Chapter 2

Process Knowledge in the Innovation-Decision Period

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Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.73307

Abstract

Current diffusion of innovations theory states that knowledge is a key first stage in the adoptive process of an innovation. However, the fact that different types of knowledge may be relevant to different adopter categories does not appear to have been investigated. In this study, the concept of process knowledge is introduced into the adoptive process of an innovation. The study object was digital terrestrial television (DTT). Data were gathered at eight data gathering points in an 18-month study period. Three different types of process knowledge were identified at different stages: the help knowledge stage, the customer participation knowledge stage, and the interaction knowledge stage. In this study, it is suggested that the following three questions are the ones that majority adopters and laggards want to be answered in the knowledge stage: (1) What is the innovation? (2) What do I need to do to adopt? and (3) Who can help me in the adoptive process? With answers to these questions, consumers have the knowledge that may help speed up the rate of adoption of an innovation. This has practical implications in communication management, for instance, for change agents who are framing messages.

Keywords: diffusion of innovations, rate of adoption, digital terrestrial television, majority adopters, laggards

1. Introduction

Knowledge plays an important part in the diffusion of an innovation as it represents a key stage in the innovation-decision period, the period from when a consumer has awareness-knowledge of an innovation until he or she has adopted the innovation. While innovations, at least at a certain time in history, may have been perceived as mainly technological, innovations in fact can have many different manifestations. One can add to that that an innovation, whether it is technological or not, may have social ramifications that makes the diffusion of the innovation a key societal priority. This can be the case with respect to digital technology,

which is likely to be utilized more and more in both government and nongovernment communications. This makes knowledge on how to speed up the diffusion process, especially with respect to digital laggards, an important issue. In this communication management process, framing of messages plays a key role.

Knowledge on the diffusion of an innovation is just one aspect of diffusion of innovations research, much of which was carried out in the twentieth century. The outcome of this research has resulted in a scientific theory of diffusion of innovations, that is, a theory that has been validated by scientific research, with Everett M. Rogers' book *Diffusion of Innovations* [1] representing the scientific theory of diffusion of innovations (up till manuscript completion of the latest edition of his book, published in 2003). Scientific theory is opposed to analytical theory, which has not been validated by science, but may be based on abductive research, in the understanding of science philosopher Charles Sander Peirce [2]. While all aspects of the diffusion of innovations certainly cannot be said to have been fully investigated, *Diffusion of Innovations* is an example of research becoming scientific theory. It is worth noting that according to a literature review of diffusion of innovations academic literature in the period 2002–2011, "diffusion research seems to be data driven and relies heavily on empirical data that support and change theories in modest ways only" [3]. This appears to be the case also with the diffusion of innovations research that was carried out before this specific review.

What is worth noting is that this specific theory is based on research that was carried out in the twentieth century, with some of the research of key aspects of the theory having been carried out in the period from the 1940s to the 1960s. By elevating research from the mid-twentieth century to scientific theory, we also implicitly accept that the research that was carried many years ago still has validity. This is a philosophy of science issue not only within the field of philosophy of science but also within the specific discipline or field of study. This paper will address this issue from the perspective of one field of study, namely, diffusion of innovations.

According to Charles Sander Peirce, science may result from different scientific processes. Peirce himself reexamined the three basic modes of inference—abduction, deduction, and induction—originally introduced by Aristotle [4]. Each of the three modes of inference has a specific and logical purpose according to Peirce: in abduction, a theory is formulated, based on casual observations. Abduction can be viewed as qualified guesswork (a term also used by Peirce [5] or as creating a theory based on what seems to be cognitively logical. A theory that is the outcome of abduction may become part of scientific discourse, without being empirically tested. But from the theoretical understanding generated by the abductive approach, other studies can be undertaken to validate or falsify the theory by way of deduction or induction. In Peirce's three-way approach, the abductive theory should be tested deductively. If falsified, the theory must be discarded (cf. [6]). If verified, it becomes science (scientific theory). In Peirce's scientific approach, a confirmed theory must be tested continuously through deduction and/or induction; in this way, a theory can stay updated or real. Likewise, even though well established, a scientific theory must be challenged on a continuous basis. One can argue, quite banally, that when society changes then one can expect theories about society also to evolve, to change, to become outdated, or to lack nuances. This is also the philosophical approach to the subject matter of this paper.

