



CAN RISK MANAGEMENT PRACTICES FOSTER THE ROLE OF BIG DATA AND DATA ANALYTICS IN IMPROVING THE QUALITY OF HEALTHCARE SERVICES? EVIDENCE FROM A SURVEY AMONG HEALTHCARE PROFESSIONALS

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1. Introduction

The **quality of healthcare service** delivery is considered the most crucial aspect by decision-makers in the healthcare industry. Several models for assessing and assuring the **quality of healthcare services** have been defined in the literature (Arah et al., 2006; Carinci et al., 2015). One of the most used and recognized by healthcare organizations is the one defined by Avedis Donabedian (Donabedian, 1988). **Donabedian's model** provides a framework for assessing the **quality of healthcare services (QoHS)** by evaluating the "structure," the "process," and the "outcome". However, despite the existence of these models, the **QoHS** is often not guaranteed, since decisions in the healthcare industry are affected by **uncertainty** conditions that may cause **unexpected and often undesirable outcomes, i.e. risks** (Lipsitz, 2012). In fact, risk and uncertain conditions characterize the **healthcare industry** since it is a **complex system**, in which decisions are influenced by many variables, such as the complexity of the patient's disease and the involvement of various actors in the decision-making process, e.g., physicians, families and patients. Aiming to **mitigate** the effect of **uncertainty** on decisions, healthcare organizations have integrated both **established and innovative techniques** into their practices. **Risk management (RM)** is one of the most established. **RM** aims to improve the quality and delivery of healthcare services, through practices designed to **identify and prevent** circumstances that could expose a patient, physician, nurse or healthcare facility to the risk of an **adverse event**. Among the innovative techniques, there is the increasing adoption of techniques that exploit **big data and data analytics (BD-DA)** to cope with the **lack of information**, which is one of the **drivers of uncertainty** in the **healthcare** industry (Han et al., 2019). However, despite the growing number of studies in the literature focusing on the use of **BD-DA in healthcare** (Malik et al., 2018) and the more established topic on the use of the **RM practices** (Cagliano et al., 2011) to **support decision-making** under conditions of **uncertainty**, to the best of the authors' knowledge, no empirical study has examined whether the **RM practice may foster the role of BD-DA to improve the QoHS**.

2. Research Questions

- 1) Does the use of **Big Data and Data Analytics** influence the **Quality of Healthcare Services**?
- 2) Does the use of **Big Data and Data Analytics** influence **Risk Management** practices?
- 3) Does the use of **Risk Management** practices influence the **Quality of Healthcare Services**?
- 4) Does the use of **Risk Management** practices mediate the relationship between the use of **Big Data and Data Analytics** and **Quality of Healthcare Services**?

3. Hypothesis

- **H1.** The use of **BD-DA** has a positive effect on the **QoHS**. (Aceto et al., 2020; Nenova and Shang, 2022; Salazar-Reyna et al., 2020).
- **H2.** The use of **BD-DA** has a positive influence on **RM practices** in the different phases: **H2a Risk Identification, H2b Risk Assessment, H2c Risk Treatment, H2d Risk Monitoring**. (Nenova and Shang, 2022; Schwendimann et al., 2018; Tartaglia et al., 2012)
- **H3.** The use of **RM practices** in the different phases (**H3a Risk Identification, H3b Risk Assessment, H3c Risk Treatment, and H3d Risk Monitoring**) has a positive effect on **QoHS**. (Odono et al., 2019; Schwendimann et al., 2018)
- **H4.** The use of **RM (H4a Risk Identification, H4b Risk Assessment, H4c Risk Treatment, and H4d Risk Monitoring)** practices in healthcare organizations can **positively mediate** the relationship between the use of **BD-DA** and the **QoHS**. (Aceto et al., 2020; Weerasinghe et al., 2022 La Russa and Ferracuti, 2022)

5. Sample and Survey

Sample:

Healthcare professionals from 100 Italian organizations (Chief Executive Officer, Chief Administrative Officer, Chief Medical Officer, UO Directors, Department Directors, Medical Executives, Physicians).

