because of asthma				13-02-2011
24	Trouble breathing on 4 or more days				MEDICATION_CONTROL_CHANGE_USE
25	Unable to carry out usual activities				MEDICATION_ORAL_INCREASE_USE
26					MEDICATION_RESCUE_INCREASE_USE
27	used rescue puffer 3 times or less per week				15-02-2011
28					MEDICATION_CONTROL_CHANGE_USE
29	11-01-15				19-02-2011
30	Awakened due to asthma				ACTION_PLAN_NOT_STARTED
31	Missed school or work because of asthma				26-02-2011
32	Trouble breathing on 4 or more days				ACTION_PLAN_NOT_STARTED
33	Unable to carry out usual activities				01-03-2011
34					ACTION_PLAN_NOT_STARTED

Figure 2-8. An example of data presented to the nurse for patient evaluation

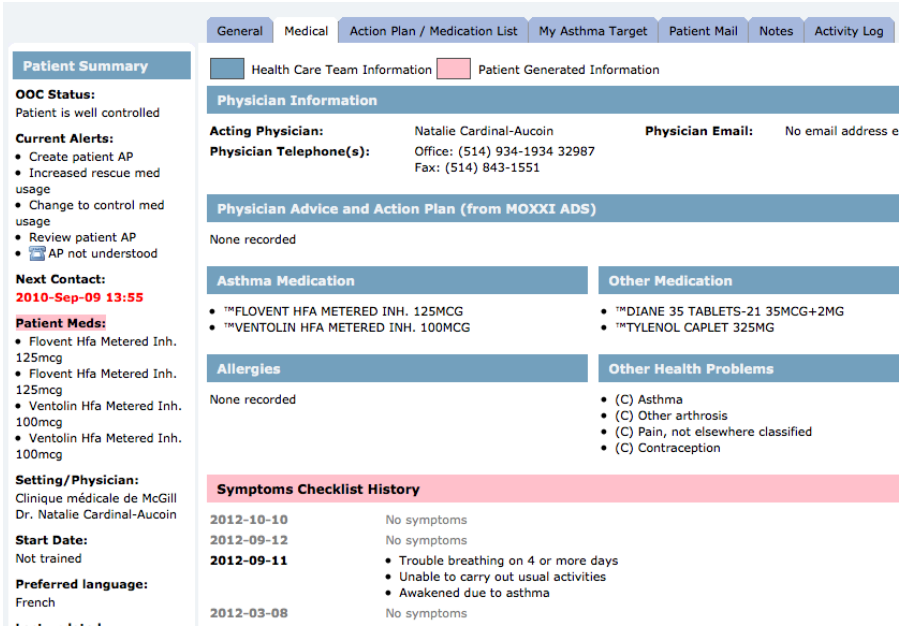


Figure 2-9. MAP's nurse interface

Table 2-5. Asthma self-management performance					
Patient	Control score before MAP usage (6m and 9m)	Control score after MAP usage (6m and 9m)	Nurse's evaluation of patient's SMP	Patient's self-management behavior (from interviews and e-mail exchanges)	Final SMP level
P1	NA	NA	High	P1 used the portal to analyze her symptoms: "I've been watching it and I noticed that even though I'm exercising and I'm eating okay ... this medication is still making me feel sick all the time"(P1) She was constantly in contact with the nurse and asked her many health related questions in her e-mails.	High
P7	NA	NA	Unable to evaluate	P7 did not mention any self-management behavior with MAP. Emails exchanged with the nurse showed P7 was not interested in communicating with the nurse and did not update her data properly.	Low
P12	In control	In control	Low	P12 did not mention any self-management behavior with MAP. He believed meditation, positive thinking and less medication was the best way to manage asthma. He had very limited communication with the nurse.	Low
P13	OOC	In control	High	"When I was using it [MAP], I was forcing myself to move more, and that was OK" (P13). P13 exchanged many e-mails with the nurse about asthma management. At times, their communication even got personal.	High

P14	In control	In control	Low	" [I manage my asthma] by my every three-four month visits to the Montreal Chest Institute and by following my regimen."(P14) There were frequent e-mail exchanges between the nurse and the patient. Although they all related to health issues, in none of the e-mails did the patient ask a question to solve a health related problem, or to get more information about asthma. Basically he only provided answers to the nurse's questions about his medication usage, or informed the nurse about the changes in his action plan.	Low
P20	NA	NA	High	P20 monitored his health status by using graphs. However, P20 did not have frequent e-mail exchanges with the nurse.	High
P28	In control	In control	High	P28 analyzed her health status by using MAP: *"There is an intellectual part there, where we link our physical conditions to the explanations. If you want … small and constant reminders"* (P 28) [Translated from French] P28 very frequently communicated with the nurse by e-mail. The content of the e-mails were related to health issues.	High
P37	In control	In control	High	P37 monitored his health status with MAP: *"It was interesting to be able to track and see when I compared medication use versus my physical activity and to be able to see the relationship on the chart…. it made me self-aware"*(P37) P37 had some communications with the nurse by e-mail. The content of the e-mails were related to health issues.	High

P40	OOC	OOC	Unable to evaluate	Based on the content of the e-mails exchanged with the nurse, it seems that P40 did not pay the necessary attention to updating his weekly symptoms and medications. The nurse wanted him to change some information on the portal that he did after many follow-ups from the nurse. However, he was interested in contacting the nurse after the study: "C*an I continue communicating with you about my health after the study? Like before, it has been very important to me"* [translated from French] (P40)	Low
P57	In control	In control	Unable to evaluate	P57 did not mention any self-management behavior with MAP. P57 also did not communicate with the nurse.	Low
P60	In control	In control	High	P60 explained that she acquired much information about asthma by using MAP. She also stated: "It helped me to gauge how much of the medication I needed". She did not forget to take her medications because of MAP. However, she exchanged only a few e-mails with the nurse.	High
P66	In control	In control	Unable to evaluate	P66 stated that she took her medications on time and exercised more due to MAP. However, the e-mails she exchanged with the nurse were mostly related to MAP's technical problems. In general, she was not very comfortable with computers.	High
P71	In control	In control	Low	P71 did not mention any self-management behavior with MAP. P71 exchanged only a few e-mails with the nurse.	Low

P101	In control	In control	Low	P101's self-management activities were independent of MAP "[To manage my asthma I] follow my doctor's advice, take my sprays in the morning, take my pills at night, and… if I didn't feel good, I go to the hospital"	Low
P122	NA	NA	Unable to evaluate	P122 did not mention any self-management behavior with MAP. The e-mails P122 sent to the nurse mostly contained complaints about MAP.	Low
P126	NA	NA	Unable to evaluate	P126 did not mention any SM behavior with MAP. The way he managed his asthma was via other methods: "The Shiatsu, the teas, the acupuncture…. Yeah, there's a homeopathic remedy that sometimes will work when nothing else will, to ease the asthma."	Low

Table 2-6 provides a listing of the high and low SMP patients that is the contrasting cases.

Table 2-6. Contrasting cases

Low SMP	**High SMP**
P7, P12, P14, P40, P57, P71, P101, P122, P126	P1, P13, P20, P28, P37, P60, P66

3.8.5. Analyzing Usage data

A key objective of this research is to show that similar usage patterns of the portal by different patients may not necessarily yield to similar health-management performance outcomes. To do so, we compared the usage patterns of contrasting cases for examples of similar usage patterns that resulted in contrasting outcomes, i.e. low vs. high self-management performance.

To show that similar usage patterns can lead to both high and low SMP,

we compared the usage patterns of contrasting SMP patients, e.g., P1 who was categorized as high MSP and P7 who was categorized as low SMP. We compared only patients that shared one or more similar instigating features. As discussed earlier, instigating features of a patient are those that shaped or strongly influenced their system level archetype. For example, both P1 and P7 had the same instigating features: asthma diagram and historical graphs (Table 2-7). That is, the asthma diagram and the historical graphs strongly influenced P1 and P7's overall perceptions of MAP. As can be seen in Table 2-5, while the actions afforded by the asthma diagram and the historical graphs appear to have shaped P1's overall view of MAP as a "facilitator", the same two features appear to have formed P7's overall perception of MAP as an "imposer". As instigating features can be considered to be the most influencing features for each patient, comparing the usage of similar instigating features for pairs of contrasting cases can provide a strong likelihood of observing cases with usage pattern similarity, but different SMP. Table 2-7 lists each patient's system level archetype and the MAP features that seemed to strongly influence them (i.e. instigating features).

Table 2-7. System level archetypes and their instigating feature

Patient	System level archetype	Instigating features
P1	Facilitator	Asthma diagram, Historical graphs
P20	Facilitator, Protector	Asthma questionnaire, Asthma diagram, Historical graphs
P28	Facilitator	Asthma diagram, E-Mail
P60	Facilitator	Asthma questionnaire, Asthma diagram, Historical graphs, Information page
P57	Inhibitor	Asthma questionnaire, Asthma diagram
P7	Imposer	Asthma diagram, Historical graphs
P12	Imposer	Asthma diagram, Historical graphs
P71	Imposer	Asthma questionnaire
P101	Imposer	E-Mail, Asthma diagram

P122	Imposer	Asthma diagram
P126	Imposer	Asthma diagram
P14	Protector	Asthma questionnaire
P13	Protector	Asthma questionnaire, Asthma diagram
P66	Protector	Asthma diagram
P37	Protector, Facilitator	Asthma questionnaire (Protector), Historical graphs (Facilitator)
P40	Protector	Asthma diagram, E-Mail

To compare all contrasting cases that share similar instigating features, we first created pairs from all possible combinations, pairing the nine low SMP cases with the 7 high SMP cases, yielding 63 contrasting pairs. Then, from among the 63 pairs, we selected 11 that had similar instigating features. Next, we compared the usage patterns of each pair via t-tests and Pearson correlations.

The t-tests helped examine whether different patients' usage of a feature was similar or different. The independent-samples t-test compares the means between two unrelated sets of data on the same variable. Here, the unrelated sets are the MAP usage of each of the 11 pairs over 24 weeks (i.e. N = 24). We assume that each patient's weekly usage frequency of a feature is a sample drawn from his or her lifetime usage of MAP, and that it meets the assumptions required for an independent t-test: 1) there is no relationship between the observations of each pair, i.e., patients' weekly usage frequencies of each feature are independent; 2) the number of times each feature was weekly used by a patient is randomly drawn from a normally distributed population, i.e. each patient's life-time usage of a feature.

For example, in order to compare Diagram/Graphs usages of P1 and P7, we relied on the number of times they each visited the Diagram/Graph page each week. As shown in Table 2-8, since the usage period was 24 weeks, we had 24 observations per patient.