While a theory may be well established as scientific theory, it may be challenged for other reasons as well. With respect to diffusion of innovations, which is a hybrid of the communication and sociology disciplines, there are issues with general or universal validity, especially because much early research was carried out in a certain cultural context ("the Western world"). One can add to that that a major part of the research was carried out in a time with less technology, certainly without digital technology, compared to what we see today. One can, therefore, argue that there are ample reasons to continue to seek validation of the diffusion of innovations theory.

In the tradition of Peirce, this paper will investigate the knowledge stage in the innovation-decision period, utilizing data that was gathered in the beginning of the twenty-first century when digital communication was fairly well established. However, to further underline the digital age context, the study object is a digital service, namely digital terrestrial television (DTT).

The philosophical approach of this paper intentionally focuses, and limits, the scope of the paper, as the aim of the paper is specifically to nuance one aspect of diffusion of innovations theory in a twenty-first-century applied communication context. Therefore, a brief summary of key aspects of diffusion of innovations theory is included below, based on Rogers' theorizing [1].

2. Diffusion of innovation theory

Diffusion is "the process by which (1) an *innovation* (2) is *communicated* through certain *channels* (3) over *time* (4) among the members of a *social system*" ([1], p. 11). Diffusion is also termed the adoptive process in which the rate of adoption is a key concept. The rate of adoption is defined as "the relative speed with which an innovation is adopted by members of a social system" ([1], p. 23). It is generally measured as the number of individuals who adopt an innovation in a specified period, such as a year ([1], p. 221). When the number of individuals adopting a new idea is plotted on a cumulative frequency basis over time, the resulting distribution is an S-shaped curve ([1], p. 23). The slope of the S-curve typically rises slowly at first and then steadily before it flattens. However, the slope of the S-curve can take many forms ([1], p. 328). The steeper the slope of the S-curve is, the faster the rate of adoption is.

Some innovations diffuse rapidly, and the S-curve is then quite steep. Some innovations have a slower rate of adoption which makes the curve more gradual. The rate of adoption is typically measured by the length of time required for a certain percentage of the members of a system to adopt an innovation. "Therefore, we see that the rate of adoption is measured for innovation in a system, rather than for an individual as the unit of analysis. […] This system may be a community, an organization, or some other structure" ([1], p. 23). The members or units of the social system may be individuals, groups, or organizations. Thus, the social system can, for instance, be a segment of consumers sharing the same trait(s) or, indeed, all consumers in a country ([1], p. 24).

The S-curve illustrates that people have different approaches to innovations: some people adopt innovations right away, others need longer time, and some people need a very long time.

This led Rogers to categorize people by adopter categories, the classifications of members of a social system on the basis of innovativeness ([1], p. 22). He identified five adopter categories: innovators, early adopters, early majority, late majority, and laggards.

The adopter categories have different personalities, interests, financial circumstances, and educational levels. Individuals who are innovators are different from the late adopters. Innovators are more open and curious than late adopters, and they want an innovation as soon as they hear about it. Laggards are the opposite and take the longest time to adopt. With respect to laggards, Rogers wrote that they "are near isolates in the social networks of their system […] [and] tend to be suspicious of innovations and change agents" ([1], p. 284).

The innovativeness dimension is used to understand and define the five adopter categories in quantitative terms. This dimension is measured by the time at which an individual adopter category adopts an innovation. Rogers partitioned the adopter categories into the five categories by calculating the standard deviation from the average time of adoption. This gave the following result ([1], p. 281): (a) innovators, 2.5%; (b) early adopters, 13.5%; (c) early majority, 34%; (d) late majority, 34%; and (e) laggards, 16%.

