



**Doctoral School  
of International  
Relations and  
Political Science**

## **THESIS SUMMARY**

to the PhD dissertation of

**Iga Katarzyna Kender-Jeziorska**

titled

**Understanding the Determinants of Policy  
Performance in Collaborative Context: The  
Case of Drug Harm Reduction Services in  
Central-Eastern Europe**

**Supervisor:**

**György Hajnal, PhD**

associate professor

Budapest, 2022

**Department of Public Policy and  
Management**

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# 1. Research background and justification of the topic

This dissertation results from my ten-year-long journey in the drug policy field. This journey involved research work, starting with my first drugs-related research back in 2012 at the University of Warsaw and continuing and expanding ever since. It also included extensive practitioner experience, with establishing a small student association in Warsaw in 2011, to subsequently work for and with dozens of national and international organisations, and to – finally – lead a European-level foundation gathering NGOs from more than 20 countries and advising the European Commission.

During my practitioner work, I have realised that there are significant between-country differences in the performance of services for people who use drugs. One can observe this high variance even in Central-Eastern Europe, where countries are characterised by a high level of similarity concerning many policy-related aspects.

The research addressing possible reasons for such differences is virtually non-existent. The available data only includes process or output indicators without

addressing broader context. There is no data that would provide a more complex picture of the situation – ways of delivering services, barriers in their delivery, policy and political context of service provision.

This dissertation aims to address this gap and contribute to a more in-depth understanding of how policy performance is affected by policy formulation and implementation in a policy field that is essentially collaborative (as I argue in the following paragraphs).

The specific focus of this work is on drug policy (and within it, harm reduction policy) and countries of the Visegrád Group as a context that is especially suitable for investigating the problem.

The choice of drug policy and – within it – harm reduction for investigating the problem of policy performance was motivated primarily by its intersectoral character. This is understood both in terms of encompassing several policy areas and extensive involvement of non-state actors (in this particular case, non-governmental organisations) in policy implementation. In drug policy – and especially harm reduction – being the (ideal)typical example of a 'wicked' policy problem, the substantial part of the policy implementation is non-state actors' task (Head, 2008). As

such, it is a policy field especially suitable for investigating policy performance and factors influencing it in a collaborative context.

The geographical scope of the work is Central-Eastern Europe. More specifically, I focus on countries forming the Visegrád Group (V4): Czechia, Hungary, Poland, and Slovakia. The V4 countries are highly suitable for comparative analyses of politics and policies (and, especially, their variance) due to significant similarities between them, including, among others, the generally poor condition of civil society, challenging policy environment of NGOs, and reluctance towards involving non-state actors in policy process. Importantly, however, there is one significant difference between them, namely, the extent of departure from the liberal democratic principles in policymaking, described as – among others – de-democratisation (Ágh, 2015), a U-turn (Kornai, 2015) or democratic recession (Diamond, 2015), which can be observed over the last several years in Hungary and Poland. State-NGO relationships are one field where signs of the illiberal turn manifest themselves. Given the above, the four selected countries are an excellent geographical scope for comparative research.

In terms of temporal scope, the work focuses on 2010-2019.

To sum up, there is an exciting puzzle here – a policy field where especially policy implementation requires strong cooperation with NGO-type entities on the one hand, and policymaking context, which does not favour such collaboration. Additionally, in two out of four chosen countries, the environment of non-governmental organisations recently turned from disregarding to openly hostile, and policymaking became even less participatory than before.

This work is a portfolio dissertation comprising three peer-reviewed articles, amended with a general introduction and overarching methodological remarks in the beginning, and conclusions at the end. Each article approaches a different aspect of policymaking, and as such, they complement one another. Particular focus is put on policy performance and various factors affecting it.

## 2. Methodology

All the papers comprising this work use the qualitative method. More specifically, all of them are, in essence, comparative qualitative case studies of exploratory nature.

The first article of the dissertation (Chapter 2) focuses on the relationship between policy formulation and policy performance in the lenses of a morality policy analytical framework. The paper aims to explore the relationships between policy formulation and policy outputs through (1) identifying the dominant frame used to outline drug policy in a country, (2) assessing the performance of harm reduction policy, (3) identifying possible relationships between (1) and (2). The article's research question is: What, if any, is the relationship between drug policy framing and the harm reduction policy performance?

