Interpretive structural modelling of inter-agency collaboration risk in public safety networks

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Abstract

Inter-agency collaboration is a well-established, yet very difficult process in public governance. Despite the fact that it is often unsuccessful, collaboration risk research is still undeveloped and the impact of this risk on the effectiveness of joint activities is still underestimated. This issue is of particular significance in public safety networks, where inter-agency collaboration processes are conducted under the conditions of the complexity and uncertainty. For this reason, the article is intended to: (1) identify factors of collaboration risk in public safety networks, (2) determine the impact of individual risk factors on inter-agency collaboration outcomes, (3) identify the relationship between risk factors of inter-agency collaboration in public safety networks, and (4) analyse the growth of this risk in public safety networks. These purposes were achieved using the Systematic Literature Review based on PRISMA Group methodology and Interpretive Structural Modelling together with MICMAC analysis. The applied research approach also has some limitations resulting from the number of experts. However, the results obtained allow us to better understand issues of inter-agency collaboration risk in public safety networks. They identify key collaboration risk factors, such as inappropriate collaboration rules and inadequate allocation of tasks and resources. In consequence, they indicate risk symptoms that are worth keeping track of in order to prevent collaboration ineffectiveness.

Keywords Collaboration risk · Inter-agency collaboration · Risk factors · Public safety networks · Interpretive structural modelling

1 Introduction

Inter-agency collaboration is a positive type of inter-organisational relationship between different units of public administration in achieving common goals (Gray 1989; Huxham 1996). It has been extensively researched in public governance for many years as it is a valuable management tool in a complex and uncertain environment (Vangen and Huxham 2003). The entities that are especially representative in this respect are the units of

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public safety networks, which operate under conditions allowing for an understanding of the processes occurring in inter-agency collaboration (Gazley 2013; Comfort 2007; Kapucu 2006). The competences of these units are complementary and the effects of their joint activities are of vital importance for the functioning and development of society. Therefore, inter-agency collaboration in the public safety networks is considered to be an important research matter.

The application of collaboration is widespread, its implementation is well known and does not represent a new concept. Nevertheless, it is an extremely complex process and does not always allow for achieving the assumed goals (Huxham and Vangen 2005; Feiock 2013; Zyzak 2017). It is generally recognised that it is better to avoid collaboration if it is not necessary (Huxham and Vangen 2005). Nonetheless, units of public safety networks are legally obliged to collaborate and are interdependent. By contrast, these units may have different strategies, organisational culture, views or expectations. Each of these units may interpret specific situations from its own perspective (Comfort 2007). These discrepancies may be a source of inter-agency collaboration risk.

Research on the issue of risk in external collaboration settings has been started by Nooteboom et al. (1997), Das and Teng (2001a, b), as well as Kumar and Van Dissel (1996). Since then, deliberations in this scope have focused on analysing the various factors and indications of this risk in many research areas and contexts, including strategic alliances (Bodnaruk et al. 2016; Delerue 2004), project management (Lehtiranta 2013; Osipova and Eriksson 2013), emergency management (Kapucu and Qian 2016; Waugh and Streib 2006), and supply chain management (Friday et al. 2018; Cheng and Chen 2016; Lindgreen et al. 2009). Although the issue of risk associated with collaboration with other entities is not novel, there has been relatively little empirical work devoted to it. Empirical research on this subject was conducted by Delerue (2004, 2005) in the field of biotechnology alliances, Feiock (2013) in the field of the institutional collective action framework, or Cheng et al. (2013, 2016) in supply chain management. Regardless of this research, the impact of collaboration risk on the effectiveness of joint activities is still largely underestimated (Bodnaruk et al. 2016; Friday et al. 2018; Jung and Song 2015). There is also a research gap concerning the comprehensive approach towards collaboration risk analysis, including the interaction between the factors of this risk and its potential development. Such research is undertaken only occasionally in the context of public safety. Hence, the article aims at finding answers to the following research questions:

1. What are the risk factors in public safety networks?
2. How the identified factors affect the development of risk of inter-agency collaboration in public safety networks?
3. What are the relations between risk factors of inter-agency collaboration in public safety networks?
4. How does the risk of inter-agency collaboration in public safety networks develop?

This article is organised as follows: Theoretical background section describes basics of inter-agency collaboration in the public safety networks and the risk related to it. The methodology section describes the methods of collecting information and the methods used for analysis, i.e., Systematic Literature Review (SLR), Interpretive Structural Modelling (ISM), MICMAC analysis. In the fourth section, there are research results to be found and the individual subsections have been developed on the basis of the adopted

research methodology. Discussion together with interpretation of the results obtained and implications are drawn in the final section of the article.

2 Theoretical background

2.1 Inter-agency collaboration in the public safety networks

Public safety networks represent a set of autonomous entities with complementary competencies that are linked by interdependencies and inter-organisational relations. The purpose of these entities is to help people, protect the environment and secure property using their resources and within the framework of the existing rules of formal and informal relations. The public safety network is described by its uniqueness, flexibility of actions and continuous adaptation to current conditions and emerging needs, which results from specific circumstances. There will be a different configuration of entities in the event of a flood threat, a different one in the event of a terrorist threat, and yet another when preparing plans and programmes for the prevention of construction disasters, road accidents or criminal acts (Waugh 2003; Andrew et al. 2013). In case of the same type of threat, similar resources are engaged, but with a different intensity and configuration, depending on the specific circumstances. Moreover, each incident occurs in a different place, with a different scale and intensity, and is accompanied by other hazards that may affect the escalation of threats. Therefore, the structure of the public safety network during the time of threats is configured in real time, differently in each case, according to the situation and means available. These entities comprise (Sienkiewicz-Małyjurek 2019a, b): government and local government units, emergency and rescue units, media, non-governmental organisations, public sector organisations, and research and development units. Each of these entities fulfils an appropriate, competent function. However, the core of public safety network comprises strictly the activities undertaken by blue lights organisations, i.e. the Police, State Fire Service and Emergency Medical Services units (Andrew and Hawkins 2013; Blackstone et al. 2007). The activities of these units are aimed at the implementation of measures for rapid assistance in case of a specific threat. They are supported by other public safety network entities, according to the demands resulting from the situation.