In diffusion of innovations theory, knowledge is an individual's initial exposure to the innovation's existence and understanding of how the innovation works ([1], pp. 177–174). There are three types of knowledge that all belong to the knowledge stage in the innovation-decision process, with the knowledge stage being the first of the five stages in the innovation-decision process: knowledge, persuasion, decision, implementation, and confirmation ([1], pp. 171–173). "The innovation-decision process is an information-seeking and information-process activity in which an individual obtains information in order to gradually decrease uncertainty about the innovation. […] At this stage the individual wants to know what the innovation is and how and why it works" ([1], pp. 20–21). According to the diffusion of innovations theoretical framework, the answer is the three types of knowledge in the innovation-decision period: (1) awareness-knowledge, (2) how-to knowledge, and (3) principles-knowledge. All the three types of knowledge belong to the knowledge stage in the innovation-decision process ([1], pp. 171–173). According to Rogers, each of the three types of knowledge can be framed as a question: (1) What is the innovation? (2) How does it work? and (3) Why does it work? The first question is about the existence of an innovation; the second question is about knowledge necessary to use an innovation properly; and the third question is knowledge about the functioning principles underlying how an innovation works ([1], p. 21). These questions can be characterized as innovation-centric. It is worth pointing out that much diffusion of innovations research does appear to have a pro-innovation bias ([1], pp. 106–107), and this may also be the case with respect to the knowledge stage of the innovation-decision process.

It is the innovation-decision process that leads to either adoption or rejection, a decision not to adopt an innovation ([1], p. 21). Adoption takes place at the decision stage of the innovation-decision process ([1], p. 170). Only when having knowledge about the innovation can an individual be persuaded to adopt. It may be easier to persuade an individual to adopt if the individual has knowledge that he considers relevant. What the individual considers relevant may be depending on the "Characteristics of [the] Decision-Making Unit" (ibid.), that is, the individual's adopter category profile.

One could speculate that the above types of knowledge, in particular type nos. 2 and 3, will mainly have appeal to innovators. The innovators have different characteristics than the other adopter categories, and they are the keenest to adopt ([1], pp. 287–292), hence an interest in innovation-centric knowledge. However, other types of knowledge may appeal to other adopter categories in *their* innovation-decision process. This study will investigate if other types of knowledge can play a role in the innovation-decision period, especially knowledge that can influence the innovation-decision behavior of late adopters, in particular laggards who take the longest time to adopt ([1], p. 215).

3. Literature overview

One article has identified more than 5,000 articles using diffusion of innovations theory [7]. Many articles use other models to explain adoption, for instance, the technology acceptance model [8], which focuses on technology and represents a different perspective than the diffusion of innovations theory utilized in this study. It should also be noted that knowledge as part of the adoption process is not exclusive to diffusion of innovations theory (see, for instance, [9]). Across theoretical approaches, it seems that some degree of knowledge regarding the existence, uses, and meaning of the innovation can influence the adoption decision. This knowledge can be actively sought by end-users, and/or it can be communicated by one or more change agents ([1], Chapter 9). However, it is notable that relatively little interest appears to have been devoted to the knowledge-type aspect of the innovation-decision stage in recent years, even though knowledge and access to knowledge seem to be undergoing many changes, not least because of rising educational levels, technology, and (social) media proliferation.

Within the context of this study, it is also worth noticing that the knowledge aspect has been specifically addressed in three studies involving terrestrial digital television [10–12]. In an early study of audience interest in adopting digital television (DTV), it was pointed out that "we still know relatively little about viewer knowledge about and interest in adopting the new, higher resolution television receivers [necessary to receive DTT]" [10]. It was concluded that "the fact that that fewer than a third of respondents feel even "somewhat educated" about DTV—only a few years before its mandated adoption in the United States—is remarkable" [10]. The findings of the study opened up questions as to what type of knowledge could help facilitate the adoption of DTT.

Dupagne [11] measured self-reported DTV knowledge, also in the United States, and pointed out that this is "not actual DTV knowledge. […] An individual may well report a degree of familiarity with DTV but may nevertheless misconstrue how the technology functions or how to use it." The author is here de facto referencing, respectively, knowledge type nos. 3 and 2. It does not appear obvious that how-to knowledge and principles-knowledge will help facilitate the adoptive process if technology insight is minimal and there is no real interest in the technology aspect of the innovation.

