

ADOPTION AND DIFFUSION PROCESSES OF TELEMEDICINE IN HEALTHCARE SYSTEMS

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ABSTRACT

Background: Adoption and diffusion processes are integral parts of the dissemination of innovations; yet, they have been studied only fragmentarily in the healthcare systems field. This article outlines the goal of a PhD thesis in progress and describes how the dissemination of telemedicine in German health care will be analyzed with a focus on innovation communication.

Methods: A three-stage qualitative and quantitative research design consisting of expert interviews, focus groups and a partially standardized questionnaire consisting of demographic and sociocultural questions, the UTAUT2 on technology acceptance in the German translation by Harborth and Pape (2018) and questions on communication behavior will be used to investigate the research topic.

Results: Initial results of the exploratory literature review reveal that innovation communication between stakeholders regarding new technologies in healthcare systems has received little attention. Furthermore, the initial results indicate that adoption and diffusion theory can be used to analyze dissemination phenomena.

Conclusions: Based on the findings of the exploratory literature review, and considering Germany's struggle to implement telemedicine, an analysis of adoption and diffusion processes in the healthcare sector will be conducted.

KEYWORDS

Diffusion of Innovation (DOI) Theory, Telemedicine, eHealth, Innovation Communication, Public Health Information

1. INTRODUCTION

Despite the announcement of the Digital Healthcare Strategy (Bundesministerium für Digitales und Verkehr, 2022) and the creation of a legal framework for digital service provision, the German healthcare system lags behind many countries. According to the Digital Health Index, Germany's score of 30 is far behind Portugal's score of 67.2, Great Britain's score of 70 or Denmark's score of 72.5 (Thiel and Deimel, 2020). This index, which makes digitization strategies internationally comparable in healthcare sectors, indicates a need for improvement in Germany, despite many attempts at structural and system-related levels. The following article outlines the goal of a PhD thesis in progress.

As part of the *Digital Healthcare Strategy*, particular importance is attached to electronic patient records, electronic prescriptions, the expansion of the telematics infrastructure and the European Health Data Space (Bundesministerium für Digitales und Verkehr, 2022). In addition to these innovations, the expansion of telemedicine is intended to support and supplement the existing provision of services in the healthcare system.

The term telemedicine is defined by the National Library of Medicine as “the delivery of health services via remote telecommunications. This includes interactive consultative and diagnostic services” (National Library of Medicine, 1993). The terms *teleconsil*, *telediagnosics*, *teletotherapy* and *telemonitoring* represent subcategories of telemedicine. In English-speaking countries, the terms *telemedicine*, *telehealth*, *telecare*, *eHealth*, *digital health*, *connected health*, *digital care* and *remote care* are used. Since 2014, alongside *telemedicine*, the term *mHealth* has been used. This refers to the concept of mobile health, which comprises the use of mobile telecommunication devices in the delivery of healthcare services (Hurst, 2016). In this paper the term *telemedicine* is used and includes the aspects of *mHealth*.

Telemedicine is a central characteristic of digitization in the healthcare sector. While particular attention is focused on the development and expansion of telematics infrastructure in Germany, other aspects, such as the (re)development of telemedical care structures, are also being targeted. Nevertheless, a sole focus on politics

and legislative measures as the originator of implementation processes in society falls short. In implementation science, for example, a wide range of factors described in theoretical frameworks that influence implementation processes are relevant for innovations in the healthcare field.

According to Greenhalgh et al. (2004), an innovation in health care refers to a novel way of behaving and working that aims to improve the quality of care. Telemedicine can be understood as such an innovation. According to Gabriel, Stanley and Saunders (2017), an innovation can be divided into four main phases: (1) problem identification, (2) invention of new ideas, (3) adoption or implementation of new ideas into practice and (4) diffusion, (i.e., the spread and adoption of an idea more widely) (Cluley et al., 2022; Gabriel, Stanley and Saunders, 2017; Greenhalgh et al., 2004). Furthermore, an innovation can be categorized as one of three types: technological and clinical innovation, process and service innovation and system innovation (ibid.). In multidimensional health care, both the phased implementation process and the frequently overlapping types of innovation increase complexity. In the context of sector-based health systems, implementation is understood as the interplay between innovation and complex adaptive health systems (Greenhalgh and Abimbola, 2019; Plsek and Greenhalgh, 2001). This interplay, with its implicit determinants, will be examined from a sociocultural perspective based on adoption and diffusion theory, as this theory precedes the technical acceptance of innovations.