The management of public safety requires collaboration between all the entities within the network (Jung and Song 2015; Waugh and Streib 2006; Berlin and Carlström 2011). This is due to the complementary competences of individual entities, and the necessity of a comprehensive and adaptive approach to each situation individually. Generally, inter-agency collaboration stands for a long-term relationship with a high level of interdependence, which requires formal communication and changes in the way the individual units operate in order to adapt them and seek innovative solutions (Ranade and Hudson 2003). This collaboration is open and partnership-based, addressing common difficulties and seeking new opportunities for joint activities as a result of multilateral analysis and consensus (Gray 1989; Huxham 1996).

However, collaboration is a very complex and ambiguous process, and as Huxham and Vangen (2005, p. 37) state: „Don't do unless you have to!” because 50% or more of collaborations are unsuccessful (Ospina and Saz-Carranza 2010, s. 407). The different organisational cultures and priorities of the collaborating organisations and their functioning in different hierarchical structures may influence these unsatisfactory results. Moreover, collaboration refers to individualities considered through the network

of relations. As a consequence, contradictions, misunderstandings, and conflicts may occur, and inter-organisational cooperation may yield to inertia and have a paradoxical nature (Huxham and Vangen 2004; O'Leary and Bingham 2007). Basic types of collaboration paradoxes included: cooperation—competition; convergence—diversity; shared responsibility—autonomy; stabilization—change; trust—control; homogeneity—differentiation; participatory behavior—authoritative behavior of managers, rooting—new relationships (O'Leary and Bingham 2007; O'Leary and Vij 2012; Kożuch and Dobrowolski 2014; Willems and Van Dooren 2011; Meuleman et al. 2010; Ospina and Saz-Carranza 2010). Ignoring paradoxes may be dysfunctional, but on the other hand, the lack of contradictions and complete adaptation lead to stagnation and limit the learning processes (Clarke-Hill et al. 2003). In public safety networks, contradictions may result from the complexity, uncertainty, and dynamics of activities undertaken. The operating procedures are not always adequate to the situation, and individual organisations interpret events differently. There is a possibility of disruptions in the communication process, and collaboration does not always run as planned. It is not enough to establish collaboration to ensure the effectiveness of jointly implemented actions. It requires plenty of effort from all collaborating units and continuous development to maintain and develop positive relationships.

The literature on this subject also emphasises the ambiguity of the concept of collaboration and the use of interchangeable terms such as cooperation, coordination, partnership, which leads to inconsistencies in the nomenclature (O'Leary and Vij 2012; Ranade and Hudson 2003; Gray and Wood 1991). These terms, however, are different concepts which in most cases do not fully reflect the dynamic and evolutionary nature of collaboration (Gray 1989; Gray and Wood 1991). Nevertheless, they are significant processes utilised in the context of collaboration (O'Leary and Vij 2012; Keast et al. 2007). In order to work together, it is crucial to share information and communicate, interact and work towards common goals, i.e., to cooperate, as well as to harmonise activities through coordination.

Inter-agency collaboration refers to activities undertaken together by public sector units, established in order to deliberately deal with a specific issue (Ranade and Hudson 2003; Smith and Mogro-Wilson 2008). Hence, it concentrates only on public sector entities, without examining the relationship between these entities and private or non-governmental organisations. Taking into account the specificity of the public safety management network described at the beginning of this chapter and the key organisations in the network, this article is focused on collaboration between blue lights agencies—police, fire brigade and emergency units. The level of collaboration among these agencies is the closest, however, it also evolves over time. In their daily routine, each agency carries out its statutory tasks according to the applicable rules and procedures. Basically, the fulfilment of these tasks does not require collaboration with other agencies, but only the execution of activities according to a given specialisation. However, in practice, even the core tasks are often performed within the framework of collaboration (Wang 2012; Maon et al. 2009).

Inter-agency collaboration is not an easy process and, in fact, entails a high risk of failure of joint activities (Feiock 2013; Keast and Mandell 2014; Gulati et al. 2012). It requires the agencies to adapt and change the way they operate, to share authority and responsibility, to share resources and knowledge, and to have a high level of trust and engagement. Each unit has its own view and expectations of collaboration and even significant reasons and best intentions are not sufficient to ensure the effectiveness of joint activities. This may result in a variety of problems and risks of inter-agency collaboration.

2.2 Risk of inter-agency collaboration in the public safety networks

Generally, the risk includes events or conditionings and their consequences which affect the achievement of goals (Drennan et al. 2015). It is a temporary measurable situation, and is a function of uncertainty which increases with it. The risk in inter-agency collaboration is the result of uncertainty about the behaviour of other units and the compatibility of joint activities. It results from transaction cost theory, institutional collective action theory, inter-organisational relations theory as well as game theory. This is an interesting issue because inter-agency collaboration is aimed at reducing the risk of not achieving common goals and at the same time can generate this risk.

The issue of risk connected with the implementation of joint activities with other organisations has been considered by many researchers and has been analysed from various perspectives. Nooteboom et al. (1997) define it as a relational risk which involves the probability and consequences of an opportunistic partner's behaviour. Das and Teng (2001a; b), however, distinguish between performance risk and relational risk, which are complementary. The relational risk in their approach refers to the partners' behaviour and is the probability of unsatisfactory collaboration because of potential opportunistic behaviour (e.g., cheating, shirking, distorting information). Performance risk, on the other hand, is based on an organisational approach and results from external factors and interdependencies among organisations (e.g., intensified rivalry, changing government policies, a lack of competence of the partners). The risk refers to the failure to achieve common goals despite satisfactory collaboration. Gulati et al. (2012) also classify risks in collaboration among organisations in a similar way. They have identified the relationship risk, resulting from behavioural aspects of the collaboration and referring to co-action, whereas the operational risk, resulting from limitations in co-ordination of activities across organisational boundaries. The research concerning relational risk both from the perspective of jointly conducted activities and organisational behaviour was carried out by Delerue (2004, 2005). She found that the relational risk is of a multidimensional nature and results from both informal and formal factors.

