Content Analysis in the Research Field of Technology Coverage

Gwendolin Gurr und Julia Metag

1 Introduction

Many technologies are fast-growing drivers of innovation and as such have the potential for major transformations of people's lives (Gaskell et al. 1998; Metag 2019). Related to that, technologies and particularly the development of new technologies (also called emerging technologies) call for a variety of actors who try to make themselves heard in the public sphere. Scientists, economic actors, politicians, regulators, and ordinary citizens try to have a voice in the public discussion about the development, implementation, and specific applications of technologies—thus, they strive to reach the audience through media coverage (Metag 2019). Communication research therefore investigates the media coverage of technologies, which is highly relevant within the discourse on technologies. Since technologies can have major impacts on many areas of the societal system, they are issues that attract journalistic attention and, consequently, are frequently covered in the news media. Research on technology coverage mostly

G. Gurr (✉)
Departement für Kommunikationswissenschaft und Medienforschung, Université de Fribourg/ Universität Freiburg, Fribourg, Switzerland
E-Mail: gwendolin.gurr@unifr.ch

J. Metag
Institut für Kommunikationswissenschaft, Westfälische Wilhelms-Universität Münster, Münster, Germany
E-Mail: julia.metag@uni-muenster.de

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started in the 1980s with analyses of the coverage of nuclear power (Friedman 1981; Gamson and Modigliani 1989; Kepplinger 1988; Mazur 1981). This was followed by research on the coverage of information technologies (e.g., Arceneaux and Schmitz Weiss 2010), biotechnology (e.g., Gaskell et al. 1998), nanotechnology (e.g., Donk et al. 2012) and—most recently—artificial intelligence (e.g., Brennen et al. 2018), the latter being characterized by more than just technological aspects—just to name the most prominent technologies under scrutiny. As can be seen from these examples, research on journalistic coverage of technologies is often concerned with emerging technologies, since they bring along as yet unknown risks and benefits for a society. Thus, the research field of technology coverage has overlaps with the fields of risk communication and science communication.

Research on media coverage of technologies has intensified over the last years alongside with a broadening of its focus (Metag 2019): Studies exist on the analysis of coverage in different countries (e.g., Metag and Marcinkowski 2014), of different media (e.g., Cacciatore et al. 2012), or different events related to a technology (e.g., nuclear catastrophes (Kristiansen 2017)).

2 Common Research Designs and Combinations of Methods

Some meta-analyses or summarizing reviews exist for specific technologies, such as nuclear energy (Kristiansen 2017) or nanotechnology (Donk et al. 2012). These overviews show that both quantitative (Anderson et al. 2005; Donk et al. 2012; Maeseele and Schuurman 2008; Weaver et al. 2009) and qualitative content analyses (Christidou et al. 2004; Tyshenko 2014) are employed in technology coverage research. Qualitative analyses often employ the concept of discourse analysis (Asayama and Ishii 2017; Maeseele 2015). There are some studies which combine qualitative and quantitative content analyses, mostly to get a more in-depth view of the quantitative data (Vicsek 2014), however the majority of the studies only employ one of the types of content analysis. With regards to research on online content about technologies, also automated content analysis plays a role (Cacciatore et al. 2012; Veltri 2013). Particularly social media content in large quantities, such as tweets in which technologies are discussed, can be analyzed through latent semantic and sentiment analysis (Veltri 2013). However, also traditional newspaper coverage is analyzed using computer-based analysis strategies (Dudo et al. 2011).

