How Tendering Affects the Resilience of Critical Societal Functions – a Literature Review

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Functions and services that are particularly important for societal safety, such as transport of critical ill or other lifesaving infrastructures, are *critical societal functions*. Although many of these services are governmental, it is also common that governments purchase the services through tendering. For such critical societal functions, there is a low social acceptance for errors that may lead to service disruptions or accidents. This means that reliable and resilient services are required. However, while theory is comprehensive with regards to how organizations can achieve resilience, less is known about the effects of tendering of critical services that require high reliability and resilience. Based on an organizational framework for critical societal functions, we present a review of relevant literature and analyze how tendering can affect the resilience of critical services. As earlier research on this topic from a risk and safety perspective is scarce, the review has a wide scope. We find that a combination of research on safety and new public management gives a basic understanding of how tendering can affect the resilience of critical societal functions. Resilience and reliability are daunting challenges for organizations, and possibly even more so when they straddle organizational boundaries.

Keywords: critical societal functions, resilience, risk management, procurement, tendering

1 Introduction

Some functions and services are particularly important for societal safety. Examples are health transport and critical infrastructures. For such critical societal functions, there is a low acceptance for errors and failures that may lead to service disruptions or major accidents. When critical services are subject to competitive tendering, however, their resilience and reliability may be affected. This is the core matter in the research project Public Procurement of Critical Services – Analysis of Effects on Societal Safety (ProCritS), which aims to generate cross-sector knowledge through case studies of air ambulance services in Norway as well as security services procured by municipalities and private corporates.

In this review we discuss literature relevant for creating an understanding of how tendering can affect the resilience and reliability of critical services. We start by examining the concepts of critical functions/services and their reliability and resilience. We then describe how management and safety science can contribute to understanding the relationship between tendering and critical functions resilience.

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2 Methods

The review of reliability and resilience of critical services recapitulate a well-defined literature from the societal safety domain – an international research oriented sub-domain that is also significantly influenced by the work and steering documents of Norwegian authorities. The following review of the relationship between tendering and critical functions resilience in the fields of management science and safety science was based on more systematic investigations of less defined literature areas.

The literature review was based on the research team's knowledge of theory on societal safety and our assumptions on which topics might inform our research. Specifically, we did a systematic, open search on google scholar for the concepts *outsourcing, tendering, procurement, contracting, private-public partnership, trust, industry fragmentation, reliability, resilience and transport,* in a variety of combinations. After a qualitative assessment of the first two pages of hits, assumed relevant literature was downloaded and saved, including references. When a saturation point (repetitive results) was reached, we did a second and more thorough assessment of the relevance of the literature. We grouped the remaining references according to content, and subsequently, topical headlines.

In the following we will present the results of the review, discussing the different contents as we proceed.

3 Critical Functions and Critical Services

The need for continuity in critical functions is closely linked to the term "societal safety" and societal resilience. Societal safety can be defined as society's ability to maintain important societal functions and attend to the life, health and basic needs of the population under varying forms of strains (The Norwegian Parliament 2002). In Norway, the term "critical societal functions" is used to describe such functions (DSB 2016). These are functions that cover the basic needs of society and the population ("food, water, heat, safety/security and suchlike"), and whose interruption for a period of seven days or less would be a threat to these needs (DSB 2016).

According to the derivation of critical societal functions, the functions can be split into three categories: governability and sovereignty, safety and security of the population and societal functionality (DSB 2016). The first category includes functions that are necessary to ensure territorial and governance-related integrity. The second category contains the critical functions "law and order", "health and care", "emergency services", "ICT security" and "nature and the environment". The last category contains what is commonly referred to as critical infrastructure (e.g., electricity, water, communications, transportation and financial services) as well as food supply and satellite-based services. For each of the three categories, the critical functions are described in terms of "capabilities" with a defined level of functional ability that should be met at any time. An example relevant to the ProCritS project is the critical function "emergency services", which contains the capabilities Search and rescue emergency response, Fire protection, Civil defense, and Chemical and explosive emergency response. For the first of these capabilities, the functional ability is defined as "The ability to implement immediate action in order to rescue people from death or injury as a consequence of acute accidents or hazards." (DSB 2016).