To answer the research question, the article uses an analytical framework on policy framing borrowed from Euchner and colleagues, who differentiate between four frames: morality, health and social, security and public order, and economic and fiscal (Euchner et al., 2013). The article includes a quantitative content analysis of relevant parts of countries' national drug strategies to classify them into policy frame categories. The policy performance is assessed based on country-level data of the European Monitoring Centre for Drugs and Drug Addiction.

The second article (Chapter 3) addresses the issue of how illiberal governance affects collaborative governance. The



article asks: What are the ideal types of collaborative governance regimes? And: How do CGRs within drug harm reduction policy differ in illiberal democracies compared with their non-illiberal (or less illiberal) counterparts in CEE?

It applies qualitative comparative case study design combined with congruence analysis (Blatter & Haverland, 2012). This approach includes the following steps: (i) developing a typology of collaborative governance regimes; (ii) identifying dimensions (variables) describing collaborative governance regimes and allowing for differentiation and comparison between them; (iii) determining the values of each dimension for each type of collaborative governance regime identified. Taken together, these steps produce a so-called prediction matrix, which allows for (iv) classifying the cases according to collaborative governance regime type, based on empirical data.

The analysed data include documentary analysis (primarily the legislation and other subsequent regulations, and policy documents of the countries concerned and reports relevant to our area of interest) and is supplemented and contrasted with the perspectives of

NGOs as entities historically being in the centre of harm reduction responses. Key-informants are selected using purposive sampling (Tongco, 2007), complemented by the snowball method (Goodman, 1961) and taking into consideration convenience.

The third article (Chapter 4) aims to fill the gap in the literature on the delivery of drug-related services and contribute to the study of policy implementation. It attempts to determine: (i) what are the structural factors affecting the functioning of NSPs, (ii) how they vary between examined countries, and (iii) how they influence the provision of needle exchange services.

This study uses an embedded multiple-case comparative case study design complemented by within-case analysis. The data is collected through semi-structured interviews.

The data collected through interviews are complemented by analysis of relevant documents, reports, and online resources, primarily the countries' criminal codes and acts addressing controlled substances, drug strategies and action plans, and reports. The analysis involves coding the data segments, using data-derived codes in the iterative process of de-contextualising and re-contextualising data units. Subsequently, aggregated data for each country are

reviewed to identify common themes and detect possible irregularities on a higher level of abstraction. Twenty-four identified coherent themes are organised into 11 categories. Subsequently, borrowing from the consolidated framework for advancing implementation science (Damschroder et al., 2009), identified themes are rated based on two aspects: the valence and the strength. In other words, it is assessed whether the influence of a factor is positive, negative, mixed or neutral and to what extent it impacts the needle exchange programmes' operation.

The interview data used in Chapters 3 and 4 of this dissertation was obtained between 2015 and 2019 from 20 key informants, mainly occupying managerial positions in NGOs providing needle exchange programmes in major cities. The interviews were semi-structured and conducted using an interview protocol including 15 questions relating to the daily operation of the organisations, external relations (with clients, donors, public authorities, local communities, other NGOs). All the interviews were recorded and transcribed verbatim by the author. The average time of one interview was approximately 90 minutes.

### 3. The findings of dissertation

#### 3.1. The findings of the first article

The analysis of countries' drug strategies revealed strong health and social orientation of the Czech drug policy and somewhat weaker such orientation in the case of Slovakia. In Hungary, the 'morality' frame was dominant in the country's drug policy, while in Poland, no frame was identified due to the highly technical character of the document.

The examined policy outputs of needle exchange programmes were poor in Hungary and Poland. The highest indicators' levels were observed in the Czech Republic. In the case of Slovakia, finally, the picture was more complex, with generally meagre performance on the country level and in the context of the entire population of people who use drugs, and much better performance at the organisation level (e.g. the number of distributed injecting paraphernalia per NSP client in an organisation).