Survey:

1. Use of Big Data and Data Analytics: 11 items
 2. Risk Identification: 5 items
 3. Risk Assessment: 5 items
 4. Risk Treatment: 4 items
 5. Risk Monitoring: 4 items
 6. Quality of Healthcare Services: 12 items
 7. Demographic characteristics
- Likert Scale ranging from 1= strongly disagree to 5= strongly agree
- Tested by 6 Healthcare Professionals

6. Data Analysis

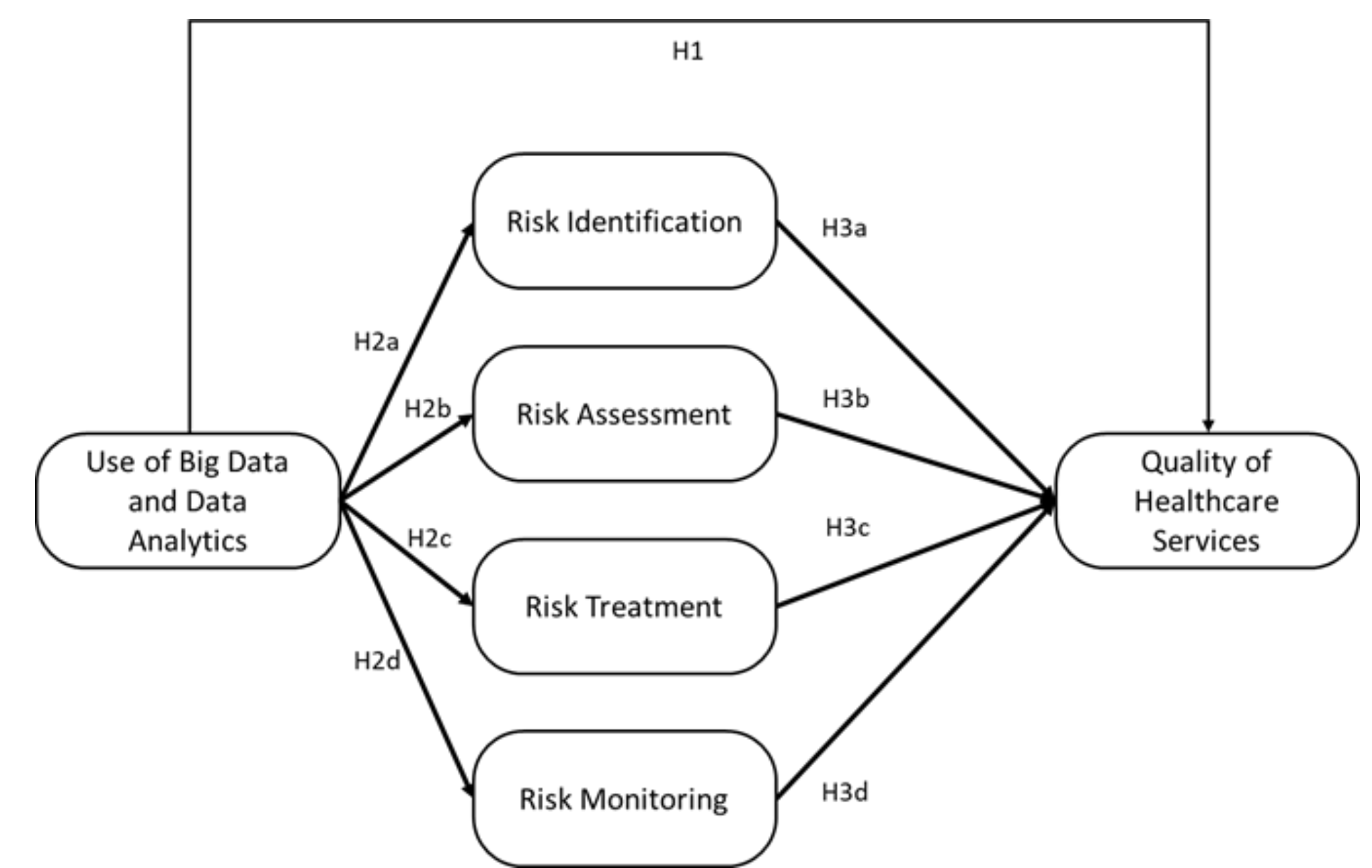
2-step PLS-SEM method (Hair et al., 2019):