3.1 *Critical functions as infrastructure services*

Although the categorization of critical functions puts infrastructure within one out of four categories, it is possible to argue that many types of critical functions can be understood as infrastructures in a broader sense. De Bruijne (2006) describes some of the characteristics of critical infrastructure, many of which are shared with critical functions in general. Critical infrastructures are according to de Bruijne (2006):

- often composed of many parts that vary in age and construction, and are spread over considerable distances;
- subject to large variations in load and to diverse weather conditions;
- governed and used by many organizations and are interconnected in various ways;
- expected to be functioning at all times, under considerable stress and volatile conditions. Inputs are variable, but output is expected to be stable and reliable.

With the exception of the first bullet point, the characteristics may also apply to critical functions in general.

Infrastructure is often understood either as 'hard' or 'soft' (see e.g. Portugal-Perez and Wilson 2010). Hard infrastructures are commonly defined as physical structures, such as roads, bridges and electricity grids. Soft infrastructures are the services that operate on these structures, such as financial services, transport, health care and security services. A characteristic of such services, as opposed to other services in the economy, is that infrastructure services tend to be specialized, with highly competent personnel and specific equipment requirements. Another characteristic is that the operation of infrastructures calls for a variable management

practice where experience and autonomous decisions are required for the system to work consistently (De Bruijne 2006). In any case, it is not the physical structures themselves that are important to the public, but the services they provide (Little 2004).

More abstractly, critical infrastructures can be understood as networked systems that societal functions rely on. This definition highlights the fact that critical infrastructures are systems upon whose reliability other functions and societal life depend (cf Almklov et al, 2018).

The provision of functions that are critical to society can thus be understood as service production, and we understand critical societal functions largely as provision of infrastructure services. In the present context we hence treat the two terms 'functions' and 'services' as more or less equivalent.

3.2 *The reliability and resilience of critical functions*

Organizational reliability, in the sense of ability to manage hazardous technical systems safely, has been of interest to many researchers the past decades (Schulman et al. 2004). "Reliability" is understood here as a process of maintaining stable outcomes even when there is a task variability (Farjoun 2010, Pettersen and Schulman 2016). In our context, reliability can be meaningfully defined as a combination of 1) the robustness of infrastructure, including redundancy as defined by (Hood 1991), and 2) the resilience of the organizations that operate on them, including the ability to adapt to new unexpected events, and the ability to return to normal operation after disruptions (Hollnagel, Nemeth, and Dekker 2008).

The research in this field has often been limited to studies of organizations. This contrasts to the fact that high reliability in providing critical services is a process achieved across organizations (Roe et al. 2005). Furthermore, for safety research in general, inter-organizational aspects have been recognized as critical but insufficiently understood (Gotcheva, Aaltonene, and Kujala 2020).

Critical functions are not only dependent on resilient organizations, but on *systemic resilience* that also involves inter-organizational collaboration and measures taken at a governmental level. As a response to large-scale crises and disasters, enhanced societal resilience is called for by both academics and practitioners, but it remains unclear how such resilience can be achieved (Boin and Lodge 2016). For critical functions, this resilience is related to the stable supply of a specific service relative to the needs in the present situation or the defined contingency levels. For instance, if organizations providing a critical service fail to deliver according to the predefined standards, there is a need for alternatives. Similarly, extraordinary situations that demand more from the critical services than they have been designed for, make alternatives necessary. This is in accordance with what Woods (2015) calls "resilience as sustained adaptability". This adaptability entails a flexible response to external circumstances, so that critical infrastructure is reliable also in periods involving changes and challenges.

As argued by Schulman and Roe (2007), reliability of large networked systems relies on *reliability professionals*, mid-level managers with extensive experience from operational work in many departments of the same infrastructure system. An ever-increasing demand on efficiency and speed under the operation of such infrastructures may lead to an overloading of reliability professionals, decreasing their capacity to react to extreme events. Another problem is the transaction costs that occur when different organizations operating the same system are to collaborate, often having to cede control over their own proprietary technology in the process (ibid). Uncertainties that arise when different organizations need to cooperate may pose a considerable threat to the reliability of the system.

4 Contributions from Management Science

4.1 *New Public Management and the justification for tendering*

To understand why some of the governmental procurement of critical services are tendered, it is useful to consider the general phenomenon of New Public Management (NPM). The components of NPM include a professional and accountable private sector style of management, explicit measures of performance, small and 'manageable' units, a shift towards competition, and a clear emphasis on output and cost control (Hood 1991).

The theoretical foundation for this development stems partly from classical contributions within organizational economics (Downs 1957, Black 1958, Buchanan and Tullock 1962, Niskanen 1975, Arrow 1951, Niskanen 1971). These central contributions led the foundations for the theory of public choice, which point to phenomena such as information asymmetry and principal-agent dynamics to describe the deficiencies of large bureaucratic organizations. The main idea is that these organizations tend to care for the interests of their employees rather than for those of the users of the service they provide.