2. EXPLORATORY LITERATURE REVIEW

To determine the current use of theoretical concepts in the analysis of telemedical implementation projects, an explorative literature search was conducted. Due to the multidisciplinary research topic, databases from the social sciences, economics, health sciences and medicine were used for this purpose. Searches in Business Source, SSRN, CINAHL, CareLit, Wiso, Wiley Online Library and PubMed (Medline) were adapted to each database and included the following search terms: change management, innovation diffusion theory, innovation diffusion, implementation, barriers, eHealth, telemedicine, digital health and mHealth. The results of the database searches were checked for relevance using the abstracts, supplemented with the results of the freehand search.

2.1 Findings

In innovation and implementation science, there are three perspectives on the phenomenon of innovation implementation (Sepasgozar, Loosemore and Davis, 2016): a socioeconomic perspective based on Rogers' (1969) diffusion theory, a psychological perspective based on various frameworks of technology acceptance (Davis, 1989; Sepasgozar, Loosemore and Davis, 2016; Venkatesh et al., 2003) and an organizational-level perspective (Sepasgozar, Loosemore and Davis, 2016). However, these are not separable, as they can overlap depending on theory-based understandings. While adoption and diffusion theory, according to Rogers (2003), addresses individual (adoption-level) and societal (diffusion-level) implementation processes, acceptance research focuses on mental and behavioral determinants regarding individual products or technologies (Howard and Moore, 1982; Sepasgozar, Loosemore and Davis, 2016). Following Niknejad et al. (2021), who call for a precise distinction between the terms *adoption* and *acceptance*, acceptance research is assigned a secondary role in this context.

Another viewpoint on implementation research in health systems notes the distinction described by Scarbrough and Kyratsis (2022) between a diffusion and an implementation perspective. While the former examines the diffusion of an innovation in a social structure, the latter describes the implementation of an innovation in a particular context (ibid.). As understood by Scarbrough and Kyratsis (2022), the diffusion perspective illuminates the communication about an innovation in the social fabric while the innovation is still changeable (see also Rogers, 1969). The diffusion process is characterized by observation, imitation and influence among individual members of the social fabric and permeates a society when it reaches sufficient mass (Rogers, 2003; Scarbrough and Kyratsis, 2022). An analysis of innovation diffusion can include the types of information and communication channels used (Greenhalgh et al., 2004; Rogers, 2003; Scarbrough and Kyratsis, 2022).

To investigate the influence of awareness (knowledge) and demand (desire) concerning an innovation, Liang (2012) developed an awareness and demand matrix. This model demonstrated that the characteristics of

an innovation and the desire for an innovation influence each other reciprocally (Liang, 2012). Thus, innovations are in tension between the technology push (introduction of innovative products to the market) and consumer pull (demand for the innovative products) (ibid.). The repetitive cycle of the technology push and consumer pull increases the awareness or knowledge of an innovation and thus the demand for it (Liang, 2012). This issue is relevant in regulated healthcare markets and requires further attention.

According to Jennett, Gagnon and Brandstadt (2005), the willingness to change and the perceived ability and necessity to change are significant factors in innovation implementation. These factors can be influenced by members of the social fabric, according to Armenakis, Harris and Mossholder (1993) and Romano (1995). As a subordinate factor of readiness to change, technology readiness should also be considered. According to Mauco, Scott and Mars (2018), technology readiness has been studied only to a limited extent in the context of health care. From a cultural perspective, it has not been studied at all (ibid.). However, the term *technology readiness* is not consistently used in the literature (Niknejad *et al.*, 2021; Vaittinen, Martinsuo and Ortt, 2017); therefore, this topic may have been studied using different terms.

Further research on user perception, perspective, experience, readiness and awareness in adoption was conducted in a literature review by Niknejad *et al.* (2021) and a cross-sectional study by Wei *et al.* (2020). Both papers highlight the relevance of perception, experience and readiness perspectives in the implementation of technological innovations in health care.

Moreover, a literature review by Dryden-Palmer, Parshuram and Berta (2020) underlines the centrality of context in innovation and knowledge implementation. Their study indicates that the complexity described by Rogers should be understood as a feature of the context, the implementation process and the innovation. Furthermore, this complexity represents a product of these factors (Dryden-Palmer, Parshuram and Berta, 2020). In addition to Dryden-Palmer, Parshuram and Berta (2020), Fitzgerald *et al.* (2002) also analyzed interactions in context.

2.2 Derived Research Topics

The literature review indicates that using established theories from implementation research can influence the diffusion of innovations and make implementation more effective (Wensing, Grol and Grimshaw, 2020). Despite these findings, previous research reveals few theoretical approaches to planning and designing implementation strategies (Lynch *et al.*, 2018). Furthermore, according to Wensing and Grol (2019), the validity of these theories in the context of health care has been little researched and is thus limited.