1. **Measurement Model**
 - Loadings analysis
 - Internal consistency reliability
 - Convergent Validity
 - Discriminant Validity
 2. **Structural Model**
 - Bootstrapping Algorithm (5000 iterations)
- SMART-PLS software: Version 4.0.8.4

7. Respondents

Demographic Characteristics			Frequency	Valid per cent	49 respondents	
Gender						
Female	18	36.73%				
Male	30	61.22%				
Prefer not to say	1	2.04%				
Region						
Abruzzo	1	2.04%				
Basilicata	2	4.08%				
Calabria	4	8.16%				
Campania	3	6.12%				
Emilia Romagna	4	8.16%				
Friuli venezia giulia	1	2.04%				
Lazio	5	10.20%				
Liguria	3	6.12%				
Lombardia	4	8.16%				
Piemonte	2	4.08%				
Puglia	13	26.53%				
Sardegna	2	4.08%				
Toscana	1	2.04%				
trentino alto adige	1	2.04%				
Umbria	1	2.04%				
Veneto	2	4.08%				
Role						
Chief Administrative Officer	1	2.04%				
Department Directors	4	8.16%				
Chief Medical Officer	1	2.04%				
UO Directors	25	51.02%				
Medical Executives	15	30.61%				
Physician	1	2.04%				
Nurse	1	2.04%				
ICT manager	1	2.04%				