Many of the quantitative content analyses also cover longer time periods of several years, thereby showing how the coverage of a technology develops over time (Arceneaux and Schmitz Weiss 2010; Asayama and Ishii 2013; Donk et al. 2012; Teräväinen 2014). For nanotechnology, (e.g., Kjærgaard 2010; Kjølberg 2009) and carbon capture and storage (e.g., Kojo and Innola 2017), the media coverage increased and reached a

peak in the early years of 2000. Biotechnology received increasing media attention already in the late 1990s (e.g., Maeseele and Schuurman 2008; Marks et al. 2007). The majority of research analyzes technology coverage in one country (e.g., Boholm 2013; Kjølberg 2009). Only few studies actually compare the coverage of technologies in different countries (e.g., Metag & Marcinkowski 2014). Most studies focus on one media type, but some research also compares different media types, e.g., print and online media (Cacciatore et al. 2012). Generally, research on technology coverage is very much focused on print media. For all kinds of technologies, studies on the print media coverage of these technologies exist. Television coverage of technologies is analyzed less frequently—for an example see Heidmann and Milde (2013). More recently, studies have investigated the coverage of technologies in the online environment (e.g., Cacciatore et al. 2012; Lupton 2017). On the Internet, technologies can be covered in journalistic channels, such as online outlets of newspapers, as well as non-journalistic forms, such as blogs. Some research has focused on the coverage of technologies on social media, such as on Twitter (Veltri 2013). Content analyses of media coverage of technologies are sometimes combined with other methods. Focus group interviews are employed to compare lay people's understanding of a technology with its representation in media coverage (Vicsek 2014). When online content is analyzed, the additional analysis of web metrics can also enlighten the analysis (Veltri 2013).

The majority of research focuses on technologies such as nuclear energy, biotechnology, GM foods, nanotechnology, carbon capture and storage, synthetic biology, and fracking. The state of research on the coverage of digital media and technologies, however, is scarcer. There are some single studies dealing with the framing of personal and microcomputers (Cogan 2005; Kelly, 2009), the internet (Rössler 2001), mobile phones (Arceneaux 2005), digitization in general (Zeller et al. 2010) or mobile app privacy (Popiel 2019). However, this area of research is quite fragmented. Most studies are concerned with the coverage of one technology, but some studies treat more than one technology (e. g. Gschmeidler and Seiringer 2012) or technology in general (e.g., Willems 1994).

3 Main Constructs Employed in Technology-Related Media Content Analyses

When analyzing the media coverage of these technologies, most researchers apply similar analytical constructs, which in part differ in how they are termed.

A great amount of studies investigates to what extent a technology is presented in terms of its **risks and benefits,** as it is assumed that they shape the public understanding and acceptance of the technology in question (Gaskell et al. 1998). Studies thus investigate to what extent risks and benefits of a technology are mentioned in the media coverage, to what extent a focus on either risks or benefits dominates a media

article or the total media coverage in a time period (e.g., Anderson et al. 2005; Dudo et al. 2011; Marks et al. 2007; Stephens 2005). While some studies analyze risks and benefits by using one variable (Strekalova 2015), the majority of studies measure risks and benefits by using several variables, such as frame elements (Donk et al. 2012) or different types of risks and benefits (e.g., Metag and Marcinkowski 2014). Many of these studies investigate the portrayal of risks and benefits by applying framing analysis (Donk et al. 2012; Dudo et al. 2011; Strekalova, 2015). The theoretical understandings and methodological approaches of framing vary, however. While some studies measure frame elements according to Entman's (1993) definition of frames (e.g., Donk et al. 2012), other studies work with news frames similar to thematic contexts of a technology (e.g., Anderson et al. 2005). Due to the variety of understandings of framing and the dependence of each frame operationalization on the single technology in question, we will give an overview of main results and trends regarding the portrayal of risks and benefits, irrespective of whether these categories are used alone or as part of a framing analysis. Findings on the portrayal of risk and benefits of a technology differ not only depending on the type of technology in question, but also on the media analyzed and among periods. For nanotechnology for example, benefits are dominant in the news media coverage (Cacciatore et al. 2012; Dudo et al. 2011; Strekalova 2015). In some studies, the types of risks and benefits mentioned are of interest. While for carbon capture and storage, political/legal and economic risks and benefits are most relevant (e.g., Feldpausch-Parker et al. 2015), for nanotechnology, medical, scientific and economic benefits are most prominent in the media coverage in Germany, Switzerland and Austria (Metag and Marcinkowski 2014). For synthetic biology, benefits related to energy are more prominent than benefits related to the environment and health (Gschmeidler and Seiringer 2012).