The institutional collective action theory of Feiock (2013) has a significant impact on the development of risk research in collaboration among organisations. According to this theory, "collaboration risk reflects the actor's assessments of the likelihood that collaboration efforts will fail to hold together or fail to effectively resolve the collective dilemma" (Feiock 2013, p. 406). The risk therefore accompanies any initiative taken at the meso and macro level. In institutional collective action theory collaborations risk contains incoordination, unfair division, and defection (Feiock 2013; Feiock et al. 2012). In this context, public safety research is being conducted by Andrew and Hawkins (2013), Jung and Song (2015), Jung et al. (2019), as well as Song (2018).

In public safety networks, efficient inter-agency collaboration is difficult to achieve. Even though the regulations provide a framework and rules for collaboration, they do not guarantee that joint efforts will be successful. The literature relevantly emphasises that many management methods need to be applied to mobilise organisations for effective collaboration, which is imposed by law (Rodríguez et al. 2007; Lowndes and Skelcher 1998). Such form of motivation, although it forces organisations to enter into collaborative relations, may prove to be insufficient to achieve even satisfactory results. It requires justification and persuasion of individual entities about the necessity of collaboration. Moreover, due to differences in the place, scale and intensity of threats and time pressure, activities undertaken in public safety networks have a different, unique course

of action in each case and force each individual configuration of forces and means. These activities require, on the one hand, scrupulous organisation and planning, but, on the other hand, spontaneity, innovation and improvisation, since the plans developed are not always adequate to reality (Waugh and Streib 2006; Kapucu 2009). Such conditions therefore entail risks both in operational and relational terms.

As far as competences are concerned, each unit in public safety networks is responsible for a specific section of the overall joint activities undertaken in a specific situation. It must integrate its own operating principles and individual perception of a specific situation with common principles and holistic interpretation of events. This creates a tension between the autonomy of individual organisations and the implementation of activities according to their own operational procedures and the shared responsibility to adjust activities and focus on joint activities. It is also worth mentioning that these units are characterised by different organisational cultures, internal regulations, traditions or processes. These differences can also be a source of problems for inter-agency collaboration. Moreover, there may appear the belief that one organisation is self-sufficient in dealing with a specific situation. Such behaviours may lead to limiting the possibility of implementing activities, building a hierarchy in the public safety management system and superseding collaboration by competition (Berlin and Carlström 2011). As a result, it can lead to contradictions, misunderstandings and conflicts, so that inter-agency collaboration can be subdued and have a paradoxical nature (Huxham and Vangen 2004). Knowledge of the risk factors in collaboration and the likelihood of developing these risks is therefore essential for both the planning and implementation of joint activities. It provides the basis for making the right decisions and projects to maintain and develop inter-agency collaboration, and consequently, increase the effectiveness of public safety networks.

3 Methodology

This article is intended to: (1) identify factors of collaboration risk in public safety networks, (2) determine the impact of individual risk factors on inter-agency collaboration outcomes, (3) identify the relationship between risk factors of inter-agency collaboration in public safety networks, and (4) analyse the growth of this risk in public safety networks. These purposes were achieved using Interpretive Structural Modelling (ISM). This is a research method proposed by Warfield (1973; 1974). It is used to understand complex situations and is based on the construction of the model of relations among the variables studied and then its interpretation (Malone, 1975; Sage 1977). It is of an interpretative nature, as experts decide on the direction of relations among variables. In this study, the relationships between the identified risk factors in inter-agency collaboration were developed with the use of interview questionnaires conducted between January and March 2019 with 15 public safety network experts. These experts were practitioners from blue lights organisations, consisting of the police, fire brigade, and emergency medical services, who have been collaborating with other agencies for at least 10 years. These experts were selected purposively based on their experience, knowledge, and willingness to participate in the research. They were asked to answer questions about the mutual influence of the collaboration risk factors. In result, the interviews have allowed to develop a structured self-interaction matrix. The ISM is a comprehensive method that is applicable in different situations in order to better understand the relationships among the variables examined (Sushil 2012; Yadav et al. 2019; Kumar Sharma and Bhat 2014; Verma et al. 2018). The

result of the ISM is the development of a model of complex relationships among the different elements and understanding the relationship among them. This method starts with an identification of variables which are relevant to the problem or issue. The relationships between the identified variables are then studied and the Structured Self-Interaction Matrix (SSIM) is developed. This serves as the basis for preparing the Reachability Matrix (RM) and developing the partition of the reachability matrix. Then, a digraph model showing the identified relationships that are subject to verification is developed (Sage 1977; Warfield 1974, Sushil 2012). These studies are supported by MICMAC analysis, which examine the strength of the relationship between research variables.. It is prepared based on dependence and driver power resulting from the Reachability Matrix. The results of this analysis can be the basis for making decisions and actions to eliminate emerging problems.

A Systematic Literature Review (SLR) based on the PRISMA Group method was additionally adapted to implement the first point of the ISM research process (Moher et al. 2009). The SLR involves the identification of facts in the analysis of secondary data. Not only does it avoid biases and errors, but it also enables the integration of information from multiple sources. In this way, it helps to comprehensively and objectively analyse the subject under examination and to generate new knowledge (Tranfield et al 2003; Grant and Booth 2009).

The SLR was carried out in November and December 2018 as a part of broader research related to collaboration performance and aimed at identifying risk factors of inter-agency collaboration. This process is presented in Table 1.

The SLR was conducted based on the Scopus and Web of Science databases with the aim of finding publications of the highest scientific value resulting from a rigorous review process. The search was to combine the word "risk" with words: "relation*", "communicat*", "cooperat*", "coordinat*", "collaborat*" and "operation*". The inclusion of these words has resulted from an initial literature review, from the linkages between these

Table 1 The SLR process

Phase	Undertakings	Results
Identification	1. Searching: "risk" with words: "relation*", "communicat*", "cooperat*", "coordinat*", "collaborat*" and "operation*" in titles, abstracts and keywords 2. Databases: Scopus and Web of Knowledge 3. Inclusion criteria: subject areas: social sciences, business, and management without time limit in articles, conference publications, and chapters 4. Removing the duplicate entries	3794 publications
Screening	1. Approach: title and abstract analysis 2. Exclusion criteria: reported not on risk connected to relationships	1201 publications
Eligibility	1. Approach: full-text assessing 2. Exclusion criteria: reported not on collaboration risk non-professional collaboration internal collaboration	18 publications
Included	Studies included from the preliminary literature review: n=2	20 publications