4. Research Model



H4a: BD-DA → RI → QoHS
H4b: BD-DA → RA → QoHS
H4c: BD-DA → RT → QoHS
H4d: BD-DA → RM → QoHS

8. Results

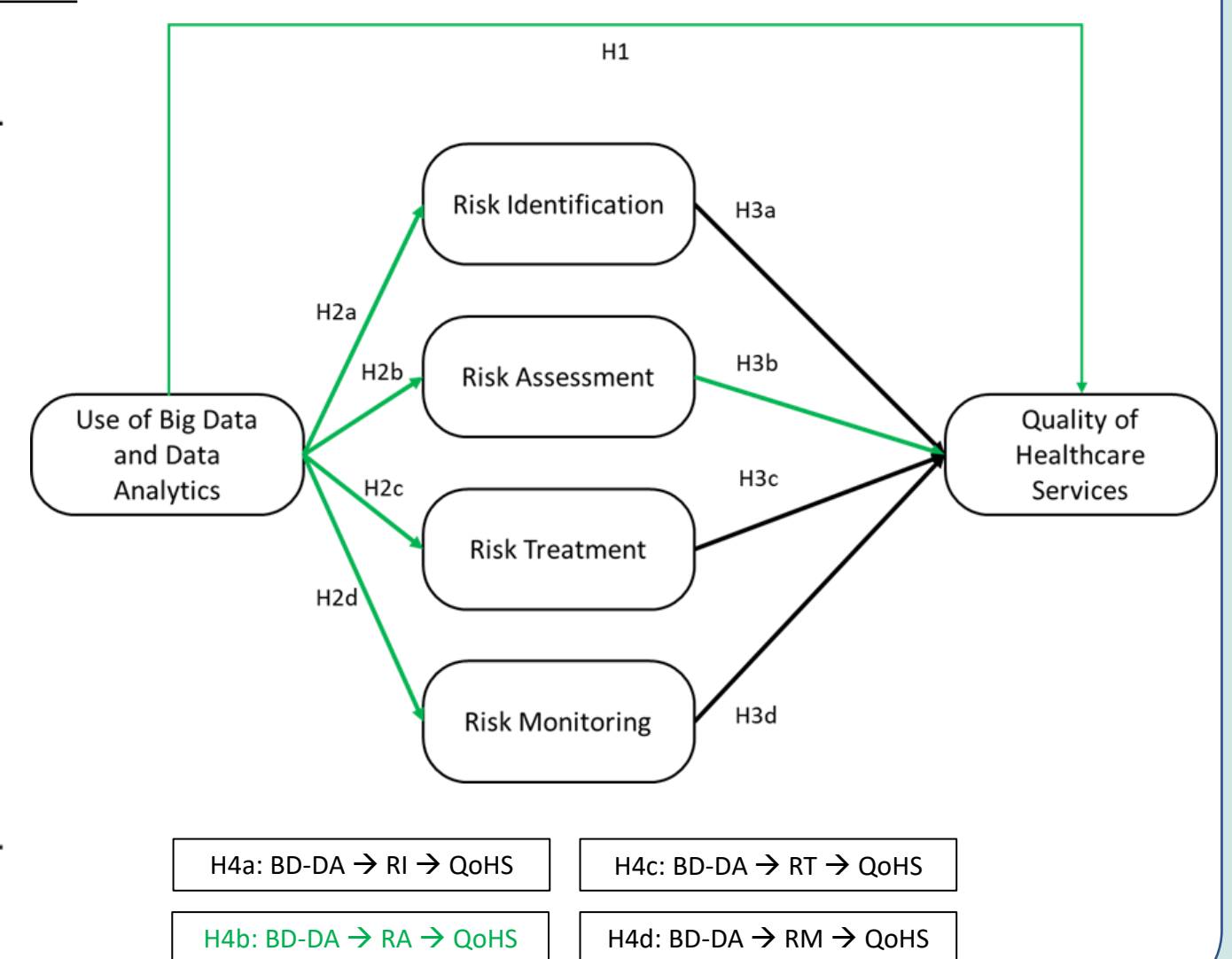
Measurement Model

	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)	BD-DA	QoHS	RA	RI	RMo	RT
BD-DA	0.878	0.900	0.502	0.708					
QoHS	0.919	0.930	0.526	0.524	0.725				
RA	0.928	0.946	0.778	0.362	0.558	0.882			
RI	0.715	0.813	0.521	0.438	0.576	0.717	0.722		
RMo	0.905	0.940	0.841	0.521	0.542	0.593	0.581	0.917	
RT	0.885	0.921	0.744	0.511	0.513	0.592	0.583	0.800	0.862

Structural Model

	Original sample	Sample mean	Standard deviation	T statistics	P values
H1	0.278	0.270	0.167	1.666	0.048**
H2a	0.362	0.391	0.112	3.234	0.001***
H2b	0.438	0.513	0.145	3.027	0.001***
H2c	0.521	0.535	0.114	4.559	0.000***
H2d	0.511	0.524	0.130	3.929	0.000***
H3a	0.216	0.229	0.188	1.149	0.125
H3b	0.188	0.233	0.162	1.343	0.090*
H3c	0.140	0.140	0.195	0.718	0.236
H3d	0.005	-0.010	0.181	0.028	0.489
H4a	0.073	0.073	0.110	0.665	0.253
H4b	0.079	0.083	0.060	1.310	0.095*
H4c	0.003	-0.001	0.098	0.027	0.489
H4d	0.095	0.120	0.104	0.914	0.180

* p<0.1; ** p<0.05; *** p<0.01



9. Conclusions and Implications

- This study **provides evidence** on the use of **BD-DA** in healthcare organizations: the use of **BD-DA** is spreading and revolutionizing the decision-making process in healthcare, fostering more informed decisions **leading to a positive effect** on the **QoHS (H1)** and enabling the **use of RM** practices to manage adverse events (**H2**). As main implication, we suggest that healthcare managers and professionals should be aware of the relevance and value of **BD-DA**, either for quality improvement or for managing adverse events, and thus encourage their collection and use in healthcare organizations.
- This study **contributes** to the body of knowledge about **quality of services in healthcare** by providing empirical evidence to **unveil the actual effect** of using **Risk Assessment (RA)** practices on the **QoHS**: the **RA** practices have a positive influence on the **QoHS (H3b)**. The role of other **RM** practices (risk identification, risk treatment, and risk monitoring) do not have a clear effect on **QoHS**, revealing the need to clarify the role of these practices in ensuring the **QoHS** in the healthcare organization .
- This study **demonstrates** that the use of **RM** practices in healthcare organizations can **positively mediate** the relationship between the use of **BD-DA** and the **QoHS (H4b)**: a part of the **positive influence** that **BD-DA** have on the **QoHS** is due to the use of **RA** practices, thus implying that using **RA** practices fosters the use of **BD-DA** to improve the **QoHS**. This result can be explained by the characteristics of **RA** practices, since these practices **rely on** available **data** and **information** to carry out the **assessment of the likelihood and impact of adverse events**.
- Limitations: small and not comprehensive sample