Table 2-8. Usage frequency of Diagram/Graphs for P1 and P7		
Weeks	Frequency of visiting Diagram/Graphs for P1	Frequency of visiting Diagram/Graphs for P7
Week 1	10	11
Week 2	1	6
Week 3	3	1
Week 4	2	1
Week 5	1	2
Week 6	2	3
Week 7	4	1
Week 8	1	1
Week 9	0	1
Week 10	0	1
Week 11	4	1
Week 12	0	2
Week 13	0	1
Week 14	0	2
Week 15	4	3
Week 16	3	2
Week 17	4	1
Week 18	2	2
Week 19	2	0
Week 20	1	0

Week 21	0	2
Week 22	1	1
Week 23	0	0
Week 24	1	2

The data was analyzed with SPSS Statistics version 17.0. We rejected the null hypothesis (H0: there is no difference between the mean number of weekly usage of a feature in a given pair) with $p<0.05$. As shown in Table 2-9, the results indicate that the asthma diagram/graph[14] usages of the following pairs were not significantly different within each pair: P1 & P7, P1 & P12, P1 & P122, P28 & P40, P7 & P66, P12 & P66, P122 & P66, P126 & P66, P57 & P13. Also, the number of questionnaire updates was not significantly different for P57 & P13. Moreover, the number e-mails sent by P28 & P40, and the number of e-mails received by P28 & P40 were also not significantly different from each other.

Table 2-9. T-test results

Patients	Feature	t value (N=24)	P value	Result
P1-P7	Diagram/ Graphs	- 0.64	.950	No significant difference
P1-P12	Diagram/ Graphs	1.030	.309	No significant difference
P1-P122	Diagram/ Graphs	- .104	.918	No significant difference
P1-P126	Diagram/ Graphs	2.564	.014	Significant difference
P28-P40	Diagram/ Graphs	.909	.368	No significant difference

[14] As the asthma diagram and historical graphs both appear on the same page of MAP, their usage level was recorded as a single number.

	E-Mail sent	1.082	.285	No significant difference
	E-Mail received	1.127	.266	No significant difference
P7-P66	Diagram/Graphs	1.407	.166	No significant difference
P12-P66	Diagram/Graphs	.298	.767	No significant difference
P122-P66	Diagram/Graphs	1.116	.270	No significant difference
P20-P57	Diagram/Graphs	4.377	.000	Significant difference
	Questionnaire	4.432	.000	Significant difference
P13- P57	Diagram/Graphs	1.591	.118	No significant difference
	Questionnaire	1.538	.131	No significant difference
P126- P66	Diagram/Graphs	-1.777	.082	No significant difference

We also examined the significance of the Pearson correlations between the usage patterns of the above 11 pairs. We interpreted a significant correlation between two patients' weekly usage of a feature as evidence of similarity in their usage patterns. As shown in Table 2-10, significant positive correlations were observed between the usage patterns of P1 & P7, P1 & P12, P1 & P122, P28 & P40 (except for the e-mails received), and P7 & P66. In sum, each of these patient pairs appears to have used MAP similarly.

Table 2-10. Correlation results

Cases	Features	r	P value	Result
P1-P7	Diagram/ Graphs	.650	.001	Significant +

P1-P12	Diagram/ Graphs	.672	.000	Significant +
P1-P122	Diagram/ Graphs	.633	.001	Significant +
P1-P126	Diagram/ Graphs	.079	.713	Not Significant
P28-P40	Diagram/ Graphs	.722	.000	Significant +
	E-Mails sent	.709	.000	Significant +
	E-Mails received	.319	.129	Not Significant
P7-P66	Diagram/Graphs	.488	.015	Significant +
P12-P66	Diagram/Graphs	.284	.179	Not Significant
P122-P66	Diagram/Graphs	.268	.205	Not Significant
P20-P57	Diagram/Graphs	.104	.628	Not Significant
	Questionnaire	-.345	.099	Not Significant
P13-P57	Diagram/Graphs	.840	.043	Significant +
	Questionnaire	.261	.218	Not Significant
P126- P66	Diagram/Graphs	-.312	.137	Not Significant

As shown in Table 2-11, the t-test and Pearson correlation results show that, despite using MAP in similar ways, some patients achieved different outcomes in terms of their asthma self-management. Hence, it is reasonable to think that factors other than MAP usage may have influenced these different outcomes. As shown in Table 2-11, patients with similar usage patterns, but with different SMPs also perceived MAP's affordances differently. In the next section we discuss how PFA archetypes can be useful in explaining this phenomenon.

Table 2-11. An example of patients who used MAP similarly but achieved different outcomes[15]

High SMP case	Low SMP case	PFA archetype	Similarity of usage patterns based on both t-test and Pearson correlation
P1	P7	Facilitator (P1), Imposer (P7)	Similar usage of Diagram/Graphs

[15] Since we selected only pairs of cases that had similar instigating features, this table includes only a subset of all possible contrasting cases with similar usage patterns. It is important to note that, by analyzing contrasting cases that had different instigating features, it might be possible to find other cases with similar usage patterns and different outcomes. For example, P66 could be compared with P71, in terms of both asthma questionnaire usage and asthma diagram usage.

P1	P12	Facilitator (P1), Imposer (P12)	Similar usage of Diagram/Graphs
P1	P122	Facilitator (P1), Imposer (P112)	Similar usage of Diagram/Graphs
P28	P 40	Facilitator (28), Protector (P40)	Similar usage of Diagram/Graphs, and E-mails sent
P66	P7	Protector (P66), Imposer (P7)	Similar usage of Diagram/Graphs
P13	P57	Protector (P13), Inhibitor (P57)	Similar usage of Diagram/Graphs

3.8.6. Theory Development: The Influence of PFA Archetypes on IT Usage and Outcomes

To answer our primary research question, i.e., how and under what conditions the usage of a self-management portal leads to high (vs. low) self-management performance, we followed Eisenhardt's (1989) approach by first categorizing our cases as low or high in terms of asthma self-management, then by comparing patients with high levels of self-management performance to patients with low levels of self-management performance (measured after using the portal for 6-months). To do so, we synthesized the interview transcripts and the usage data into individual case histories. These histories included narrative, selected quotes from the patients, as well as tables that summarized their portal usage, performance, and other key facts. We also created a table to summarize the usage, SMP, and PFAs of each patient. This provided a general view of the cases, and helped us compare them to generate a theory. The case histories were used for both within-case and cross-case analyses (Miles and Huberman 1994).

A first analysis of contrasting SMP pairs with similar usage patterns suggested that patients' perceptions about MAP's affordances could explain why their SMPs were different. As shown in Table 2-11, patients with similar usage patterns, but with different SMPs also perceived MAP's affordances differently. To further explore this idea, we compared the cases that shared similar archetypes. Below we discuss each archetype and its influence on the patients'

MAP usage and SMP.

Facilitator

While patients P1, P28, and P60 perceived MAP as a Facilitator, P20 and P37 saw it as a Facilitator and a Protector. All of them had a positive attitude towards MAP, and were willing to continue using it if such an opportunity was available. For example, P1 stated "*I liked the Portal a lot because it gave me a way to not only understand the asthma better, but it gave me resources with which to manage it and without it, it's just me at home trying to scramble around, do my best and keep an eye on the asthma."*(P1). Moreover, all the five patients had high levels of SMP. Also, most of them used MAP frequently, as can be seen for P28 in Figure 2-10. She logged into the portal almost every week.

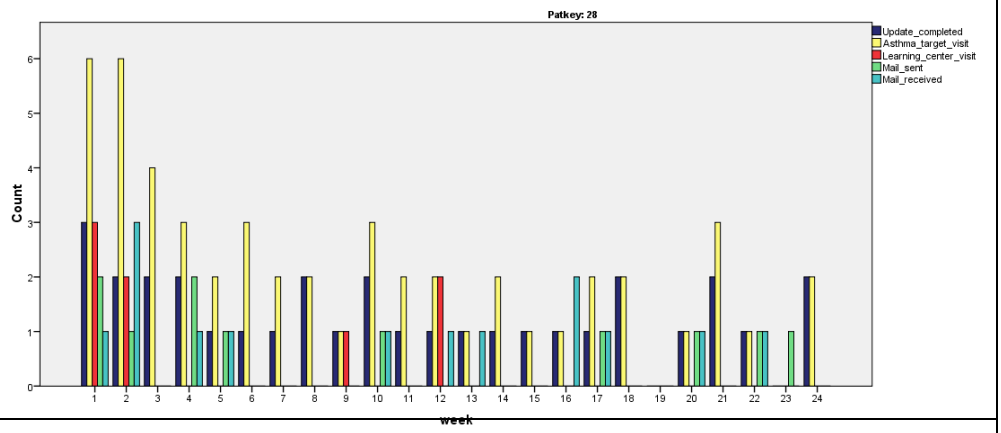


Figure 2-10. MAP usage pattern (P28)

The analysis of the interview transcripts revealed that the patients who perceived MAP as a Facilitator seemed to feel very responsible for their asthma self-management. For example, P28 stated: *« This is not the physician who treats you. It is not him who cures you like a spirit or priest … You are also responsible for your health, to take care of it »* All patients in this group used MAP for managing their asthma and saw themselves as actors. Perceiving the portal as a

Facilitator conveys the message that the patient is willing to take responsibility for managing her/his asthma. It is important to note that, patients often play a very important role in managing chronic diseases like asthma: "The patient should be an active partner, applying his or her knowledge continuously to the care process … the patient's success in meeting the responsibilities will determine the outcome for the patient" (Holman and Lorig 2004, p. 119). Therefore, we can assume that patients who see the portal as a facilitator are likely to use it to manage their asthma, and as a consequence achieve high SMP. Hence, we suggest *Proposition 1:*

P1: Usage of a health self-management IT will be likely to yield high self-management performance when users perceive the IT artifact essentially as a "Facilitator".

Imposer

Patients P7, P12, P71, P101, P122, and P126 perceived MAP as an Imposer and their attitude towards MAP was generally negative. For example, P7 stated: *"I don't think it helped that much, it just reminded me of, oh you have to do this"*. While they all had a low level of asthma self-management with MAP, they also had different usage patterns, with some of them using MAP frequently (e.g. P7), and others using it little or even trying to stop using it (e.g. P71). It is interesting to note that P7 was a nurse who thought she had a good knowledge about asthma: *"... for managing my asthma this wouldn't be the right tool because I know pretty much how to deal with it."* However, she had also been denying her asthma for many years, "… I didn't want to face it. I was in denial the whole time." She perceived MAP as an Imposer in that she tended to see it as an actor that reminded her about her disease: *"... since I don't consider myself*

sick … I don't see the necessity in it" However, she felt responsible for regularly logging to MAP to enter her information and to also check her asthma graphs and diagrams (Figure 2-11). Despite her almost frequent usage of MAP, the portal could not help her manage her asthma.