A third study found that knowledge of DTV had a significant influence on the intention to adopt DTV. This study also pointed out that a lack of knowledge was likely to lead to a delay in

making any decision on adopting DTV [12]. The study categorized DTV knowledge into three categories: environment, content, and equipment. These categories appeared after a review of the frequently asked questions reported by American DTV information websites. The environment knowledge category (which is mainly knowledge about process) can include statements like, "DTV sets are in stores now" or "There is a government deadline for DTV conversion." The content knowledge category can include statements like "DTV enables interactivity on TV" and "DTV enables multicasting." The equipment knowledge category can include statements like "Regular TV sets will be obsolete when only digital transmission is in the air" and "A converter is needed to receive DTV signals." The findings showed that, among the three knowledge categories, the DTV environment and DTV content categories seemed to be the most relevant to the adoption intention of new TV sets and that the DTV environment knowledge category had significance with respect to the adoption intention of converters. It seems that DTV environment knowledge, in particular, may have an effect on innovation-decision process. The three knowledge-type categories that currently are proposed as key in the innovation-decision process are innovation-specific, and, especially, 2. How-to knowledge and 3. Principles-knowledge appear to belong in the DTV equipment knowledge category. This type of knowledge may not have the effect on the innovation-decision process that theory suggests.

It should be noted that studies of knowledge are not only of the stages or of the process. Also, content is studied (see, for instance, [13]), as are the psychological processes underlying knowledge (knowledge structures) [14]. Several studies have looked at the barriers to adoption of technology, of which lack of knowledge may play a part. A meta-analysis of factors determining older adults' technology adoption addresses some of the same issues as the present study [15]. Lee and Coughlin write "The factors suggest that older adult's adoption of technology is not a purely technical topic, but a rather complex issue with multiple aspects" ([15], p. 750). The factors include delivery channels, defined as "Ways in which technology is communicated and distributed to older adults for purchase and use" ([15], p. 750). An earlier study had suggested that older adults' access to technologies relies on how much information is open to them and how the delivery systems are formed [16]. This could indicate that knowledge about the distribution channel, for instance, stores, can be relevant.

In conclusion, it appears that the previous research indicates that it can be relevant to explore environment knowledge in the innovation-decision period. Knowledge related to questions, like How does it work? and Why does it work?, may be interesting to early adopters. The late adopter categories may be more interested in environment knowledge questions like "Where can I get information?", "Who can help me?", and "Which actions do I have to take in order to adopt?" These types of questions have a different perspective, in that they reflect that the adopter categories being asking these questions may not be interested in the innovation as such, only in the outcome of the adoption process, for instance, being able to watch television or use digital technology.

The three questions mentioned above reflect that maybe an environment knowledge perspective could help facilitate the innovation-decision process: especially, majority adopters and laggards may be more prone to adopt if they know where they can get help and know how to ask for help. However, environment knowledge may not be the right knowledge category term, as the word environment may lead to associations to environmental issues. Therefore, it

is suggested to use another term that precisely describes what this knowledge category is about, namely, knowledge about process. Instead of using the term environment knowledge, the term process knowledge will be used. In a study of lead users, a distinction is made between product knowledge, process knowledge, and knowledge about factual matters [17], confirming the meaningfulness of the term in this context. However, one should be aware that in other contexts, the term process knowledge may have slightly different meanings. For instance, in the study of text mining, process knowledge means specific documents that are used in many processes, for instance, communication logs and process descriptions [18]. In the present study, process knowledge does not relate to documents.

4. Research question

The research question is as follows:

> RQ: In a diffusion of innovation process, how high are process knowledge levels when majority adopters and laggards adopt an innovation?

Three types of process knowledge are selected for this study: (A) knowledge on where to get help, (B) knowledge about the actions required by the user/customer/consumer in order to adopt, and (C) knowledge on how to interact with staff at a store.

In order to answer the RQ, data on the rate of adoption of majority adopters and laggards has to be established. This de facto means that the entire rate of adoption of the innovation has to be established, as laggards are the last to adopt.

The units of analysis of the study are Danish households with analog terrestrial television (ATT). This segment is the approximately 600,000 Danish households with ATT as of March 31, 2006 ([19], p. 319).

In June 2005 the Danish Parliament decided that the ATT signal was to be switched off permanently on the night between October 31 and November 1, 2009. The digital terrestrial television signal was "in the air" in Denmark for the first time on March 31, 2006, and would be so along with the ATT signal until the cutoff date. After the cutoff date, only the DTT signal would be in the air [20, 21]. In other words, the entire adoptive period is from March 31, 2006, to October 31, 2009.