The case of Hungary suggests the association between morality framing and poor (and deteriorating) policy outcomes (specifically, the accessibility and quality of needle exchange programmes). Second, the case of Czechia suggests the association between strong health-

social orientation and excellent policy outcomes (with modest improvement over time) in the area of harm reduction.

### 3.2. The findings of the second article

The article addresses the problem of policy implementation in a collaborative field, looking at how types of collaborative governance depend on the essential contextual macro-political and policy features, which are the key factors affecting policy performance.

Three findings, in particular, are central to the research objective.

Firstly, taking an approach assuming the significant role of governments in shaping collaborative governance (as opposed to spontaneous occurrence), and including possible neutral and hostile government attitudes towards collaborative governance (as opposed to different levels of pro-collaborative attitudes existing in the scholarship hitherto), a conceptual classification of collaborative governance regimes was developed, and regimes were operationalised along a number of observable features.

Secondly, only Czechia unquestionably exhibited the features of a pro-collaborative regime. Poland and

Slovakia, meanwhile, were located between pro-collaborative and neutral collaborative governance regimes. Importantly, however, one case – Hungary – indisputably qualified as an anti-collaborative governance regime – a regime distinctly different from the customary ‘neutral collaborative governance regime’ characteristic for many countries in CEE (and elsewhere). This ‘anti-collaborative regime’ predominantly differs from earlier ones in that it openly and deliberately impedes harm reduction NGOs.

Thirdly, but no less importantly, this anti-collaborative regime appeared in only one of the two illiberal cases, namely Hungary, while it was absent from Poland. Nevertheless, although not covered by the empirical research, it seems justified to mention that an anti-collaborative regime very similar to the one identified in Hungary is also present in Poland, not in harm reduction policy, but in reproductive and women’s rights and the services and advocacy activities attached to them.

In sum, it seems that the specifically anti-collaborative element of collaborative governance regimes in CEE – where they exist at all – does not appear uniformly across different policy areas. On the contrary, large segments of

the NGO community and the corresponding collaborative governance arrangements operate practically untouched by illiberalism. The illiberal doctrine is found only in a few policy areas, which embody, ideologically and politically, an antithesis of the worldviews held by the ruling political parties.

### 3.3. The findings of the third article

This study identified 24 themes (structural barriers and facilitators) across 11 categories on three levels (culture, state, local). They included issues related to the broader society (e.g., morality), politics and policy on state and local level, frameworks and amounts of funding, the situation on the education labour market, and attitudes of local communities.

Based on the analysed data, it seems that structural barriers play a significant role when it comes to the performance of service delivery. Both cross-case and within-case analysis confirmed that the numerous and severe structural barriers are related to poor performance of needle exchange programmes, and the other way around, the presence of numerous facilitators is related to services' development.

Overall, the dissertation contributes to understanding policy performance in essentially collaborative settings. The results show the vital role of policy standards and objectives in determining the policy effects. However, perhaps even more notably, the study confirms, in line with the third-generation implementation researchers' observations (and especially scholars focused on network governance), the remarkable role of relationships between actors and level of conflict in affecting policy performance. It shows that in a complex policy field like drugs, collaboration is essential for achieving satisfactory policy effects (O'Toole, 1988). Further, the dissertation demonstrates that 'policy implementation is far from being a trivial activity' (Knill & Tosun, 2012) and highlights the importance of specific policy programmes' institutional context (McLaughlin, 1987).

The principal value of this dissertation lies in its aim of exploring the policymaking process and explaining policy performance in case of a highly contested policy field, where conflicts around policy formulation and implementation include not only more technical considerations of choice of policy instruments, etc. but, first and foremost, disagreements on deep beliefs and



values. Focusing on such a context made it possible to reveal challenges in the policy process that are clearly different from factors we can find in most implementation studies, which often focus on much less contested policy fields.

The analytical approach, especially the development of the typology of collaborative governance regimes and adoption of the ecological framework for studying organisations, may serve as an inspiration and be applied by other researchers to investigate other, similar policy fields and policy issues, e.g., reproductive rights, migration, assisted suicide, homelessness, etc.