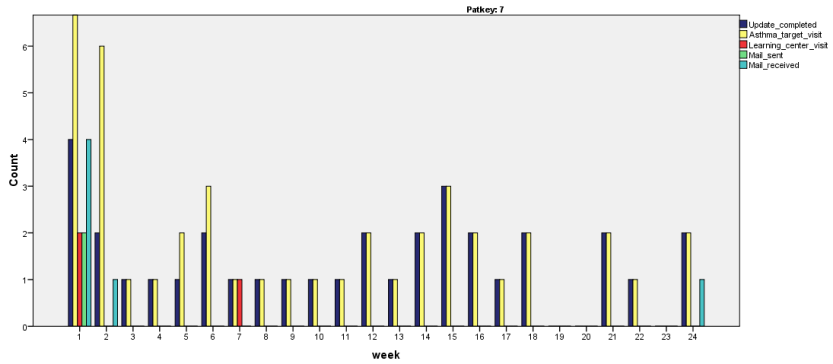


Figure 2-11. MAP usage pattern (P7)

Patient P71 was a nurse as well. Like P7, she too believed that she knew about asthma: *"I'm a nurse so I know about asthma, I know what I need to do, I know what triggers it, I know what helps it."(*P71) However, she did not manage her asthma well. She was a smoker and perceived MAP as an Imposer who created in her feelings of guilt: "… it [MAP] would trigger something in me, guilt for being a nurse being a smoker." Reacting to this image, she did not regularly log in to MAP (Figure 2-12).

In general when patients perceived MAP as an imposer, they tended to see it as an actor that acted against their will. Although they might have used the portal because of a sense of responsibility, they all had low SMP. Hence, we suggest *Proposition 2:*

P2: Usage of a health self-management IT will be likely to yield low self-management performance when users perceive the IT artifact essentially as an "Imposer".

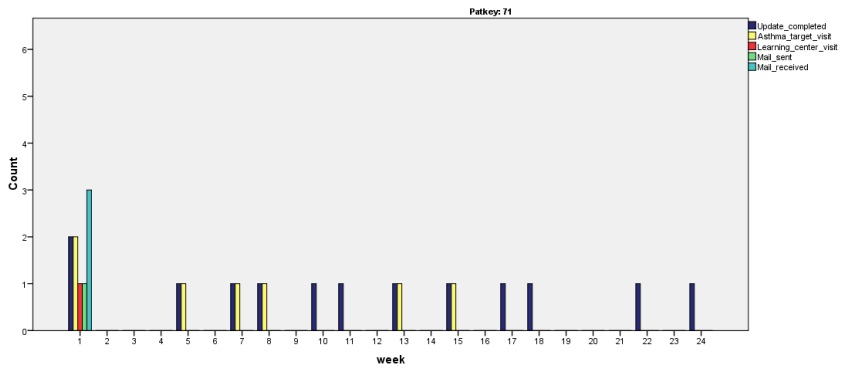


Figure 2-12. MAP usage pattern (P71)

Inhibitor

Patient P57 was the only one who perceived MAP as an Inhibitor which did not provide her the affordances she wanted. She thought the nurse would regularly provide feedback on her health status, but this was not the case: *"I thought this was going to be a little bit more present in a way but it turned out it's just like if you need her [the nurse] you go, but I had kind of the feeling that the nurse would give you feedback on what you would put in every week and there wasn't really that feature."* Moreover, she also thought that MAP was not very usable: "*Portal did not work with the most recent version of Internet Explorer for example so I had to keep my work computer on the older version so that I could complete the study because at home it would not work like I wouldn't be able to complete the form or it would take like 25 minutes to log in onto the thing, which was a problem."* Her attitude towards MAP was negative as she felt that it could

not provide her the support she had expected: *"I think because I didn't feel this helped me a lot to manage my asthma, I would not have continued using it even after the study was finished, I think*." As shown in Figure 2-13, she was regularly using MAP for a while, but then stopped using it. While she seemed responsible in managing her asthma, she did not use MAP to do so. Hence, we suggest *Proposition 3:*

P3: Usage of a health self-management IT will be likely to yield low self-management performance when users perceive the IT artifact essentially as an "Inhibitor".

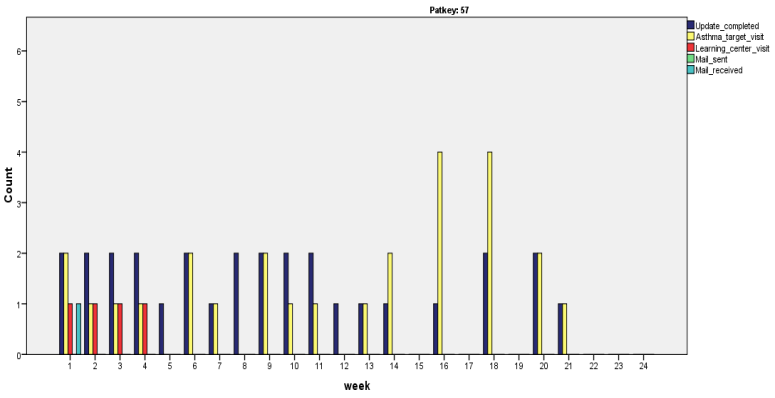


Figure 2-13. MAP usage pattern (P57)

Protector

Patients P13, P14, P40, and P66 perceived MAP as a Protector, with P20 and P37 perceiving it as both a Protector and a Facilitator. In general they all had very positive attitudes towards MAP. For example, they expressed their interest in MAP by saying *"I found it very pleasant"* (P40) or "*Many thanks for linking me up to this program! I love it!"* (P20). Most of the patients who perceived MAP as a Protector used it frequently. Some of them also were interested in continuing

to use it if given a chance to do so. Although they all had positive attitudes towards MAP and most of them frequently used it, they did not all achieve high levels of SMP: P13, P20, P37, and P66 had high SMP, but P14 and P40 had low SMP.

P13 perceived MAP as a protector and tended to do well in her asthma self-management. She said that she was a very busy person but that MAP had helped her to think more about herself and take care of her asthma: *"... it was making me touch, always be in touch with my real situation and knowing that, ok, no, I really don't feel well; I have to take care of this now… it kind of pushed me to walk. Usually, I'm sitting all day long. I don't go out so often. So with MAP, actually, I was moving much more" (P13).*

P14 also perceived MAP as a "Protector" but tended to do poorly in his asthma self-management. He used MAP mainly to e-mail the nurse and update his health status. He basically never checked his asthma diagrams and graphs[16] (Figure 2-14). When asked about MAP's affordances, he stated that it reminded him to take his medication, and monitored his inputs. In his view, MAP was the initiator of actions and he was the responder. He also wanted to provide accurate information to MAP because he wanted "the people who are looking after [him] to know as much about [him] as they need to know" (P14). Contrary to our expectations, his SMP was low, despite having a positive attitude towards MAP and using it frequently.

[16] Yellow bars represent the usage of asthma diagrams and graphs.

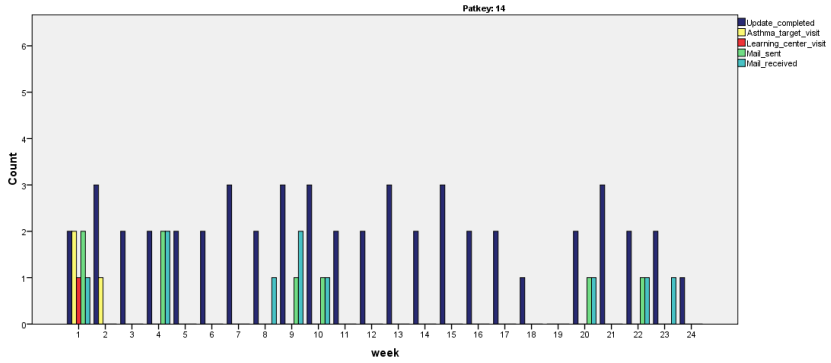


Figure 2-14. MAP usage pattern (P14)

Although both P13 and P14 perceived MAP as a Protector, the way they reacted to this image was different. P13 seemed to respond actively to this image and took responsibility of her disease. She perceived MAP as the actor, but instead saw it as some kind of teacher who told her what to do, which then she did. For example, she noted: *"... as you're at school and your teacher's telling you, "Do your homework. You have to do this!" Otherwise, you would not do it."* Then, she followed MAP's advice: *"... it kind of pushed me to walk. Usually, I'm sitting all day long. I don't go out so often. So with MAP, actually, I was moving much more." (P13)*

On the other hand, P14 acted in a passive way and expected MAP or the health care team behind it to take care of him: *"... it's like somebody is looking in on you. It's like when you're sick and you're a kid and your mother comes to look in on you. She's not going to make you any better, but if she looks in on you at night before you go to sleep you feel better. So someone's looking in. That's what I feel." (P14).* Referring to MAP, he also noted that it was like someone who was monitoring him: "… *somebody is actually watching and taking care to monitor what I'm feeding in. So if I'm feeding in information that goes outside of my*

personal profile, someone's going to pick up on it." This can also be observed in his usage pattern. As shown in Figure 2-14, he regularly provided information to the health care team (as shown by the blue bars), but never checked the portal's feedback about his health status (as shown by the yellow bars).

The above observations suggest that the Protector archetype could be sub-divided into Protector-coach (e.g. P13) and Protector-mom (e.g. P14). In the Protector-coach sub-archetype, patients saw MAP as an actor who expects them to react by being an active participant in their own self-management. However, in the Protector-mom sub-archetype, the patients' perceptions of MAP's capabilities were aligned with their desires and goals, and MAP was perceived as an actor who does not expect any reactions from them. So basically they perceived MAP as an actor that did some things for them which they liked, approved, or appreciated, and saw themselves as passive participants in their own self-management. As such, a plausible explanation of why the SMPs of P13 and P14 differed may be because of their participation in self-management. As noted above, patients' active participation in their treatment process is usually the key to successfully managing chronic diseases. P14 who perceived MAP as a Protector-mom may have been too dependent on the health care providers, and may not have actively managed his asthma, whereas P13 who saw MAP as Protector-coach took responsibility and actively managed his asthma. In sum, the key difference between these two sub-archetypes of the Protector archetype occurred in how the patients responded to the actor, i.e., MAP: while those who viewed it as Protector-mom (i.e. P14 and P40) remained unengaged in their own treatment, those who viewed it as Protector-coach (i.e. P13, P20, P37, and P66) undertook some type of action regarding their asthma and followed the advice they were given.

Hence, we suggest *Propositions 4 and 5:*

P4: Usage of a health self-management IT will be likely to yield low self-management performance when users perceive the IT artifact essentially as a

"Protector-mom".

P5: Usage of a health self-management IT will be likely to yield high self-management performance when users perceive the IT artifact essentially as a "Protector-coach".