The strategy to break up this tendency has been for authorities to take the perspectives as users themselves, on behalf of the citizens, instead of service producers. By letting private producers compete for customers, while being held explicitly accountable for the quality of their services, privatization is supposed to ensure both efficiency, reliability, adaptivity and satisfied end users (Pollitt and Bouckaert 2004). Competition among producers will transfer information from bureaucrats to political authorities, and secure efficiency. It is the competition itself that ensures this, not the fact that producers are private rather than publicly owned.

Organizational management strategies can give an understanding of the management of tendered critical services. Management strategies can be broadly grouped into three categories according to Hood (Hood 1991, Hood and Jackson 1992). The first category is the lean, economic type of management where scarce input is matched to well-defined tasks, and where output is easily measured. The second category is based on the pursuit of honesty, fairness and equality, and is central to many public administrative tasks. The third category focuses on reliability and the minimization of risk. Even though all three management strategies often are present, the latter category – of reliability and reduction of risk – can potentially be most relevant for critical infrastructure management. A key capability in this respect is redundancy: backup systems and personnel if something should fail; diversity in competence, to avoid group thinking and path dependence; and robustness, understood as using a greater amount of materials than strictly necessary for the job.

To understand how tendering affects resilience one thus need further studies of whether competition, outsourcing and privatization serve to promote resilience and reliability, or put them at stake.

4.2 *Fragmentation of organizations*

Outsourcing may lead to fragmentation of the organizational processes, in terms of structure, management, the coordination of tasks, communication and information flow (Milch and Laumann 2016). In the construction industry, subcontracting breaks the organization into smaller units with conflicting interests, ambiguity about responsibility, inadequate communication and teamwork and differences in safety cultures between main contractors and subcontractors (Manu et al. 2013).

Studies conducted on High Reliability Organizations (HROs) providing critical infrastructures, reveal that various forms of organizational fragmentation pose a challenge to the reliability of these organizations (Roe and Schulman 2008, Almklov and Antonsen 2010, La Porte 2006). As an example, tendering processes introduce periods of instability and change in the involved organizations, potentially affecting the core processes (La Porte and Consolini 1991).

Almklov and Antonsen (2010) argue that outsourcing and buyer-supplier models in operations of critical infrastructures entail organizational modularization and leads to commoditization of operational work. Modularization refers to a shift towards small entities that communicate through highly standardized interfaces, demanding high degrees of measurement and auditing – often including more formal procedures. This is in line with the NPM strategy of breaking large organization down to smaller and more manageable units.

Commoditization describes how operational work that was formerly part of an integrated responsibility in an organization, is broken up into sets of standardized tasks, specified as products for trade and control. The very notion that goods and services are traded between the individual parts of a formerly integrated value chain implies that all these goods must be treated as commodities. The commoditization of work is not an explicit part of the NPM doctrine, but follows as a consequence of modularization of organizations.

Almklov and Antonsen (2014) describe that some operational work which is central to the reliability and resilience of an organization, is rendered invisible by the commoditization process. For example, situational adaptation and improvisation are features that are hard to standardize. Safe work essentially revolves around what is not going to happen and is invisible if successful. As such then, safe work is invisible work, and its output or results hard to measure. The modularization implies that each organization, and thus each employee, get more narrow responsibilities and potentially less overview of the infrastructure. This might make the employees less adaptable and the operations less resilient (Dekker 2015) . It can also lead to new procedural challenges.

5 Contributions from Safety Science

Through the decades, safety science has developed through different phases, each with a particular scope of technology, human factors and organizations respectively (Hale and Hovden 1998). Within the organizational scope – which also encompasses the technical and the human factors' scope – we have seen the development of theories that explore and diagnose the reliability and resilience of organizations, such as theories of HRO (cf. La Porte and Consolini 1991, Weick 1987) and Resilience Engineering (RE) (cf. Hollnagel, Woods, and Leveson 2006). These

theories have also been central in the new wave of societal safety research witnessed the last few years (e.g. Almklov et al. 2018). The turn to societal safety and the consequent interest in critical infrastructures challenge safety theory in at least three respects in connection with tendering.