In addition to general barriers and facilitating factors, the importance of perceptions or knowledge about an innovation, attitudes toward it and the prevalence of the combination of these elements in the social fabric have been highlighted (Jungwirth and Haluza, 2019; Liang, 2012; Lin and Bautista, 2017; Zolkepli and Kamarulzaman, 2015). The interaction between individuals' perceptions, attitudes and desire for innovation adoption in the social fabric has been identified as a significant diffusion factor (Jungwirth and Haluza, 2019; Wei *et al.*, 2020). Despite the importance of interpersonal communication in the social fabric for innovation diffusion, as described in the literature (Fitzgerald *et al.*, 2002; van de Ven *et al.*, 1999), interprofessional, cross-sector communication about innovations (or aspects of innovation communication) in health systems has not yet been explored. Furthermore, the role of health professionals in the diffusion and implementation of innovations and their adoption is still unclear.

Another significant aspect of innovation diffusion and implementation represents the influence of sociocultural factors, which can operate differently at the organizational, professional and national levels (Heinzl and Leidner, 2012). The inclusion of cultural awareness in respective healthcare systems in analyzing the adoption and diffusion processes of innovations has not been the subject of research to date, nor has innovation communication.

Considering this research, the PhD project focuses on the descriptive analysis of telemedicine innovation as perceived by health professionals. The first study phase aims to describe possible sociocultural factors influencing the implementation of telemedicine from the perspective of experts in (tele)medicine (licensed physicians and/or telemedicine experts) in the German healthcare system. Based on the findings of the literature research, which indicate the relevance of sociocultural factors in the adoption and diffusion process of implementation, a restriction to the German healthcare system will be made.

The second study phase examines individual diffusion experiences of innovations in healthcare systems. For this purpose, licensed physicians with at least 1 year work experience concerning innovation

communication in health systems will be studied. Here, the geographical limitation to Germany will allow the consideration of sociocultural and political characteristics.

Under the assumption that socio-cultural influencing factors and innovation communication in health care systems influence each other, a causal analysis will take place in the third phase within the framework of an explorative, partially standardized questionnaire survey. For this purpose, an analysis of the perceptions and attitudes of licensed physicians (like in phase 2) towards innovation communication is to be conducted. The question to be answered is whether sociocultural factors of health professionals contribute to innovation communication in health care systems and what effects this has on the perceived technology acceptance of innovations. The correlation hypotheses derived from this are:

ZH1: Sociocultural factors of health professionals contribute to innovation communication in health systems. (Undirected hypothesis)

ZH2: A high level of innovation communication among licensed physicians contributes to a higher perceived acceptance of innovations.

ZH3: A high level of perceived acceptance of innovations in health systems contributes to innovation communication among licensed physicians.

To answer the research question, a semi-standardized questionnaire consisting of demographic and sociocultural questions, the UTAUT2 on technology acceptance in the German translation by Harborth and Pape (2018) and questions on communication behavior will be used.

3. METHODS

The research questions will be answered using a two stage qualitative design with a subsequent quantitative design. For this purpose, guided expert interviews will be conducted in the first study phase. The number of expert interviews is based on the theoretical saturation to be achieved. The interview questions are based on the elements of adoption and diffusion theory, according to Rogers (1969). The interviews are conducted and evaluated according to the qualitative and quality criteria of Kuckartz (2018) in a systematic, rule- and theory-based manner.

Building on the findings from phase 1, moderated focus groups will be conducted in phase 2 on innovation communication in healthcare systems, using Germany as an example. The discussion topics are intended to revisit and deepen aspects of phase 1 and to extend the research topic to the aspect of innovation exchange in the social structure, according to Rogers (1969).

The medical and telemedical experts required to conduct the guideline-based interviews will be recruited from the professional environment and snowball sampling. Prerequisites for participation in the expert interview are a professional connection to medicine or telemedicine and professional activity in the last 12 months, the understanding of the German language in speech and writing as well as written consent to participate. At the beginning of the interview, an information sheet about the interview survey and a consent form for participation will be distributed. If desired, the interview can be conducted remotely via Zoom in compliance with applicable data protection conditions.

The focus groups will be conducted with the subjects of the expert interviews. An extension of the participant group is possible if inclusion criteria are fulfilled. Due to the pandemic, a remote execution is possible but not intended.