Hybrid archetypes

Patients P20 and P37 perceived the portal both as Facilitator and Protector-coach and had very positive attitudes towards MAP. For example, P20 expressed his interest by saying *"The portal definitely helped me to keep my asthma under control… Yeah, it gave me the incentive to get out there for a walk…to pass on the information to you people... to alter things".* Also, both P20 and P37 tended to do well in their asthma self-management. As shown in Figures 2-15 and 2-16, they used MAP frequently and regularly, and were also very keen to continue to use it.

Compared to the other 14 patients, P20 and P37 had the highest frequency of usage. This can be explained by the fact that they perceived MAP as a hybrid archetype, which in turn is likely to be due to the combined effects of the Facilitator and Protector-coach archetypes, both of which seem to result in desirable outcomes. The fact that both P20 and P37 were very active participants in their health management while also perceiving MAP as a coach who guided them through this process suggests such a combined effect as being an important factor for these patients' high frequency of MAP usage. This hybrid archetype was the only one we could observe among the 16 patients; however other combinations might theoretically exist.

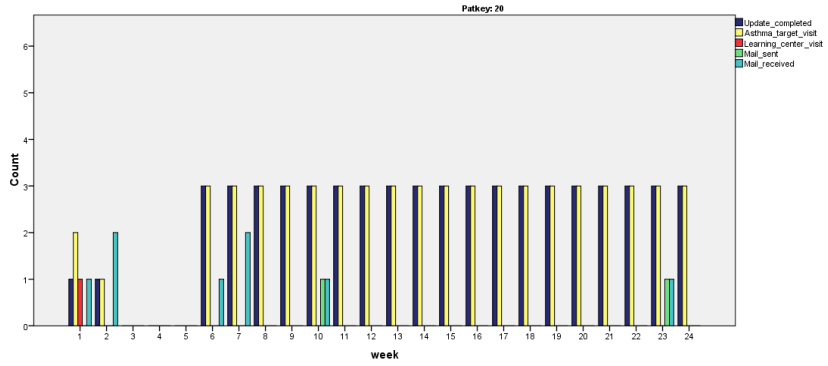


Figure 2-15. MAP usage pattern (P20)

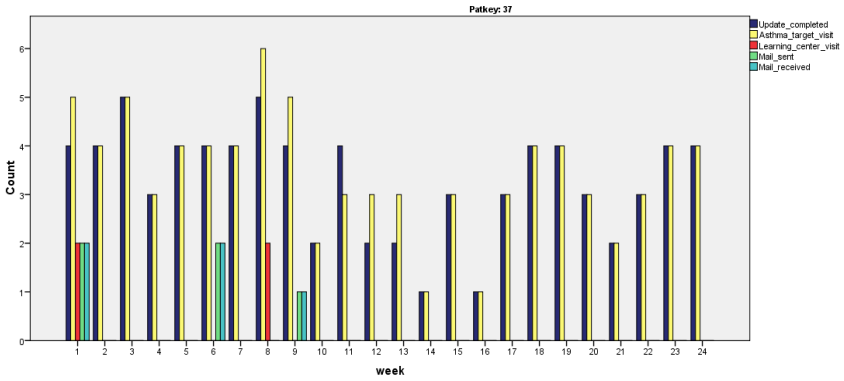


Figure 2-16. MAP usage pattern (P37)

3.9. Discussion and Conclusions

Based on an affordance perspective we investigated how usage of an asthma self-management system can lead to its desirable outcome. An inductive analysis of interviews we conducted with patients who used such a system for six months suggested a need for extending existing definitions of affordances.

Current conceptualizations of affordances tend to view users as actors and the object (e.g. the IT artifact) as a thing that users act upon. In addition, past research has not clearly distinguished between the IT artifact and other objects. Because IT can have embedded intelligence and a capability to perform actions on their own, users can at times view the IT artifact as a source of actions and perceive it as something that acts for or against their own will. Such a characteristic is less likely to be seen in static objects, such as chairs or closets, given that they do not act or react automatically. As such, a first contribution of this research is to extend current definitions of affordances by specifying "who/what is perceived as the source of action" and by defining the construct of perceived functional affordances (PFA) as "*perceived possibilities of action provided by an IT artifact to an individual user who could view either herself or the IT artifact as undertaking such possibilities*." As the tendency of new IT, such as wearable computers, software agents, and chips in everyday gadgets, is to increasingly embed intelligence, this extended conceptualization can provide a more powerful lens with which we can better study and understand IT usage and its effects.

A second contribution of the present study is the proposed categorization of PFA: Facilitator, Imposer, Inhibitor, and Protector (Coach and Mom). While the four archetypes that emerged in this research stemmed from a healthcare context, we think that they are likely to apply well to other contexts of human-IT interactions. For example, the four types can be applied to users' perceptions of social media such as Facebook: a user can perceive Facebook primarily as a tool that allows communication with friends (Facilitator), threatens one's privacy by stealing their private information (Imposer), provides emotional support (Protector), or prevents one from logging to someone else's page without knowing that person's password (Inhibitor). As such, the four types can help explain why users might continue using an IT, why they discontinue its usage, or why they create workarounds to reach their goals. While the four types can be observed in other IT, their importance and their effects might be different. For

example, given the importance of active patient participation in health self-management and the role of health care teams in providing care and emotional support, the roles of Facilitator and Protector-mom are likely to be more salient in health care settings. However, for other IT, such as social media and online games, the four types could play different roles in contributing to desirable outcomes which may depend on the characteristics of the IT in question, as well as the users' reactions to the affordance archetypes, suggesting interesting avenues for future research.

A third contribution of this study can be found in its use of the four archetypes to explain the self-management performance in a health-care context. We used these archetypes to explain how perceived affordances influenced the way patients used a self-management portal, and to show that PFAs played a key role in determining whether or not their usage led to desirable outcomes. Our analysis showed that in a self-management context, patients who viewed the IT as a Facilitator or a Protector-coach used the portal more and their self-management performance was high. Interestingly, we also found that not all patients who used the portal often achieved a high level of self-management performance. For example, a patient who viewed the portal mostly as a Protector-mom was using it frequently, but was also not taking responsibility in self-controlling his disease. Our findings suggest that the effects of IT usage in the studied context depended not only on the patients' amount of usage, but also on how they perceived the IT's affordances. While this finding may not be generalizable to all types of IT, i.e. not all IT that are perceived as a Protector-mom may result in undesirable outcomes, the role of PFA archetypes in determining usage outcomes can provide a useful lens with which to examine human-IT interactions in contexts other than health care as well.

It is also important to note that our study benefited from having access to a complete and unique data set which enables us to examine different concepts from multiple perspectives. For example, patients' self-management performance

was assessed with data from three data sources (patient interviews, nurse interview, and RAMQ data) which enabled us to triangulate our observations and strengthen the validity of our conclusions. Moreover, being able to access the patients' usage logs of provided us the opportunity to more clearly observe how perceived affordances and real actions were inter-related. To our knowledge, this is the first study that has examined affordances and objectively measured usage data together.

Some limitations of the present study need to be acknowledged. The present study only focused on perceived functional affordances, and did not examine affordances that might not have been perceived by the patients. As argued earlier, this was based on the idea that users only actualize those affordances they perceive. However, in some cases, hidden affordances that are not perceived by a user might exist, and such affordances can at times be actualized accidentally or unconsciously. For example, some users may not be aware that a specific icon on their smartphone can change the phone's security setting. Thus, they might accidentally activate or deactivate the setting, without being aware or perceive its existence. If users do not eventually become aware of the outcomes of such affordance actualizations (e.g. by a virus corrupting or deleting data on their smartphone), then those affordances could stay hidden from them for a while (or forever). It can be argued that such hidden affordances might influence the outcomes of using an IT, and that they would be difficult to identify via interviews. While this may happen, we believe that it would occur fairly infrequently, as users will eventually become aware of most hidden affordances that have been actualized accidentally. As such, they will become perceived after actualization, and can be captured during interviews, if these interviews are conducted after a reasonable time has elapsed since the start of usage. If an affordance becomes actualized without being eventually perceived, then it will not be captured through interviews, which would require direct observation of users during their usage period.

Moreover, MAP usage was part of a study conducted by the McGill Clinical and Health Informatics research group to test the viability of asthma self-management systems, and the patients were to use MAP for a limited period (i.e. six months). Knowing that its usage would be temporary might have affected how the patients viewed MAP and their usage. Another limitation is due to the fact that we had no control over how many patients were included in the McGill study and how they were selected.

3.9.1. Future research

For future research, it would be interesting to investigate how each archetype is formed and what factors influence this process. For example, future studies could investigate what IT characteristics influence the formation of different PFA archetypes. Such research could help designers develop IT that promotes the archetypes thought to lead to desirable outcomes, as well as preventing the formation of archetypes that hinder the achievement of desirable outcomes. For example, the authoritative messages of the asthma diagram page in Figure 2-3 suggests that MAP's current user-interface could promote the perception among patients that MAP is an Imposer (e.g., the "advice from the health care team" section of this page includes the following message to patients who do not take their medications properly: "Remember, it's important to use your controller medication every day"). It is possible that revising the above text with a softer and friendlier tone might reduce the likelihood that patients will perceive MAP as an imposer. Similarly, investigating the design characteristics of other IT and how they might influence the formation of each archetype can yield useful design guidelines that can help designers improve the user experience, and eventually help users achieve more desirable outcomes.

The present study also inductively developed several propositions linking the portal's usage to self-management performance. It would be interesting to test these propositions in similar health care contexts to test the generalizability of the present study's findings. It would also be interesting to extend the present study

by observing additional cases to see if other hybrid archetypes than the one observed here actually exist and what their effects may be.

Another future research possibility might be to investigate how users' perceptions of IT affordances change during the usage period. Given the cross sectional nature of our interviews, we could only investigate how MAP's affordances were perceived after the six-month usage period. However, it is possible that users' perceptions of IT affordances may change over time. As such, it would be useful to undertake longitudinal studies to observe the changes that might happen to users' perceptions of affordances and their effects on usage patterns.

In conclusion, the proposed conceptualization of affordances provides a very powerful lens to study human-IT interactions. The new conceptualization emphasizes on the role of IT as an actor that has been overlooked in previous conceptualizations of affordances. Moreover, the four archetypes that emerged in this research are likely to help researchers gain a better understanding of IT usage and IT effects.