Source own elaboration based on Moher et al. 2009

concepts, and from the fact that they are often used in the same context and omitting any of them could result in an incomplete list of factors. This searching did not include the context—public safety networks. It was assumed that general publications relating to collaboration risk would be found and then verified in research with public safety experts. The search was carried out in article titles, abstracts and keywords, without time limit, in articles, conference publications and chapters in collective works. The subject areas have included social sciences, business, and management. The search resulted in the identification of 3,279 publications in the Scopus database and 1,169 publications in the Web of Science database. With duplicate records removed, these numbers were reduced to 3,179 for Scopus and 1,128 for Web of Science. Combining the records from both databases resulted in 4,237 publications. After removing the duplicate entries, 3,794 papers were obtained, and the titles and abstracts were screened in the next phase of analysis. The screening was based on the compliance of the analysed publications with the undertaken research subject. The result of this was 2,593 records excluded as not relevant. After having read the remaining publications for eligibility purposes, 18 articles were selected for analysis, which are the most relevant to the discussed issues and which are of key importance for the development of risk theory in inter-agency relationships. The analyses also included 2 publications from the preliminary literature review regarding the risk of collaboration in public safety networks. Altogether, they formed an essential basis for identifying risk factors in inter-agency collaboration in the public safety networks. They are presented in the “Appendix”.

The applied research approach also has some limitations resulting from the number of experts. Quantitative research over a large research sample could provide more detailed results. However, despite these limitations, the results obtained provide a basis for understanding collaboration risk, and opportunities for continued research.

4 Results

4.1 Identification of risk factors affecting the examined problem based on the SLR

The first ever extensive inter-organisational risk studies were carried out by Nooteboom (1996, 1997, 1999) and Das and Teng (1996, 1999, 2001a, b). Their research defined the main risk factors, including: opportunistic behaviour, expected inequities and asymmetries, lack of trust, different preferences, rivalry, new entrants, demand fluctuations, changing government policies, a lack of competences of the partners, bad luck, locus of control, future orientations, experiences, shared efforts, commitment and intensity of relationships, appropriating resources, conflicts, defection of the partners. The risk factors identified by them in inter-organisational relations have continuously been pursued by many researchers, in different settings and contexts. In the field of biotechnology, risk factors in inter-organisational relations were researched by Delerue (2004, 2005) and Delerue and Perez (2009). The author focused her research on the risk associated with collaboration processes, partner's behaviour, context, the degree of relational capital, partner asymmetries and governance structure. Other than the factors mentioned above, the author also took into consideration dependence and power, incomprehension, absence of flexibility, encroachment, contributions and retentions, transaction and negotiation costs, no-learning. Meanwhile, Billitteri et al. (2013) carried out multidimensional operationalisation of relational and performance risk in biopharmaceutical inter-firm relationships. Their operationalisation framework

includes investment specificity partners' asymmetry, lack of trust, lack of inter-firm relationship experience, technology/product newness, technological distance, and nationality.

In the context of supply chain operations, studies on collaboration risk were carried out by Cheng and Chen (2016), and Cheng et al. (2013). They have considered risk factors, such as institutional orientation, moral orientation, opportunistic behaviour, loss of competences, incomprehension, dysfunctional conflict, and no-learning. Grudinschi et al. (2014), however, included the factors in their research model, such as of relationship risk, trust, communication, governance and administration, and collaboration fluency.

The issue of collaboration risk in inter-organisational relations is also raised in the public sector. In the institutional collective action theory, collaboration risk was studied by Feiock (2013). According to his approach, this risk refers to coordination, division, and defection issues. Carr et al. (2017), have taken into account conditions associated with regional norms, the structure of networks, and patterns of ethnic and racial differences in their research. Research of Zyzak (2017) is based on structural conditions (asymmetry and interdependence, weak administrative capacity, resource scarcity, weak formalisation, proximity) and process ones (mistrust, negative previous relations/experience, sparse communication, maintaining of resources and information, commitment towards own agency, and high turnover). In the field of emergency management Berlin and Carlström (2011) identified three main reasons for the failure of collaboration, namely: uncertainty, asymmetries, and lack of incentives.

The factor of collaboration risk used in the publications mentioned above was analysed in terms of the relevance of their inclusion in public safety networks. The loss of competences, technology/product newness, technological distance, nationality, new entrants, and encroachment were rejected, since they do not correspond to the specificity of the networks studied (Moynihan 2008; Sienkiewicz-Małyjurek et al. 2019). The identified factors in the SLR are listed in Table 2.

4.2 Modelling the collaboration risk in crisis management networks using the ISM

4.2.1 Structured self-interaction matrix (SSIM)

The first step in the collaboration risk modelling in crisis management networks based on the ISM was the development of the Structured Self-Interaction Matrix (SSIM). The development of this matrix was based on the expert interviews. This step involved analysing the relationships among the identified factors. The following symbols were used—where "i" means the number of rows and "j" means the number of columns (Warfield 1974; Yadav et al. 2019; Girubha et al. 2016):

- V—when i allows to achieve j;
- A—when j allows to achieve i;
- X—when i and j allow to achieve each other;
- O—when there is no relationship between i and j.

The analysis of the answers received from the questionnaire surveys allowed to establish the relationships between the individual pairs of factors, as shown in the Table 3.