Studies investigating the coverage of a technology frequently examine the overall impression a media article gives of a technology. Some studies measure the positive or negative **tone** or predominant evaluation of a technology by looking at the ratio of risks and benefits mentioned (e.g., Nisbet and Lewenstein 2002; Zimmer et al. 2008) or at statements regarding the technology in question (e.g., Boyd and Paveglio 2014). In other studies, the overall evaluation within the article (e.g., Pietzner et al. 2014; Racine et al. 2006) or optimistic/pessimistic views are analyzed by means of frames (e.g., Nerlich and Jaspal 2013; Tyshenko 2014). While for some technologies such as genomics (Racine et al. 2006) or nanotechnology (Lemańczyk 2012), reporting tends to be more positive or balanced, the tone of reporting on carbon capture and storage varies across countries (Boyd and Paveglio 2014; Pietzner et al. 2014). For some technologies such as nuclear energy, the predominant tone depends on time period or key events respectively (Kristiansen 2017).

Many studies analyze which **actors** or **sources** are cited or quoted by journalists in the media coverage of a technology. Which types of actors are represented to what extent depends on the technology in question. However, scientists, government persons,

politicians, interest groups, business representatives, some kinds of experts, citizens or the media are frequently considered (see for example Lemańczyk 2012, 2014; Maeseele 2015; Nisbet and Lewenstein 2002). For nanotechnology (Anderson et al. 2005; Kjærgaard 2010), carbon capture storage (Asayama and Ishii 2013) and electromagnetic fields (Claassen et al. 2012), scientists, politicians and actors with an economic background are dominant.

In order to identify the aspects of a technology to which the media coverage pays attention, the thematic context, in which the technology is embedded, is analyzed. While this is a primary interest of the majority of studies, different levels of detail are applied, however. In some analyses, the focus is on broad themes such as the role technology plays for health, economics or politics (e.g., Cacciatore et al. 2012; Claassen et al. 2012; Dudo et al. 2011; Maeseele and Schuurman 2008; Teräväinen 2014). Other studies analyze specific topics related to the technology in question either solely or in addition to a broader thematic category (e.g., Kohring et al. 2011; Nisbet and Lewenstein 2002). Again, the themes analyzed and thus the findings differ depending on the technology in question.

4 Research Desiderata

For the study of the media coverage of technology, it would be useful to increase the generalizability of results. So far, most of the analyses focus on the coverage of a single technology in a few media outlets in one country. Conducting more comprehensive and comparative content analyses could be achieved by, first, taking into account more than one technology or technology as an overall domain or not just one or a few but several media genres and outlets. Second, broadening the geographical context of the analyses would be useful. In order to provide an overview of the results so far obtained within the variety of individual case studies on the coverage of technologies, such as nanotechnology, meta analyses could be conducted.

Moreover, it would be beneficial to expand the analyses to media genres other than print media, in particular to online and social media, which has so far rarely been done. This could also include the more prominent use of automated content analysis and methods such as topic modelling. Similar to other areas of content analysis, a stronger focus on the multimodality of content would be desirable, e.g., by including the analysis of texts, visuals and other, often interactive, forms of presentation, such as gifs.

Furthermore, inconsistencies in the frequently applied framing approach impede the comparability of the results, which is why a common application of the framing approach or the development of generic frames for technology coverage regardless of the technology in question would be highly valuable. Related to that, the field would benefit from establishing a common understanding and measurement of risks and benefits related to a technology.

Relevant Variables in DOCA—Database of Variables for Content Analysis

Benefit/risk framing: https://doi.org/10.34778/2zl
Tone: https://doi.org/10.34778/2zn
Representation of actors and sources: https://doi.org/10.34778/2zm

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Dr. Gwendolin Gurr is Senior Research and Teaching Associate at the Department of Communication and Media Research at Université de Fribourg/Universität Freiburg. Her research interests include political communication, media use and effects.

Prof. Dr. Julia Metag is Professor at the Department of Communication at the University of Muenster, Germany. Her research interests include science communication, political communication, and media effects.