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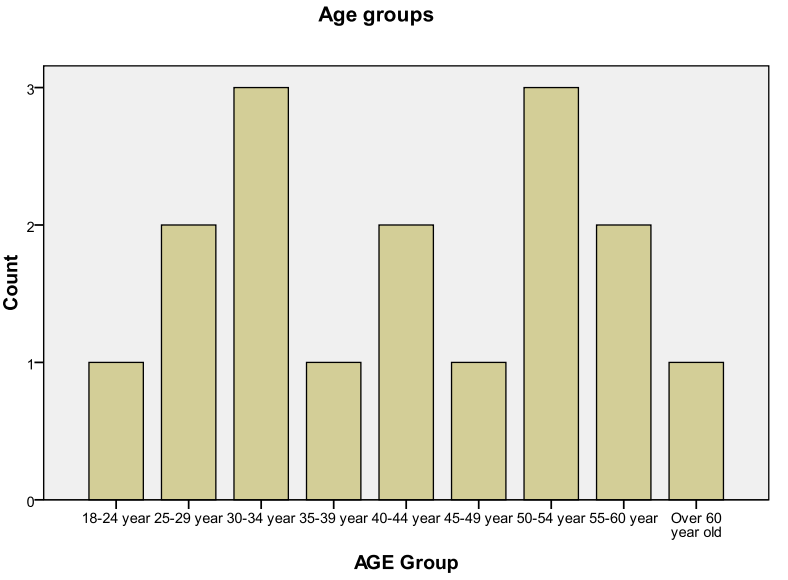
3.11. Appendices

3.11.1. Appendix 1- Demographic information

Number of female patients	**10**
Number of male patients	**6**
Average age range	**40-44**
Average age of asthma diagnosis	**23**



3.11.2. Appendix 2- Interview protocol (patients)

Users' general experience about their usage

- First I am interested to know about your experience of using the portal.
  How did you find it?
    - Can you tell me about the difficulties you might had during usage?
    - Can you think of any unexpected experience that you had during your usage? If yes, can you explain what happened?
    - [Look at the usage logs, ask them about the reason behind any unusual usage (very low and very high usage)]

Perceptions of users about the portal capabilities and constraints

- In general, what do you think of the portal capabilities?
- In general, what do you think of the portal limitations?

The respondent's activities on the portal

The interviewer presents the portal's screenshots print outs to the participants, or
The interviewer will log in to the portal and will let the respondents access the portal. This will help them to remind themselves about the portal features and their functionalities.

- Being more specific about your usage of the portal, can you please tell me about what you were generally doing on the portal?
    - How you were doing each of them? Can you show me how?
    - How each of them was useful to you?
- What else could you have done with the portal that you did not do?

▪ Why you were not using those functionalities? o Are there any functionalities of the system that you might not had liked to use? Why? o Is there any other functionality that you would have liked to exist on the portal, but which it does not exist? ▪ Why such functionalities are important for you? o Which features of the portal did you use the most? o Which features of the portal did you use the least? *****Other info. (if not already provided by the participant): o Communicating with the nurse o Learning center o Graphs o Action plan o Asthma target
Users' expectations
- Before using the portal, how did you picture the portal functionalities in your mind? - To what extent was the portal what you expected to be?
Users' overall motivations- continued usage
- What in general motivated you to use the portal? - If you had a chance to continue using the portal, would you do it? Why?
Asthma self-management with and without the portal
- How did you manage your asthma before using the portal? o Exercising?

o Taking medications? o Communicate with your nurse and doctor? o Look for information? o Coping with emotional problems? - Since you started using the portal, what changes do you see in the way you manage your asthma as a result of using the portal? What has changed in your daily life? o Exercising? o Taking medications? o Communicate with your nurse and doctor? o Look for information? o Coping with emotional problems?
The help that the participants receive from their hospitals
- How much help do you receive from your health care team? Do you have an easy access to your doctor and nurses?
Social influence
- What did your family and friends think about the portal?
Computer Self efficacy- portal quality
• How would you evaluate the quality of the portal? [Ease of use- features- design] • How comfortable do you feel using the computers in general? What about this portal?
Other
Is there anything else you would like to add in terms of your experience with the portal?

3.11.3. Appendix 3- Interview protocol (nurse)

1- I am interested to know about your experience of interacting with participants through the portal. How would you characterize it?

a- Can you tell me about the difficulties you might have had during the project?

b- How did you help them better manage their asthma?

c- Was the portal the only communication tool between you and the participants?

2- How did you evaluate if a participant well controlled his/her asthma?

a- What measures did you use?

b- Could the portal provide you with all the required measures to evaluate a patient's condition? What other measures could help you better evaluate their condition?

c- How did you react in case of problems?

3- In your view, what type of asthma patients can benefit from the portal? What type of asthma patients cannot benefit from the portal? Why?

a- Can you think of any participants who were doing very bad in case of self-management and after using the portal for a while improved their skills?

b- Is it possible that they get dependent on the portal? How?

4- I will provide you with a list of participants who were in the study; can you indicate how well they overall were managing their asthma through the portal? You can login to the portal if you like.

5- How did you find the portal's interface design?

a- Is there any other feature that you would have liked to exist on the portal, but which currently it does not exist?

b- Is there any feature that you find unnecessary?

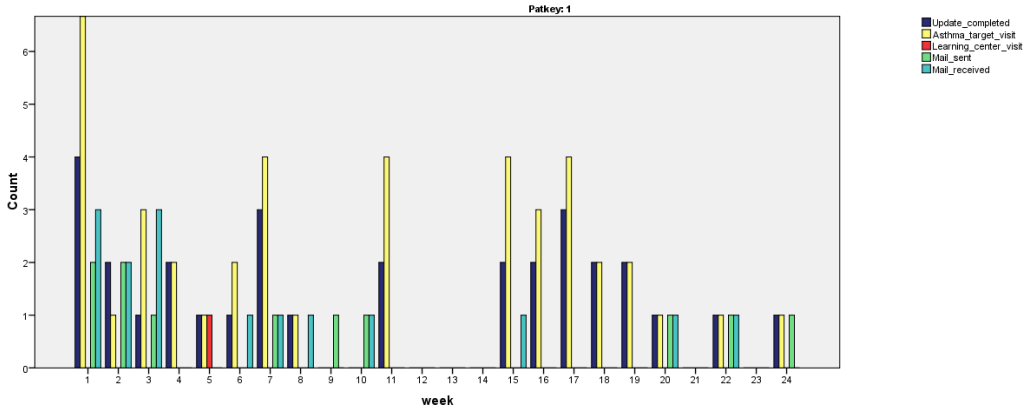
c- Do you have any suggestions for improving the portal's design?

6- In general, what do you think of the portal capabilities for the patients? What do you think of the portal's limitations for the patients?

7- Can a nurse's activities in a hospital setting be facilitated through such a portal? What would be the benefits and shortcomings of a system like MAP for such a situation?

3.11.4. Appendix 4- Usage patterns

Patient 1:



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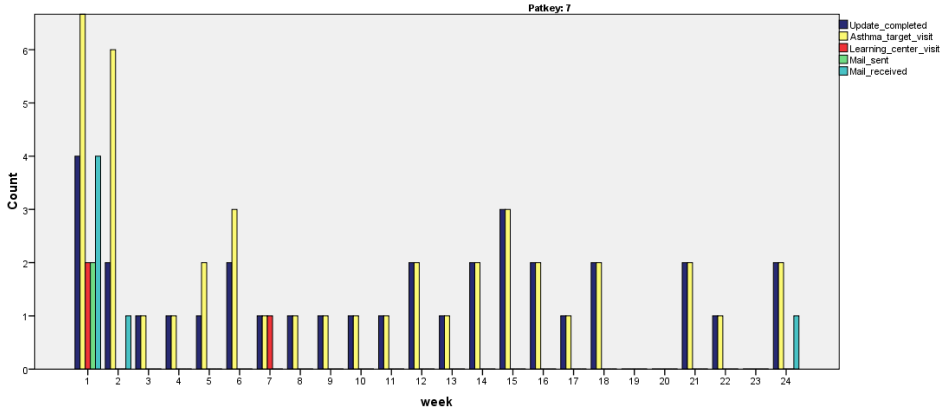
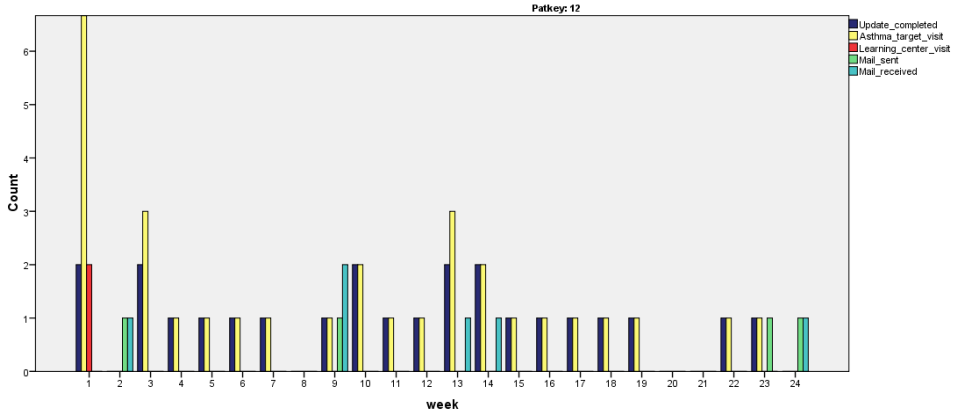
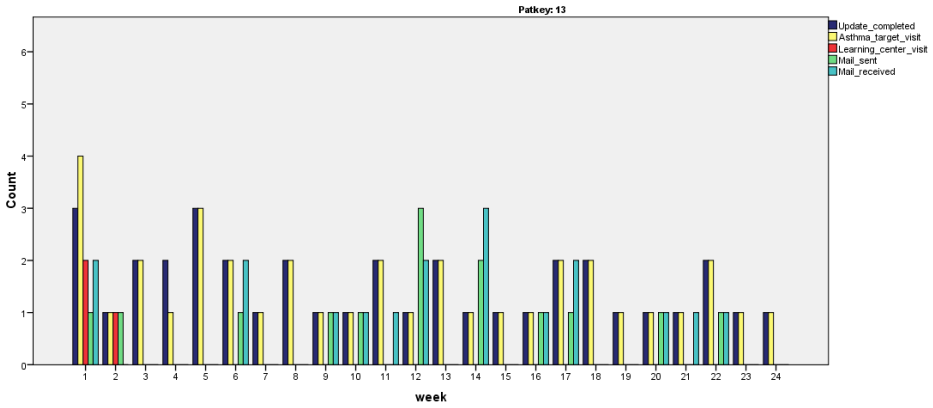


Patient 12:



Patient 13:



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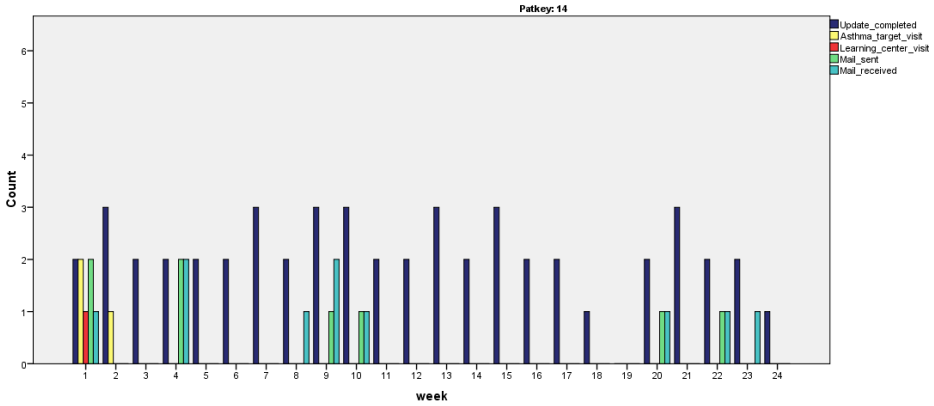
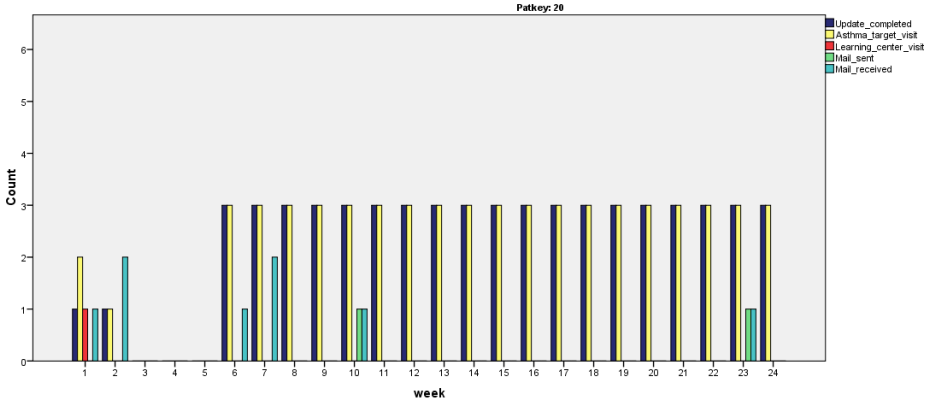
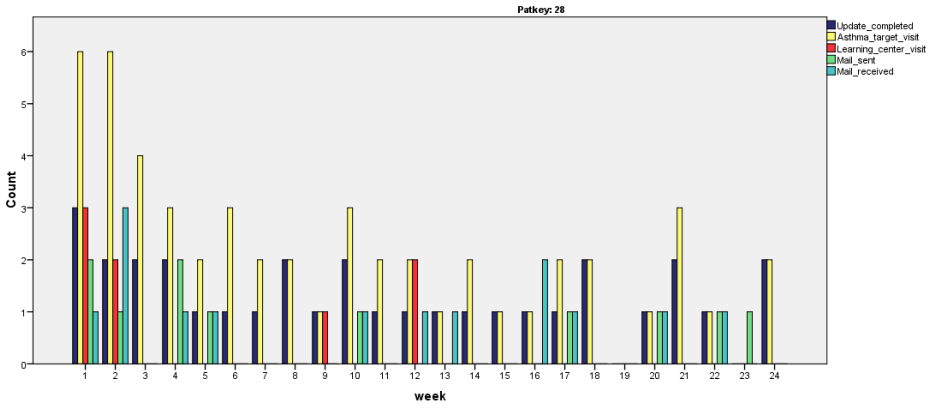


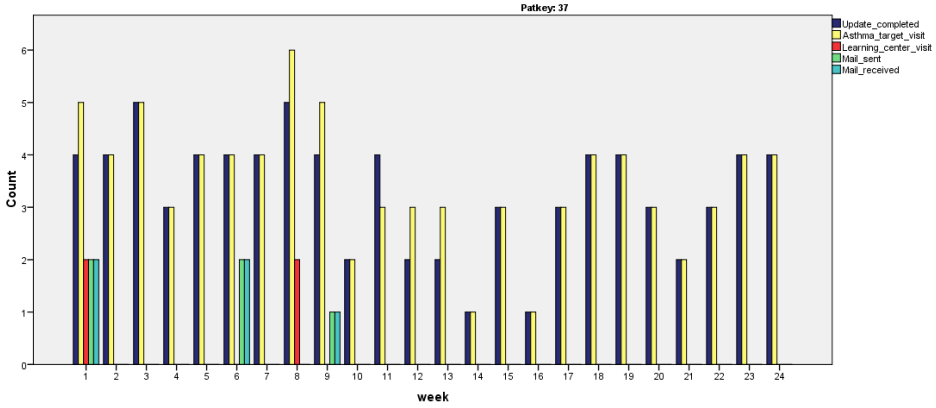
Patient 20:



Patient 28:



Patient 37:



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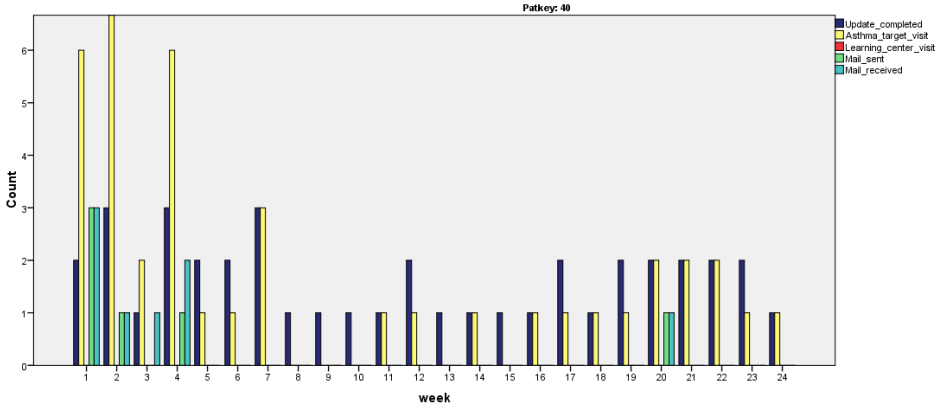

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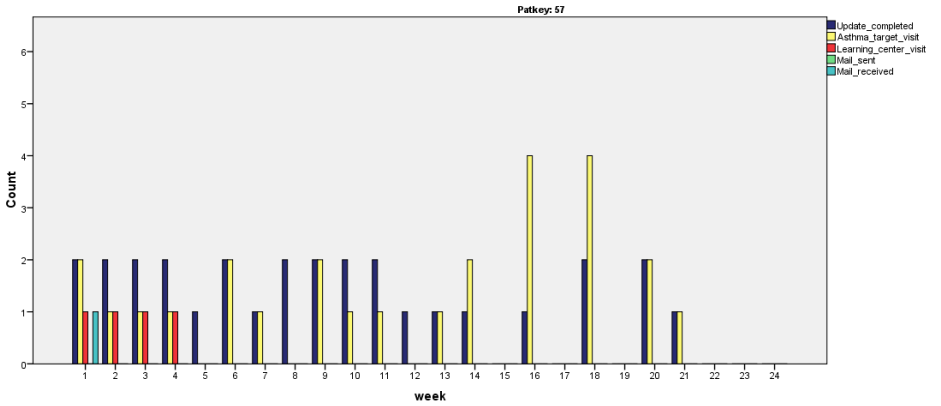

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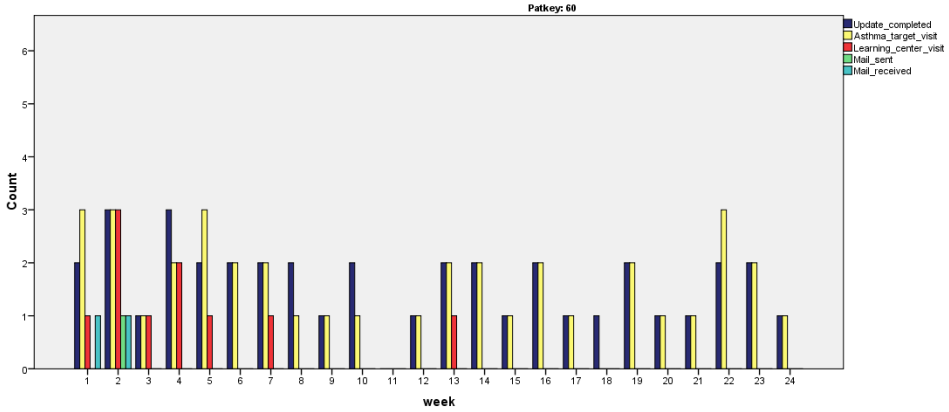

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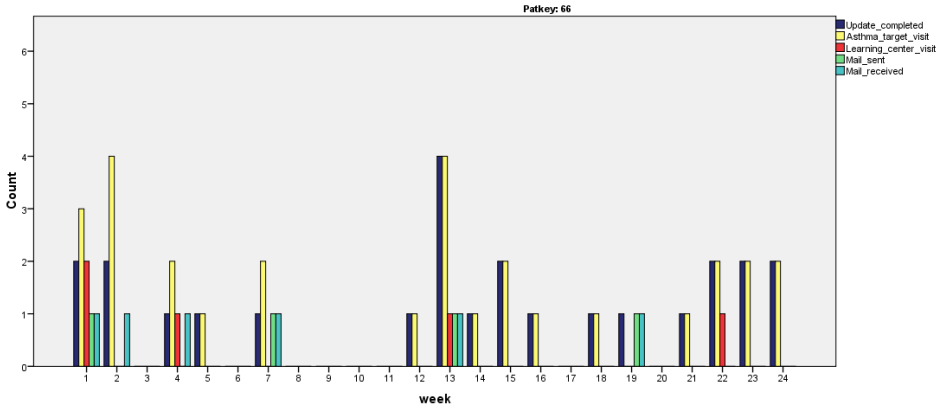

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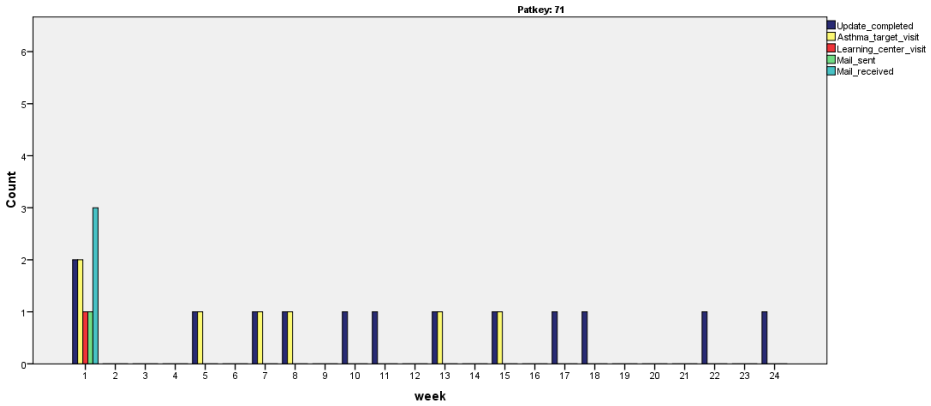