In the third study phase, a correlation analysis between socio-cultural factors, innovation communication and perceived acceptance will be carried out on the basis of the results from phases 1 and 2 and standardized questionnaires. The sample size is based on the total number of physicians practicing in Germany in 2021 (N=416100) (Bundesärztekammer, 2022). With a confidence interval of 95% and a standard deviation of 5%, the currently assumed sample size is 384.

4. CONCLUSION

Recent pandemic-related developments in health care have increased interest in implementing telemedicine care concepts. However, it is still unclear how telemedicine approaches can be implemented to improve the quality of care. Based on the findings of the literature review, it seems likely that the wishes, fears, attitudes

and assumptions regarding an innovation, such as telemedicine, which have been only rudimentarily researched to date, can considerably influence the diffusion process. Likewise, the role health professionals play in the context of innovation communication in healthcare systems is still unclear. This dissertation project aims to contribute to answering these questions.

REFERENCES

- Armenakis, A., Harris, S. and Mossholder, K. (1993) 'Creating Readiness for Organizational Change', *Human Relations*, 46, pp. 681–704. doi: 10.1177/001872679304600601
- Bundesärztekammer (2022) Gesamtzahl der Ärzte in Deutschland im Zeitraum von 1990 bis 2021 (in 1.000). Available at: <https://de.statista.com/statistik/daten/studie/158869/umfrage/anzahl-der-aerzte-in-deutschland-seit-1990/> (Accessed: 3 March 2023).
- Bundesministerium für Digitales und Verkehr (2022) Digitalstrategie Deutschland: Gesundheit und Pflege. Available at: <https://digitalstrategie-deutschland.de/gesundheits-und-pflege/> (Accessed: 1 January 2023).
- Cluley, V. et al. (2022) 'Mapping the role of patient and public involvement during the different stages of healthcare innovation: A scoping review', *Health Expectations*, 25(3), pp. 840–855. doi: 10.1111/hex.13437
- Davis, F. (1989) 'Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology', *MIS Quarterly*, 13, p. 319. doi: 10.2307/249008
- Dryden-Palmer, K.D., Parshuram, C.S. and Berta, W.B. (2020) 'Context, complexity and process in the implementation of evidence-based innovation: a realist informed review', *BMC health services research*, 20(1), pp. 1–15. doi: 10.1186/s12913-020-4935-y
- Fitzgerald, L. et al. (2002) 'Interlocking interactions, the diffusion of innovations in health care', *Human Relations*, 55(12), pp. 1429–1449.
- Gabriel, M., Stanley, I. and Saunders, T. (2017) Open innovation in health: A guide to transforming healthcare through collaboration. Available at: https://media.nesta.org.uk/documents/open_innovation_in_health_0.pdf (Accessed: 1 January 2023).
- Greenhalgh, T. and Abimbola, S. (2019) 'The NASSS Framework – A Synthesis of Multiple Theories of Technology Implementation', *Studies in health technology and informatics*, 263, pp. 193–204. doi: 10.3233/SHTI190123
- Greenhalgh, T. et al. (2004) 'Diffusion of Innovations in Service Organizations: Systematic Review and Recommendations', *The Milbank Quarterly*, 82(4), pp. 581–629. doi: 10.1111/j.0887-378X.2004.00325.x
- Harborth, D. and Pape, S. (2018) 'German Translation of the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) Questionnaire', *SSRN Electronic Journal*. doi: 10.2139/ssrn.3147708
- Heinzl, A. and Leidner, D.E. (2012) 'Informationssysteme und kulturelle Einflussfaktoren', *WIRTSCHAFTSINFORMATIK*, 54(3), pp. 103–104. doi: 10.1007/s11576-012-0319-1
- Howard, J.A. and Moore, W.L. (eds.) (1982) *Changes in consumer behavior over the product life cycle*. Boston, Mass. (u.a.): Pitman.
- Hurst, E.J. (2016) 'Evolutions in Telemedicine: From Smoke Signals to Mobile Health Solutions', *Journal of Hospital Librarianship*, 16(2), pp. 174–185. doi: 10.1080/15323269.2016.1150750
- Jennett, P.A., Gagnon, M.P. and Brandstadt, H.K. (2005) 'Preparing for success: readiness models for rural telehealth', *Journal of Postgraduate Medicine*, 51(4), pp. 279–285.
- Jungwirth, D. and Haluza, D. (2019) 'Information and communication technology and the future of healthcare: Results of a multi-scenario Delphi survey', *Health Informatics Journal*, 25(1), pp. 161–173. doi: 10.1177/1460458217704256
- Kuckartz, U. (2018) *Qualitative Inhaltsanalyse: Methoden, Praxis, Computerunterstützung*. 4th edn. (Grundlagentexte Methoden). Weinheim: Beltz Verlagsguppe; Ciando. Available at: https://ebooks.ciando.com/book/index.cfm/bok_id/2513416.
- Liang, T.-H. (2012) 'Matrix analysis of the digital divide in eHealth services using awareness, want, and adoption gap', *Journal of medical Internet research*, 14(1), e11-e11. doi: 10.2196/jmir.1670
- Lin, T.T.C. and Bautista, J.R. (2017) 'Understanding the Relationships between mHealth Apps' Characteristics, Trialability, and mHealth Literacy', *Journal of Health Communication*, 22(4), pp. 346–354. doi: 10.1080/10810730.2017.1296508
- Lynch, E.A. et al. (2018) '"There is nothing so practical as a good theory": a pragmatic guide for selecting theoretical approaches for implementation projects', *BMC Health Services Research*, 18(1), p. 857. doi: 10.1186/s12913-018-3671-z
- Mauco, K.L., Scott, R.E. and Mars, M. (2018) 'Critical analysis of e-health readiness assessment frameworks: suitability for application in developing countries', *Journal of Telemedicine and Telecare*, 24(2), pp. 110–117. doi: 10.1177/1357633X16686548