Knowledge is a variable in the innovation-decision process. Knowledge, ultimately, has an effect on the rate of adoption. However, a person does not get knowledge without proceeding stimuli, typically interpersonal communication and/or mass communication, both of which can take place with a change agent as the sender. It is well known from diffusion of innovations theory and research that many different variables determine the rate of adoption ([1], Chapters 5 and 6). Therefore, in the adoptive process, the variable representing knowledge is in fact an intermediate variable, as there were many public information and commercial are activities informing of the ATT switch-off affecting the knowledge of the consumers. In this

study, the campaign activities are rendered a black box, but they have been described by Sepstrup [19]. There are also typical prior conditions, for instance, felt needs/problems ([1], p. 170). These variables are interconnected in the following way:

Prior conditions (conditioning variable) → communication stimuli (causal variable) → knowledge (intermediate variable) → rate of adoption (effect variable)

In diffusion of innovations theory, knowledge is presumed to be a de facto active causal variable in a very complex process.

5. Methodology

In classic diffusion of innovations research, it was common to use data based on respondents' memories, sometimes going back 10–15 years. Much of the original diffusion research gathered data from adopters by asking respondents to look backward in time after the innovation had diffused ([1], pp. 126–127). Rogers suggested an alternative research approach to the after-the-fact data gathering. He wrote "It is possible to investigate the diffusion of an innovation while the diffusion process is still underway. […] Data can be gathered at two or more points during the diffusion process, rather than just after the diffusion process is completed […]" ([1], p. 112). The question of diffusion of innovations methodology, and the problems with the early research methods, has been addressed by Meyer [22] who also suggested, among other innovative methodologies, point-of-adoption studies. In point-of-adoption studies, "data is gathered from respondents at the time they adopt the innovation rather than at some point in the distant future. [… enabling] the investigator to obtain more accurate data about the innovation decision […]" [22]. This paper represents a point-of-adoption study. In order to measure the affective variable, the research design is based on conducting a series of surveys over a period of time, at the time when the adoptive process is taking place (thus, this study is not based on respondents looking backward in time).

Rogers indicated that three points at which data are gathered can form an S-curve if you also have a zero ([1], p. 113). In this study there were eight data gathering points. Eight data gathering points should thus yield a very "readable" curve.

A structured interview guide consisting of 72 questions was used for all the respondents. The questions were of a sociodemographic nature and about TV habits and TV reception. For this study the following three survey questions were asked, each representing a different type of knowledge:

Survey question A: Do you know where you can get further information?

Survey question B: Do you know how you ensure that you can watch television after the analog signal has been switched off?

Survey question C: Did you feel well prepared for the encounter with the store?

To establish the rate of adoption, the following survey question was asked:

Survey question D: Has your household converted to the digital terrestrial television signal?

In a structured interview with 72 questions, one should very carefully consider the reply categories and aim to keep them consistent, yet meaningful to each question. While scale measuring is often considered the most suitable way to elicit replies from respondents by the researcher, the researcher should also try to view the interview from the point of view of the interviewee: when carrying out structured interviews with fixed reply categories, one should carefully consider the use of scales and in all circumstances limit the use of scales to as few as possible. As the interviewee only hears the scale spoken, he may be more unsure of the scale than when viewed on paper or on a screen. Some scales may result in a high number of replies; others will result in very precise replies. The researcher wants to achieve both. In this study, it was decided that the reply categories for all four questions should be the same and that three reply categories could satisfactorily represent the expected replied to the questions. The reply categories for all four questions were "Yes," "No," and "Don't Know," which appear to be reply categories that are likely to be meaningful to the respondent because of the way the questions are phrased. With respect to survey question D, it was possible to cross-check and to verify responses concerning television reception by asking multiple behavioral and technical questions. Thus, if someone answered "I don't know" to the survey question *after* the ATT switch-off, it would in fact be possible to change this to a "Yes" or a "No" in a simple way: ask the respondent to turn on the television set, and see if there is a signal. If the answer to that question was a "Yes," the answer to survey question D would also be a "Yes."

Adoption could not start to take place until the DTT signal was in the air on March 31, 2006. Therefore, March 2006 is set as zero.

