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Information Sharing in Complex Systems: A Case Study on Public Safety Management

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Abstract

The main purpose of this article is to explore the information-sharing process in complex systems on the basis of public safety management, and also identify the role of emergency call centres in this area. The methodology, based on the desk research method and empirical investigations, contains semi-structured interviews with the heads of 4 emergency call centres in Poland (25% of all of them), 1 in the Czech Republic, and also 54 survey questionnaires with the operators of these centres. As a result, the model of information sharing in complex systems was elaborated, and also the properties of this process were explored.

Keywords: Information sharing; Complex system; Public safety management; Emergency call centre.

Introduction

Public safety management involves the protection of communities, in certain social areas, from risks that may stem from the behaviour of people (social risk), technological development (technical risk), and natural hazards (environmental risk). For this reason, the subject matter and sources of public safety are wide, extending from social policy through regional policy, crime policy, to emergency and disaster management (Tomasino, 2011; Williams et al., 2009). The complexity of public safety management is manifested in the high number, and variety, of units involved in the execution of actions, the level of interactions occurring between its elements, interdependencies produced by linking certain tasks, and adaptation to the environment underlying learning. Therefore, public safety

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tends to be a fascinating research area, and complexity theory allows for its systemic interpretation. Moreover, the scope of research conducted in the field of public safety worldwide, corroborated by publications in international scientific literature, is modest, and functions were not thoroughly specified, or tasks performed in this area failed to be defined (Tomasino, 2011). Therefore, the main purpose of this paper is to explore the information-sharing process in complex systems on the basis of public safety management, and also identify the role of emergency call centres in this area.

The purpose of this publication has been achieved on the basis of research carried out under the research project entitled: "Coordination, communication and trust as factors driving effective inter-organisational collaboration in the system of public safety management". This project was financed by the National Science Centre, based on decision no. DEC-2012/07/D/HS4/00537. To achieve the purpose of this article, the desk research method and empirical investigations were carried out. Desk research was based on the analysis of international scientific literature, and also on analysis of internal documents, ordinances, and regulations of police, fire brigade, and medical rescue in Poland. Furthermore, there were also semi-structured interviews with the heads of 4 emergency call centres in Poland (25% of all of them), 1 in the Czech Republic, and also 54 survey questionnaires with operators of these centres. The survey was conducted among 37 women and 17 men. The age of the respondents was as follows: 66.7% from 22 to 30 years, 20.4% from 31 to 40 years, and 12.9% from 41 to 50 years. 74.1% of the respondents had higher education, while the others had secondary. The interviews and survey primarily related to the principles and factors affecting the efficiency of information sharing in public safety management. They also concerned the functioning of emergency call centres, and the role of these centres in the process of information sharing.

1. Public safety management as a complex system

Public safety embraces the entirety of ventures taken by public administration in the form of regulatory policy, as well as planning and organisational activities, in an attempt to provide society with an adequate level of safety, and rapid assistance when a specific hazard emerges. This also refers to the environment, where a specific community functions and it relies on the physical infrastructure (e.g. network of roads, green areas, alarm systems), which creates conditions for carrying out operations (Fleischner, von Hippel & Barton, 2009). Given the character of operations, public safety requires adequate low-structured management, as execution of procedures alone may be insufficient. In the context of complex adaptive systems, characteristics underlying public safety management include (Kożuch & Sienkiewicz-Małyjurek, 2014, p. 475):

- Large number of components: The activities are performed by organisations from different sectors, which are complex systems themselves. Organizations play a fundamental role in the safety of the public (public administration and intervention and rescue units) and operate at all levels of the state. Their activities support other entities of the system, including NGOs, universities, the media and the private sector.
- Variation: A considerable amount of resources in varying amounts and configurations is dispatched towards the activities - in every case differently, depending on the needs.
- Self-organisation: System components are subject to continuous, spontaneous organising. The structures are formed under the influence of relations between elements of the system and between the system and its surroundings.
- Diversity: The system is aimed at preventing and combating social, natural and technical risks. The scale and nature of the hazards are the basis of the diversity of the actions taken.
- Dynamism and liveliness: Every event, even of the same type, is different [...].
- Adaptation to their environment: Conditions for the implementation of activities create a need for an individual approach to each hazard, adequately to the emerging needs and requirements of the situation [...].
- Interactions: The units of a public safety system operate within the framework of cross-organisational collaboration built on the basis of formal and informal relationships.
- Non-linearity: It is never known what the outcome of actions will be, and the measures implemented are not directly proportional to the achieved results.
- Selection: In any case, there are many ways and strategies to perform actions [...]