5.1 *Within and across organizations*

Safety science has developed a rich theoretical repertoire, but the scope of those theories tends to be restricted to that which happens within the borders of organizations. This is true for HRO and RE, that both incline to organizational culture and human factors more than to societal safety. Few studies have focused on how the interactions between multiple organizations result in increased complexity and on how this impacts safety. This leaves out important aspects, as work processes involving multiple organizations requires collaboration and coordination between organizations that differ e.g. in terms of work habits and safety perceptions (Milch and Laumann 2016).

Characteristics of infrastructures include their extension over very large geographical areas, and that their reliability/resilience seldom depends on one organization alone. Think for example of multilayered ICT infrastructures: the functioning of such infrastructures involves an intricate web of functionality stretching out from software to hardware, from providers to users, from usability to vulnerability, and from tasks to anti-tasks. The latter refers to Turner (1976) and his conception of anti-tasks, that are unwanted events travelling along the same effective infrastructures that are designed for wanted events. Safety science has largely focused on the work that is observable and that is taking place within confined organizations, but they do not offer us the same volume of knowledge for the more wide-reaching phenomena of infrastructure.

5.2 *Between procedures and practice*

Safety science has a long history of understanding the relation between procedures and practice (Braithwaite, Wears, and Hollnagel 2016, Antonsen, Almklov, and Fenstad 2008). The context for this has also to a large extent been individual organizations. The excellent works of Hale and Borys (2013b, 2013a), for example, have a lot to say about procedure formation and adoption, but mostly within the context of individual organizations within which one can decide on (top-down) and develop (bottom-up) practices and cultures. Outsourcing, however, leads to situations where procedures and practices are distributed over several different organizations that may be working on the same project or object, and where those who develop and maintain procedures do not necessarily belong to the organization that practices them. In this situation, the conditions are very different than those under which the advices of Hale and Borys (2013a) of

> *"making the monitoring and improvement of rules an explicit and central process in the rule management process and by arranging for explicit participation of those at the sharp end in the rule making and monitoring" (Hale and Borys 2013a, 223)*

were formulated. Hale and Borys (2013a, 222) further advice "keeping those rules alive and up to date in a process of regular and explicit dialogue with first-line supervision".

In networked organizations, not only can the trajectory between rule formation and rule practices be long and winded; organizational culture as well can be expected to be more fragmented than we are used to. Rules and procedures, as accountable prescriptions of work, can be part of the transactions between organizations. As described, the fragmentation into many small entities demands high degrees of measurement and auditing for the sake of accountability (Almklov and Antonsen 2010). One consequence of tendering thus might be more formal procedures in each organization. Employees already experience that operational procedures limit their potential for local adaptations and "trap safety into rules" (Bieder and Bourrier 2013), so additional procedures and more accountability might not favor resilience. However, procedures can also tame employees' overoptimistic adaptability, since some employees are so resilient that they always find a way to carry out an operation, even though it might be safer to stop (Morel, Amalberti, and Chauvin 2008).

5.3 *Safety and tendering*

Safety research have touched upon how tendering affect safety. Too much focus on price in procurements has been a problem worldwide (Eriksson and Laan 2007), and is said to have led to for example the Rana Plaza collapse in 2013, where 1138 textile workers lost their lives. When several organizations are involved, economic pressures negatively affects the shared sense of responsibility (Milch and Laumann 2016). The recent research of Oswald et al. (2020) on large infrastructure projects demonstrates empirically the safety risk implications of low-bidding to win tenders when it comes to the project delivery stage.

In maritime transport, tendering of passenger services has led to operations with minimal safety investments and minimal crew (Størkersen, Antonsen, and Kongsvik 2017). Since price is by far the most measureable aspect in many procurements, and has thus often been the main award criterion, the result often is that the cheapest vendor is chosen. The tenderers' competence on how to include other criteria has been lacking in Norwegian public transport procurement (Gullestad 2013). Also the health care literature now contains numerous examples of purchased systems that failed to meet user needs and that ultimately became safety issues (Kushniruk et al. 2010, 54).

6 Conclusion

In this literature review, we shed light on how the resilience of critical services are affected by tendering processes. Thus, we have showed how literature explain critical services and resilience, and presented how this literature, as well as management and safety sciences, can contribute to an understanding of resilience in tendering of critical services. The review reveals fragmentation as a central issue: even though the service provision often involves a variety of organizations, the literature traditionally has been concerned with resilience and reliability *within* organizations. These new organizational interfaces in connection with critical infrastructures challenge the established approaches to safety. Our study suggests a need for more research, both empirical and theoretical, on how tendering itself may affect critical services, and how organizations in this setting still provide resilience.

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