Table 2 Identified collaboration risk factors

No	Risk factor	Example source
1	Inappropriate collaboration rules	Delerue (2004, 2005); Delerue and Perez (2009); Feiock (2013); Cheng and Chen (2016)
2	Changing government policies	Das and Teng (1996, 1999, 2001a, 2001b); Zyzak (2017)
3	Interdependencies	Kumar and Van Dissel (1996), Nootboom (1996, 1997), Das and Teng (1996, 1999, 2001a, 2001b), Delerue (2004), Zyzak (2017)
4	Lack or negative experience	Nootboom (1996), Das and Teng (1996, 1999), Billitteri et al. (2013), Delerue (2005)
5	Power asymmetry	Delerue (2004, 2005), Billitteri et al. (2013), Berlin and Carlström (2011)
6	Inadequate division of tasks and resources	Delerue (2004); Feiock (2013); Grudinschi et al. (2014); Zyzak (2017)
7	Uneven access to information	Delerue (2004, 2005); Delerue and Perez (2009); Grudinschi et al. (2014); Zyzak (2017)
8	Incomprehension	Delerue (2004, 2005); Delerue and Perez (2009); Cheng and Chen (2016); Cheng et al. (2013)
9	Lack of trust	Nootboom (1996, 1997, 1999); Das and Teng (1996, 1999, 2001a, 2001b); Grudinschi et al. (2014); Zyzak (2017); Billitteri et al. (2013)
10	Lack of commitment in collaboration	Song (2018); Zyzak (2017); Berlin and Carlström (2011); Das and Teng (1996, 1999)
11	Conflicts	Kumar and Van Dissel (1996), Das and Teng (1996, 1999); Cheng and Chen (2016); Cheng et al. (2013); Carr et al. (2017)
12	Opportunistic behaviour	Nootboom (1996, 1997, 1999); Das and Teng (1996, 1999, 2001a, 2001b); Cheng and Chen (2016); Cheng et al. (2013); Carr et al. (2017); Delerue (2004, 2005); Delerue and Perez (2009)
13	Rivalry	Das and Teng (1996, 1999); Berlin and Carlström (2011); Billitteri et al. (2013)
14	No-learning	Delerue (2005); Cheng and Chen (2016); Cheng et al. (2013); Carr et al. (2017)
16	Absence of flexibility	Delerue (2005); Delerue and Perez (2009); Feiock (2013); Grudinschi et al. (2014)

Table 3 Structured Self-Interaction Matrix (SSIM)

	Changing government policies (2)	Interdependencies (3)	Lack or negative collaboration experience (4)	Power asymmetry (5)	Inadequate division of tasks and resources (6)	Uneven access to information (7)	Incomprehension (8)	Lack of inter-agency trust (9)	Lack of inter-agency commitment (10)	Inter-agency conflicts (11)	Opportunistic behaviors (12)	Rivalry between agencies (13)	No learning (14)	Absence of flexibility (15)
Inappropriate collaborative laboration rules (1)	A	O	A	X	V	X	X	V	V	X	X	X	V	V
Changing government policies (2)		V	V	V	V	O	O	O	O	O	O	O	V	V
Interdependencies (3)			O	V	O	O	O	O	O	V	O	O	O	O
Lack or negative collaborative laboration experience (4)				O	O	O	O	V	V	O	V	O	O	O
Power asymmetry (5)					X	X	O	V	V	V	V	V	O	O
Inadequate division of tasks and resources (6)						X	A	X	V	V	X	V	O	V

Table 3 (continued)

	Changing government policies (2)	Interdependencies (3)	Lack or negative collaboration experience (4)	Power asymmetry (5)	Inadequate division of tasks and resources (6)	Uneven access to information (7)	Incomprehension (8)	Lack of inter-agency trust (9)	Lack of inter-agency commitment (10)	Inter-agency conflicts (11)	Opportunistic behaviors (12)	Rivalry between agencies (13)	No learning (14)	Absence of flexibility (15)
Uneven access to information (7)						V		V	V	V	X	V	O	V
Incomprehension (8)							V	V	V	V	O	O	V	V
Lack of inter-agency trust (9)								X	X	A	X	A	O	V
Lack of inter-agency commitment (10)										X	X	O	V	V
Inter-agency conflicts (11)											A	A	O	V
Opportunistic behaviors (12)												O	V	V

Table 3 (continued)

Changing government policies (2)	Interdependencies (3)	Lack or negative collaboration experience (4)	Power asymmetry (5)	Inadequate division of tasks and resources (6)	Uneven access to information (7)	Incomprehension (8)	Lack of inter-agency trust (9)	Lack of inter-agency commitment (10)	Inter-agency conflicts (11)	Opportunistic behaviors (12)	Rivalry between agencies (13)	No-learning (14)	Absence of flexibility (15)
Rivalry between agencies (13)												O	V
No-learning (14)													O

4.2.2 Reachability matrix (RM)

In further analyses, SSIM was transformed into a binary matrix, i.e., reachability matrix (RM), by replacing the symbols V, A, X and O with a value of 0 or 1. The substitution rule applied was as follows (Warfield 1974; Yadav et al. 2019):

- if a particular cell in matrix contains entry of (i,j) as V, then (i,j) entry will be replaced by 1 and (j,i) entry will become 0;
- if a particular cell in matrix contains entry of (i,j) as A, then (i,j) entry will be replaced by 0 and (j,i) entry will become 1;
- if a particular cell in matrix contains entry of (i,j) as X, then (i,j) entry will be replaced by 1 and (j,i) entry will also be 1; and
- if a particular cell in matrix contains entry of (i,j) as O, then (i,j) entry will be replaced by 0 and (j,i) entry will also be 0.

Also, the possibility and logic of transitory relationships for the examined cases was evaluated and reachability matrix developed as a result of these analyses is presented in Table 4.

4.2.3 Level partitioning and the ISM-based model

Based on the availability matrix, reachability and antecedent sets were defined. Reachability set comes from the dependence of each factor on other factors that activate it. Meanwhile, antecedent set indicates the number of factors activated by a given variable. In both cases, the own impact is also taken into consideration. Variables that are common in both sets are included in the interaction set. Convergence analyses of reachability and antecedent sets made it possible to identify factors belonging to particular levels (Table 5). The elements of the highest level are those factors which can not reach any other factor above their own level. After identifying the highest level factors, they are removed and the process of searching for elements in the next levels is repeated until each factor is assigned to a specific level. Based on level partitioning, after removing the transitivities in accordance with the ISM methodology (Sage 1977; Warfield 1974; Sushil 2012), ISM-based model is developed (Fig. 1).