Complex systems are characteristic of contemporary organisations and the modern world. It constitutes that all components of the system are interrelated and interact with each other (Jiang & Zhang, 2014). Moreover, these systems interrelate with other systems and with their surroundings (Chiva, Ghauri, & Alegre, 2014). Such systems may be only understood from an overall perspective, as they collaborate within a dense network of interconnections, while relationships occurring among them are non-linear in their character and not causally determined (Espinosa & Porter, 2011, p. 56; Wulun, 2007). From the perspective of complex system theory, the public safety management system constitutes a complex structure of units, subgroups and modules, configured differently for each situation, dependant on needs. In this area, communication is a priority in modelling organisational behaviours and coordinating actions. Therefore, it is an appropriate research area in the field of information sharing and complex systems.

2. Basics of inter-organisational information sharing for the purposes of ensuring safety

Information sharing between different organisations "was defined to mean exchanging or otherwise giving other executive agencies access to program information" (Dawes, 1996, p. 382). This constitutes a causally justified process, where its entities deliberately decided on which information, and in what manner, should be handed over to other entities involved in the process, so as to accomplish projected aims (Wittenbaum, Hollingshead & Botero, 2004, p. 286). Therefore, information transfer is the bedrock for inter-organisational collaboration, pivotal for increasing efficiency and performance of organisations (Mishra, Allen & Pearman, 2011; Yang & Maxwell, 2011). It progresses within information policies, procedures and practices, relevant legislation and privacy principles.

Information sharing is a difficult process. Previous research proves that "teams fail to share information when they most need to do so" (Mesmer-Magnus & DeChurch, 2009, p. 544). Principally, it is determined by such perspectives as: organisational and managerial perspective (organisational boundaries; different origins, values and cultures; lack of experience and resource, trust, leadership, etc.); technological perspective (heterogonous hardware, software and information systems, information security, etc.); political and policy perspective (legislations and policies, information as power and authority, etc.) (Yang and Maxwell, 2011, p. 169). Safety hinges on a capability of transferring adequate information to appropriate persons in an appropriate time (National Strategy for Information Sharing..., 2012). The literature on the subject shows multiple examples, which demonstrate that limitations in information sharing have negative implications for decision-making processes and effectiveness of actions taken in emergency situations (Helsloot, 2005; Kelman, 2006). In such circumstances, many organisations are obliged to collect, compile, and share data and information with other organisations in a bid to determine which actions should be taken, and which resources should be used to mitigate social and economic ramifications caused by the incident. The information shared is concerned with on-going events, resources possessed, expertise, insights, and actions taken to date, etc.

In public safety management, information on an occurring threat may be provided by victims, witnesses of the incident, other emergency rescue units, patrols or hazard detection systems (Niczyporuk & Sienkiewicz-Małyjurek, 2008). It is assumed that other emergency rescue units and patrols provide complete or incomplete, yet certain information, hazard detection systems generate automatic alarm signals, whereas victims and outsiders provide incomplete and uncertain information (Framework guidelines of the Chief Commander..., 2012, p. 7). Emergency rescue units, patrols, and hazard detection systems directly warn about the necessity of undertaking actions by the unit performing a leading role when the incident occurs, while society members provide the information through 112 systems to emergency call centres. In these centres, information is verified and transferred to appropriate units.