The results of the dissertation also have considerable practical application. First, they can guide decision-makers regarding how to design and implement controversial policies to minimise the influence of factors undermining policy performance. Second, they may contribute to the advocacy efforts of drug-related non-governmental organisations in negotiating policy solutions. Third, they can serve as an important source of information for international organisations like, for example, the European Union, in mapping the challenging

policy environments and addressing them in their own policy strategies.

#### 4. Main references

- Ágh, A. (2015). De-Europeanization and de-democratization trends in ECE: From the Potemkin democracy to the elected autocracy in Hungary. *Journal of Comparative Politics*, 8(2), 4–26.
- Ansell, Chris, and Alison Gash. 2007. 'Collaborative Governance in Theory and Practice'. *Journal of Public Administration Research and Theory* 18(4):543–71. doi: 10.1093/jopart/mum032.
- Babor, Thomas, Jonathan P. Caulkins, Griffith Edwards, Benedikt Fischer, David R. Foxcroft, Keith Humphreys, Isidore S. Obot, Jürgen Rehm, Peter Reuter, Robin Room, Ingeborg Rossow, and John Strang. 2010. *Drug Policy and the Public Good*. Oxford; New York: Oxford University Press.
- Bartha, Attila, Zsolt Boda, and Dorottya Szikra. 2020. 'When Populist Leaders Govern: Conceptualising Populism in Policy Making'. *Politics and Governance* 8(3). doi: 10.17645/pag.v8i3.2922.
- Bedwell, Wendy L., Jessica L. Wildman, Deborah DiazGranados, Maritza Salazar, William S. Kramer, and Eduardo Salas. 2012. Collaboration at Work: An Integrative Multilevel Conceptualization. *Human Resource Management Review* 22(2):128–45. doi: 10.1016/j.hrmr.2011.11.007.
- Bingham, Lisa Blomgren. 2011. 'Collaborative Governance'. in *The SAGE handbook of governance*. London: Sage Publications.

- Birkland, Thomas A. 2010. *An Introduction to the Policy Process: Theories, Concepts, and Models of Public Policy Making*. 3rd ed. Armonk, NY: M.E. Sharpe.
- Blatter, J., & Haverland, M. (2012). Congruence analysis. In *Designing case studies: Explanatory approaches in small-N research*. Palgrave Macmillan UK.
- van der Borgh, Chris, and Carolijn Terwindt. 2012a. 'Shrinking Operational Space of NGOs – a Framework of Analysis'. *Development in Practice* 22(8):1065–81. doi: 10.1080/09614524.2012.714745.
- Bronfenbrenner, Urie. 1979. *The Ecology of Human Development*. Cambridge: Harvard University Press.
- Bryson, John M., Barbara C. Crosby, and Melissa Middleton Stone. 2006. 'The Design and Implementation of Cross-Sector Collaborations: Propositions from the Literature'. *Public Administration Review* 66(s1):44–55. doi: 10.1111/j.1540-6210.2006.00665.x.
- Burris, Scott, Kim M. Blankenship, Martin Donoghoe, Susan Sherman, Jon S. Vernick, Patricia Case, Zita Lazzarini, and Stephen Koester. 2004. 'Addressing the "Risk Environment" for Injection Drug Users: The Mysterious Case of the Missing Cop'. *The Milbank Quarterly* 82(1):125–56. doi: 10.1111/j.0887-378X.2004.00304.x.
- Christie, Nils. 1986. 'Suitable Enemy'. in *Abolitionism: toward a non-repressive approach to crime*. Amsterdam: Free University Press.
- Cianetti, Licia, James Dawson, and Seán Hanley. 2018. 'Rethinking "Democratic Backsliding" in Central and Eastern Europe – Looking beyond Hungary and Poland'. *East European Politics* 34(3):243–56. doi: 10.1080/21599165.2018.1491401.
- Damschroder, L. J., Aron, D. C., Keith, R. E., Kirsh, S. R., Alexander, J. A., & Lowery, J. C. (2009). Fostering implementation of health services research findings into

practice: A consolidated framework for advancing implementation science. *Implementation Science*, 4(1), 50. <https://doi.org/10.1186/1748-5908-4-50>

Diamond, L. (2015). Facing up to the democratic recession. *Journal of Democracy*, 26(1), 141–155. <https://doi.org/10.1353/jod.2015.0009>

Dunn, W. N., Staronova, K., & Pushkarev, S. (2006). Implementation – the missing link. In *Implementation—The missing link in public administration reform in Central and Eastern Europe* (pp. 13–25). NISPAcee.