6. Data gathering

As a consequence of the above, eight surveys were carried out, at the following times: June 2008, October 2008, January 2009, June 2009, August 2009, September 2009, October 2009, and November 2009. The precise data gathering process has been reported in previous research, utilizing other data from the data sets than what are reported here. Therefore, the following is a description of a data gathering process that has been reported in other academic papers (for instance, [23, 24]).

The June 2008 survey was carried out in a different way from the subsequent seven surveys. The June 2008 survey was an internet-based questionnaire with close-ended questions distributed to a representative number of Danes aged 18+, with their own household, from a large base of potential respondents, selected randomly. The number of respondents was 969 individuals. The survey question was the same as for the subsequent surveys. The respondents were representative of the Danish population on all standard parameters. The response rate and statistical variance could not be established for this survey. This is an obvious problem with respect to reliability, and this should be borne in mind when analyzing the data, especially if the data are not "in line" with the subsequent survey results.

The seven surveys carried out in October 2008–November 2009 were all done using the same method. Surveying television reception can be carried out in many ways. It is important to be aware of the technological issues involved and of the fact that some consumers have little or no knowledge of their own television reception.

For each of the seven surveys, the following method was used: a sample population representative of the Danish population, aged 18+, with their own household, was selected randomly. After selection the potential respondents received a letter informing them that they had been selected to participate in a survey of television habits. Each person in the sample population was then contacted in one of two ways: 80% were contacted by telephone and 20% were visited in their own home by an interviewer. Irrespective of contact method, the respondent selected for interviewing was the household member responsible for the TV equipment in the household. If a potential respondent could not be reached or refused to participate, a new potential respondent with the same sociodemographic characteristics was selected and included in the sample. Thus, it was secured that the sample population would always be representative. Consequently, the surveys in principle can be said to have 100% response rates. The selection and interviewing process lasted 4 weeks.

7. Survey results

The results of the eight surveys are shown in **Table 1**.

	March 2006+	**June 2008**	**October 2008**	**January 2009**	**June 2009**	**August 2009**	**September 2009**	**October 2009**	**November 2009**
Number of Respondents	-	969	1001	1024	978	977	989	998	976
A. Do you know where you can get further information?		*	43%	44%	55%	59%	60%	**	***
B. Do you know how you ensure that you can watch television after the analogue signal has been switched-off?		*	87%	92%	81%	84%	78%	**	***
C. Did you feel well prepared for the encounter with the store?		*	*	65%	74%	87%	90%	**	80%
D. Has your household converted to the digital terrestrial television signal?	0%	4%	*	13%	**	**	26%	38%	99,7%

As a general rule numbers are rounded up or down.
+ DTT launched in Denmark March 31, 2006 (not a survey).
*Not part of this survey.
** Not reported because of statistical variance due to the error level compared to the January 2009 survey.
*** Not included in the survey because of too few respondents (under 31).

Table 1. Survey questions results. Danish households affected by the ATT switch-off.

Survey Question C	Result	Result with Statistical Variance
January 2009	13%	0-32%
September 2009	26%	0-43%
October 2009	38%	22-54%

Table 2. Statistical variance for survey question D.

For questions A, B, and C, the statistical uncertainty for all surveys was ±3.6% or less. For question D, the statistical uncertainty is reported in **Table 2**.

8. Findings

With the survey results, the RQ can be answered. Three types of process knowledge were measured among the affected households: (A) knowledge on where to get help ("help knowledge"), (B) knowledge about the actions required by the user/customer/consumer in order to adopt ("customer participation knowledge"), and (C) knowledge on how to interact with staff at a store ("interaction knowledge").

Help knowledge had the lowest knowledge level in the entire process. From 43%, the number grew 17% points. Customer participation knowledge started out with a high knowledge level in the period measured: From 87%, the knowledge level fell 9% points (at the second measuring point, it rose by 5% points, and then it started falling). Interaction knowledge rose during the measured period up to the deadline but fell at the very end of the adoptive period. From 65%, it rose 25% points (at the very end, it fell 10% points).

It appears that at different stages in the adoptive process the level of certain types of knowledge is high; in fact, there appear to be three different process knowledge stages: the help knowledge stage, the customer participation knowledge stage, and the interaction knowledge stage. The help knowledge stage was 11 months, from October 2008 to September 2009. Of the three knowledge stages, the help knowledge stage had the lowest average knowledge level (52%), that is, of the three types of process knowledge, most adopted without having this type of knowledge.