10. References

- Aceto, G., Persico, V., Pescapé, A., 2020. Industry 4.0 and Health: Internet of Things, Big Data, and Cloud Computing for Healthcare 4.0. J. Ind. Inf. Integr. 18, 100129.
- Arah, O.A., Westert, G.P., Hurst, J., Klazinga, N.S., 2006. A conceptual framework for the OECD Health Care Quality Indicators Project. Int. J. Qual. Health Care J. Int. Soc. Qual. Health Care 18 Suppl 1, 5–13.
- Cagliano, A.C., Grimaldi, S., Rafele, C., 2011. A systemic methodology for risk management in healthcare sector. Saf. Sci. 49, 695–708.
- Carinci, F., Van Gool, K., Mainz, J., Veillard, J., Pichora, E.C., Januel, J.M., Arispe, I., Kim, S.M., Klazinga, N.S., OECD Health Care Quality Indicators Expert Group, 2015. Towards actionable international comparisons of health system performance: expert revision of the OECD framework and quality indicators. Int. J. Qual. Health Care 27, 137–146.
- Donabedian, A., 1988. The Quality of Care: How Can It Be Assessed? JAMA 260, 1743–1748.
- Hair, J.F., Risher, J.J., Sarstedt, M., Ringle, C.M., 2019. When to use and how to report the results of PLS-SEM. Eur. Bus. Rev. 31, 2–24.
- Han, P.K.J., Babrow, A., Hillen, M.A., Gulbrandsen, P., Smets, E.M., Olstad, E.H., 2019. Uncertainty in health care: Towards a more systematic program of research. Patient Educ. Couns. 102, 1756–1766.
- La Russa, R., Ferracuti, S., 2022. Clinical Risk Management: As Modern Tool for Prevention and Management of Care and Prevention Occupational Risk. Int. J. Environ. Res. Public. Health 19, 831.
- Lipsitz, L.A., 2012. Understanding health care as a complex system: the foundation for unintended consequences. JAMA 308, 243–244.
- Malik, M.M., Abdallah, S., Alaraj, M., 2018. Data mining and predictive analytics applications for the delivery of healthcare services: a systematic literature review. Ann. Oper. Res.
- Nenova, Z., Shang, J., 2022. Personalized Chronic Disease Follow-Up Appointments: Risk-Stratified Care Through Big Data. Prod. Oper. Manag. 31, 583–606.
- Odono, A., Bossi, E., Gaeta, M., Garancini, M.P., Orlandi, C., Cuppone, M.T., Signorelli, C., Nicastro, O., Zotti, C.M., 2019. Risk Management in healthcare: Results from a national-level survey and scientometric analysis in Italy.
- Salazar-Reyna, R., Gonzalez-Aleu, F., Granda-Gutierrez, E.M.A., Diaz-Ramirez, J., Garza-Reyes, J.A., Kumar, A., 2020. A systematic literature review of data science, data analytics and machine learning applied to healthcare engineering systems. Manag. Decis. 60, 300–319.
- Schwendimann, R., Blatter, C., Dhaini, S., Simon, M., Ausserhofer, D., 2018. The occurrence, types, consequences and preventability of in-hospital adverse events – a scoping review. BMC Health Serv. Res. 18, 521.
- Tartaglia, R., Albolino, S., Bellandi, T., Bianchini, E., Biggeri, A., Fabbro, G., Bevilacqua, L., Dell'Era, A., Privitera, G., Sommella, L., 2012. Adverse events and preventable consequences: retrospective study in five large Italian hospitals. Epidemiol. Prev. 36, 151–161.
- Weerasinghe, K., Scallill, S.L., Paulsen, D.J., Taskin, N., 2022. Big data analytics for clinical decision-making: Understanding health sector perceptions of policy and practice. Technol. Forecast. Soc. Change 174.