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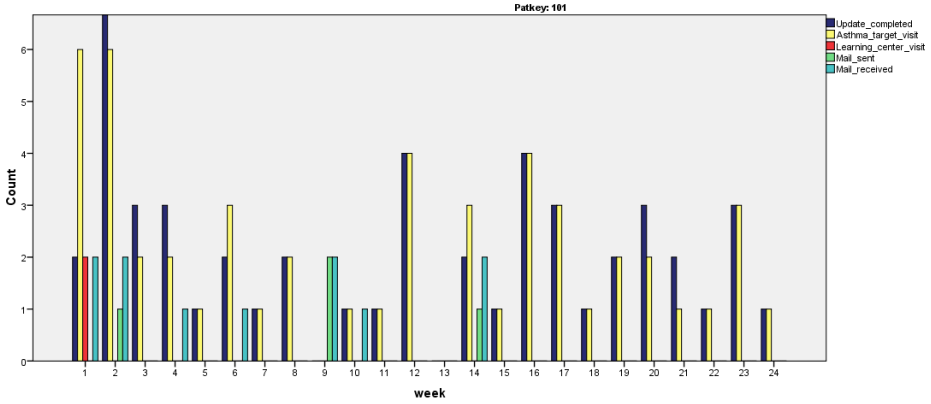
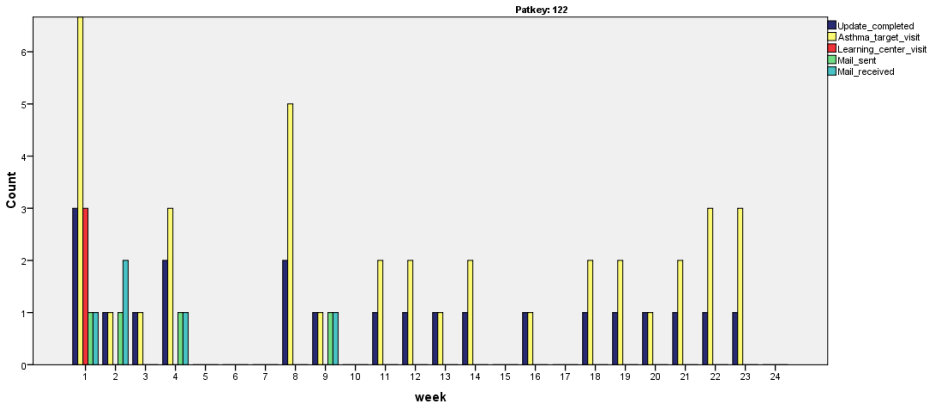


Patient 122:



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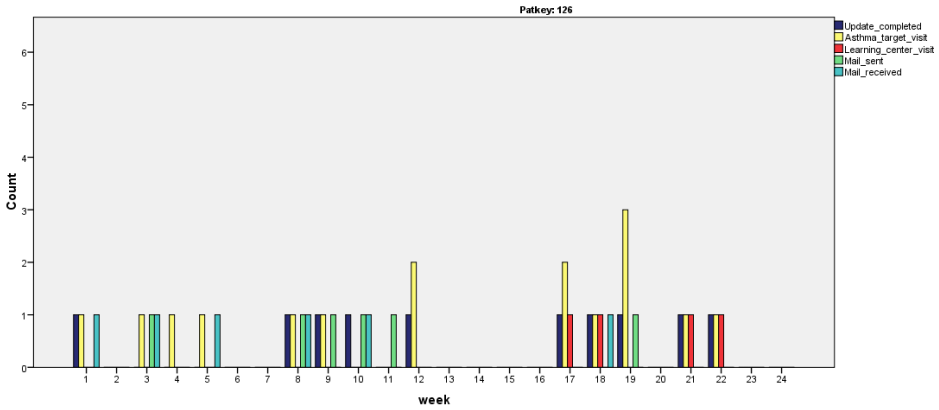
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3.11.5. Appendix 5. A list of representative quotes for the function and system level of each archetype for each patient

Patient 1		
MAP was seen by P1 as a Facilitator Representative system level quote: “it’s helpful to have at least one place [MAP] to keep track of all of them [medication usage], including the changes, so that I can see oh I took this for three months and it didn’t work and I took this for two months and it did work.”		
Function (feature)	Function level PFA Archetype	Quote
Updating health status (Asthma questionnaire)	Facilitator	“I would be able to update my health and then compare it to what had come before with the graphs”
Alerts and advice (Asthma diagram)	Facilitator	“I can check how I am doing”
Feedback (Historical graphs)	Facilitator	“ I could pretty much look at that information at a glance and realize oh okay, this combination of factors makes my asthma worse or better"
Self-learning (Information page)	-	-
Messaging (Email)	Protector-coach	“So once in a while she would remind me, oh have you tried this? Oh yes, I forgot; thank you. .... I could just e-mail the nurse, I have this thing, it’s not going away, what do I do? Stay at home, stay in bed, drink tea, take my inhalers, wait for an answer.”

Patient 7		
MAP was seen by P7 as an Imposer Representative system level quote: "I have a mild asthma, and I have a pretty good understanding of my symptoms…but it [the portal] just reminded me of oh you have to do this"		
Function (feature)	Function level PFA Archetype	Quote
Updating health status (Asthma questionnaire)	Protector-coach	"Sort of reminded me that I just had to take care of myself"
Alerts and advice (Asthma diagram)	Imposer	"I didn't like it, I was like yeah it shows that I'm very sick when I just needed it...I like to be in the green. I had to be in the green. ... didn't like the fact that I got sick maybe once and then I was in the red and I was like oh geez this thing you know, you need to like focus and do your stuff so you're not sick anymore...it's like it's the sense of you're not doing it right"
Feedback (Historical graphs)	Imposer	"I feel like they [graphs] don't give a proper sense of what it's like really...And I always thought I wasn't sick. I don't consider myself a sick, like if I have asthma I'm not a sick person per se.
Self-learning (Information page)	-	"…I guess because I'm, I go on Google and stuff so I think what I did is probably that, instead of going to My Learning Centre. ... I didn't see the point in me learning about asthma"
Messaging (Email)	-	"I only communicated once or twice. ...I don't remember asking anything about me being sick."

Patient 12		
MAP was seen by P12 as an Imposer Representative system level quote: "using that [the portal] reinforces medications and I don't want to do that."		
Function (feature)	Function level PFA Archetype	Quote
Updating health status (Asthma questionnaire)	Facilitator	"I think that answering the questions was more beneficial because each question started a thought process and that brought me somewhere else."
Alerts and advice (Asthma diagram)	-	"…the icon on the Target wasn't clear for me because some flags weren't changing colours when I was in the supposedly in the right place, the colour of the flag didn't turn green, it would stay always yellow or something like that or red. So but that, I never really got an answer for that."
Feedback (Historical graphs)	Imposer	"… [graphs] just bang me on the head that I'm not doing enough but that's it. So it doesn't work on your will, well not on mine anyway."
Self-learning (Information page)	Facilitator	"It gave me the possibility to see exactly what is going on inside"
Messaging (Email)	Facilitator	"…well, she [the nurse] answered my question"

Patient 13		
MAP was seen by P13 as a Protector-coach Representative system level quote: "…. [using MPA is] as you're at school and your teacher's telling you, "Do your homework. You have to do this!" Otherwise, you would not do it."		
Function (feature)	Function level PFA Archetype	Quote
Updating health status (Asthma questionnaire)	Protector-coach	"…it kind of pushed me to walk. Usually, I'm sitting all day long. I don't go out so often."
Alerts and advice (Asthma diagram)	Protector-coach	"…it was making me touch, always be in touch with my real situation... otherwise I never think of myself"
Feedback (Historical graphs)	-	"I've checked them, but they were not very much evident"
Self-learning (Information page)	Facilitator	"I had some worries [about my asthma], and I went to check if there was any information"
Messaging (Email)	Facilitator	"I was afraid it[a symptom] could be a kind of deterioration for my asthma….I sent that question actually to the nurse"

Patient 14		
MAP was seen by P14 as a Protector-mom Representative system level quote: "… it's like somebody is looking in on you. It's like when you're sick and you're a kid and your mother comes to look in on you. She's not going to make you any better, but if she looks in on you at night before you go to sleep you feel better. So someone's looking in. That's what I feel."		
Function (feature)	Function level PFA Archetype	Quote
Updating health status (Asthma questionnaire)	Protector-mom	"…[by updating the questionnaire] Yeah I was giving the people in MAP my data, you know, so that they could see that I was doing what I was supposed to be doing."
Alerts and advice (Asthma diagram)	-	"So periodically I would look at it, but it never changed. It wasn't an issue for me to look at the asthma target."
Feedback (Historical graphs)	-	-
Self-learning (Information page)	-	"I didn't know that that was going to be changing or updating as it went along."
Messaging (Email)	Facilitator	"But if I had sort of questions about this or that, I'm not going to call her. But on the portal I would be able to do, because I knew that it wasn't an intrusion into her busy work time."

Patient 20		
MAP was seen by P20 as Facilitator and Protector-coach Representative system level quote: "I figure it would be advantageous for me to monitor my progress, to check my progress", "one way or another I felt like I was being monitored."		
Function (feature)	Function level PFA Archetype	Quote
Updating health status (Asthma questionnaire)	Facilitator	"I would log in to inform the doctors about my use of Bricanyl or Pulmicort"
Alerts and advice (Asthma diagram)	Protector-coach	"[It is like] Yeah and oh, you're doing great, or yeah, maybe you should be walking a little more or maybe you should be using your, maybe you really should use your Bricanyl or whatever"
Feedback (Historical graphs)	Protector-coach/ Facilitator	"…to monitor my progress to see okay, is there something I should be doing or something I shouldn't be doing….Yeah, it gave me the incentive to get out there for a walk"
Self-learning (Information page)	-	-
Messaging (Email)	Protector-mom	"But every so often they contact me, to check on me"

Patient 28		
MAP was seen by P28 as a Facilitator Representative system level quote: “In the end, it’s an assistant. It’s like a virtual assistant”		
Function (feature)	Function level PFA Archetype	Quote
Updating health status (Asthma questionnaire)	-	-
Alerts and advice (Asthma diagram)	Facilitator	“For knowing where I have been…knowing the things that I had to do which I did not”
Feedback (Historical graphs)	Protector-coach	« It is like all physical education things, there is a small coach side that tells you…a little more, a little more, you see. That’s it. It is the same principle as a gym finally.
Self-learning (Information page)	-	-
Messaging (Email)	Facilitator	« But there I allowed myself to ask my questions »

Patient 37		
MAP was seen by P37 as a Protector and a Facilitator Representative system level quote: "I just referred to it if I needed to see based on my signs and symptoms and my values of my peak flow testing. Did I need to notify my asthma team that I was in crisis? Was I within normal range?", "…that it reminded me that some days I was a little lazy and didn't do as much as I should have."		
Function (feature)	Function level PFA Archetype	Quote
Updating health status (Asthma questionnaire)	Protector-coach	"…it was in my face, it was there, it was very visible and it was my daily reminder that I have to watch these guidelines. I have to stick to them."
Alerts and advice (Asthma diagram)	Inhibitor	"I wanted to use it as a tracking tool and it wasn't able to do that for me"
Feedback (Historical graphs)	Facilitator	"It was interesting to be able to track and see when I compared medication use versus my physical activity and to be able to see the relationship on the chart"
Self-learning (Information page)	-	-
Messaging (Email)	-	"But it was rare that I was exchanging mail with the nurse."