The customer participation knowledge stage was the 7 months' period from June 2008 to January 2009 in which period customer participation knowledge was at the highest. This stage had the highest average knowledge level (84%). The interaction knowledge stage was from September 2009 to November 2009 in which period interaction knowledge was at the highest. This stage had the next-highest average knowledge (79%). The customer participation knowledge stage and the interaction knowledge stage have the highest average knowledge levels of the three process knowledge categories.

In order to answer the RQ, the rate of adoption has to be established. The rate of adoption of DDT in Denmark was 99.7% which is here considered as 100% rate of adoption; in other words, both the majority adopters and the laggards have adopted DTT. However, just 1 month before

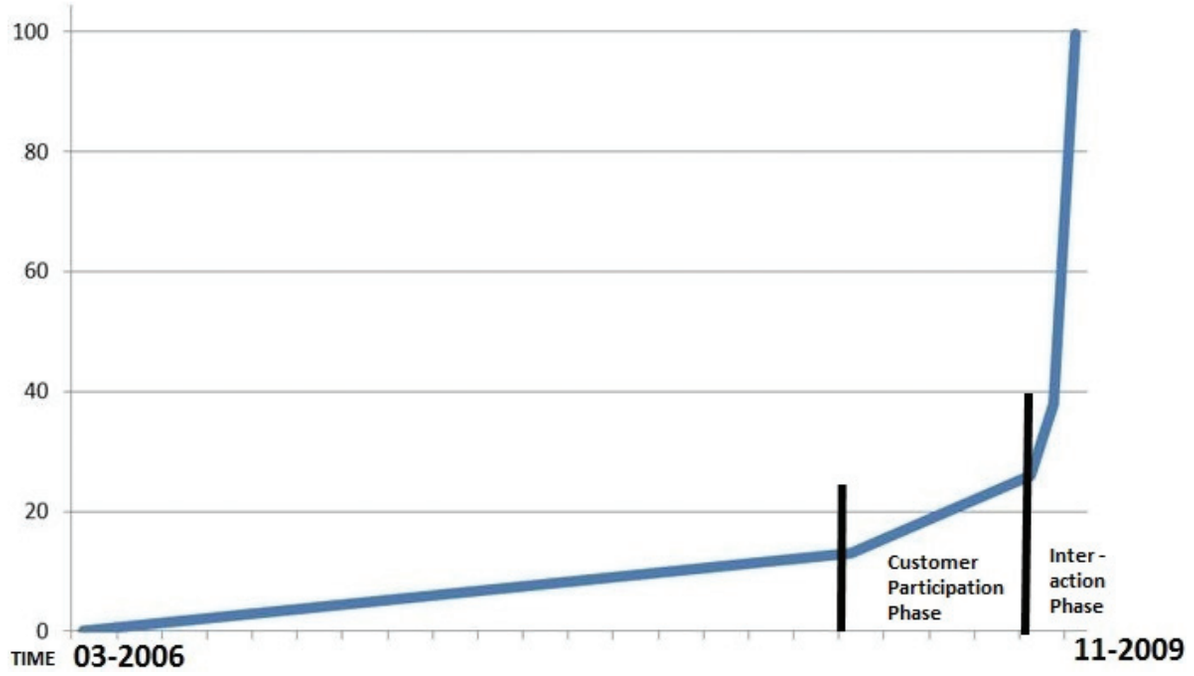

Figure 1. The rate of adoption of DTT in Denmark with two process knowledge stages.

the deadline, only 50% had adopted. The curve at the end of the adoptive process is extremely steep which means that the rate of adoption at this stage was very fast, making it an atypical S-curve. However, even with this atypical S-curve, it is possible to establish the five adopter categories' time of adoption. The 15–84% range is when the majority adopters adopt, and the 16–100% range is when the laggards adopt. After the 15% mark, there is an upward movement in the curve, indicating that when the early majority adopters adopt customer participation knowledge is high. After the 25% mark, there is an upward movement in the curve, indicating that when many majority adopters and laggards adopt, interaction knowledge is high. The upward movements in the curve show that the rate of adoption becomes faster.