- National Library of Medicine (1993) Telemedicine. Available at: <https://www.ncbi.nlm.nih.gov/mesh/?term=telemedicine> (Accessed: 1 January 2023).
- Niknejad, N. et al. (2021) 'Understanding Telerehabilitation Technology to Evaluate Stakeholders' Adoption of Telerehabilitation Services: A Systematic Literature Review and Directions for Further Research', *Archives of Physical Medicine and Rehabilitation*, 102(7), pp. 1390–1403. doi: 10.1016/j.apmr.2020.12.014
- Plsek, P.E. and Greenhalgh, T. (2001) 'Complexity science: The challenge of complexity in health care', *BMJ (Clinical Research Ed.)*, 323(7313), pp. 625–628. doi: 10.1136/bmj.323.7313.625
- Rogers, E.M. (1969) *Diffusion of innovations*. 7th edn. New York: Free Press.
- Rogers, E.M. (2003) *Diffusion of innovations*. (Social science). New York: Free Press. Available at: <http://www.loc.gov/catdir/bios/simon052/2003049022.html>.
- Romano, C.A. (1995) 'Predictors of nurse adoption of a computerized information system as an innovation', *Medinfo. MEDINFO*, 8 Pt 2, pp. 1335–1339.
- Scarborough, H. and Kyratsis, Y. (2022) 'From spreading to embedding innovation in health care: Implications for theory and practice', *Health Care Management Review*, 47(3), pp. 236–244. doi: 10.1097/HMR.0000000000000323
- Sepasgozar, S.M.E., Loosemore, M. and Davis, S. (2016) 'Conceptualising information and equipment technology adoption in construction', *Engineering, Construction and Architectural Management*, 23, pp. 158–176.
- Thiel, R. and Deimel, L. (2020) *SmartHealthSystems: Digitalisierungsstrategien im internationalen Vergleich*. online. Available at: <https://www.bertelsmann-stiftung.de/de/publikationen/publikation/did/smarthealthsystems/> (Accessed: 23 September 2022).
- Vaittinen, E., Martinsuo, M. and Ortt, R. (2017) 'Business customers' readiness to adopt manufacturer's new services', *Journal of Service Theory and Practice*, 28. doi: 10.1108/JSTP-03-2017-0053
- van de Ven, A.H. et al. (1999) 'The innovation journey'.
- Venkatesh, V. et al. (2003) 'User acceptance of information technology: Toward a unified view', *MIS Quarterly*, 27, pp. 425–478. doi: 10.2307/30036540
- Wei, Y. et al. (2020) 'Physicians' perception toward non-invasive prenatal testing through the eye of the Rogers' diffusion of innovation theory in China', *International journal of technology assessment in health care*, 36(3), pp. 239–244. doi: 10.1017/S0266462320000136
- Wensing, M. and Grol, R. (2019) 'Knowledge translation in health: how implementation science could contribute more', *BMC Medicine*, 17(1), p. 88. doi: 10.1186/s12916-019-1322-9.
- Wensing, M., Grol, R. and Grimshaw, J. (eds.) (2020) *Improving patient care: The implementation of change in health care*. Hoboken, NJ: John Wiley & Sons.
- Zolkepli, I.A. and Kamarulzaman, Y. (2015) 'Social media adoption: The role of media needs and innovation characteristics', *Comput. Hum. Behav.*, 43, pp. 189–209.