Each emergency rescue organisation, in the system of public safety management, possesses its own duty services charged with monitoring threats. When they occur, the organisations are responsible for transferring information regarding courses of action and changes in the situation to their own units, who conduct direct operations on the site. These services are permanently in touch with those commanding actions. Each emergency rescue unit has its commander on the site. However, a chief commander is a person from the organisation with the leading role ascribed in the event when a specific threat occurs. A chief commander organises meetings for commanders of all organisations engaged in the specific operation, aimed at sharing information and insights.

3. The significance of emergency call centres

Emergency call centres are elements of the 112 system, based on the Directive 2009/136/EC of the European Parliament, and of the Council of 25 November 2009. The Directive obliges European Union member states to create legal, technical and organisational conditions to make it possible for users of telecommunications networks to use the single European emergency call number, "112", in situations where assistance provided by emergency services is required, and for emergency services to effectively handle calls to the emergency call number. In accordance, the 112 system functions at a local and provincial level.

It was found that emergency call centres constitute an element that links services and organisations performing actions, in a bid to safeguard society (92.5% of affirmative answers). The finding was also corroborated by the interviews conducted, which revealed that these centres unburden emergency rescue units by eliminating and annulling false calls which, depending on the centre, constitute around 80% of all calls. Emergency call centres also allow for effective performance of joint actions by multiple organisations, as well as facilitating effective coordination of operations by services, inspections, and fire brigades (87% of affirmative answers).

Transfer of information in emergency call centres is primarily horizontal in character. It proceeds on a daily basis between centres and organisations and services tasked with safeguarding society at the local government level (100% of answers). Occasional information is transferred to units at the central level of the state organisation. The research conducted also showed that there are problems in relationships between employees in emergency call centres and emergency rescue units. They essentially result from different interpretations of events, and failure to know the procedures behind the 112 system. Positive experiences in relation to emergency rescue units are reported by 72.2% of employees from emergency call centres (11.1% answered "definitely yes", and 61.1% answered "rather yes"). Whereas 16.7% of employees had negative experiences in this respect. 11.1% of employees surveyed had no definite view on the issue. In-depth research allowed for the claim that relationships, within the system of public safety management, are influenced by organisational factors (principles and requirement for collaboration), technical factors (equipment, facilities and technologies applied), and social factors (organisational behaviours, formal and informal relations).

Emergency call centres perform the role of the buffer that halts and eliminates unnecessary information flowing to the system from the surrounding macro-environment. However, they only represent one of the elements of the system, they do not have a monopoly on information sharing, and they do not control information flow within the system.

4. Properties of information sharing in complex systems

Complex systems are distinguished in each moment by different properties; they undergo continued shifts, creating a new structure of elements. In a complex system such as the system of public safety management, single elements may cluster through direct and intense interactions, thus setting up a new, larger organism. Such structures may be permanent or temporary in their character. For this reason, both the structures, as well as boundaries of complex systems, are volatile, determined by existing circumstances. Information sharing in such systems also hinges on current circumstances, and information may also be received from the surrounding setting. Based on this research, the model of information sharing in complex systems was established, as illustrated in Figure 1, where information sharing tends to be a process typified by the following attributes:

- Consistency: information sharing proceeds across the whole process of operations management;
- Multi-dimensionality: information sharing proceeds at various levels of complex systems between other and the same entities, and in each case it may refer to different information;
- Multi-directionality: information sharing occurs between multiple entities, and it regards numerous issues;
- Asymmetry: information sharing occurs in an unparalleled way; relations between some entities are stronger and between others weaker; superiority is given to the information which is necessary at the given moment and between entities which need this information;
- Variability: information sharing in complex systems does not occur conventionally, but differently in each case, depending on the needs.