In **Figure 1**, the numbers from survey question D in **Table 1** have been turned into a curve. In the figure the customer participation knowledge stage and the interaction knowledge stage are identified. These two stages represent the highest process knowledge levels when the majority adopters and the laggards adopted.

9. Discussion

This paper has investigated what type of knowledge is relevant to consumers in the innovation-decision period, with a focus on the application in communication management. In established diffusion of innovations theory, the adopter categories need answers to the following three questions: (1) What is the innovation? (2) How does it work? and (3) Why does it work? While these three questions and their answers may play a key role for innovators and

early adopters in *their* innovation-decision process, here it is suggested that other questions and issues may be more relevant and more meaningful to majority adopters and laggards.

It seems that process knowledge can play a part in the diffusion of innovations process in the middle and the late part of the adoptive process. While question type no. 1, What is the innovation?, may be relevant to all adopter categories, it could appear that the two other questions that late adopters may want answers to are *not* equipment related. Rather, they are process related: knowledge on which actions are required in order to adopt and about how to interact with someone who can help (for instance, store staff). Based on the findings in this study, it is suggested that the following three questions are the ones that those who adopt *after* the innovators and early adopters have adopted want answered: (1) What is the innovation? (2) What do I need to do to adopt? and (3) Who can help me in the adoptive process? With answers to these questions, consumers have the knowledge that will help speed up the rate of adoption. This insight may be relevant with respect to many communication aspects that involve adoptive processes, not least the message being communicated. It may be relevant to utilize a differentiated messaging strategy in the communication during the innovation-decision period.

From this study it appears that customer participation knowledge is important to early adopters and interaction knowledge is important to most majority adopters and to the laggards. The latter insight makes sense because of what we know of these adopter categories, especially laggards: they are generally suspicious of change agents, which may have to do with the fact that they do not know how to communicate with change agents. It, therefore, makes sense that getting knowledge on how to interact with staff in a store can affect the behavior of the laggards, making them more ready to adopt. The early adopters have a wider network than late majority adopters and laggards, and they may know who to ask. They just need to know what they need to do.

As has already been pointed out, any cause and effect relation in the adoptive process of an innovation is complex, and no simple cause and effect are likely to exist. While this study has indicated a cause and effect relationship between knowledge and rate of adoption, it is important to underline that there may have been many other factors involved in the adoptive process. The effect on the rate of adoption could, for instance, be ascribed to the influence of opinion leaders. They are typically early adopters ([1], p. 223), and it may be their buzzing that can explain the first increase in the rate of adoption identified in this study. Only further research can give us precise insight into this. However, this study can open up a discussion of new aspects of the innovation-decision period that need to be researched further. We may still be some way from completely understanding the diffusion process as it takes place in the twenty-first century, especially with respect to innovations in a digital age context. For instance, certain aspects of digitalization may be more difficult to grasp by some adopter categories.

This study has identified two types of process knowledge and two corresponding stages that can help nuance the innovation-decision process. However, while the findings of this study must be considered part of an ongoing research process to update diffusion of innovations theory, they may have value to practitioners until further research is carried out. Practitioners can avail themselves of communication models that focuses on the communication process, for

instance, the AIDA model. This study has shown that it is relevant to use process knowledge when the communication messaging is related to the diffusion of innovations process.

One aim of this study was to test if current diffusion of innovations theory is still valid or needs to be updated or discarded, following the tradition of Charles Sander Peirce. The conclusion is that it appears that the diffusion of innovations theory needs to be updated. However, this study only relates to one aspect of diffusion of innovations theory, and what is represented here is only study. It is certainly relevant to ask if the present findings are generalizable before any findings become theory. One should always be careful to conclude any generalizability based on studies from just one country. Before answering any questions with respect to generalization, the study must be put in a cultural context. The cultural context is Denmark, a so-called Nordic welfare state, with an advanced economy. Denmark is a fairly small country, but this should not have any influence on the findings. Studies that have proven to have general validity have been carried out in much smaller communities than Denmark. There is no reason to believe that the adopter categories are very different across countries in the Western world, if they are exposed to the similar commercial and technological influences as those that are present in the country in which the study took place. Therefore, it is likely that the findings have validity in geographical areas that are similar or somewhat similar to Denmark, culturally, economically, and technologically.

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