4.2.4 MICMAC analysis

Apart from identifying the factors that occur in the process of developing the risk of collaboration in public safety networks at different stages, it is also vital to know how each of the factors affects the whole system. This can be determined by MICMAC analysis, which classifies the variables into four categories depending on driving power and dependence power (Yadav et al. 2019; Poduval et al. 2015): autonomous (low driving and low dependence), linkage (high driving and high dependence), independent (high driving and low dependence), and dependent (low driving and high dependence). The dependence and driver power levels are read out from the Reachability Matrix. The results of MICMAC analysis concerning the development of collaboration risk in public safety networks are illustrated in Fig. 2.

Table 4 Reachability matrix

	Inappropriate laboration rules (1)	Changing government policies (2)	Interdependencies (3)	Lack or negative collaboration experience (4)	Power asymmetry (5)	Inadequate division of tasks and resources (6)	Uneven access to information (7)	Incomprehension (8)	Lack of inter-agency trust (9)	Lack of inter-agency commitment (10)	Inter-agency conflicts (11)	Opportunistic behaviors (12)	Rivalry between agencies (13)	No learning (14)	Absence of flexibility (15)	Driver power
Inappropriate laboration rules (1)	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	12
Changing government policies (2)	1	1	1	1	1	1	0	0	0	0	0	0	0	1	1	8
Interdependencies (3)	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	3
Lack or negative collaboration experience (4)	1	0	0	1	0	0	0	0	1	1	0	1	0	0	0	5
Power asymmetry (5)	1	0	0	0	1	1	1	0	1	1	1	1	1	0	0	9
Inadequate division of tasks and resources (6)	0	0	0	0	1	1	1	0	1	1	1	1	1	0	1	9
Uneven access to information (7)	1	0	0	0	1	1	1	1	1	1	1	1	1	0	1	11
Incomprehension (8)	1	0	0	0	0	1	0	1	1	1	1	0	0	1	1	8

Table 4 (continued)

	Inappropriate col-laboration rules (1)	Changing govern-ment poli-cies (2)	Interde-pend-encies (3)	Lack or negative col-laboration experi-ence (4)	Power asym-metry (5)	Inadequate division of tasks and resources (6)	Uneven access to informa-tion (7)	Incom-prehen-sion (8)	Lack of inter-agency trust (9)	Lack of inter-agency com-mitment (10)	Oppor-tunistic behav-iors (12)	Rivalry between agen-cies (13)	No-learn-ing (14)	Absence of flex-ibility (15)	Driver power
Lack of inter-agency trust (9)	0	0	0	0	0	1	0	0	1	1	0	0	0	1	5
Lack of inter-agency com-mitment (10)	0	0	0	0	0	0	0	0	1	1	1	0	1	1	6
Inter-agency conflicts (11)	1	0	0	0	0	0	0	0	1	1	0	0	0	1	5
Oppor-tunistic behaviors (12)	1	0	0	0	0	1	1	0	1	1	1	0	1	1	9
Rivalry between agencies (13)	1	0	0	0	0	0	0	0	1	0	1	0	0	1	5
No-learning (14)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Absence of flexibility (15)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Dependence	9	1	2	2	6	8	5	3	11	10	8	5	6	11	

Table 5 Level partitioning

Variables	Reachability set	Antecedent set	Interaction set	Level
Inappropriate collaboration rules (1)	1,5,6,7,8,9,10,11,12,13,14,15	1,2,4,5,7,8,11,12,13	1,5,7,8,11,12,13	VI
Changing government policies (2)	1,2,3,4,5,6,14,15	2	2	VIII
Interdependencies (3)	3,5,11	2,3	3	VI
Lack or negative collaboration experience (4)	1,4,9,10,12	2,4	4	VII
Power asymmetry (5)	1,5,6,7,9,10,11,12,13	1,2,3,5,6,7	1,5,6,7	V
Inadequate division of tasks and resources (6)	5,6,7,9,10,11,12,13,15	1,2,5,6,7,8,9,12	5,6,7,9,12	V
Uneven access to information (7)	1,5,6,7,8,9,10,11,12,13,15	1,5,6,7,12	1,5,6,7,12	VII
Incomprehension (8)	1,6,8,9,10,11,14,15	1,7,8	1,8	VI
Lack of inter-agency trust (9)	6,9,10,12,15	1,4,5,6,7,8,9,10,11,12,13	6,9,10,12	II
Lack of inter-agency commitment (10)	9,10,11,12,14,15	1,4,5,6,7,8,9,10,11,12	9,10,11,12	II
Inter-agency conflicts (11)	1,9,10,11,15	1,3,5,6,7,8,10,11,12,13	1,10,11	III
Opportunistic behavior (12)	1,6,7,9,10,11,12,14,15	1,4,5,6,7,9,10,12	1,6,7,9,10,12	IV
Rivalry between agencies (13)	1,9,11,13,15	1,5,6,7,13	1,13	IV
No-learning (14)	14	1,2,8,10,12,14	14	I
Absence of flexibility (15)	15	1,2,6,7,8,9,10,11,12,13,15	15	I

Fig. 1 ISM-based model of inter-agency collaboration risk in public safety networks

Autonomous variables are external in their nature and do not significantly affect the relationship flow in the ISM-based model. Autonomous factors in public safety networks are: interdependencies (3), lack or negative collaboration experience (4), and no-learning (14). The reverse is true for the linkage category. Any change in the factors in this group significantly affects the whole system. In public safety networks, factors in this category include: inappropriate collaboration rules (1) and inadequate division of tasks and resources (6). Independent variables have a strong impact on the arrangement of factors. As a result of the analyses conducted, independent factors are: inconsistency of government policies (2), power asymmetry (5), uneven access to information (7), incomprehension (8), and rivalry between agencies (13). Factors in the dependent variable category do not have a significant impact on other factors, but they are heavily influenced by other factors. These include: lack of inter-agency trust (9), lack of inter-agency commitment (10), inter-agency conflicts (11), and absence of flexibility (15).

Fig. 2 MICMAC analysis of inter-agency collaboration risk in public safety networks

These results make it possible to determine which factors are the key factors in shaping effective collaboration in public safety networks.

5 Discussion

The issue of collaborative effectiveness is still a challenge for both researchers and public management practitioners. The risk of failure of joint activities may arise at any stage of collaboration and may have multiple root causes. It is essential, therefore, to know what the factors of collaboration risk might be, which of them are crucial, how they interact with each other and how this risk might potentially evolve. Such knowledge provides an early diagnosis of threats to joint activities and allows to undertake appropriate preventive measures. This article aims at expanding knowledge in this field and indicates what risk factors in collaboration are worth taking into consideration, as well as helps to understand how this risk may evolve. Such information is a basis for decision making and preventing the negative effects of inter-agency collaboration risk.