Elmore, Richard F. 1985. ‘Forward and Backward Mapping: Reversible Logic in the Analysis of Public Policy’. Pp. 33–70 in *Policy implementation in federal and unitary systems*, edited by K. Hanf and T. A. J. Toonen. Dordrecht: Springer Netherlands.

Emerson, Kirk, and Tina Nabatchi. 2015. *Collaborative Governance Regimes*. Washington, D.C: Georgetown University Press.

Emerson, Kirk, Tina Nabatchi, and Stephen Balogh. 2012. ‘An Integrative Framework for Collaborative Governance’. *Journal of Public Administration Research and Theory* 22(1):1–29. doi: 10.1093/jopart/mur011.

Euchner, E.-M., Heichel, S., Nebel, K., & Raschok, A. (2013). From ‘morality’ policy to ‘normal’ policy: Framing of drug consumption and gambling in Germany and the Netherlands and their regulatory consequences. *Journal of European Public Policy*, 20(3), 372–389. <https://dx.doi.org/10.1080/13501763.2013.761506>

Goggin, M. L., Bowman, A. O., Lester, J. P., & O’Toole, L. J., Jr. (Eds.). (1990). *Implementation theory and practice: Toward a third generation*. Scott, Foresman/Little, Brown Higher Education.

- Goode, Erich, and Nachman Ben-Yehuda. 2009. 'The Moral Panic: An Introduction'. in *Moral panics: The social constructs of deviance*. Oxford: Blackwell Publishing Ltd.
- Goodman, L. A. (1961). Snowball sampling. *The Annals of Mathematical Statistics*, 32(1), 148–170.
- Hajnal, György, and Miklós Rosta. 2016. 'A New Doctrine in the Making? Doctrinal Foundations of Sub-National Governance Reforms in Hungary (2010-2014)'. *Administration & Society* 009539971562620. doi: 10.1177/0095399715626202.
- Head, B. W. (2008). Wicked problems in public policy. *Public Policy*, 3(2), 101–118.
- Heichel, Stephan, Christoph Knill, and Sophie Schmitt. 2013. 'Public Policy Meets Morality: Conceptual and Theoretical Challenges in the Analysis of Morality Policy Change'. *Journal of European Public Policy* 20(3):318–34.
- Hill, Michael J., and Peter L. Hupe. 2002. *Implementing Public Policy: Governance in Theory and Practice*. London; Thousand Oaks, Calif: Sage.
- Howard, Marc Morje. 2003. 'The Weakness of Postcommunist Civil Society'. *Journal of Democracy* 13(1):157–69. doi: 10.1353/jod.2002.0008.
- Howlett, Michael. 2014. 'From the "Old" to the "New" Policy Design: Design Thinking beyond Markets and Collaborative Governance'. *Policy Sciences* 47(3):187–207. doi: 10.1007/s11077-014-9199-0.
- Klijin, E. H., and J. F. M. Koppenjan. 2000. 'Public Management and Policy Networks: Foundations of a Network Approach to Governance'. *Public Management: An International Journal of Research and Theory* 2(2):135–58. doi: 10.1080/14719030000000007.
- Knill, Christoph. 2013. 'The Study of Morality Policy: Analytical Implications from a Public Policy Perspective'.

*Journal of European Public Policy* 20(3):309–17. doi: 10.1080/13501763.2013.761494.

Knill, C., & Tosun, J. (2012). *Public policy: A new introduction*. Palgrave Macmillan.

Kornai, J. (2015). Hungary's U-Turn: Retreating from Democracy. *Journal of Democracy*, 26(3), 34–48. <https://doi.org/10.1353/jod.2015.0046>

Lipsky, Michael. 2010. *Street-Level Bureaucracy: Dilemmas of the Individual in Public Services*. 30th anniversary expanded ed. New York: Russell Sage Foundation.

Matland, Richard E. 1995. 'Synthesizing the Implementation Literature: The Ambiguity-Conflict Model of Policy Implementation'. *Journal of Public Administration Research and Theory*. doi: 10.1093/oxfordjournals.jpart.a037242.