Patient 40		
MAP was seen by P40 as a Protector-mom Representative system level quote: « …if I have a problem I don't need to go to the hospital, it will be solved by itself, then, if I have any questions about my health and I don't feel well, there is someone who can do something »		
Function (feature)	Function level PFA Archetype	Quote
Updating health status (Asthma questionnaire)	-	-
Alerts and advice (Asthma diagram)	Protector-coach	« It gave me a good idea about the statistics and if I succeeded to do what I had to do »
Feedback (Historical graphs)	Facilitator	« I noticed when I regularly take my medications during a week, the week after the symptoms would be less, so before I was not very aware of this improvement »
Self-learning (Information page)	-	« I have not consulted it anymore »
Messaging (Email)	Protector-mom	« There I felt well because I had a personalized follow up, then I really liked it »

Patient 57		
MAP was seen by P57 as an Inhibitor Representative system level quote: "Portal did not work with the most recent version of Internet Explorer for example, so I had to keep my work computer on the older version so that I could complete the study because at home it would not work like I wouldn't be able to complete the form or it would take like 25 minutes to log in onto the thing, which was a problem."		
Function (feature)	Function level PFA Archetype	Quote
Updating health status (Asthma questionnaire)	Inhibitor	"I guess the updates could have been a little more detailed in a way. Sometimes it was like general questions or yeah, I guess so."
Alerts and advice (Asthma diagram)	Inhibitor	"I was correctly taking my medications but it never showed that I was in the green for taking my medication."
Feedback (Historical graphs)	-	"…it was like basically a flat line so it wasn't super interesting"
Self-learning (Information page)	-	"that was kind of a one-time thing, and it kind of seemed to be always the same as well so"
Messaging (Email)	-	"I didn't feel the need to email the nurse."

Patient 60		
MAP was seen by P60 as a Facilitator Representative system level quote: "I think it was more geared towards me looking at myself to see how I'm doing each day"		
Function (feature)	Function level PFA Archetype	Quote
Updating health status (Asthma questionnaire)	Facilitator	"I do know the medication that I'm taking so I did go through it to see exactly what it did, how it worked and what level it fell under"
Alerts and advice (Asthma diagram)	Facilitator	"I'm like, okay I have this going, I have this under control, I know what I'm doing, I can keep going, I can keep doing it and I'll be good, my breathing would be very good, keep taking my medication"
Feedback (Historical graphs)	Facilitator	"I was looking at it mostly to see my exercise activity because that was the one that really like fluctuated"
Self-learning (Information page)	Facilitator	"I was learning, reading the articles, seeing what's going on…. I'm generalizing the articles that I'm reading and actually directing them back to myself."
Messaging (Email)	-	"Just because I had the direct access. I would think that that's the only reason why I didn't use that part"

Patient 66		
MAP was seen by P66 as a Protector-coach Representative system level quote: « The website emphasizes on doing exercises and me, I have difficulties in doing exercises and it motivates me »		
Function (feature)	Function level PFA Archetype	Quote
Updating health status (Asthma questionnaire)	-	-
Alerts and advice (Asthma diagram)	Protector-coach	« When it becomes green, it was like Bravo! I liked it, I really liked it,… you succeeded. You did what you had to do this week. Something like that. I liked that…this is green. I am not in danger »
Feedback (Historical graphs)	-	"The graphs, I looked at them at the beginning but I did not understand them. It bring me nothing...I don't look at them"
Self-learning (Information page)	-	« There was not many new things »
Messaging (Email)	Facilitator	« Some times I had questions like… there is one part of the target that is always yellow…even when we take our medications as prescribed…so I was worried. I called the nurse and I wrote to her…why it is like that? When I was writing to the nurse it was about the website. Because if I was not feeling well I called the nurse in the hospital »

Patient 71		
MAP was seen by P71 as an Imposer Representative system level quote: "I'm a nurse so I know about asthma, I know what I need to do, I know what triggers it, I know what helps it. …my answers never changed. I didn't look into the portal at all."		
Function (feature)	Function level PFA Archetype	Quote
Updating health status (Asthma questionnaire)	Imposer	"I feel guilty. I know that's my own self, it's my own thing, you know, my own personal thing, I feel guilty for smoking….it would trigger something in me, guilt for being a nurse being a smoker."
Alerts and advice (Asthma diagram)	-	"It was the same every week because nothing ever changed for me."
Feedback (Historical graphs)	-	"It wasn't useful for me because there's no change. I've been pretty stable since the study began."
Self-learning (Information page)	-	-
Messaging (Email)	-	"I never really communicated with the nurse either, I never had questions for the nurse"

Patient 101		
MAP was seen by P101 as an Imposer Representative system level quote: "they'd [people behind the portal] keep bothering me to start my Action plan…. my doctor saying one thing and the machine is saying something else… I can't start every time you tell me to start. I start it sometimes, but like I said, I would rather see a doctor, and then I see a computer."		
Function (feature)	Function level PFA Archetype	Quote
Updating health status (Asthma questionnaire)	-	-
Alerts and advice (Asthma diagram)	Facilitator-Imposer	"[I look at the target] to make sure I wasn't always in the red, that I was always in the green for the walk and for the medication. "Like it's always pushing to start your action plan"
Feedback (Historical graphs)	-	"I never dealt with graphs … they don't mean anything to me"
Self-learning (Information page)	-	"I never went onto it. Basically I never knew how to get onto different things and everything."
Messaging (Email)	Imposer	"… the asthma nurse contacted me saying, basically how come you haven't started your action plan yet? … I can't do it all the time, because even the pharmacy would deny a prescription."

Patient 122		
MAP was seen by P122 as an Imposer Representative system level quote: « It's like taking a child by the hand, and saying - Look, you're not able to feel yourself. We'll show you ... we will tell you that you are fine. Because you responded to this question, or to that question »		
Function (feature)	Function level PFA Archetype	Quote
Updating health status (Asthma questionnaire)	-	-
Alerts and advice (Asthma diagram)	Imposer	« The target…Look, when...well…you have to do this…me, I know what to do »
Feedback (Historical graphs)	Facilitator	"It gives you a very good idea of the… evolution of … you where you were standing a week ago and what… how it changed"
Self-learning (Information page)	-	"What is that? I don't need this"
Messaging (Email)	-	"If you have a heart attack, you are not going to write an e-mail."

Patient 126		
MAP was seen by P126 as an Imposer. Representative system level quote: "… but I know what my asthma was like. I didn't need them to tell me I was in the yellow. I knew I was in the yellow".		
Function (feature)	Function level PFA Archetype	Quote
Updating health status (Asthma questionnaire)	Inhibitor	"I found it a little frustrating that many of the multiple choice questions did not have the answer that I wanted to give… I felt more that it was me providing data as supposed to it providing it to me."
Alerts and advice (Asthma diagram)	Imposer	"If you didn't know what your asthma was and you needed somebody to say "okay, go to plan A, B or C" like yellow, red or green, that's fine. But I know what my asthma was like. I didn't need them to tell me I was in the yellow."
Feedback (Historical graphs)	-	"… the graphs [were] not accurate for me"
Self-learning (Information page)	-	"… there wasn't anything particularly that stood out to me."
Messaging (Email)	Protector	"Because it was someone at the other end of the line you could ask a question to and get a response within a couple of days. You know, it felt like I had support…. it relieved the frustration that I was able to contact the asthma nurse and get some feedback and get an appointment with an asthma doctor"

Chapter IV - Conclusion

The objective of this dissertation was to conceptualize the concept of functional affordances (FA) and to put it into practice in studies of IT usage and IT effects. To do so, two different studies were conducted. Emphasizing the context-dependent nature of functional affordances, the first study proposed a methodological approach that enables the identification of an IT's functional affordances and their linkages for an individual user, as well as for a specified user group. For any given IT, the proposed approach provides a way to identify all possible appropriation moves of a group of users, and link them to the IT's features-in-use. In the second study, we adopted a holistic view of functional affordances to create a broad picture of functional affordances without being concerned about the IT's components. Adopting the functional affordance perspective, the second paper investigated how the use of an IT could or could not lead to desirable outcomes its designers may have intended. Specifically, applying the FA concept at the individual level of analysis, and also relying on an inductive analysis of our data, we extended existing definitions of functional affordances by specifying "who/what is perceived as the source of action" and defined "perceived functional affordances" (PFA) as perceived possibilities of action provided by an IT artifact to an individual user who could view either herself or the IT artifact as undertaking such possibilities. We then examined how PFAs influence the way people use IT, and thereby play a key role in determining whether their usage will lead to desirable outcomes. As a result, we developed a PFA categorization that introduced four PFA archetypes: Facilitator, Protector, Imposer, and Inhibitor. Subsequently, we used these archetypes to explain the conditions under which the PFA of an e-health system can be transformed into usage that is conducive to the attainment of its desirable outcomes.

This dissertation has notable contributions. The research conducted in Paper #1 provides an approach to create a context dependent picture of IT use and its effects. Although an IT's features remain the same in different contexts, the

way they are perceived by users can be very different. Depending on the cultural characteristics of the social context, norms, values, and individual characteristics of its users, some IT features might be perceived as more valuable, while some of them might get totally ignored. Our proposed approach provides an empirical methodology to study these differences. Moreover, the approach can help identify the possible outcomes of using an IT for a specified group of users. The research conducted in Paper #2 extended current definitions of affordances by specifying "who/what is perceived as the source of action" and proposed a categorization of four PFA archetypes that are likely to apply well to other contexts of human-IT interaction. Finally the four archetypes were used to explain self-management performance in a health-care context. Our findings suggested that the effects of IT usage in this context depended not only on the amount of usage patients made of the health-care portal, but also on how they perceived the portal's affordances.

In conclusion, this dissertation provides a powerful lens with which one can study IT affordances. The proposed approach and concepts provide a practical way to collect and analyze data about affordances. Also, our extended conceptualization of affordances underscores the role of IT as an actor that past conceptualizations of affordances have largely overlooked. It is hoped that the four archetypes identified, as well as the affordance networks that emerged in this dissertation can help researchers gain a better understanding of IT usage and its effects.