The research conducted allowed to identify the factors of inter-agency collaboration risk and to analyse the relations among them. When analysing driving power and dependence power it was found that uneven access to information (7) and inappropriate

collaboration rules (1) have the greatest impact on other factors. The first of these factors may result from limitations on the information flow among agencies. This conclusion is a compliment to the results of Bharosa et al. (2010), according to which, in practice, agencies involved in public safety activities are aware of the necessity to exchange information, however, they often limit themselves to obtaining information without paying attention to sharing it with others. As a result, there may be obstacles to building a common picture and to establishing inappropriate collaboration rules (1). These rules, according to the results obtained, are also of key importance in preventing inter-agency collaboration risk. They affect both the organisational conditions of collaboration and inter-agency relationships. These results are consistent with the Feiock research and analysis (2013), according to which collaboration rules should be flexible and embedded in social relations. Rigid rules and central control increase the likelihood of further factors of collaboration risk and limit the effectiveness of joint activities. However, lack of inter-agency trust (9) and absence of flexibility (15) are the most susceptible to the influence of other factors. According to the reachability matrix (Table 4), they represent outcomes of collaboration risk.

The analyses carried out on the basis of the ISM have established what path collaboration risk in public safety networks might potentially take (Fig. 1). The first source of this risk are the government policies (2), which, among other things, specify the tasks assigned to each unit. Their inconsistency is the first of collaboration risk activators and influence on negative experience (4). At this level, uneven access to information may be added to the risk factors (7). These factors together may lead to the establishment of inappropriate collaboration rules (1) and mutual incomprehension (8). The incomprehension (8) limits mutual cognition, which according to Comfort (2007, p. 189) “is the triggering insight of emerging risk that initiates the emergency response process”. Different cognition may also have significant direct and indirect effects. At level VI, there is also a third risk factor—interdependencies (3). All relations based on collaboration, especially in public safety networks, are facing issues of task division, which generates interdependencies both in terms of the sequence of implemented projects, material resources and organisational competences (Gulati et al. 2012; Kapucu 2009). They represent a challenge for the organisation of joint activities. Factors at level VI affect power asymmetry (5) and inadequate division of tasks and resources (6). These results add value to the research carried out by Billitteri (2013) and Delerue (2004), according to which power asymmetry is considered to be one of the main sources of relational risk and collaborative failure. This factor may lead to a decrease in joint activities and opportunistic behaviours (12). Moreover, despite the division of tasks and resources constituting the basis for collaboration, some units may control more critical resources leading to inequalities in interdependence and competition between agencies (13). This is consistent with the statement of Berlin and Carlström (2011), where members of units of public safety networks, who have specific social functions and high competences, want to be at the centre of action. This may also lead to the conviction that one organisation is self-sufficient in dealing with a particular situation. Such attitudes can lead to the supersede of collaboration by competition. Both opportunistic behaviours (12) and rivalry between agencies (13) can lead to conflicts (11), which in turn can reduce the level of trust (9) and commitment (10) to inter-agency collaboration. In the context of collaboration risk, conflicts are of a dysfunctional nature (Cheng et al. 2013; Das and Teng 2001a, b), and, together with a decrease in trust and commitment to joint activities, may result in limitations of inter-agency collaboration outcomes. As a result, collaboration risk of joint activities includes a lack of flexibility (15) and a lack of activation of inter-agency learning processes (14).

Based on the analysis of the development of inter-agency collaboration risk in public safety networks (Fig. 1) together with "black box" model of collaboration by Thomson and Perry (2006), it is possible to distinguish the risk associated with: 1. Antecedents, 2. Processes and 3. Outcomes of collaboration. Antecedents include levels VII and VIII and interdependencies from level VI. The risk involved in the processes is related to levels II to VI. The arrangement of factors at these levels also clearly shows their division into two groups—organisational and relational. The first group includes levels V and VI, and the relational factors are at levels from IV to II. These findings are included in the risks of collaboration identified in the literature, e.g., performance risk and relational risk according to Das and Teng (2001a; b) and relationship risk and operational risk by Gulati et al. (2012). Moreover, the results obtained indicate the dependence of relational factors on organisational factors. It is worth emphasising here that collaboration risk can be a triggering factor at each of the identified levels and each of the analysed factors is a source of other factors (see Tables 3, 4). Additionally, removing one of the factors of collaboration risk or changing its level activates changes in the entire ISM-based model (Fig. 1). The last of the areas of collaboration risk—related to the outcomes of collaboration—is at level I. The absence of flexibility (15) and no-learning (14) are both of an organisational nature. This indicates that the outcomes of collaboration risk will result in limited organisational effectiveness.

MICMAC analysis provided an answer to the question how the identified factors affect the risk of inter-agency collaboration in public safety networks. The results obtained show that factors classified as linkage [inappropriate collaboration rules (1), inadequate division of tasks and resources (6)] and independent [inconsistency of government policies (2), power asymmetry (5), uneven access to information (7), incomprehension (8), and rivalry between agencies (13)] are of key importance for reducing this risk. These factors are mainly organisational in nature and relate to the performance risk according to Das and Tang (1996, 1999, 2001a) and operational risk according to Gulati et al. (2012). Nevertheless, the factors located in the other two categories are also of importance, since they indicate problems resulting from external conditions leading to collaboration risk, as well as its further implications.

6 Implications

The allocation of tasks and responsibilities between the individual units of public safety networks stems from the complexity of problems and activities in public safety, the existing legal regulations in this matter and the complementary competences of the units forming these networks. There are a number of problems of both organisational and relational nature associated with combining the tasks of many autonomous units into one coherent structure. These problems give rise to risk in inter-agency collaboration which is reflected in the results of joint activities and thus in the level of public service provision. Therefore, it is important to diagnose the symptoms and potential evolution of this risk at the earliest possible stage.