McLaughlin, M. W. (1987). Learning from experience: Lessons from policy implementation. *Educational Evaluation and Policy Analysis*, 9(2), 171–178. <https://doi.org/10.3102/01623737009002171>

McNamara, Madeleine. 2012. 'Starting to Untangle the Web of Cooperation, Coordination, and Collaboration: A Framework for Public Managers'. *International Journal of Public Administration* 35(6):389–401. doi: 10.1080/01900692.2012.655527.

Meier, Kenneth J. 1994. 'The Politics of Sin'. Pp. 242–55 in *The politics of sin: Drugs, alcohol and public policy*. Armonk, NY: M. E. Sharpe.

Meier, Kenneth J. 1999. 'Drugs, Sex, Rock, and Roll: A Theory of Morality Politics'. *Policy Studies Journal* 27(4):681–95. doi: 10.1111/j.1541-0072.1999.tb01996.x.

Osborne, Stephen P. 2006. 'The New Public Governance?' *Public Management Review* 8(3):377–87. doi: 10.1080/14719030600853022.

O'Toole, Laurence J., Jr. 2000. 'Research on Policy Implementation: Assessment and Prospects'. *Journal of Public Administration Research and Theory* 10(2):263–88. doi: 10.1093/oxfordjournals.jpart.a024270.

O'Toole, L. J. (1988). Strategies for intergovernmental management: implementing programs in interorganizational networks. *International Journal of Public Administration*, 11(4), 417–441.

<https://doi.org/10.1080/01900698808524596>

Rhodes, Tim. 2009. 'Risk Environments and Drug Harms: A Social Science for Harm Reduction Approach'. *International Journal of Drug Policy* 20(3):193–201. doi: 10.1016/j.drugpo.2008.10.003.

Rhodes, Tim, and Milena Simic. 2005. 'Transition and the HIV Risk Environment'. *BMJ* 331(7510):220–23. doi: 10.1136/bmj.331.7510.220.

Rhodes, Tim, Gerry V. Stimson, Nick Crofts, Andrew Ball, Karl Dehne, and Lev Khodakevich. 1999. 'Drug Injecting, Rapid HIV Spread, and the "Risk Environment": Implications for Assessment and Response'. *AIDS* 13(Suppl.A):259–69.

Rupnik, Jacques, and Jan Zielonka. 2013. 'The State of Democracy 20 Years on: Domestic and External Factors'. *East European Politics and Societies: And Cultures* 27(1):3–25. doi: 10.1177/0888325412465110.

Tongco, Ma. D. C. (2007). Purposive sampling as a tool for informant selection. *Ethnobotany Research & Applications*, 5, 147–158.

Van Meter, Donald S., and Carl E. Van Horn. 1975. 'The Policy Implementation Process: A Conceptual Framework'. *Administration & Society* 6(4):445–88. doi: 10.1177/009539977500600404.

Wood, Donna J., and Barbara Gray. 1991. 'Toward a Comprehensive Theory of Collaboration'. *Journal of Applied Behavioral Science* 27:139–62.

Yin, Robert K. 2003. *Case Study Research: Design and Methods*. 3rd ed. Thousand Oaks, CA: Sage Publications.

## 5. List of own (or co-authored) publications related to the topic

**Iga Jeziorska (2021).** A Sin or a Health Issue? Morality Policy Framing and the State of Harm Reduction in East-Central Europe. *Intersections* 7(1):97–115, DOI: 10.17356/ieejsp.v7i1.695

**György Hajnal, Iga Jeziorska (2021).** Collaborative Governance Regimes in Illiberal Democracies: A Comparative Case of Drug Harm Reduction Policy in Central-Eastern Europe. *Transylvanian Review of Administrative Sciences* 62 E/2021(62 E):60-80, DOI: 10.24193/tras.62E.4

**Iga Kender-Jeziorska (2019).** Needle exchange programmes in Visegrad countries: a comparative case study of structural factors in effective service delivery. *Harm Reduction Journal* 16, Article number: 54, DOI: 10.1186/s12954-019-0323-5