Information sharing in complex systems relies on circumstances, which specify which data and information, in which time and configuration and by whom it is needed. Organisational, technical and social drivers also determine it, and it is connected to the role performed by the specific entity in the system. In addition, there is no chance to marshal either a structure or processes emerging in complex systems. Any measures, such as emergency call centres in the system of public safety management, contribute to maximising creativity and innovations which, in line with complexity theory, are likely to be achieved at the verge of chaos, when both order as well as chaos exist simultaneously (Levy, 2000; Blomme & Bornebroek-Te Lintelo, 2012).
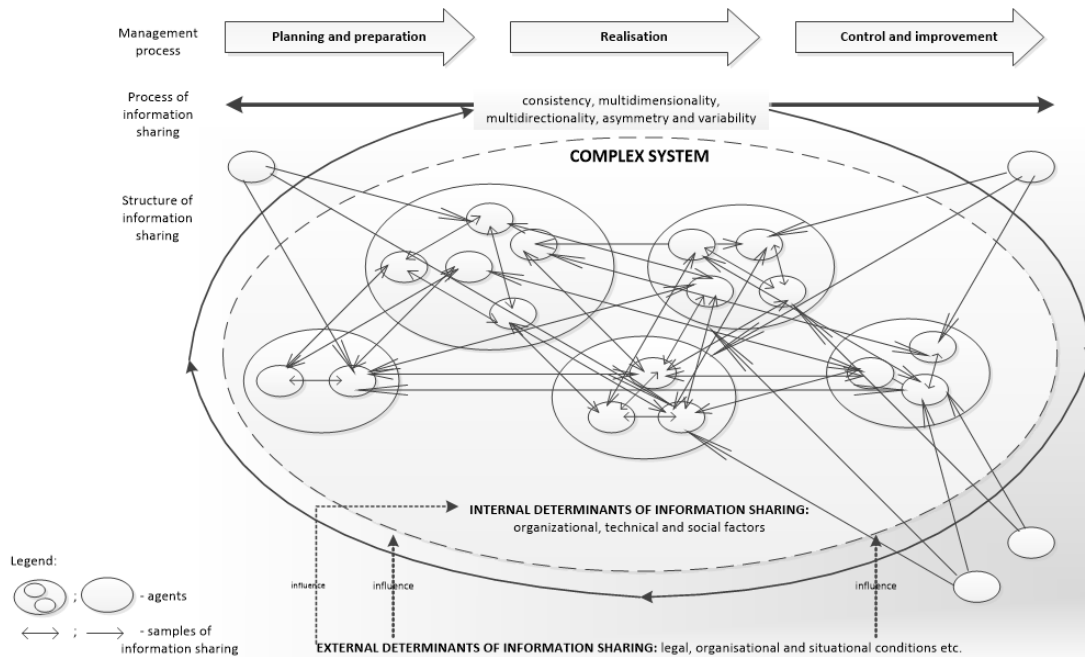
Fig. 1. Model of information sharing in complex systems
Source: author's study based on the research conducted and (Tilebein, 2006; Palmberg, 2009; Comfort, 2007).

Conclusions

Analyses of research results allows exploration of the information sharing process in complex systems on the basis of public safety management, and also identification of the significance of emergency call centres in this area. Although the theoretical background was accurately presented and the research concept was correctly developed, the nature of this investigation was essentially exploratory. A primary reason behind this is limitation of fieldwork, which solely confined itself to the findings from the research conducted in one of the entities within the public safety management system. Despite these restraints, the paper managed to portray the progress of the information sharing process within a complex system, such as the system of public safety management. As a result of the research carried out, the following can be claimed:

- The specifics underlying complex systems, particularly a high number, and diversity of, entities, elements and sub-systems, as well as relations between them, prompt the need for effective and continual information sharing. This results from the necessity of joint interpretation of the situation, and strengthening adaptive capabilities under uncertain circumstances.
- Information sharing between appropriate entities in complex systems provides the foundation for making decisions, performing actions, locating resources, allocating funds, collaboration, and coordination of operations.

- The role of emergency call centres in the public safety management system is to boost the effectiveness of operations through appropriate management of calls, and elimination of insignificant information. By doing this, these centres mitigate uncertainty and information chaos in the course of action.
- The process of information sharing in complex systems is multi-dimensional, asymmetrical and dynamic. Furthermore, it is governed by situational circumstances, as well as organisational, technical, and social determinants. It also follows from the role played by the specific entity in the system. Therefore, information sharing in complex systems proves to be dispersed and decentralized.

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