This article contributes to the inter-agency collaboration theory by filling the identified research gap on a comprehensive approach to studying risk factors in collaboration between organisations, including analysis of the interaction among these factors and potential development of risk in collaboration. The proposed framework creates foundations for analysis of collaboration risk by identifying its factors, analysing relationships between these factors, and analysing how they influence collaboration outcomes. For building this

framework, ISM and MICMAC analysis was used and this framework was tested in the context of public safety networks. In that way, this article contribute also to understanding of growth of inter-agency collaboration risk in one of the main public governance areas.

The findings have also some managerial implications. They highlight such collaboration risk activators as government policies, uneven access to information, and interdependencies. Managers of public safety networks should continuously keep track of these factors to prevent the sources of potential collaboration risk. The analyses conducted also allowed to determine how this risk evolves and which factors significantly affect this development. These include: inappropriate collaboration rules and inadequate division of tasks and resources. Public managers should strive to shape the linkage and independent factors identified in MICMAC analysis. By doing so, they can significantly reduce the impact of collaborative risk in public safety networks.

However, the findings are not free from the limitations. Firstly, the research was carried out only in Poland. Secondly, the collaboration risk can increase in a different way in different contexts of public governance. For this reason, there is a need to verify the elaborated framework in other countries and in other contexts of public governance. The results obtained, nevertheless, permit to make certain findings that can be verified in further research.

Appendix

See Table 6

Table 6 Articles selected as a result of the SLR

Publication	Purpose	Research method	Key findings
Berlin and Carlström (2011)	Studying why collaboration among police, fire, and ambulance services is minimised at accident scenes	Observations and semi-structured interviews	Identification of the asymmetry, uncertainty, and lack of incentives as sources of limited forms of collaboration
Billitteri et al. (2013)	Proposing a new theoretical framework for assessing the influence of risk in shaping the governance form in biopharmaceutical inter-firm relationships	Comparison of inter-firm relationships	To find a significant moderating effect of the performance risk on the Transaction Cost Economics relation between relational risk and governance forms
Carr et al. (2017)	Exploring the nature of collaboration risk in joint ventures and the factors that affect local development officials' perceptions of these risks	Survey questionnaire	Understanding the dimensions of collaboration risk in joint ventures and highlight the importance of the regional climate of cooperation among municipal leaders in shaping these perceptions
Cheng and Chen (2016)	Investigating the contribution of institutional and moral orientations to relational risk management	Survey questionnaire	Identification of three types of relational risk (opportunistic behavior, loss of competences, and incomprehension) as significantly affected by institutional and/or moral orientations
Cheng et al. (2013)	Exploring how inter-organizational relationship interacts with factors affecting the development and implementation of information sharing	Survey questionnaire	The determination that relational benefits are critical in ensuring information sharing and mitigate relational risk in the process
Das and Teng (1996)	Examination of the choice between equity and non-equity forms of inter-firm alliances from an 'integrated risk' perspective, which combines relational risk and performance risk in inter-firm alliances	Desk research	The determination that an equity alliance is adopted to control relational risk, while a non-equity alliance is aimed at minimise performance risk
Das and Teng (1999)	Proposing a comprehensive framework of risk management	Desk research	Identification of the key risk that may affect alliance success: fit, flexibility, collaboration, and planning for the future

Table 6 (continued)

Publication	Purpose	Research method	Key findings
Das and Teng (2001a)	Proposing a model of strategic alliance structuring that has managerial risk perception as its core	Desk research	The development of the model consists of the following parts: the antecedents of risk perception, relational risk and performance risk, risk perception and structural preference, and the resolution of preferences
Das and Teng (2001b)	Examination of the inter-relationships between trust, control, and risk	Desk research	Proposing of a comprehensive and integrated framework for research trust, control, and risk in the context of strategic alliances
Delerue (2004)	Exploring the impact of critical variables that shape the alliance relationship and can affect some dimensions of relational risk	Survey questionnaire	The determination that relational risk perception is more influenced by informal contextual factors than by formal contextual factors
Delerue (2005)	Explanation of what is relational risk and how is this risk to be managed	Survey questionnaire	To demonstrate the multidimensional character of relational risk and the duality of relational control
Delerue and Perez (2009)	Proposing a real perspective to examine how relational risk perceptions shape commitment behaviour in biotechnology alliance relationships	Survey questionnaire	The determination that commitment can be seen as a real option, which reduces the degree of asymmetry of information concerning a partner's behaviour
Feiock (2013)	The systematisation of knowledge in the field of institutional collective action	Desk research	Determining the institutional collective action framework, outlines its basic assumptions, reviews empirical applications of the framework, and draws implications for governance
Grudinschi et al. (2014)	The determination which issues managerial teams must emphasize when aiming to create a solid partnership based on pre-existing collaborative relationships	Survey questionnaire	Finding that high perceived relationship risks influence trust, communication, and the quality of collaboration management positively; communication, governance, and administration have strong influences on collaboration fluency

Table 6 (continued)

Publication	Purpose	Research method	Key findings
Kumar and Van Dissel (1996)	Identification of possible risks of conflict in the inter-organisational systems and suggest strategies for minimising the likelihood of such conflict	Desk research	The determination that to realisation and sustaining of the intended benefits of the collaboration. There is a need to nurturing the cooperation by anticipating risks and managing them proactively
Nooteboom (1996)	Developing a tool for the analysis, diagnosis, and design of inter-firm partnerships	Desk research	Developing opportunities to values and risks balanced in different ways
Nooteboom et al. (1997)	Testing the effects of governance and trust on the risk perceived by agents of firms in alliances	Survey questionnaire	Identification of trust-related variables that have significant effects
Nooteboom (1999)	Identification of different instruments for the control of relation-specific investments which creates risks of 'hold-up' and 'spill-over'	Desk research	Identification of two "generic" kinds of innovation systems in respect of instruments for relational governance
Song (2018)	Investigating the effect of a strong commitment driven by drills on building sustainable emergency management networks during disasters	Survey questionnaire	Finding that higher levels of strong commitment driven by exercises are more likely to result in sustainable ties
Zyzak (2017)	To analyse what causes the breakdown of newly established politico-administrative orders	Desk research	The conceptualisation of the breakdown of cooperation and discusses how to measure it empirically

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